



**HAL**  
open science

## Sporadic occupation in Armiña cave during the Upper Magdalenian: What for?

Joseba Rios-Garaizar, Aixa San Emeterio, Martin Arriolabengoa, Josu Aranbarri, Juan Rofes, Ana Belen Marín-Arroyo, Olivia Rivero, Iñaki Intxaurbe, Amaia Arranz-Otaegui, Sergio Salazar, et al.

### ► To cite this version:

Joseba Rios-Garaizar, Aixa San Emeterio, Martin Arriolabengoa, Josu Aranbarri, Juan Rofes, et al.. Sporadic occupation in Armiña cave during the Upper Magdalenian: What for?. *Journal of Archaeological Science: Reports*, 2020, 30, pp.102271. 10.1016/j.jasrep.2020.102271 . hal-03951640

**HAL Id: hal-03951640**

**<https://hal.science/hal-03951640>**

Submitted on 25 Jan 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright



## Sporadic occupation in Armiña cave during the Upper Magdalenian: What for?

Joseba Rios-Garaizar<sup>a</sup>, Aixa San Emeterio<sup>a</sup>, Martin Arriolabengoa<sup>b</sup>, Josu Aranbarri<sup>c</sup>, Juan Rofes<sup>d</sup>, Ana B. Marín-Arroyo<sup>e</sup>, Olivia Rivero<sup>f</sup>, Iñaki Intxaurbe<sup>e</sup>, Amaia Arranz-Otaegui<sup>g</sup>, Sergio Salazar<sup>f</sup>, María Ángeles Medina Alcaide<sup>c</sup>, Diego Garate<sup>e,\*</sup>

<sup>a</sup> Archaeology Program, Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Paseo Sierra de Atapuerca 3, 09002 Burgos, Spain

<sup>b</sup> Dpto. Mineralogía y Petrología, Euskal Herriko Unibertsitatea/Universidad del País Vasco, 48940 Leioa, Spain

<sup>c</sup> Dpto. Geografía, Prehistoria y Arqueología, Euskal Herriko Unibertsitatea/Universidad del País Vasco, 01006 Vitoria-Gasteiz, Spain

<sup>d</sup> Archaeological Studies Program, University of the Philippines, Albert Hall, Lakandula St., UP Diliman, Quezon City 1101, Philippines

<sup>e</sup> Instituto Internacional de Investigaciones Prehistóricas de Cantabria (IIIPC), Universidad de Cantabria, 39005 Santander, Spain

<sup>f</sup> Dpto. Prehistoria, Historia Antigua y Arqueología, Universidad de Salamanca, 37008 Salamanca, Spain

<sup>g</sup> Department of Cross-Cultural and Regional Studies, University of Copenhagen, 2300 Copenhagen, Denmark

### ARTICLE INFO

#### Keywords

Cave  
Archaeological context  
Engravings  
Magdalenian  
Occupation

### ABSTRACT

The cave of Armiña is the lower level of the same karst cave system as Atxurra Cave, which has a habitat site in the entrance, covering from the Gravettian to the Late Magdalenian periods, and an important Paleolithic rock art ensemble in the inner part of the cave. The current entrance of Armiña was opened artificially at the end of the 19th century. Between 2016 and 2017 several tests and a 6 m<sup>2</sup> excavation were performed in the main hall of Armiña to evaluate its archaeological record. The excavated stratigraphic sequence is sealed by a succession of sterile units (Ia-Ic) with no archaeological or faunal remains. At the bottom of this sterile unit a continuous flowstone separates it from Unit III, an almost sterile unit containing a few transported bones, charcoal fragments and a few lithics found in contact with Unit IV, where the bulk of archaeological remains were found. In Unit IV, a number of bone fragments and lithic tools are associated with a small hearth and an ochre stain. The available archaeological evidence, and the first results of the ongoing multiproxy analyses, suggest that the deposit is the result of a very short occupation event or even shorter visits to this spot inside the cave. These visits were more or less contemporaneous with the occupation levels in Atxurra and probably correspond chronologically to the artistic activity in the deep part of the cave. However, although Armiña Cave is quite suitable for human settlement, only a short-term occupation has been recognized. This could partially be related to the morpho-topographic conditions of the cave which would imply that access from the exterior was difficult at the time of the occupation. Thus, the occupation site might be defined as an Inner Archaeological Context (I.A.C.). Therefore, our main hypothesis is that this short-term occupation was an activity spot for Magdalenian explorers inside the cave, in which the activities they carried out were not exclusively related to technological and subsistence practices, nor to the execution of art, given the particular nature of the finds and the absence of Paleolithic artistic manifestations in Armiña.

### 1. Introduction

The Cantabrian Region is one of the classic areas for the study of the western European Late Paleolithic. Historically, the study of rock art (Garate, 2014) and longstanding aggregation sites (Conkey, 1980) has attracted the attention of researchers. Other sites, representing much more discreet occupations, have been disregarded because apparently they offered less information for the reconstruction of chronological sequences or the understanding of human adaptations.

Recently, certain interest has been devoted to these kinds of occupations in an attempt to understand possible ritual activities (Arias, 2009) or rock art and to obtain a global interpretation of the use of deep sites in caves through an interdisciplinary and integral analysis, including, but not only, the relationship of these internal deposits with rock art manifestations (Medina-Alcaide et al., 2018a). Besides this, many lines of evidence suggest that the Magdalenian in Western Europe represents a rich cultural complex with abundant manifestations of non-utilitarian activities, like for example art and ornament produc-

\* Corresponding author.

E-mail address: [diego.garate@unican.es](mailto:diego.garate@unican.es) (D. Garate)

tion. In addition, in recent years other kinds of non-utilitarian behavior have been identified, such as the occupation and exploration of deep caves for purposes usually linked with rock art production (Medina-Alcaide et al., 2018b, Intxaurbe et al., submitted). The archaeological signature of these kinds of cave uses has often gone unnoticed but reveals an important aspect of Magdalenian culture, such as the deep symbolism of caves and the use of caves as spaces for non-mundane activities (Clottes, 2006).

Atxurra-Armiña is a complex karst system of interconnected caves with a main occupation site (Atxurra entrance), several decorated sectors in the deeper part of Atxurra, and an ephemeral occupation in Armiña (Fig. 1B). The current entrance of Armiña was opened up at the end of the 19th century by roadworks between the villages of Markina and Lekeitio. There is no indication that the cave was open before the limestone hillside was cut back. Since its discovery, Armiña has been explored by such specialists as A. Galvez Cañero, J. M. Barandiarán and J. Altuna, who found there only scattered evidence of human and animal presence (Garate, 2012). Also, there are numerous dug pits attributed to clandestine diggers who had easy access to the cave, located by the side of the road. In the collections stored in Bilbao Arkeologia Museoa, a few materials are kept in a box labeled “Barandiarán Cueva de Armiña 1926”. Among these materials there are few cave bear remains (a canine, a baculum, and a humerus) and a red deer humerus distal fragment with carnivore damage. In addition, there are two flint tools: a long Urbasa flint blade with simple retouch on the proximal half; and a bec made with abrupt retouch on the base (Fig. 6: 6). This piece is made from Flysch flint and has one side retouched with scaly partially invasive retouch, and a sort of bec on the distal extremity (Fig. 6: 7; Fig. 7: 1). Both pieces have macroscopic traces caused by hard mineral grooving that are compatible with a use for engraving. No precise information is available about the provenance of these pieces, and we suspect that they could have been obtained in any part of the cave system. The personal records of J.M. Barandiarán contain no indication about the provenance of these pieces.

A new archaeological project started in the Atxurra-Armiña system in 2014. The site of Atxurra was re-excavated between 2014 and 2015 revealing a long and well-preserved sequence comprising the Early Gravettian, Lower and Late Magdalenian. In 2015, a rich Magdalenian

rock art ensemble was discovered in the deepest part of Atxurra (Garate et al., 2016). Unit II in Atxurra, the rock art in the decorated sectors in the inner part of the cave, and the occupation in Armiña can be confidently placed in the Late Magdalenian, according to the material culture, the radiocarbon dates and the style of the engravings (Garate et al., submitted). A single occupation episode has been excavated in a restricted zone of Armiña Cave. Few lithic artifacts, some modified bones, a small hearth and an ochre stain have been documented in a 5 m<sup>2</sup> area, close to the cave wall, over flowstone, and 15 m from the modern cave entrance. This cave entrance was opened artificially during roadworks at the end of 19th century and thus the nature of the real entrance during the Paleolithic remains unknown. This evidence will be presented here to sustain or refute several hypothesis: 1) Armiña Unit IV represents a single ephemeral Upper Magdalenian occupation; 2) It can be regarded as an Inner Archaeological Context; 3) It is related to coeval occupations in Atxurra Cave; 4) The function of the deposit was not related with purely utilitarian activities.

## 2. Materials and methods

The excavation in Armiña Cave followed the quadrant and arbitrary spit method. Initial tests consisted of 1 × 1 m excavations that followed the sedimentological variations until an archaeological signature was recognized. Three tests were performed in different parts of the main hall. None of them reached the bedrock but they were abandoned after the presence/absence of Magdalenian occupations was attested. None of these tests revealed an archaeological signature. The main excavation was carried out after cleaning the section of hole dug by unknown persons some time after the 1960s. It recorded the presence of archaeological remains in a precise level (Fig. 1C). This excavation area was divided into 1 × 1 m squares, which were then sub-divided into four 50 × 50 cm quadrants. The excavation followed arbitrary spits (up to 5 cm thick) adapted to the orientation, dip and surface of the sedimentological units. As a result, each sedimentological/archaeological unit was excavated in one or more spits. The position of the archaeological materials and samples was recorded with a Leica TC407 total station according to a user-defined coordinate system. Also, all the sediment from the archaeological units was floated (1 mm mesh) and all the archaeological and paleontological remains were recovered. A

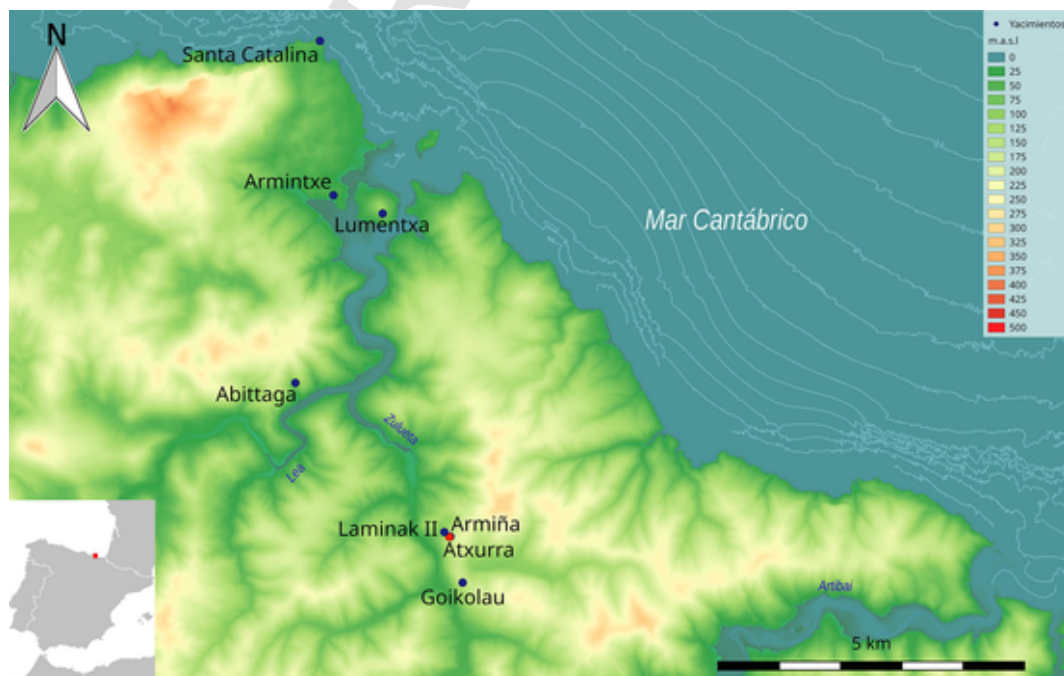


Fig. 1. Map of the Eastern Cantabrian Region showing the position of Armiña and the other main sites mentioned in the text.

column from W17.3 quadrant was floated and sieved with a 0.25 mm mesh to recover the micropaleontological remains. Finally, the sediment samples from sterile layers, except for those from the aforementioned micropaleontological column, were dry sieved (1 mm mesh).

A stratigraphic column was constructed by taking into account the lithological and archaeo-paleontological characteristics. Samples were taken with kubiena boxes for micromorphological analysis of unconsolidated sediment. Thin sections were produced in the Soil Micromorphology Laboratory (CENIEH, Burgos, Spain). After drying, impregnation was carried out under vacuum with 7:3 part mixture of polyester resin (Palatal P4-01), acetone and 7 ml methylethyl ketone peroxide (MEKP) per liter of polyester resin and acetone mixture. The impregnation took about 5 weeks and thus the mixture was absorbed slowly. The hardened samples were then sliced into blocks of 135 × 60 × 10 mm. The blocks were mounted on a glass slide (140 × 68 mm) and finally were reduced to the standard thickness of 30 µm.

Lithic analysis follows the Integral Lithic Analysis perspective. This approach investigates lithic industry from a slightly different view from the classic 'chaîne opératoire' (Pelegri et al., 1988; Rios-Garaizar, 2007). Its aim is to understand technological organization, including the selection and integration of different strategies of production, use and transport (Nelson, 1991). Raw material provenance was determined according to the flint-types defined by Tarrío-Vinagre (2006) and Risetto (2009) and by comparing the archaeological samples with geological samples stored at LITHO (CENIEH's Lithothèque), and the technological and typological features were described following the systematics defined for other Upper Paleolithic assemblages (Rios-Garaizar et al., 2011, San Emeterio and Rios-Garaizar, 2017). Use-wear of lithic artifacts has been analyzed at the CENIEH Prehistoric Technology and Archaeology laboratory following the same systematic as previous research and using the CET (CENIEH's use-wear reference collection) for comparison (Rios-Garaizar et al., 2019).

Nine pollen samples were selected from the various stratigraphic units. Pollen extraction was carried out at the IPE-CSIC laboratory following the standard chemical procedure (Moore et al., 1991) with HF (40%), HCl (37%), KOH (10%) and Thoulet solution (density = 2.0). Palynomorph identification was supported by the determination keys and photo atlases (Reille, 1992). Results are expressed as percentages, excluding hygrophytes, Pteridophyta spores and other non-pollen palynomorphs (NPP) from the pollen sum. Psimpoll 4.27 software (Bennett, 2009) was used to draw the pollen diagram. Major palynological changes in pollen composition were used as criteria to subdivide the results into pollen assemblage zones.

### 3. Results

#### 3.1. Geomorphology of the karstic system

The Atxurra-Armiña cave is formed in Aptian-Albian limestone, and it is 1085 m long. The cave system is developed on two interconnected cave levels, the lower one called Armiña and the upper one Atxurra (Fig. 1B). Both levels have entrances in the Zulueta valley 30 m apart from each other (Armiña is 26 m above the river bed, and Atxurra 35 m). The two levels are connected by two passages; one close to the current entrances and the other situated at the end of Armiña level. The one close to the entrance is in the passage from the main hall to the main gallery of Armiña. It is an almost vertical conduit with a very steep slope, 12 m long and 1 m wide, with a ramp of almost 10 m, currently covered with flowstone. It leads immediately to the first sector after the entrance hall of Atxurra, where the main human occupations took place in that cave level.

The current entrance of Armiña was opened up during roadworks at the end of the 19th century (1882). Until then, the site was in the dark zone, although the exterior was a few meters away behind rock walls. We cannot rule out that a connection with the outside was practicable

for small animals through small or vertical entrances. However, the absence of historical graffiti or any other document previous to this date testifies that in historical times this entrance was most probably sealed. Atxurra entrance was never closed, but when J.M. Barandiarán explored it for the first time (1926) the access was possible only by crawling. In Armiña Cave, two zones can be differentiated: the main gallery (3–5 m high, 3–4 m wide), where no proper archaeological excavation has ever been performed; and the entrance hall, with the current artificial entrance, a steep slope down formed by modern debris from the outside, a quite flat-floored hall, separated in two halves by a column, and a low passage heading towards the exterior which is blocked by colluvial deposits from outside. The internal connection with Atxurra cave level is located between the hall and the passage and this connection between Atxurra and Armiña was most probably practicable during the Late Magdalenian occupations.

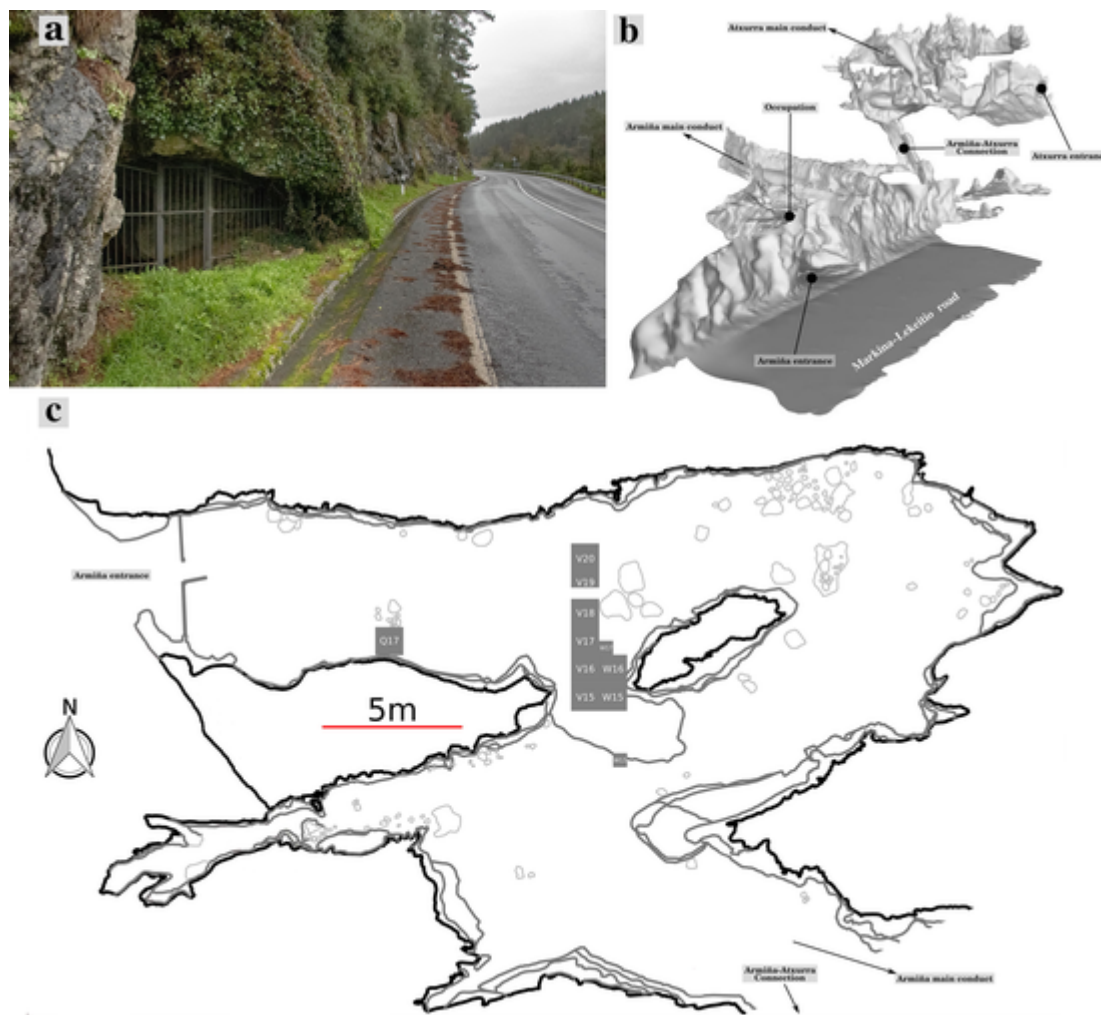
#### 3.2. Archeo-stratigraphic sequences

A total of three test pits were excavated in different parts of the cave (Fig. 1C). One situated close to the current entrance (Q17), another in the flat area of the main hall (V19.1-2-V20), and finally a small one on the other side of the clandestine excavation (W13.4) (Fig. 1: C). All these tests were negative. None of them was fully excavated but in all of them the depth and stratigraphic position of the fertile layer (Unit IV) was passed. In V19-20 a 2 m deep sequence of relatively high energy fluvial deposits (sequence of cm to dm-diameter pebbles) was excavated. In Q17 a relatively low energy fluvial deposit (rhythmic deposits of silt and sand) was excavated over a roof collapse. Finally, in W13 a relatively medium energy fluvial deposit was reached (coarse sand and cm-diameter pebble deposit). This means that in these parts of the cave the possible human presence was not preserved, or that they were never occupied. The presence of low energy fluvial deposits suggests that the cave flooded intermittently, surely since the Holocene, but probably also during Late Pleistocene. On the other hand, the high-energy torrential events recorded in V19-20 were strong enough to erode any previous sedimentary record, including a possible human presence.

The main excavation was carried out from the section left by a clandestine excavation in the connection between the two halves of the main hall, just beside the big column. In 2016, squares W15-V15 were excavated, and in 2017 the excavation was extended to squares V16, W16, V17, W17.3 and V18. In 2016, a 1.30 cm deposit was excavated, revealing a complex stratigraphy (Fig. 2: b, c). Units 11-1 represent the oldest sequence in the cave, with a succession of fluvial episodes, and some paleontological remains. This sequence is eroded by a channel, filled with fine fluvial sediments (a-b), covered by flowstone which contains cemented faunal remains (VIII). Then another fluvial, low energy deposit fills the irregular topography (VII-V). In a drier episode, the human occupation took place (IV), a fluvial episode of higher energy occurred (IIIa-IIIb), and then a thin flowstone covered the whole deposit (II). This was followed by a completely sterile unit of very low energy fluvial deposits (I), which is covered by modern dirt.

The stratigraphic column established in Quadrant W17.3 revealed four stratigraphic units (Fig. 3). From bottom to top:

- Unit IV, a brown colored silty-sand unit at least 10 cm thick. The micromorphological analysis revealed a matrix-supported unit, displaying granular microstructure, poorly-sorted, open porphyric coarse-fine (c/f) related distribution, and undifferentiated b-fabric. The groundmass is sandy silt which tends to display a granular microstructure with 0.5 – 2 mm homogeneous micro-aggregates. Skeleton grains consist of 0.3 – 1 mm speleothem fragments (75%), little phosphatized, 0.1 – 0.4 mm microfaunal bones (15%), 0.3 – 0.5 mm limestone fragments (8%; Figure Xa), and 0.5 – 1 mm flint fragments



**Fig. 2.** A: Photography of the entrance of the cave, cut by the road; B: Position of Armiña (red) and Atxurra (blue) entrances and the connection between them. The flat surface in front of the entrance is the road. Extracted from the three-dimensional mesh of Atxurra-Armiña cave system, formed from the points cloud; C: Plan of Armiña entrance and main hall.

(2%; Figure Xb). Highly porous, vughy-type porosity is at times partially or fully cemented by calcite crystals, which also cement the groundmass, giving the microstructure an even more granular appearance (Fig. 4b).

- Unit III, a reddish-brown colored muddy silt unit 8 cm to 10 cm thick, with the bottom compound of centimetric lithoclasts (sub-unit IIIb). Sub-unit IIIb is a 2 – 3 cm thick layer, deposited upon Unit IV by an irregular surface. It is matrix-supported, massive microstructure, close porphyric coarse-fine (c/f) related distribution and undifferentiated b-fabric unit. The groundmass is a compound of phosphate-rich sandy and muddy silt. Skeleton grains consist of 0.5 – 3 mm flint fragments (50%), 0.5 – 2 mm speleothem fragments (25%), and 0.2 – 2 mm altered microfaunal bone fragments (25%). The flint fragments are covered by a speleothem layer (Fig. 4c, d), giving them a cave pearl appearance. Bone fragments are highly altered, and the speleothem fragments appear highly corroded by the phosphatic rich groundmass (Fig. 4c, d). The vughy pores are not filled with calcite precipitation. Sub-unit IIIa is a 6 – 8 cm thick unit, matrix-supported, massive microstructure, poorly sorted open porphyric coarse-fine (c/f) related distribution and undifferentiated b-fabric unit. The groundmass is a compound of phosphate-rich sandy and muddy silt. Skeleton grains consist of 0.2 – 3 mm microfaunal altered bone fragments (50%), 0.5 – 2 mm altered speleothem fragments (30%), 1 – 4 mm rip-up clast from Unit IV (15%), and 0,2

– 0,5 flint fragments (5%). The vughy pores are not filled with calcite precipitation.

- Unit II, flowstone adapted to the surface irregularities at least 2 cm thick, which changes to 70 cm-tall stalagmites in some areas of the cave. In some places, because of the occasional drips, there are 1 – 3 cm stalagmites. Toward the upper part of the unit, rather than flowstone laminar formation there are cave pearls 1 – 10 mm in diameter. Alternate with the flowstone and cave pearl formation there are a few deposits of 0.2 to 0.5 mm-thick red mud layers.
- Unit I, formed by three rhythmic deposits (sub-unit Ia, Ib and Ic) separated by a 0.5 – 2 cm thick flowstone. The top of the sequence is covered by a 10 to 15 cm thick deposit of disturbed sediment and lithoclasts derived from the modern human use of the cave (opening of the entrance by the road, clandestine entrances, etc.). Although three sub-units were differentiated, the three of them show the same microstructure, microfabric, and post-depositional features, and they will therefore be described together. The unit consists of well-sorted matrix-supported rhythmic deposits, alternating laminated homogeneous mud, laminated homogeneous muddy silt, laminated homogeneous sandy silt, and laminated homogeneous silty sand microstructures (Fig. 4f). Horizontal vughy-type porosity is well developed in the sandy layers (Fig. 4f). In the three sub-units, the rhythmic sequence starts with the muddy layer adapting to the flowstone surface (Fig. 4f), it then becomes a muddy silt layer (Fig. 4f), and after that the alternation between sandy silt and silty sand layers starts. There

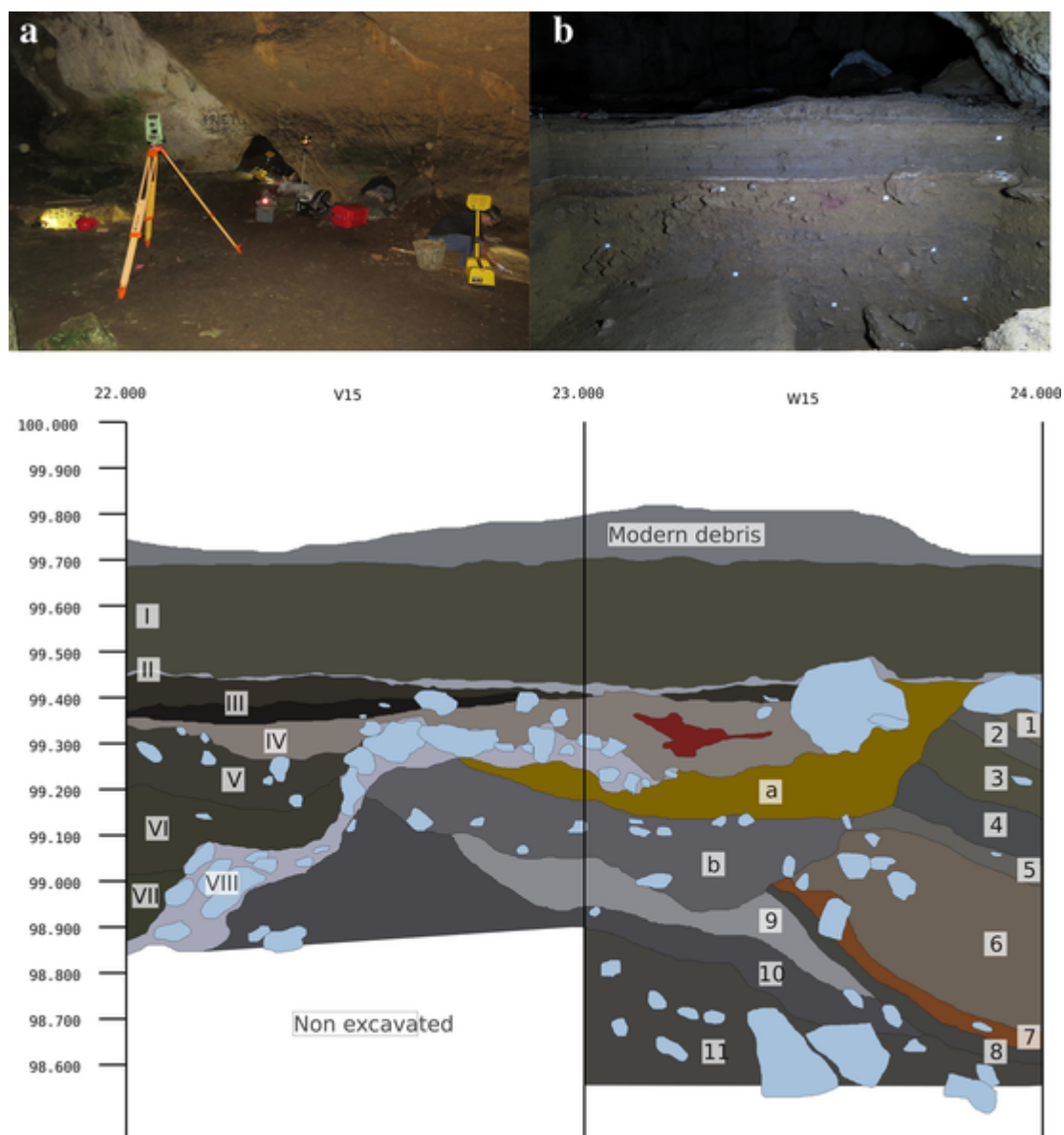


Fig. 3. a: View of excavation test in V19-20 (left), Q17 (right) and main excavation block in V15-W15 (center); b: North section after 2016 excavation in V15-W15; c: Schematic representation of the north section after 2016 excavation in V15-W15.

are millimeter to centimeter bioturbation features; the biggest ones are filled by sandy silt deposits while some of the smallest features do not contain any fill.

From the depositional point of view, there are two major phases in the stratigraphic sequence, separated by the speleothem formation of Unit II. In this sense, stratigraphic units IV and III are formed by poorly-sorted fine sediments, which were transported to the site by occasional runoff rip-up processes during relatively small floods in the passage, except for sub-unit IIIb, which is related to a localized stream process that eroded and redeposited the upper part of Unit IV in some parts of the cave (Fig. 5). The absence of anorthic ferruginous nodules and allochthonous soil rip-up clasts, which are a common feature in cave entrances in this region where they are brought by streams (Arriolabengoa et al., 2018), suggests that the streams were coming from the inner part of the cave, and the current Armiña cave entrance was closed by this time. Therefore, once deposited, those sediments have been under aerobic conditions with occasional water fluctuations. The phosphatization of the bones in cave environments is usually strongly influ-

enced by deposits of bat guano (Huisman et al., 2017), which are nowadays abundant in the cave. Furthermore, aerobic conditions with hydrological fluctuation could equally help the decay of the bones (Collins et al., 2002; Huisman et al., 2017). On the other hand, calcite precipitation filling partially and fully the different type of vugs, is only present in Unit IV. Waters rich in calcium carbonate probably penetrated by infiltration from the laminar waters that were forming Unit II. However, while percolating through Unit III, the phosphate rich sediment characteristic of this unit did not allow its precipitation, which could only take place after reaching Unit IV. As for other post-depositional processes, it is known that fluvial sediments are usually highly bioturbated and rapidly homogenize the sediment (van der Meer and Menzies, 2011), and this could have occurred in Armiña Cave. Additionally, Units IV and III are coeval to the prehistoric human use of the cave, and the occupants probably trampled the sediment and altered its original microstructure.

In contrast, stratigraphic units II and I are related to a relatively constant presence of water. Flowstone speleothems are formed by a laminar water sheet flow (Fairchild and Baker, 2012), while the

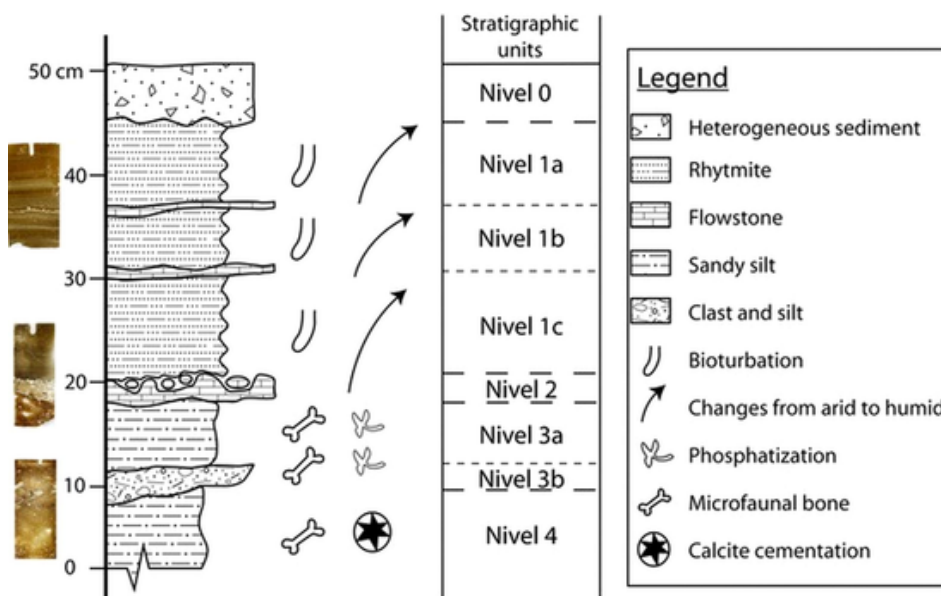


Fig. 4. Stratigraphic column of Armiña cave in W17.3 reference quadrant.

rhytmite deposits are linked to lacustrine environments. In this sense, the environment is relatively more humid than in Units IV and III, and the water fluctuation alternated the formation of speleothems when the water level was relatively low and formation of rhytmites when the water level was relatively high and flooded the gallery creating a pool. The only diagenetic features found in these layers are the multiple bioturbation features of different scales.

Apart from the current stratigraphic Unit 0, all units in the studied deposit lack allochthonous clastic sediments originating in the surrounding soils. This implies that the current Armiña entrance was closed during this period. In this sense, during the end of the Upper Pleistocene the cave was under aerobic conditions, with eventual runoff or flood occurrence. The anthropic remains in Armiña are also from this period, and this is particularly evident in stratigraphic unit IIIb, which contains abundant flint fragments. Afterwards, there is evidence of climatic oscillation in Armiña cave entrance, and the hall becomes relatively more humid. At first flowstone was formed by a laminar water sheet, but as the hall ponded, rhythmic sediments were deposited. Those changes from water sheet to a pool occurred at least three times. According to the obtained radiocarbon data (see below), the analyzed sedimentary sequence started forming after the Last Glacial Maximum. The significant change from drier to humid conditions from Unit III to II, and the prolongation of those humid conditions with small oscillations, suggest that these units might belong to the beginning of the Holocene. However, we cannot dismiss entirely the possibility that they could also belong to the last phase of the Younger Dryas when the conditions also became more humid (Bartolomé et al., 2015).

### 3.3. Structures

Unit IV develops over a degraded flowstone that contains eroded faunal remains with a characteristic brown-reddish coloration. The extension of the human occupation is restricted to the extension of this flowstone; accordingly, it is not present in V18, only partially in V17, and absent in the eastern quadrants of W15 and W16. To the north this flowstone is delimited by a big base of a stalagmite, to the west by a big speleothem fragment, and to the east by the column dividing the main hall in two. To the south it is interrupted by the clandestine excavation, but considering that Unit IV is not present in the W13 test excavation, its probable extension in this direction was less than 2 m. In this

southern part, two features have been identified. First a partially dismantled hearth, made using a natural hollow in the flowstone and delimited by limestone and speleothem blocks which are affected by fire. When it was excavated it had been partially affected by the clandestine excavation, and it seems to have been dismantled after its use. The hearth was oval-shaped with an estimated size of  $27 \times 29$  cm. An ocher-stained elongated area of  $120 \times 35$  cm, containing some ocher-stained artifacts, was identified beside the hearth. There is a refit of two fragments of a blade found in the hearth and in the ocher stain (40 cm) (Fig. 5).

### 3.4. Radiocarbon dating

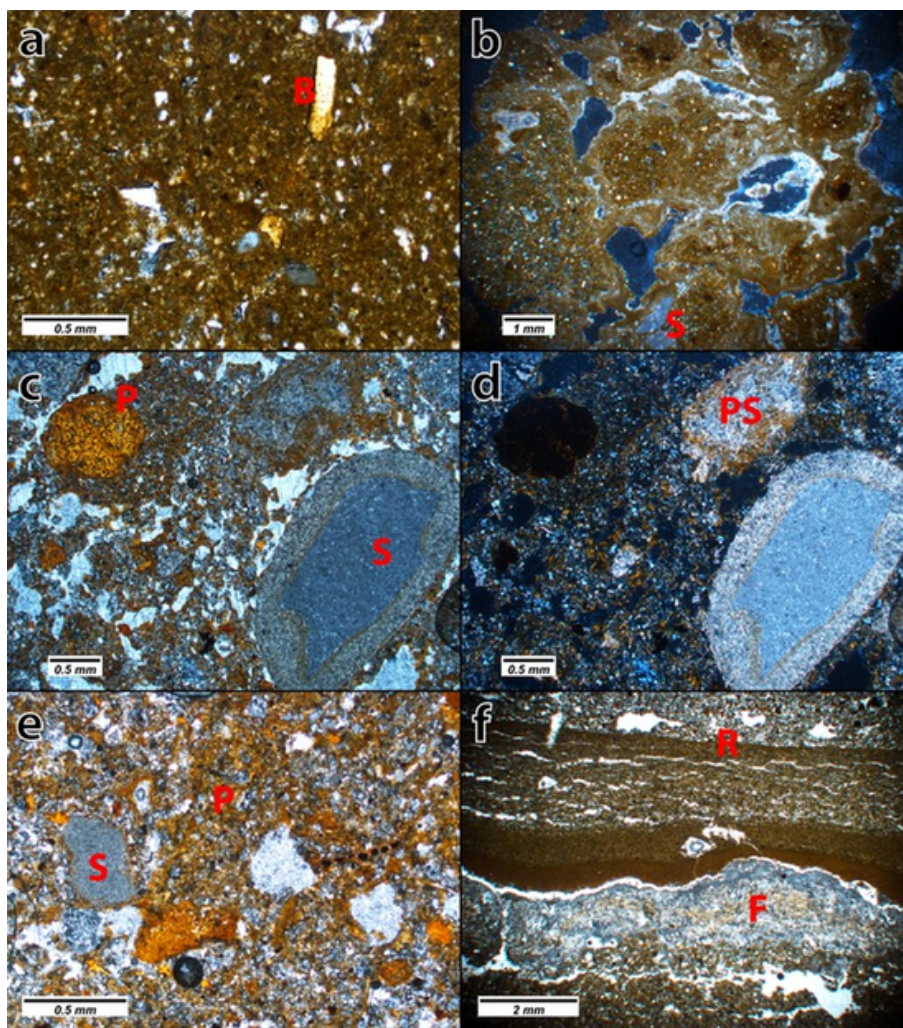
Two bone samples from Unit IV were submitted for dating. Bones with a taphonomic aspect clearly different from the heavily fossilized bone fragments inherited from the underlying flowstone were selected. Also, both samples had traces related with anthropogenic activity. One of the samples came from the vicinity of the hearth, while the other came from the northern limit of Unit IV.

The calibrated results (95.4%, IntCal13) of these dates, despite the degree of precision, supports the idea of a single occupation event that took place during the Bølling-Allerød warming episode (Table 1). These dates are similar to those obtained from Atxurra Unit II (Late Magdalenian) occupation, and probably coincident with the date of the rock art taking into account the IAC associated with the decorated sectors and the artistic style of the engravings.

### 3.5. Lithic assemblage

The base of Unit IIIB has yielded a few lithic remains ( $N = 7$ ) that probably belong to Unit IV. They are a small flake of Flysch flint, a proximal blade fragment on Treviño flint, a distal blade fragment on Flysch flint, a shapeless limonite fragment and three chips on Flysch flint. In addition, five  $< 1$  cm shreds of ocher without use-wear traces, and two flat sandstone pebbles, one with possible use-traces, have been recovered.

The lithic assemblage from Unit IV is formed by 81 lithic remains, plus two partially burnt sandstone fragments and eight  $< 1$  cm shreds of ocher without use-wear traces. There are also a few unmodified/non-used sandstone, limestone, rock crystal and limonite fragments whose



**Fig. 5.** Microphotographs of thin sections. a) stratigraphic unit IV, sandy silt sediment with a relatively well preserved bone fragments (B); b) stratigraphic unit IV with vughs partially filled by calcite cement and a flint fragment (S), under XPL; c) stratigraphic unit IIIb with a phosphatized bone (P) phosphate rich matrix, flint with a speleothem cover (S), and speleothem partially corroded by phosphates; d) same as c) but under XPL; e) stratigraphic unit IIIa, whit phosphatic rich matrix (P) and a flint fragment (S); f) Stratigraphic unit 1b and 1a rhythmic sediments (R) divided by a thin flowstone (F).

presence in Unit IV may be due to natural factors. Among the lithic remains, almost half are small (<10 mm) chips. Several activities, like tool resharpening, tool use or casual knapping could have contributed to the presence of chips. Most of the chips are made on Flysch flint (n = 34), and a few of them on Treviño flint (n = 3), exogenous flint (n = 1), non-determined flint (n = 1) and rock crystal (n = 3). There are also four resharpening flakes, all of them made on Treviño flint, two burin spalls (one on Flysch and the other on Treviño flint), and one splintered piece on Flysch flint that equally inform about tool resharpening and use.

The rest of the lithic assemblage can be explained as the result of the importation of tools, including retouched tools and possibly raw big cortical flakes (n = 4), raw blades (n = 5) and raw bladelets (n = 8). Other remains, such as the discoidal flake core, the small cortical flakes (n = 2), the micro flakes, the crests and the platform rejuvenation flake inform about limited on-site knapping activities (Table 2).

The retouched toolkit is quite characteristic. It includes three backed points. One of them was made on Treviño flint (Fig. 6: 2), and presents a bidirectional straight back, a truncated base, and a tip that has been repaired after a possible impact fracture (Fig. 7: 3). Another one was made on Flysch flint, and presents a unidirectional back (Fig.

6: 3). The third one, also made on Flysch flint, presents a curved back (Fig. 6: 4). Other retouched tools are an outstanding Aurignacian blade, made on a large Treviño flint blade, with scaly retouch on both edges (Fig. 6: 1); a Flysch flint blade with continuous retouch in one side and use-wear traces of cutting medium-hard organic material on the opposite side (Fig. 6:5; Fig. 7: 2); a distal fragment of a burin; and a cortical pointed flake, made on Flysch flint, with limited retouch in the pointed end and associated burinant fracture, probably related with piercing. The last tool is a probable core made on Treviño flint that has been recycled as a fire-lighter (Fig. 7: 4). The presence of multiple battered surfaces and the association with typical micro traces (Sorensen et al., 2018) suggest that this piece was used to produce fire.

Although the assemblage is too small for making comparisons with other Late Magdalenian assemblages, the recovered elements fit with the already known features of Late Magdalenian tool kits. The association of curved backed points, and straight backed points (including examples with truncated bases) and Aurignacian blades is present, alongside typical tools as endscrapers, backed bladelets or burins, in Late Magdalenian sites as Urutiaga, Laminak II, Arenaza, La Pila, La Garma, La Chora o el Otero (Berganza and Arribas, 1994, Chauvin Grandela, 2012, González Sainz, 1989, Lagüera García, 1991).





Fig. 6. a: Armiña Unit IV occupation plan, the blue arrow shows the direction and the space affected by the stream that formed level IIIb; b: detail of the ochre stained area during the excavation; c: detail of the fireplace and the ochre stained area during the excavation.

Table 1  
Radiocarbon dating results.

Lab Number	Sample	Measured Radiocarbon age (BP)	Material	Pretreatment	d13C	d15N	2 sigma calibration (BP) (IntCal13)
Beta-456230	ARM.V15.4.6.001	12,300 +/- 40	bone collagen	collagen extraction with alkali	-20.4	+2.9	14531–14,059
Beta-498136	ARM.W17.3.4.004	12,390 +/- 30	bone collagen	collagen extraction with alkali	-20.8	+3.3	14,722 – 14,175

### 3.6. Macrovertebrate assemblage

The macrofauna remains were recovered during the excavation field-work in 2016 and 2017. Although animal elements were also found in other units, this study focuses on those recovered in Units III and IV. The total number of remains was 42, implying a limited osseous assemblage. Of them, 12% corresponded to bears, 45% was only possibly attributed to large and medium-size mammals and 43% to indeterminate taxa. The bear remains identified in Unit IV are a deciduous left canine from an infant and fragments of two radii/ulnae and a pelvis from an adult individual. Not enough material was preserved to distinguish between cave and brown bear. The fragmentation state has prevented skeletal profile analysis of the taxa, although 7% were attributed to cranial elements (surprisingly only a single tooth is repre-

sented), 10% to the axial skeleton and 20% to fore and hindlimbs, while the other 64% belong to indeterminate anatomical elements. Those indeterminate elements are: 71% mid-shaft fragments with less than an eighth part of the shaft circumference, 5% with almost mid-shaft circumference, 13% with mid-shaft circumference and 11% with complete diaphysis (Fig. 9).

No clear bone spongy fragments were identified possibly due to attrition. 72% of the long-bone fragments recovered are less than 3 cm long and 28% between 4 and 7 cm in length. Regarding the anthropogenic modifications found in the assemblage, just one bone clearly displays a fresh breakage and oblique cut-marks are visible in the diaphysis of two other medium-size mammal fragments. The rest of the assemblage shows a dry fragmentation pattern that occurred after the bones had lost their organic content, probably post-depositionally owing to sediment pressure, as the assemblage is highly concreted in bre-

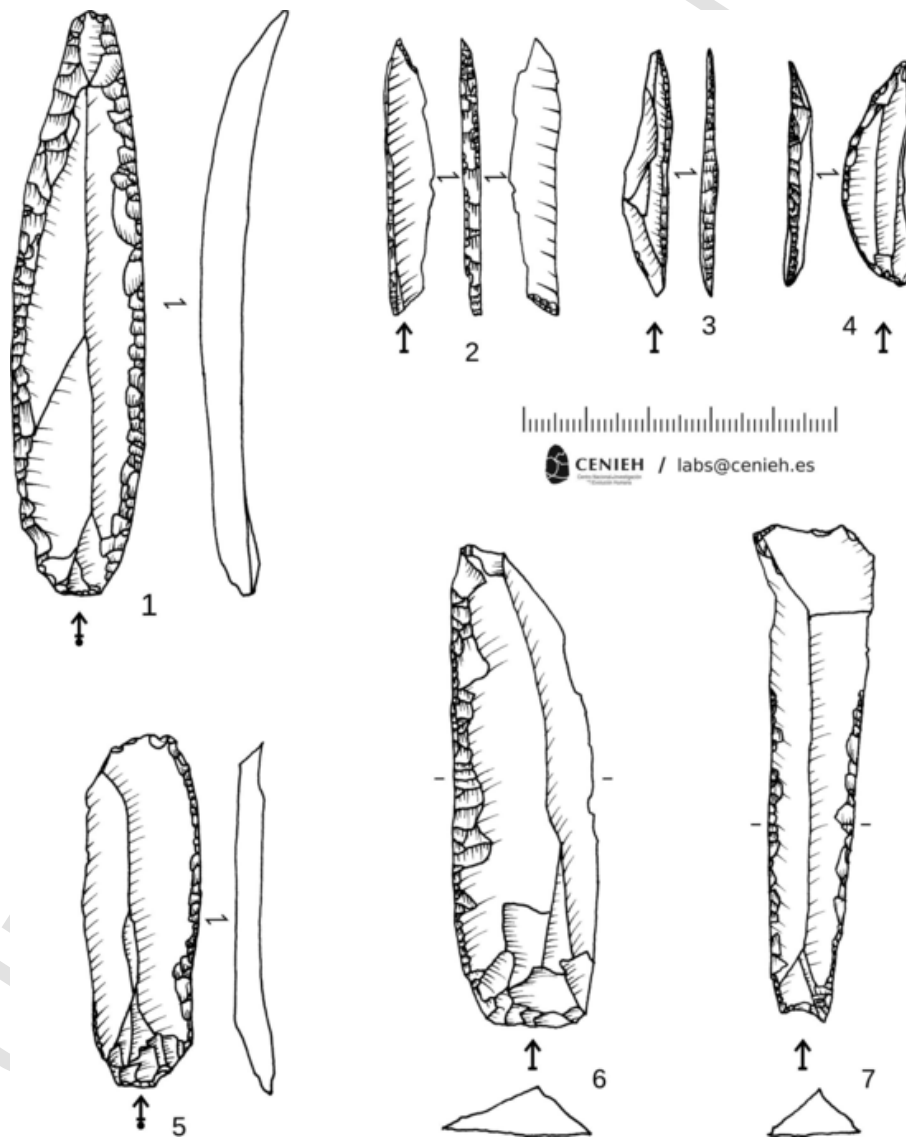
**Table 2**  
Lithic assemblage from Units IIIB + IV.

Blank type	Rock Crystal	Limonite	flint	Total	Retouched
Core			1	1	1
Flake core			1	1	
Cortical flake			6	6	1
Unifacial crest			2	2	
Platform rejuvenation			1	1	
Micro flake			4	4	
Blade			13	13	6
Bladelet			8	8	
Resharpener flake			4	4	
Burin spall			2	2	
Splint			1	1	
Inform fragment		1	4	5	
Chip	3		37	40	
<b>Total</b>	<b>3</b>	<b>1</b>	<b>84</b>	<b>88</b>	<b>8</b>

cia. No evidence of carnivore activity was found. Other taphonomic modifications were visible within the assemblage such as trampling marks (2%), dissolution (14%), polish due to water flow or bear cave use for hibernation (10%), iron (12%) and manganese coating (10%), and bones in breccia (52%). In general, we observed that the material recovered in 2017 in Square V16 belong mostly to a large-size mammal, likely bear, highly concreted and iron-stained, while in V17 the materials are less concreted and all related to a medium-size mammal. In summary, this is an assemblage with limited human influence, where bear played an important role, and it probably accumulated in the site during hibernation.

3.7. Small-mammal assemblage

A total of 181 remains has been analyzed: 24 from Unit I, 82 from Unit III and 75 from Unit IV. A total of 13 taxonomic groups have been identified, namely: *Sorex minutus*, *Apodemus sylvaticus*, *Glis glis*, *Myodes glareolus*, *Microtus oeconomus*, *M. lusitanicus*, *Chinomys nivalis*, *Arvicola sapidus*, Subfamily Arvicolinae, Subfamily Murinae, Order Rodentia, Order Chiroptera and Class Mammalia. The identifications were made on



**Fig. 7.** Armiña retouched tools, 1–5: Unit IV; 6–7 J.M. Barandiarán collection 1926. 1: Aurignacian blade; 2: Backed point with truncated base; 3: Backed point; 4: Curved backed point; 5: Retouched blade; 6: Blade with flat scaly retouch and a borer on the distal end 7: Blade with simple retouch on the proximal half and a borer.



**Fig. 8.** 1: Heavy worn trihedrals on a retouched blade; 2: Retouched blade with traces of cutting medium-hard organic material; 3: Backed point with tip repaired after a possible impact fracture; 4: Treviño flint core recycled into fire-lighter.

the basis of known anatomical criteria and with the support of osteological guides (Chaline, 1974; Rolland, 2008). The category Arvicolinae corresponds to toothless maxilla or isolated molars of voles with poorly preserved occlusal surfaces (i.e., abrasion, corrosion). Murinae identifies isolated teeth clearly assignable to this subfamily, but without the possibility of stating genus and species. Rodentia agglutinates isolated incisors of rodents from which it is impossible to determine the species. It has not yet been possible to establish the precise identity of the remains of bats (Table 3).

The material in the three units corresponds, in its great majority, to isolated teeth of the different identified taxonomic groups. The low

proportion of maxilla and mandibles with teeth *in situ* is striking. According to the classification of Fernández-Jalvo et al. (2016), the remains from Unit I, with a light to moderate degree of digestion, correspond to category 2 (i.e., nocturnal birds of prey such as *Bubo scandiacus* and *Strix nebulosa* may be responsible for the accumulations). The remains from Unit III, with light to heavy digestion, more closely match categories 2 and 3 of the same authors, so it is necessary to add *Bubo bubo*, *Strix aluco* and *Athene noctua* to the previous two species as possible sources. Finally, the digestion of the remains from Unit IV is also assignable to categories 2 and 3 of Fernández-Jalvo et al. (2016), implying the same range of nocturnal predators as for Unit III.

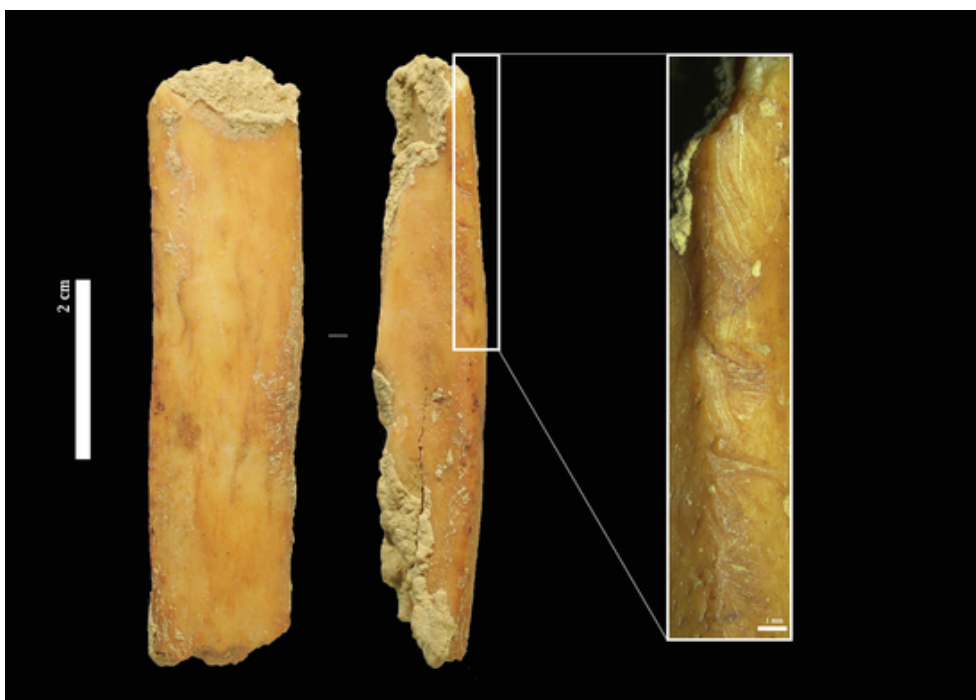


Fig. 9. Bone with cut-marks.

Table 3  
Small-mammal assemblage from W17.3 column.

Species	Common name	Unit I		Unit III		Unit IV	
		NR	NMI	NR	NMI	NR	NMI
<i>Apodemus sylvaticus</i>	Wood mouse	1	1	6	2	2	1
<i>Arvicola sapidus</i>	Southern water vole			10	3	10	2
<i>Chionomys nivalis</i>	Snow vole			1	1		
<i>Glis glis</i>	Edible dormouse	2	2				
<i>Microtus lusitanicus</i>	Lusitanian pine vole			1	1		
<i>Microtus oeconomus</i>	Tundra vole					1	1
<i>Myodes glareolus</i>	Bank vole	8	2				
<i>Sorex minutus</i>	Pigmy shrew					2	1
Arvicolinae	Arvicolines	1		24		19	
Murinae	Murines	2					
Rodentia	Rodents	4		5		11	
Chiroptera	Bats	1	1	35	2	28	
Mammalia	Mammals	5		1			

There is a certain environmental stability between Units III and IV, with good levels of humidity, vegetation cover and permanent water courses, which allowed the proliferation of the wood mouse and the water vole in the vicinity of the cave, as well as the tundra vole and the pigmy shrew first (Unit IV) and the Lusitanian pine vole, afterwards (Unit III). However, Unit III would have been less humid than Unit IV, because of the presence of the snow vole in the former, as it is typical of open and rocky environments. Unit IV, on the other hand, seems to correspond to a colder period than the subsequent ones (and the current one), owing to the presence of the tundra vole, absent today in the Iberian Peninsula.

Despite these differences, in both cases (Units IV and III) we would have mosaic landscapes, with, alternatively, wooded, open (meadows), and rocky areas, water courses and good vegetation cover. The temperate and humid climate assignable to these units would hence be expected in strata that would be marking the start (Unit IV) and perhaps the peak (Unit III, slightly warmer than IV) of the Bølling-Allerød warm pulse, after the cold Oldest Dryas.

More problematic is the chronological allocation of Unit I, whose association of small mammals (wood mouse, edible dormouse and bank vole), taken altogether, is a clear proxy of warm and forested environments, a scenario more suitable to the Holocene climate optimum. However, we do not have radiocarbon dates to support this hypothesis.

### 3.8. Archaeobotanical record

The palynological preservation and the attained diversity in the analyzed samples are good except in ARM-5, which does not contain enough pollen to draw environmental inferences. Therefore, the pollen diagram consists in eight pollen samples. The assemblages reveal two well-defined zones (Fig. 8).

The basal Unit IV, comprising pollen sample ARM-1, reveals an open-landscape dominated quasi-exclusively by steppe herbs. Apiaceae attains the highest levels, followed by Poaceae, Asteraceae, Cichorioideae, *Centaurea*, *Cirsium/Carduus* type and Fabaceae, among others. Shrubs are represented by Rosaceae. Trees show the lowest frequencies in the entire sequence, only represented by scattered *Juniperus*, *Pinus sylvestris/nigra* type, *Betula* and *Salix*. In Unit III (samples ARM-2, ARM-3 and ARM-4), herbaceous communities continue being the main landscape component, although the frequencies of shrubs, mainly Rosaceae, show a minor increase (Fig. 8). Broadleaved taxa like *Betula* or *Quercus robur/petraea* type are sporadically recorded, and also *Quercus ilex/coccifera* type.

The upper samples, namely Unit I, reveal a marked change in the landscape physiognomy that could be explained as the environmental response towards milder and moister climate conditions well-evidenced across the Cantabrian Region (Iriarte-Chiapusso et al., 2016; Morellón et al., 2018). The pollen data from Unit Ic and Ib (ARM-6

and ARM-7) suggest a forested landscape although the frequencies reached by the herbaceous component are still noteworthy (Fig. 8). However, Apiaceae shows a marked decrease. Broadleaved elements like *Corylus*, *Betula*, *Carpinus betulus* and *Quercus robur/petraea* type predominate while *Quercus ilex/coccifera* type and shrubs like Rosaceae or Ericaceae are also present. Both Monolete spores and *Polypodium* type increase exponentially, indicative of humid environmental conditions. This is especially well-evidenced in the uppermost samples (Unit Ia, ARM-8 and ARM-9) when *Corylus* and *Quercus robur/petraea* type attain their maxima (Fig. 10).

Only three samples of charcoal were recovered from Unit IV. The wood charcoal remains were badly preserved and small in size (1–3 mm), which has hampered the analyses. The only identifiable fragment found in the hearth (Unit IV) is a conifer (cf. *Juniperus*) while the other two can be attributed to Gymnosperms.

#### 4. Discussion and conclusions

One of the important issues regarding the human occupation in Armiña Unit IV is to determine if it is a discrete occupation in the twilight zone of a regular cave, or if it is an Inner Archaeological Context (IAC), a kind of archaeological phenomenon that is usually related with symbolic activities such as rock art (Medina-Alcaide et al., 2018a). As mentioned above, the Atxurra-Armiña cave system is characterized by the presence of a habitation context in the Atxurra cave entrance, and several IACs associated with deep cave transit and rock-art production. It is a fact that the Magdalenian groups occupied the system and moved through it without many problems (Intxaurbe et al., submitted).

In these transits, they surely discovered the access to Armiña level through the described internal connections. Additionally, at the same time as the Armiña Unit IV occupation took place, the entrance of Atxurra was inhabited. Atxurra entrance hall, in comparison with Armiña, is narrow and small. Also, the Armiña level would be closer to the river, yet the cave was not occupied during the Gravettian, the Lower Magdalenian or Recent Prehistory, and not with the same intensity during the Late Magdalenian. There are three possible explanations for this; first, because the cave was not easily accessible at that time; second, because the cave was not comfortable for habitation, for example because it was more humid or because it was very dark; third, because the evidence of previous occupations has been eroded.

Starting with the last possibility, it is true that in some areas of the hall, more precisely in squares V19 and V20, there was a stream flowing through the cave, and all the possible previous occupations would

have been eroded. Also, in the main excavation area several erosive episodes have been identified but just few centimeters from there, in the preserved sediments, there is not a single evidence of human presence prior to Unit IV or after it. So, while we cannot completely rule out that the remains of occupations have been washed away, it seems quite unlikely.

We need to contemplate also the possibility that the main hall in Armiña Cave was not comfortable for habitation. As we have noted, the human occupation seems to have been preserved only on a raised and dry flowstone platform with occasional water courses or flooding. Also, if the entrance was closed, it would have been almost completely dark, maybe with some light entering through small holes. In these conditions a continuous occupation as we see in Atxurra, would have been very unlikely.

A third possibility, somehow related with the aforementioned options, is that the cave entrance was closed or difficult to access. The current entrance to Armiña was opened during roadworks at the end of 19th century, and these works completely altered the external morphology of the cave. Today, it looks like a normal down-slope entrance, but this is probably an effect of the accumulation of modern debris from the outside during the last 130 years. Indeed, there is no evidence of external inputs into the sedimentary sequence, and this speaks in favor of this hypothesis. In addition, the absence of human evidence closer to the current entrance suggests that this space, usually the area preferred by humans, was not occupied. Another argument would be the scarcity of macropaleontological remains; they are mostly bear remains, which could correspond to bones transported by water or to hibernation dens. More problematic is the presence of microvertebrates and the pollen component. The latter record shows a clear over-representation of steppe herbs. We can hypothesize that these remains were water-transported from other parts of the cave, for example the Atxurra entrance, but with the available information this is difficult to demonstrate and this possibility would not apply for all the considered units. Another possibility is the existence of a small, or overhanging entrance, that allowed restricted and sporadic access to bats, nocturnal raptors and wind-blown pollen. In open cave entrances with or without ephemeral human presence, the presence of microvertebrate remains tends to be much more intense than has been recorded in Armiña (see for example Antoliñako Koba, Rofes et al., 2015), and only a continuous human presence produces an appreciable diminution in microvertebrate samples. Thus, if we consider the possibility of a small or overhanging entrance, we can still propose that human access to Armiña was probably

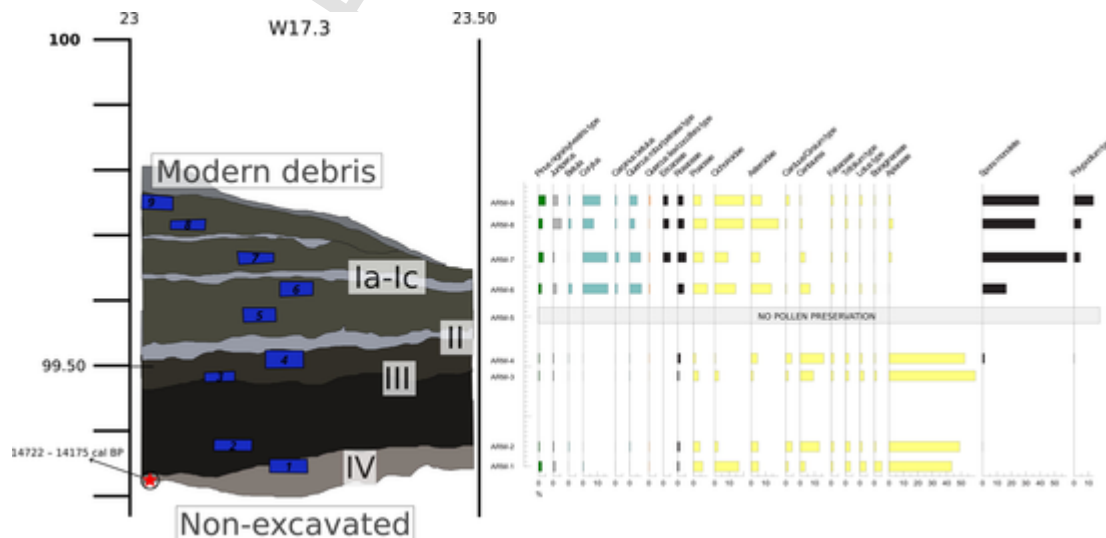


Fig. 10. Pollen diagram.

through Atxurra via the internal connection that exists near the main hall in Armiña Cave.

In spite of this discussion about the condition of Armiña Cave, the fact is that the occupation detected in Unit IV is very particular. We have presented some evidence supporting the hypothesis of a single, ephemeral occupation. The radiocarbon chronology, the small extension of the occupation, the existence of a related structure, the discreet number of lithic artifacts, the existence of some refits, and the practical absence of faunal consumption, suggest that this unit is the result of a single ephemeral occupation. The composition of the lithic assemblage, the use-wear information, and the contextual information informs us that a fire was lit, that ocher was processed (or that a container of ocher was abandoned), that some activities, including re-sharpening lithic tools, were carried out there, and that few lithic artifacts were abandoned at the site, including an outstanding Aurignacian blade, a firelighter and three projectile points, none of them with severe impact damage.

During the Late Magdalenian there are, in the same river basin, other caves with occupations dating to the Late Magdalenian, for example in Abittaga, where an occupation of certain intensity, parallel to Atxurra Unit II has been documented (San Emeterio pers. comm.); or Laminak II, where a Terminal Magdalenian multi-purpose camp took place and where thousands of lithic remains were produced and abandoned (Berganza and Arribas, 1994). It is also noteworthy that the Late Magdalenian occupations in Santa Catalina Cave have yielded thousands of archaeological remains, indicating a more stable occupation (Berganza et al., 2012), and Unit V in Lumentxa, also attributed to the Upper Magdalenian, is characterized by a rich archaeological assemblage. All these sites represent more or less stable occupations very different from Armiña Unit IV.

The characteristics of Armiña Unit IV assemblage could closely tally with a possible ephemeral hunting camp, where a few activities are carried out, including weapon repairs. With some exceptions (Rios-Garaizar et al., 2015), such ephemeral camps have been rarely described in the literature of the Late Upper Paleolithic in the region, and indeed they are more common during the Initial Upper Paleolithic (Rios-Garaizar, 2011; Rios-Garaizar et al., 2012). In those hunting camps we observe a preponderance of hunting-related tools among the retouched artifacts, which are accompanied by few other tools, some by-products generated during knapping and re-sharpening, and few anthropogenically modified bones. Thus, in Ekain IXb (Aurignacian) dismantled heaths were found alongside lithic and faunal remains. In this unit, also, many refits were achieved. However, it makes little sense to have an ephemeral hunting camp right beside an occupation cave (Atxurra). There is the possibility of a hunting party chasing spelean species, like hibernating bears, in an inner cave context, which has been documented in other sites (Morel, 1998). But in the absence of direct evidence this possibility seems quite unlikely. Does it mean that the people occupying Armiña were totally unaware of the existence of Atxurra? Or, should we find a more complex interpretation for this occupation?

When we excavated Armiña, we also considered the hypothesis that some artistic activity could have been made on the walls near the occupation place, rock art that could have been erased by water or hidden by the thick flowstones covering the pillar that divides the main hall. The presence of ocher and artificial light would make more sense in this kind of context. In the deepest part of Atxurra, where the rock art ensemble is concentrated, we have evidence of red stains rubbed on the walls and also the presence of several hearths and a large quantity of charcoal fragments on the floor, probably detached from torches. However, ocher was used in the Paleolithic for many mundane activities, even for weapon making (Wadley et al., 2004), but the evidence in Armiña more closely resembles other examples, such as the ocher deposits in Lumentxa, Morgota and Ondaro; in all three cases related with

rock-art production (Garate et al., 2013, 2015, 2016/17). Did the Paleolithic artists in Atxurra Cave prepare their painting and engraving tools and the rest of the required logistics at Armiña? We think that it is likely, but we cannot dismiss other possibilities also related with ritual and symbolic activity. There are close examples of ritual use of caves during the Magdalenian in the caves of Praile Aitz, Erralla and La Garma (Arias, 2009), so we cannot reject the possibility that some kind of ritual activity involving firelight, ocher and lithic tools was performed in the depths of the Atxurra-Armiña cave system.

The example of Armiña highlights the complexity of human activity in caves during the Late Upper Paleolithic. Small assemblages or discreet occupations can be very informative about the different activities, both mundane and symbolic ones, carried out by Magdalenian hunter-gatherers in a particular region. Considering the rich and varied record of activity in the surroundings of Armiña during the Magdalenian, including more or less stable occupations (Santa Catalina, Lumentxa, Atxurra), short occupation camps (Abittaga, Laminak II), and several rock-art assemblages (Atxurra, Armintxe, Lumentxa, Goikolau) (Garate, 2012, 2017), Armiña inner archaeological context informs us about a different kind of symbolic activity and a different kind of use of cave environments.

## Acknowledgements

We want to thank the people that took part in the excavation of Armiña, Encarnación Regalado, Jesús Tapia, Daniel Ruiz, Iñaki Libano, Akilesh Kumar and Irantzu Bilbao. Penélope González-Sampérez is thanked for helping with palynological procedures. This research has been funded by the Cultural Heritage Service of the Diputación Foral de Bizkaia.

## References

- Arias, P., 2009. Rites in the dark? An evaluation of the current evidence for ritual areas at Magdalenian cave sites. *World Archaeol.* 41, 262–294. doi:10.1080/00438240902843964.
- Arriolabengoa, M., Iriarte, E., Aranburu, A., Yusta, I., Arnold, L. J., Demuro, M., Arrizabalaga, A., 2018. Reconstructing the sedimentary history of Lezetxiki II cave (Basque Country, northern Iberian Peninsula) using micromorphological analysis. *Sed. Geol.* 372, 96–111.
- Bartolomé, M., Moreno, A., Sancho, C., Stoll, H. M., Cacho, I., Spötl, C., Belmonte, A., Edwards, R.L., Cheng, H. & Hellstrom, J. C., 2015. Hydrological change in Southern Europe responding to increasing North Atlantic overturning during Greenland Stadial 1. *Proceedings of the National Academy of Sciences*, 112(21), 6568–6572.
- Bennett, K., 2009. Documentation for Pspimpoll 4.27 and Pscomb 1.03: C Programs for Plotting Pollen Diagrams and Analysing Pollen. Data, Queen's University of Belfast, Department of Archaeology and Palaeoecology.
- Berganza, E., Arribas, J. L., 1994. Excavación, cronología, análisis de las industrias lítica y ósea. *Kobie (Paleoantropología)* 21, 7–83.
- Berganza, E., Arribas, J. L., 1994. Características de las ocupaciones del yacimiento de Laminak II. *Kobie (Paleoantropología)* 21, 243–253.
- Berganza, E., Arribas, J.L., Castaños, P.M., Elorza, M., González-Urquijo, J.E., Ibáñez-Estévez, J.J., Iriarte, M.J., Morales, A., Pemán, E., Rosales, T., Roselló E., Ruiz-Idarraga, R., Uriz, A., Uzquiano, P., Vázquez, V. & Zapata, L. (2012): La transición tardiglaciaria en la costa oriental de Bizkaia: el yacimiento de Santa Catalina. Resultados preliminares, in Arias, P., Corchón, S., Menéndez-Fernández, M. (Ed.): *El Paleolítico Superior Cantábrico. Actas de la Primera Mesa Redonda*, San Román de Candamo (Asturias), 26-28 de abril de 2007, Universidad de Cantabria, Santander.
- Chaline, J., 1974. Les Proies des Rapaces. *Petits Mammifères et leur environnement*, Doin.
- Chauvin Grandela, A., 2012. España) entre ca. 15.000 y 12.000 cal BC. *BAR international series*. In: *Tecnología lítica de los cazadores-recolectores del final del Pleistoceno: la producción y transformación de los soportes en la Garma A*. Archaeopress, Oxford, p. 2336.
- Clottes, J., 2006. Spirituality and religion in Paleolithic times. In: Leron Shults, F. (Ed.), *The evolution of rationality. Interdisciplinary essays in honour of J. Wentzel van Huyssteen*, William Eardmans, Cambridge, pp. 133–148.
- Collins, M. J., Nielsen-Marsh, C. M., Hiller, J., Smith, C. I., Roberts, J. P., Prigodich, R. V., Wess, T. J., Csapo, J., Millard, A. R., Turner-Walker, G., 2002. The survival of organic matter in bone: a review. *Archaeometry* 44, 383–394.
- Conkey, M. W., 1980. The identification of prehistoric hunter-gatherer aggregation sites: the case of Altamira. *Current Anthropology* 21, 609–630.
- Fairchild, I. J., Baker, A., 2012. *Speleothem Science: From Process to Past Environments*. Wiley-Blackwell, Chichester (432, pp).

- Fernández-Jalvo, Y, Andrews, P, Denys, C, Sesé, C, Stöetzel, E, Marinó-Monfort, D, Pesquero, D, 2016. Taphonomy for taxonomists: Implications of predation in small mammal studies. *Quat. Sci. Rev.* 139, 138–157.
- Garate, D, 2012. Neandertales y Cromañones. Los primeros pobladores de Bizkaia. Guías del Arkeologi Museoa. 2, Diputación Foral. de Bizkaia, Bilbao.
- Garate, D, 2014. Altamira and Paleolithic Cave Art of Northern Spain. In: Smith, C (Ed.), *Encyclopedia of Global Archaeology*, 1. Springer, New York, pp. 158–163.
- Garate, D. 2017. Los primeros artistas de Bizkaia. Las cuevas decoradas durante el paleolítico. *Kobie (serie anejos)*. 15. Diputación Foral de Bizkaia.
- Garate, D, Ríos-Garaizar, J, Ruiz, A, 2013. El arte parietal paleolítico de la cueva de Lumentxa (Lekeitio, Bizkaia). *Kobie (Serie Paleoantropología)* 32, 5–28.
- Garate, D, González, C, López-Quintana, J C, Guenaga, A, García, A, Aranzabal, G, Medina-Alcaide, M, 2015. Arte parietal paleolítico en Morgota Koba (Kortezubi, Bizkaia). *Kobie (Serie BAI)* 5, 57–74.
- Garate, D, Rivero, O, Ríos-Garaizar, J, Intxaurbe, I, 2016. La grotte d'Atxurra: un nouveau sanctuaire majeur du magdalénien au Pays Basque. *International Newsletter of rock-art*. 1–4.
- Garate, D, González, C, Intxaurbe, I, 2016/17. Arte parietal paleolítico en la cueva de Ondaro (Nabarniz, Bizkaia), *Kobie (Serie Paleoantropología)* 35, 37–48.
- Garate, D., Rivero, O., Ríos-Garaizar, J., Arriolabengoa, M., Medina-Alcaide, M.A., Ruiz-López, J.F., Intxaurbe, I., Salazar, S. & Libano, I. Submitted. The cave of Atxurra: a new major Magdalenian rock art sanctuary in Northern Spain. *Journal of Archaeological Science (Reports)*.
- González Sainz, C, 1989. El Magdaleniense superior final de la región cantábrica. *Tanfín, Santander*.
- Huisman, H, Ismail-meyer, K, Sageidet, B M, Joosten, I, 2017. Micromorphological indicators for degradation processes in archaeological bone from temperate European wetland sites. *J. Archaeol. Sci.* 85, 13–29.
- Intxaurbe, I., Arriolabengoa, M., Medina-Alcaide, M.A., Rivero, O., Ríos-Garaizar, J., Salazar, S., Libano, I., Garate, D., Submitted. Accessibility to Palaeolithic rock-art in underground spaces: Proposal of Methodology for the Study of Human Transit in Atxurra Cave (Northern Spain). *Journal of Archaeological Science*.
- Iriarte-Chiapusso, M J, Muñoz Sobrino, C, Gómez-Orellana, L, Hernández-Beloqui, B, García-Moreiras, I, Fernández Rodríguez, C, Heiri, O, Lotter, A F, Ramil-Rego, P, 2016. Reviewing the Lateglacial-Holocene transition in NW Iberia: a palaeoecological approach based on the comparison between dissimilar regions. *Quat. Int.* 403, 211–236.
- Lagüera García, M A, 1991. La tipología del utillaje lítico del yacimiento de La Pila (Cuchía, Mogro, Cantabria). *Espacio, Tiempo y Forma. Serie I, Prehistoria* 4, 37–92.
- Medina-Alcaide, M A, Garate, D, Ruiz-Redondo, A, Sanchidrián, J L, 2018. Beyond art: The internal archaeological context in Paleolithic decorated caves. *J. Anthropol. Archaeol.* 49, 114–128.
- Medina-Alcaide, M.A., Garate, D. & Sanchidrián, J.L., 2018b. Painted in red: In search of the multiple causes of Palaeolithic cave art *Quaternary International*. 491, 65–77.
- Moore, P D, Webb, J A, Collinson, M E, 1991. *Pollen Analysis*. 2nd Edition Blackwell, Scientific Publications, Oxford, UK.
- Morel, P, 1998. La grotte du Bichon (La Chaux-de-Fonds, canton de Neuchâtel, Suisse): un site archéologique singulier, ou l'histoire d'une chasse à 1 ours brun il y a 12 ans dans le Jura suisse. In: Cupillard, C, Richard, A (Eds.), *Les derniers chasseurs-cueilleurs du Massif jurassien et de ses marges*. Centre jurassien du Patrimoine, Lons-le-Saunier, pp. 88–93.
- Morellón, M, Aranbarri, J, Moreno, A, González-Sampériz, P, Valero-Garcés, B L, 2018. Early Holocene humidity patterns in the Iberian Peninsula reconstructed from lake, pollen and speleothem records. *Quat. Sci. Rev.* 181, 1–18.
- Nelson, M, 1991. The study of technological organization. *Archeological Method and Theory* 3, 57–100.
- Pelegrin, J., Karlin, C. & Bodu, P. 1988. "Chaînes opératoires": un outil pour le préhistorien. In: CNRS (ed.), *Technologie Préhistorique. Notes et Monographies Techniques Du CRA, CNRS, Paris*, 55–62.
- Reille, M, 1992. Pollen et Spores d'Europe et d'Afrique du Nord. *Laboratoire de Botanique Historique et Palynologie, Marseille*.
- Ríos-Garaizar, J, 2007. Industria lítica y sociedad en la Transición del Paleolítico Medio al Superior del Cantábrico oriental: la necesidad de un enfoque integral. *Nivel Cero* 11, 29–46.
- Ríos-Garaizar, J, 2011. El nivel IXb de Ekain (Deba, Gipuzkoa): Una ocupación efímera del Auriñaciense Antiguo. *Munibe (Antropología-Arkeología)* 62, 87–100.
- Ríos-Garaizar, J., de la Peña, P. & San Emeterio, A., 2011. Estudio de las industrias líticas y óseas de la cueva de Aitzbitarte III (Zona de la entrada), in: Altuna, J., Mariezkurrena, K., Ríos-Garaizar, J. (Eds.), *Occupaciones Humanas En La Cueva de Aitzbitarte III (Rentería, País Vasco) Sector Entrada: 33.000-18.000 BP*. Eusko Jaurlaritzaren Argitaletan Zerbitzu Nagusia, Vitoria-Gasteiz, pp. 81–351.
- Ríos-Garaizar, J., Arriabalaga, Á. & Villaluenga, A., 2012. Haltes de chasse du Châtelpéronien de la Péninsule Ibérique. *Labeko Koba et Ekain (Pays Basque Péninsulaire)*. *L'Anthropologie* 116, 532–549. <https://doi.org/http://dx.doi.org/10.1016/j.anthro.2012.10.001>
- Ríos-Garaizar, J, Garate, D, Bourrillon, R, Gómez-Olivencia, A, Karampaglidis, T, 2015. The venuses block from Arlanpe Cave (Northern Iberian Peninsula): Implications for the Origins and Dispersion of Gönnersdorf-Lalinde Style Depictions Throughout the European Magdalenian. *Oxford J. Archaeol.* 34, 321–341. doi:10.1111/ojoa.12062.
- Ríos-Garaizar, J, Škrdl, P, Demidenko, Y E, 2019. Use-wear analysis of the lithic assemblage from LGM Mohelno-Plevovce site (southern Moravia, Czech Republic). *C.R. Palevol* 18, 353–366. doi:10.1016/J.CRPV.2018.11.002.
- Rissetto, J.D., 2009. Late Pleistocene hunter-gatherer mobility patterns and lithic exploitation in eastern Cantabria (Spain). *The University of New Mexico*.
- Rofes, J, Garcia-Ibaibarriaga, N, Aguirre, M, Martínez-García, B, Ortega, L, Zuluaga, M C, Bailon, S, Alonso-Olazabal, A, Castaños, J, Murelaga, X, 2015. Combining Small-Vertebrate, Marine and Stable-Isotope Data to Reconstruct Past Environments. *Sci. Rep.* 5, 14219. doi:10.1038/srep14219.
- Rolland, C, 2008. Clé d'identification des micromammifères de Rhône-Alpes: Identification à partir des restes osseux contenus dans les pelotes de réjection des rapaces. *CORA Faune Sauvage*.
- San Emeterio Gómez, A. & Ríos-Garaizar, J., 2017. Estudio de las industrias líticas de la Cueva de Aitzbitarte III (Zona del Interior), in: Altuna, J., Mariezkurrena, K., Ríos-Garaizar, J., San Emeterio Gómez, A. (Eds.), *Aitzbitarte III (País Vasco)*. 26.000-13.000 BP (Zona Profunda de La Cueva). Eusko Jaurlaritzaren Argitaletan Zerbitzu Nagusia, Vitoria-Gasteiz, pp. 31–186.
- Tarriño-Vinagre, A, 2006. El sílex en la Cuenca Vasco-Cantábrica y Pirineo Navarro: caracterización y su aprovechamiento en la Prehistoria. *Monografías del Museo Nacional y Centro de Investigación de Altamira, Ministerio de Cultura, Madrid*.
- Van der Meer, J J M, Menzies, J, 2011. The micromorphology of unconsolidated sediments. *Sed. Geol.* 238, 213–232.
- Wadley, L, Williamson, B, Lombard, M, 2004. Symbolic or functional? A practical role for ochre in mastics for hafting in Palaeolithic Southern Africa. *Antiquity* 78, 700–714.