

## SUPPLEMENTARY MATERIALS

### *MATERIAL OSAGARRIAK<sup>1</sup>*

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<sup>1</sup> Irudiak, taulak eta estatistika kodeak ingelesezko bertsioan daude eskuragarri.

## *S1: Description of the selected sites*

### **1. SANTIMAMIÑE**

#### **Location**

**ETRS89 / UTM ZONE 30N      X: 529452      Y: 4799371      Z: 160**

The cave of Santimamiñe is located in the municipality of Kortezubi (Bizkaia), in the Aptian-Albian massive reef limestones of the Ereñozar mountain, in its southern side, 160 metres above current sea level. It's placed in the valley of river Oka, in the estuary of Urdaibai, 6 km from the modern shoreline.

#### **Brief topographic description**

It is formed along a joint that dips 45° (similar to its appearance in the entrance), with a 365m long main gallery, with an average width is between 3.5 and 4 metres (although at some points it also covers measures of up to 10 metres) and an average height of 6-7 metres (although at some point it reaches a height of about 40 metres) (Maeztu and Aranzabal, 2011).

The area of the cave which was used by the ancient humans (named as the archaeological area) covers the first 120 metres of the cave. In this field we shall first find the entrance of the cave, with the habitat site from the Lower Magdalenian to the Roman period (Aranzadi et al., 1931; López-Quintana, 2011), although there are some evidence of older occupations (Aranzadi and Barandiarán, 1935; Ruiz Idarraga, 1987), and then the decorated area (with paintings and engravings from the Magdalenian period, see below).

The decorated area is divided into several sectors: the vestibule itself, the so-called “Salon” (the first interior hall of the main gallery), the set of the “Old Hall of the Paintings” (with an “Antechamber” and the main “Chamber”) and the “New Hall of the Paintings” (the last decorated section of the main gallery). Although it is few metres in length, it has a very abrupt topography, which greatly increases the difficulty of walking through it. Although we can find the first paintings in the entrance room itself (red dots and stains), the most important areas are located in the deep parts of the cavern (in the dark rooms). Above all, in a lateral gallery about sixty metres from the entrance (despite it is geologically part of the Main Gallery, which was separated by formations -see above-) we shall find the main set of cave figures (“Old Hall of the Paintings”). Along the Main Gallery there are also a few more isolated rock art (in the room opposite the “Old Room of Paintings”, called the “Salon”). The last figures are in the “New Hall of the Paintings”, after a steep and dangerous path, nowadays achievable thanks to stairs and walkways.

From the “New Hall of the Paintings”, after a vertical climb of 6.5 metres, the gallery continues 240 metres further into the depths. No archaeological remains have been found in these areas. However, through these deep areas of the cavern we will find the largest volumes of Santimamiñe (the “Great-Hall” and the “White-Hall”) and spectacular geological formations, like the “Fried-Egg”.



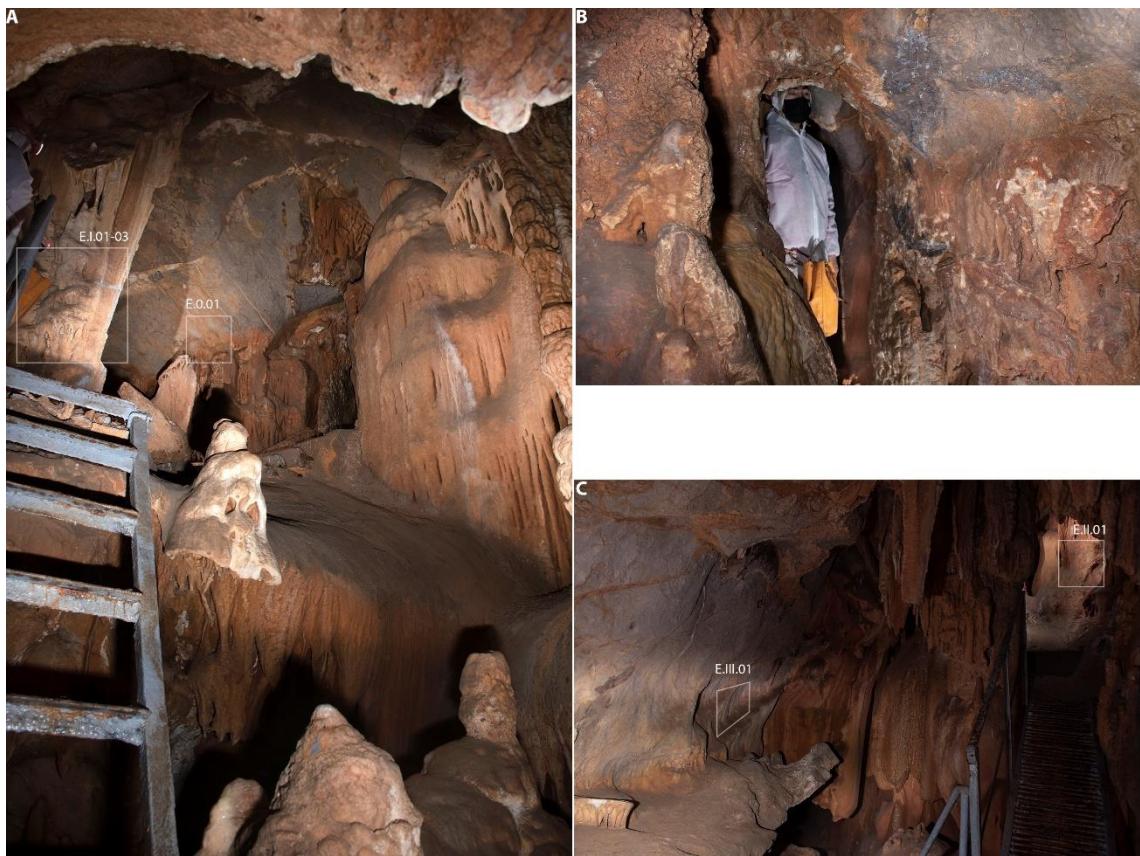
**Figure S1-1.** Entrance hall of Santimamiñe, where the occupation layers are located (S. Yaniz). *SI-1 Irudia. antimamiñeko ataria, non giza-ocupazio aztarnategiko geruzak dauden (S. Yaniz).*



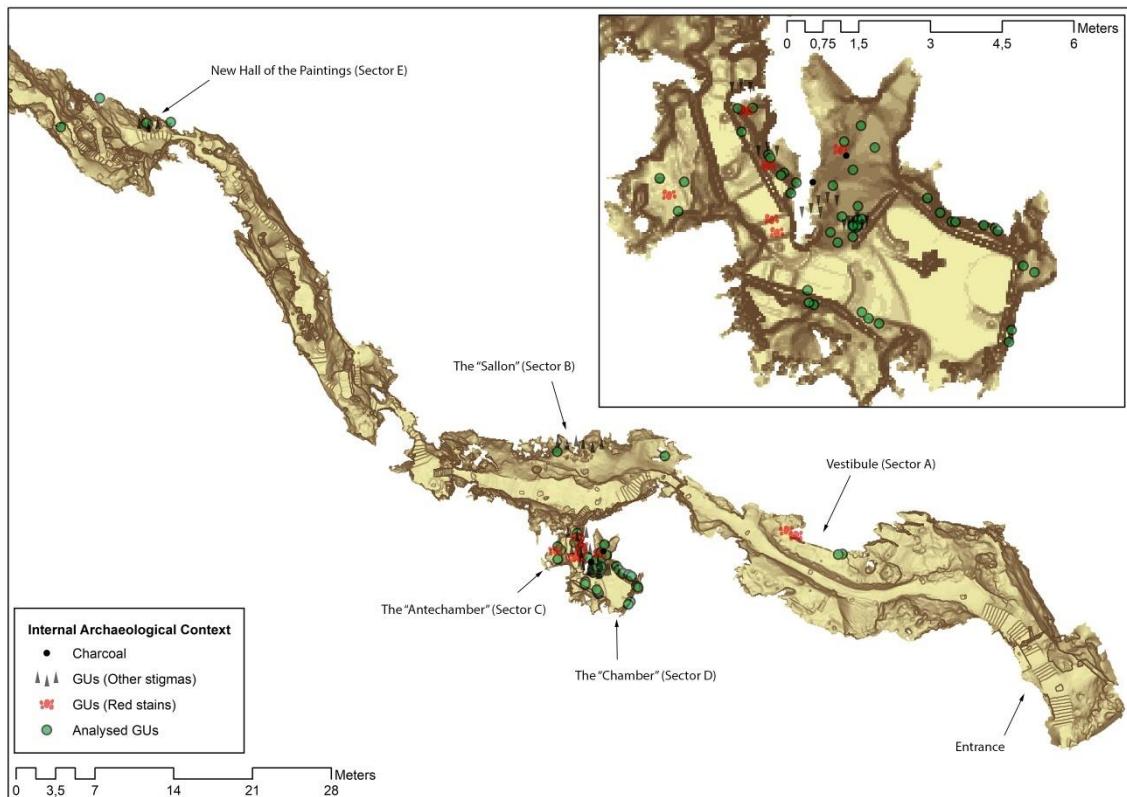
**Figure S1-2.** A) The “Sallon”. B) The “antechamber”, looking towards the entrance door (The location of rock art motifs is signaled). *SI-2 Irudia. A) “Aretoa”. B) “Aurreganbera”, sarrerako aterantz begira (labar arte irudien kokapena seinalatu dugu).*



**Figure S1-3.** A) The “Antechamber”, looking towards the gate to the “Chamber”. B) The “Chamber”, looking towards the entrance from the “Antichamber” (The location of rock art motifs is signaled). *SI-3 Irudia. A) “Aurreganbera”, “Ganbera”-rantz doan aterantz begira. B) “Ganbera”, “Aurreganbera”.ko sarrerarantz begira (labar arte irudien kokapena seinalatu dugu).*



**Figure S1-4.** A) The “New Hall of the Paintings”, looking towards the gate which comes from the main gallery. B) The gate to Sector E. C) The two final panels of the cave, in both sides of a 6.5 metres cham. *SI-1 Irudia. A) “Pinturen Areto Berria”, galeria nagusitik datorren aterantz begira. B) E. Sektorerako atea. C) Haitzuloaren amaierako bi panelak, alde bietan 6,5 metroko zabalera dutenak.*



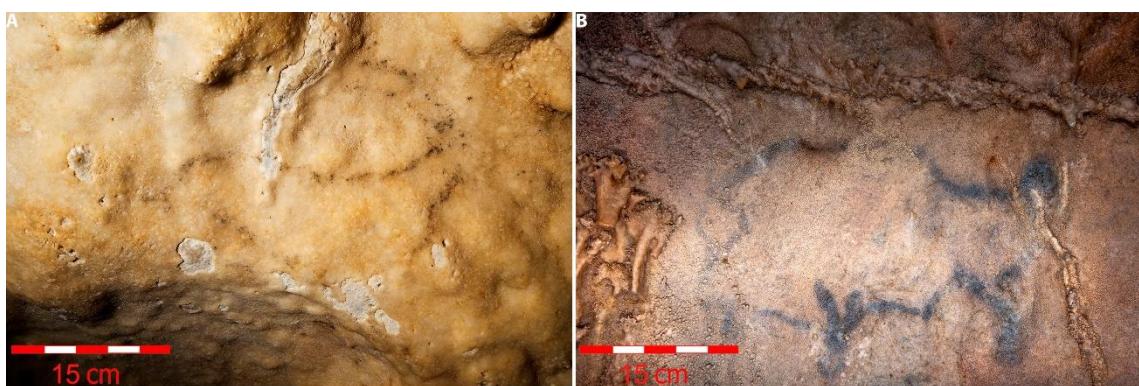
**Figure S1-5.** Topographic plan of the cave of Santimamiñe, showing the archaeologic evidence (I. Intxaurbe over 3D survey of VirtualWare). *SI-5 Irudia. Santimamiñeko haitzuloko plano topografikoak, aztarna arkeologikoak erakusten dituena.*

## The cave art

Based on the latest inventories of Palaeolithic cave art carried out in Santimamiñe (Aranzadi et al., 1925; González Sainz & Ruiz Idarraga, 2010; González Sainz, 2016/17; Garate, 2017b; Intxaubur & Garate, 2022), we have developed a database of graphic elements (we have added some new images identified in our project, apart from some re-interpretations).

The rock art in the cave consists of 75 individualised graphic units (GU's), of which 30 represent bison, together with 8 animals hard to identify, 8 horses, 4 ibex, 1 bear, 1 deer, several simple signs (dots, paired marks, etc.) and involuntary traces (stains, marks, etc.). They are placed in 5 different sectors: A or the “Vestibule”, B or the “Sallon”, C or the “Antichamber”, D or the “Chamber” and E or the “New Hall of the Paintings”. The paintings were created mostly with black pigment made from charcoal, although shallow engraving was also used (sometimes combined with the paintings) as well as red pigment based on iron oxide (González Sainz and Ruiz Idarraga, 2010). The engravings are mostly fine and superficial, although there are cases that go deeper. The stroke is single or repeated.

An attempt was made to date the paintings, obtaining a date that was too recent (907-671 cal. BP) (Moure & González, 2000), produced by insufficient pretreatment to ensure the elimination of modern carbon pollution and at the same time preserve the sample, too small (H. Valladas, Personal Communication). However, because of the similarity with other dated portable and rock art, it can be firmly attributed to a time between the Middle Magdalenian and the first phase of the Upper Magdalenian (ca. 17.5-14.5 ka). On the other hand, in 2022 several charcoal fragments were found in the vicinity of the main panel by M. Medina-Alcaide and I. Intxaubur, likely to date a possible ancient human frequentation in the room, perhaps linked to the production of rock art.

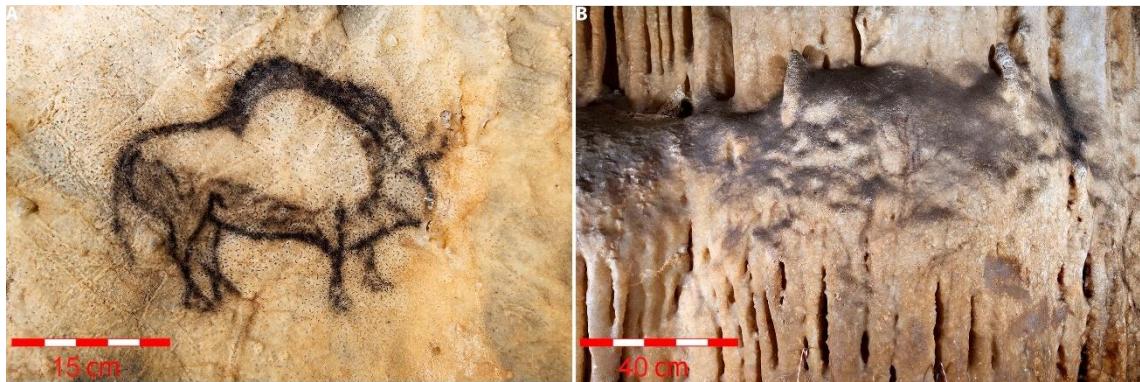


**Figure S1-6.** A) Goat painted in black S.B.IV.01 (S. Yaniz). B) Bison painted in black S.C.III.02 (D. Garate). *S1-6 Irudia. A) S.B.IV.01 beltzez margotutako ahuntza (S. Yaniz). B) S.C.III.02 beltzez margotutako bisontea (D. Garate).*

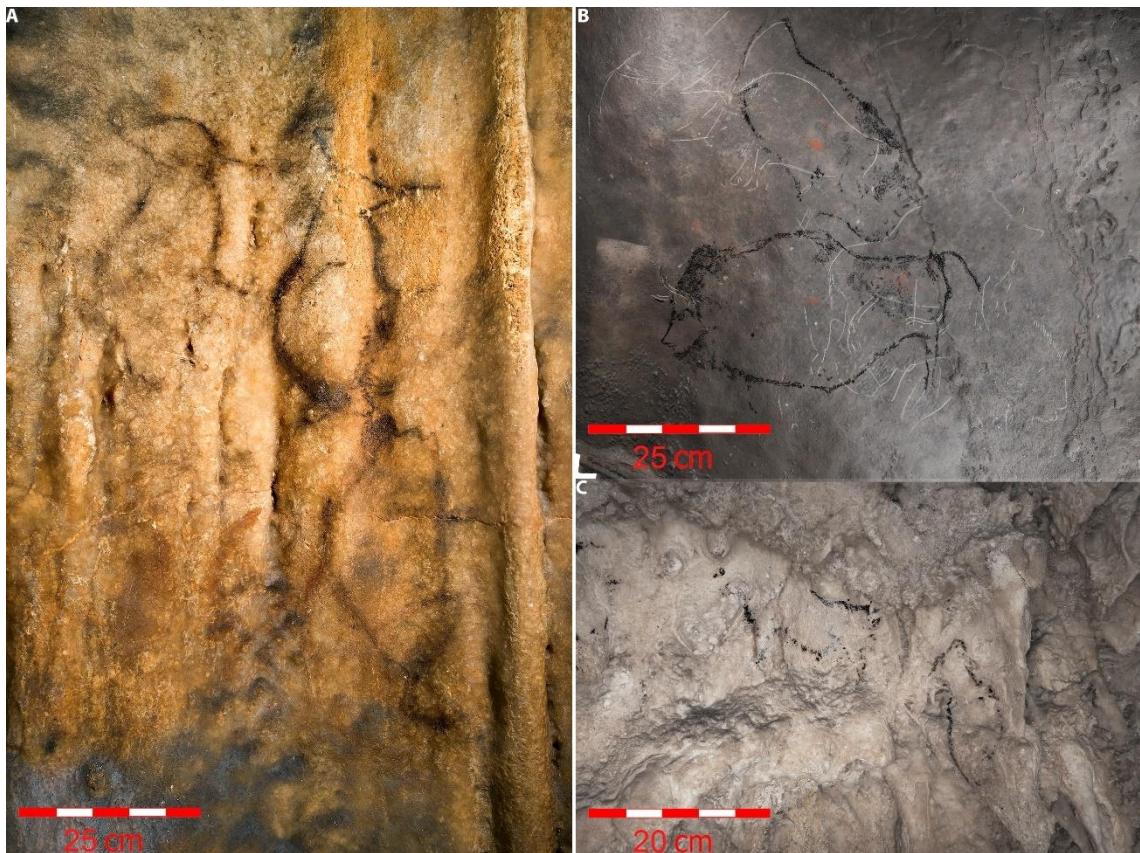
**Figure S1-9 (next page).** A) The group of bison arranged vertically S.D.V.01-03. B) Restitution of the group of engraved and painted in black bison S.D.II.01-10, currently most of them have disappeared (for a 3D model look: <https://sketchfab.com/3d-models/santimamineko-sdii-panelaren-berreraiketa-d97a8a98d8d9410abdc5c37a80bd48aa>). C) The group of black paintings disposed over old capillarity formations and stalactites S.D.VIII.01-03. *S1-9 Irudia. A) S.D.V.01-03 Bisonte taldea bertikalki antolatuta. B) S.D.II.01-10 grabatu eta beltzez margotutako bisonte taldearen berreraiketa, gaur egun gehienak desagertu dira (3Dko eredua ikusteko: <https://sketchfab.com/3d-models/santimamineko-sdii-panelaren-berreraiketa-d97a8a98d8d9410abdc5c37a80bd48aa>). C) Kapilaritate bidezko eraketa eta estalaktita zaharren gainean egindako S.D.VIII.01-03 pintura beltzen multzoa.*

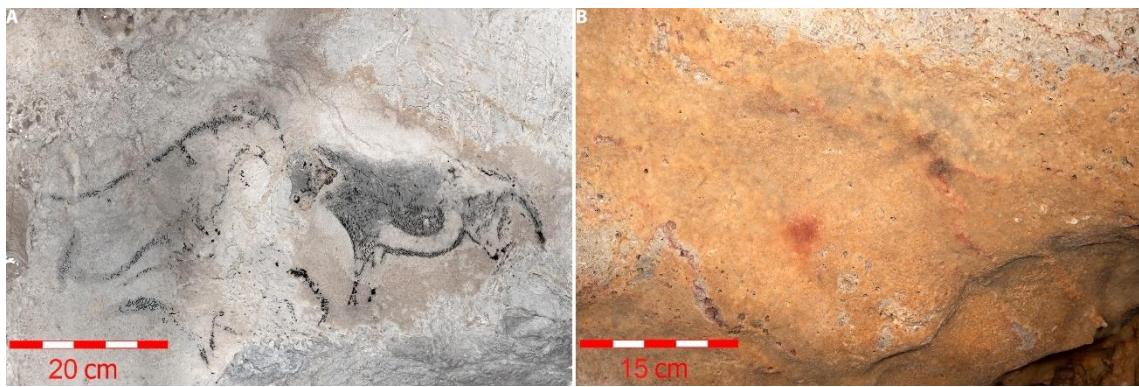


**Figure S1-7.** A) Horse painted in black S.C.II.02 (S. Yaniz). B) Horse painted in black S.D.III.06 (S. Yaniz). *S1-7 Irudia. A) S.C.II.02 beltzez margotutako zaldia (S. Yaniz). B) S.D.III.06 beltzez margotutako zaldia (S. Yaniz).*



**Figure S1-8.** A) Bison painted in black S.D.III.07 (S. Yaniz). B) A horse, brown bear, a deer and a goat painted in black S.D.IV.01-04 (S. Yaniz). *S1-8 Irudia. A) S.D.III.07 beltzez margotutako bisontea (S. Yaniz). B) S.D.IV.01-04 beltzez margotutako zaldia, hartz area, orein arra eta ahuntza (S. Yaniz).*

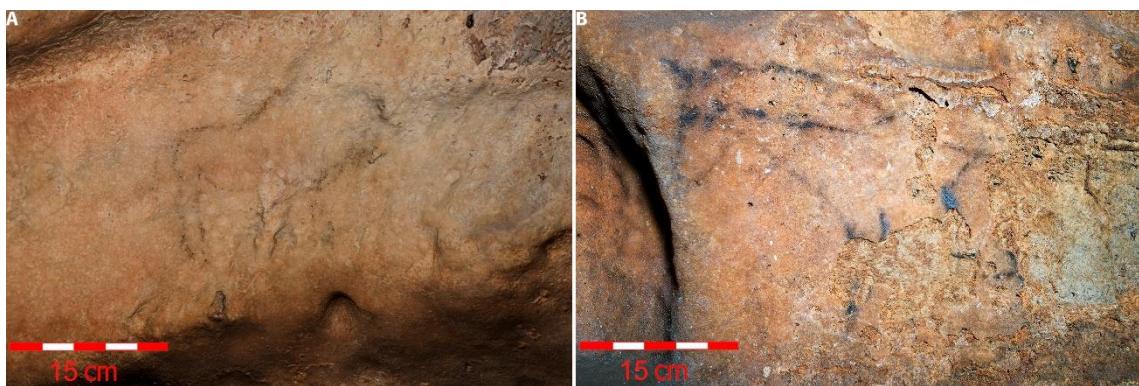




**Figure S1-10.** **A)** Group of horses and an indeterminate painted in black S.D.I.01-03 (Photogrammetry: D. Garate; Tracing: I. Intxaurbe). **B)** A red point S.E.0.01 (M. Á. Medina-Alcaide). **S1-10 Irudia.** **A)** S.D.I.01-03 beltzez margotutako zaldi taldea eta zehaztugabe bat (Fotogrametria: D. Garate; Kalkoa: I. Intxaurbe). **B)** S.E.0.01 puntu gorria (M. Á. Medina-Alcaide).



**Figure S1-11.** **A)** Bison painted in black and torch marks S.E.I.02-03 (M. Á. Medina-Alcaide). **B)** Ibex head painted in black S.E.I.01 (M. Á. Medina-Alcaide). **S1-11 Irudia.** **A)** S.E.I.02-03 beltzez margotutako bisontea eta zuzi kolpeak (M. Á. Medina-Alcaide). **B)** S.E.I.01 beltzez margotutako ahuntz burua (M. Á. Medina-Alcaide).



**Figure S1-12.** **A)** Bison painted in black S.E.III.01 (D. Garate). **B)** Horse painted in black S.E.II.01 (S. Yaniz). **S1-12 Irudia.** **A)** S.E.III.01 beltzez margotutako bisontea (D. Garate). **B)** S.E.II.01 beltzez margotutako zaldia (S. Yaniz).

## 2. LUMENTXA

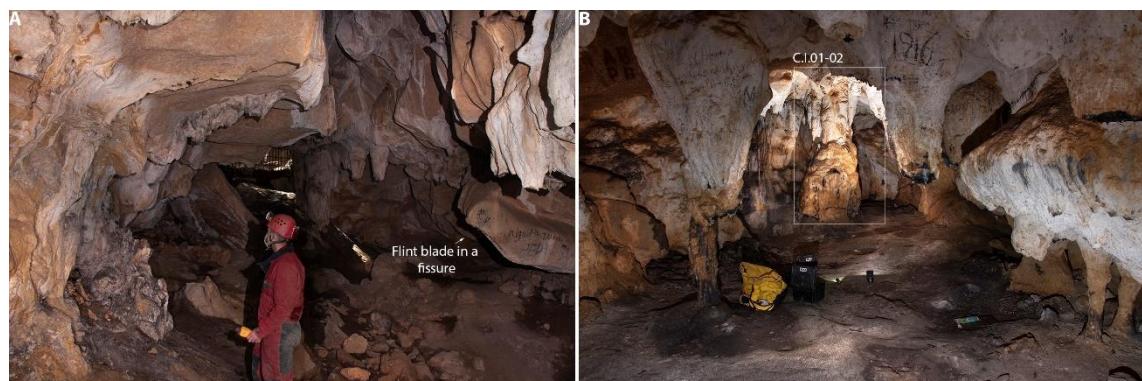
### Location

ETRS89 / UTM ZONE 30N      X: 540408      Y: 4800919      Z: 88

The cave of Lumentxa is located in Ispaster (Bizkaia), near Lekeitio, on the south side of the hill of the same name, on the western bank of the Lea Valley, very close (less than 1 km) to the current coastline. It opens in organogenic Aptian-Albian micritic limestone, 88 metres above sea level.

### Brief topographic description

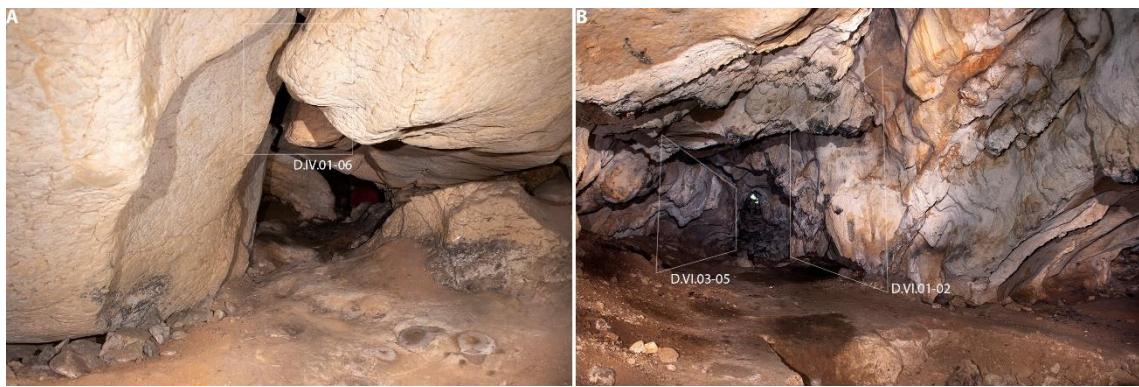
The cave has two entrances, one facing south and one facing northeast. The habitat site in the main entrance hall contains occupation layers with materials from Lower Magdalenian period to Roman age (Aranzadi and Barandiarán, 1935; Arribas Pastor and Berganza Gochi, 2018). It has a development of about 50 m and consists of a main gallery. At the end of this gallery, there are some old ceiling collapses, creating some side passages and pseudo cave levels. The main part of the rock art set of the cave is placed in these last sectors of the cave. Unfortunately, the cave has been intensively used since historic times (at least XVIII century), and it's full of graffiti, soot marks and broken speleothems.



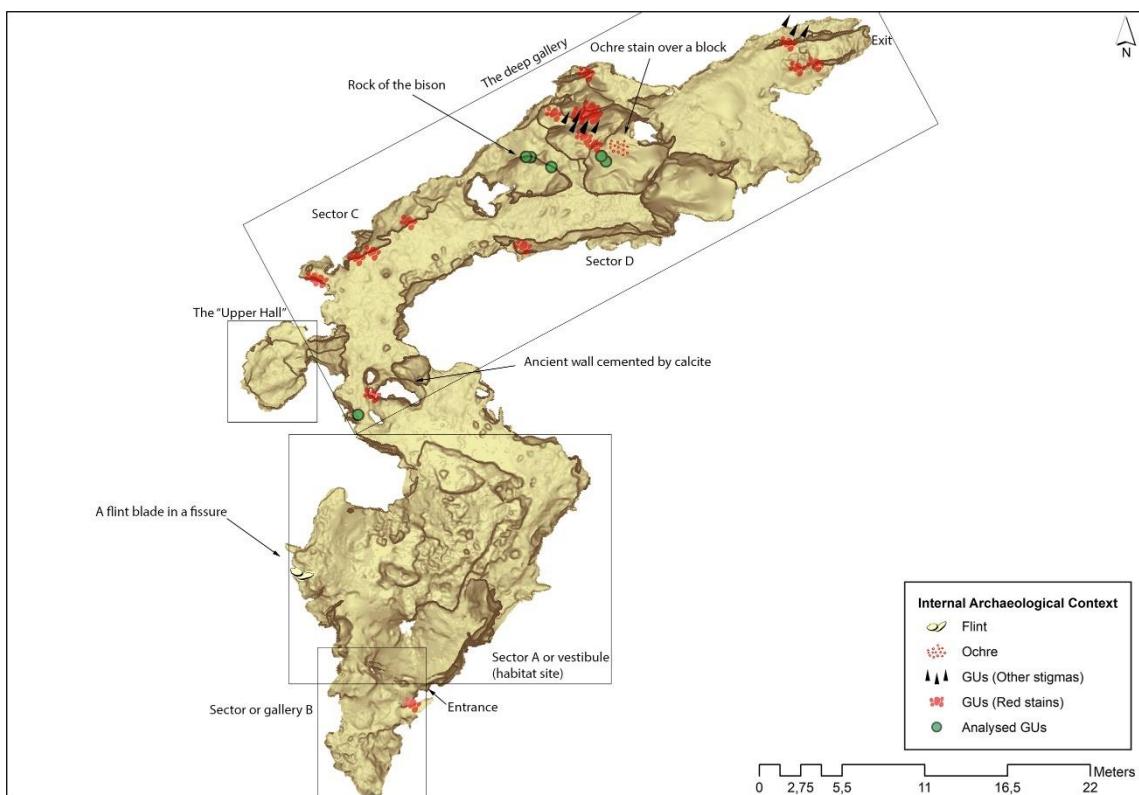
**Figure S1-13.** **A)** Entrance hall of Lumentxa, where the occupation layers are located. **B)** The Sector C, looking towards the entrance from the entrance hall (The location of rock art motifs is signaled). *SI-13 Irudia. A) Lumentxako ataria, non giza-okupazio aztarnategiko geruzak dauden. B) C sektorea, ataritik datorren sarrerarantz begira (labar arte irudien kokapena seinalatu dugu).*



**Figure S1-14.** **A)** Sector D, showing the block with the painted red bison on the left. **B)** Tilted and subsequently fluvially eroded blocks of sector D. *SI-14 Irudia. A) D sektorea, ezkerraldean bisonte gorriz margotutako blokea erakutsiz. B) D sektoreko bloke baskulatuak eta, ondoren, flubialki higatuak.*



**Figure S1-15.** **A)** Sector D, showing the crawlway in front of the block with the painted red bison, which goes towards the ochre stain saw in the previous picture. **B)** The final hall of the cave and the small exit. There are very old, eroded speleothems. *S1-15 Irudia. A) D sektorea, bisonte gorriaz margotutako blokearen aurreko katazulora begira, aurreko irudian ikusitako okre orbanerantz doana. B) Haitzuloaren azken aretoa eta irtearra txikia. Badira espeleotema zahar higatuak.*



**Figure S1-16.** Topographic plan of the cave of Lumentxa, showing the archaeologic evidence (I. Intxaурbe over 3D survey of GIM Geomatics). *S1-16 Irudia. Lumentxako haitzuloko plano topografikoak, aztarna arkeologikoak erakusten dituena (I. Intxaурbe, GIM Geomatics-en 3D-az baliatuz).*

## The cave art

Based on the latest inventories of Palaeolithic cave art carried out in Lumentxa (Garate et al., 2013b), we have developed a database of graphic elements (we have added some new images identified in our project). The rock art in the cave consists of 31 individualised graphic units (GU's), of which 2 represent bison, 1 horse, 3 simple signs (dots) and involuntary or very simple traces (stains, finger flutings, etc.) (Figure S1-1). They are placed in 3 different sectors: B, C and D. The paintings were created mostly with red pigment made with iron oxides (hematite) (C. Chanteraud, Personal Communication), although multiple thing engraving technique was also used in the deepest part of the cave, along with some finger engravings in soft surfaces (very eroded limestone surface). On this sense, there is a large stain of ochre covering the soil of a huge rock, close to the main panel and other simple GUs (stains, points, etc.). A flint blade was also found inserted in a fissure of the entrance. These remains (and especially the ochre stain) seem to be related with the graphic activity of the cave. There are also some charcoals covering the ground in areas with difficult access, as well as a wall made with rocks covered with a stalagmite. In any case, is difficult to connect these other remains with the graphic activity, due to the intense use of the cave throughout history (Libano & Vega, 2019/20).

Owing to the similarity of the ensemble to other portable and parietal art dated directly and contextually, it can be firmly attributed to a time between the Middle Magdalenian and the first phase of the Upper Magdalenian (ca. 17.5-14.5 ka). In the habitat site, red ochre pieces were found in Upper Magdalenian levels, one of them with three engraved horses (Aranzadi and Barandiarán, 1934), one of them using the border of the piece to represent the back of the animals, as the two bison do in the main panel of the cave.



**Figure S1-17.** Tracing of the Lum.D.II.01-03 panel from the Lumentxa cave (D. Garate), which contains two bisons taking advantage of the support forms to depict the hump, and a horse protome. **S1-17 Irudia. Lumumentxa kobazuloko Lum.D.II.01-03 panelaren kalkoa (D. Garate). Bertan, konkorra irudikatzeko euskarriaren formak baliatzen dituzten bi bisonte eta zaldi-protomo bat daude.**

### **3. ATXURRA**

#### **Location**

**ETRS89 / UTM ZONE 30N      X: 541048    Y: 4797129    Z: 55**

The cave system formed in Aptian-Albian reef limestone (Lower Cretaceous), in the southern slope of the mountain “Gazteluko Atxa” or “Gerika”, in Berriatua (Biscay), 55 metres above current sea level, in the valley formed by the stream of Zulueta, a tributary of the Lea, 3 km from the current coast.

#### **Brief topographic description**

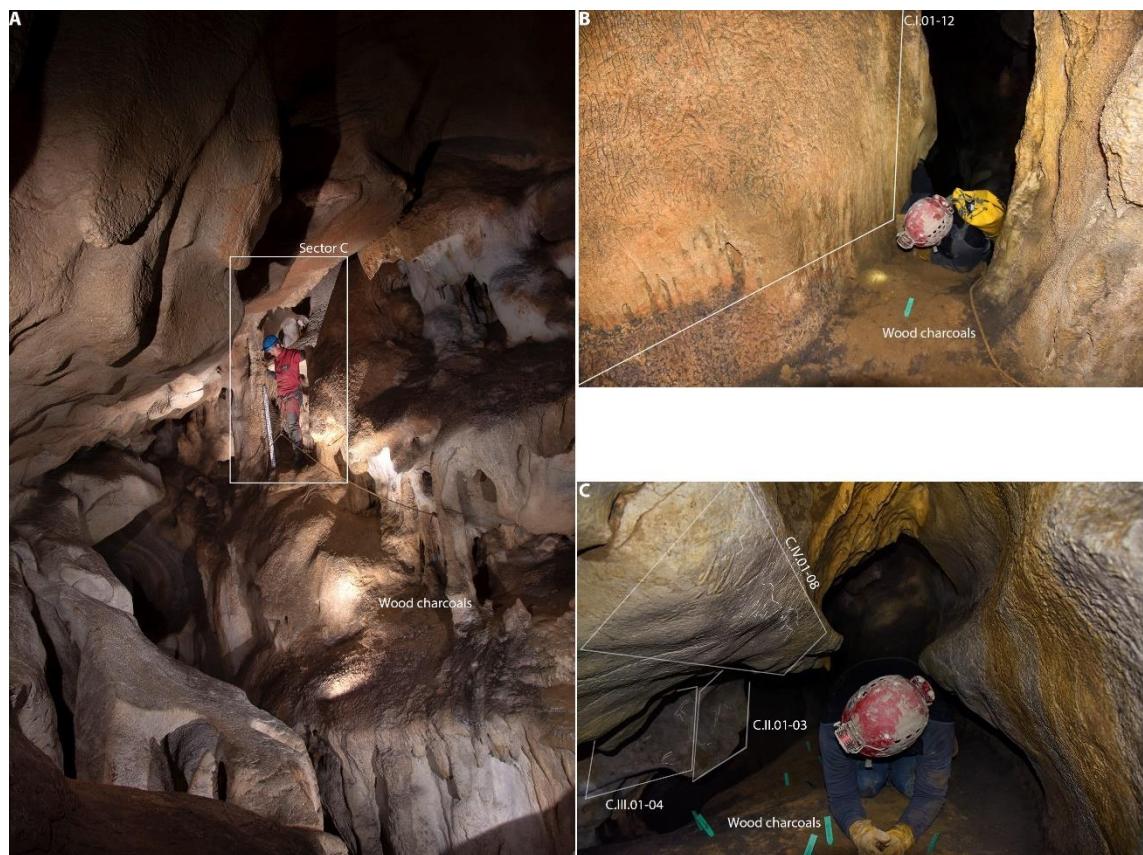
It consists of two subhorizontal passages (cave levels) at different heights, the lower one called Armiña and the upper one called Atxurra. The cave has two entrances which lead access to two horizontal levels; the lower one is called Armiña (it was artificially opened by roadworks in 1882), and the upper one is called Atxurra. Both are part of the same endokarstic system; the total topographical development of the cave system is 1085 metres (A.D.E.S., Personal Communication). After the upper-level entrance, the only access point to the cave in the past, there is a small vestibule with at least 2 metres of sedimentary deposit developed during at least the last Pleistocene (Gravettian, Lower and Upper Magdalenian) to Holocene (Neolithic/Calcolithic) (Barandiarán Ayerbe, 1961a; Rios-Garaizar et al., 2019; Aranbarri et al, 2024). After crossing this space and going through a small window, we reach the inner sectors of the cave. At this point, 17 metres deep from the entrance, there is a very pronounced ramp which has a length of 15.03 metres by an average wide of 1 metre and descends vertically 10 metres, connecting with the lower level of the cave. If we cross the shaft going around of it, we will enter an area with low ceilings that end in several crawlways. After this point, the sizes of the gallery increase, crossing several large spaces with the floor filled with cave bears nests. After other passages opened in stratified limestone, we will reach the point where this level reconnects with the lower level. If we continue towards the interior, it would be the point where the decorated areas begin.

Nowadays, accessing the system is done by using the lower level's artificial entrance (Armiña), where there are at least two colluvial cones of matrix-supported heterogeneous clastic sediments filling the passage from the outside. Close to this point, there is evidence of a sporadic human occupation dated in the Upper Magdalenian cultural period, suggesting that this entrance was isolated from the outdoor, with humans likely entering from the upper level's entrance through the endokarst (Rios-Garaizar et al., 2020). This cave-level is formed by a large passage with regular dimensions of 4 by 4 metres and a relatively horizontal floor (except for the last part, where we can find a series of bear dens), which is stable for its extension of about 200 metres. In its final stretch, it connects with the upper level (Atxurra) through a steep ramp caused by a roof collapse (at a distance of 203 metres from the entrances).

The areas with rock art and archaeological remains also begin here (in the upper level), 10 metres before the union between Armiña and Atxurra with a first depiction hidden in

a small phreatic tunnel located in the lower part of the right wall (Sector A). Between this point and up to a depth of 365 metres from the entrance, the decorated sectors will follow one another. There are 15 sectors with archaeological remains (rock art or superficial evidence like flint pieces or charcoals) in the right wall, and 10 in the left wall. They are normally found on elevated shelves above the easiest transit area (which runs through the lowest area of the gallery), some with difficult access (Sector C, Sector H, Sector F' and G'), although there are also some areas on both sides of the main road towards the interior (Sector G' floor, I floor or J' floor). Some of the sectors, such as sector D (the "Hall of at the Bison") or J (the "Cornice of the Horses") have the capacity to accommodate quite a few people at a time.

Thirty metres after the last archaeological sectors (K' and J'), but in the middle section of the upper level, there is a vertical speleothem formation, covering almost the entire passage. This has been partially broken at a height of 3 metres by cavers to allow further exploration of the cave deeper into the mountain, through a narrow passage. The passage continues 600 metres having the same morphologies as before, but there is also a stational lake. No rock art evidences (or other archaeological remains) have been found in the cave portion beyond this gravitationally formed speleothem.

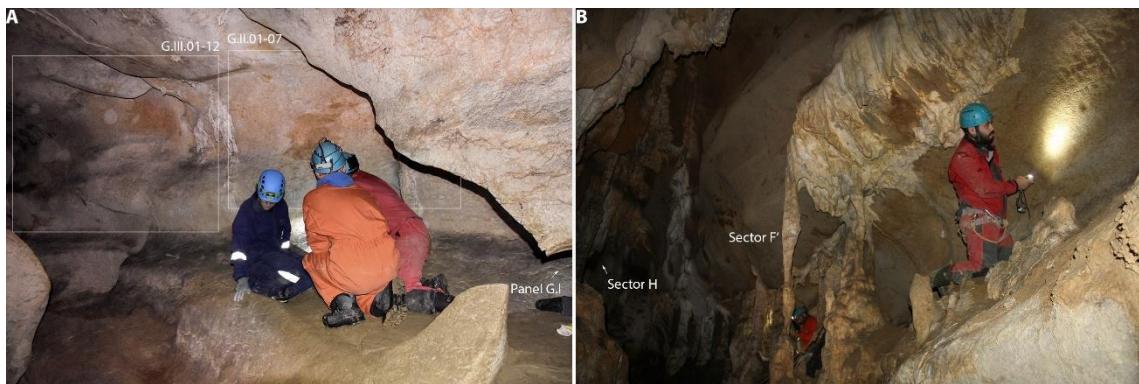


**Figure S1-18.** A) The access Sector C or the “Alcove of the Claw Marks” in Atxurra cave, looking from the main gallery. B) Sector C, looking towards the gate to enter it. C) The last passage of the sector C, with several panels and archaeological vestiges, looking towards the entrance (Tracings: O. Rivero). **SI-18 Irudia.** A) *Atxurako kobazuloko C Sektorerako edo “Hatzapar Marken Ganbarara”-ko bidea, galeria nagusitik begiratuta.* B) *C Sektorea, bertara sartzeko ateria begira.* C) *C Sektoreko azken pasabidea, hainbat panel eta aztarna arkeologiko dituena, sarrerara begira* (Kalkoak: O. Rivero).

## PAPER V: SUPPLEMENTARY MATERIALS – MATERIAL OSAGARRIAK



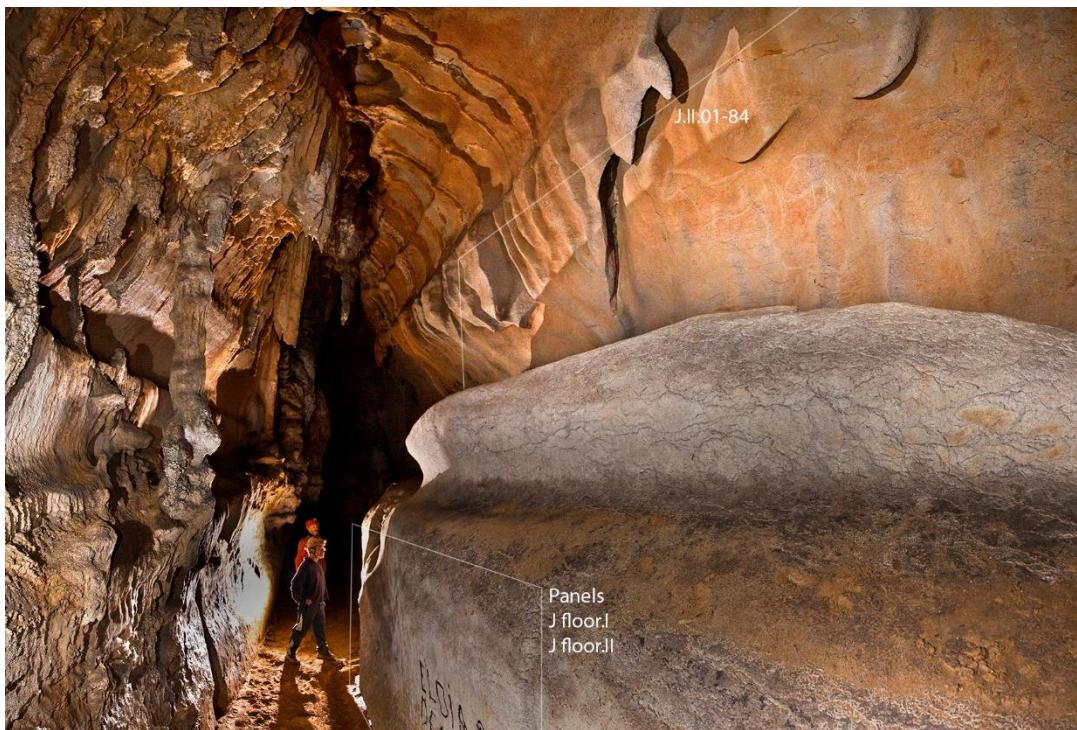
**Figure S1-19.** **A)** The access Sector D or the “Hall of the Bison” in Atxurra cave, looking from the main gallery. **B)** The small hall of Sector D, looking from the entrance gate (D. Garate). **S1-19 Irudia.** **A)** Atxurra kobazuloko D Sektorerako edo “Bisonteen Gela”-rako bidea, galeria nagusitik begiratuta. **B)** D Sektorea osatzen duen gelaxka, bertara sartzeko atetik ikusia (D. Garate).



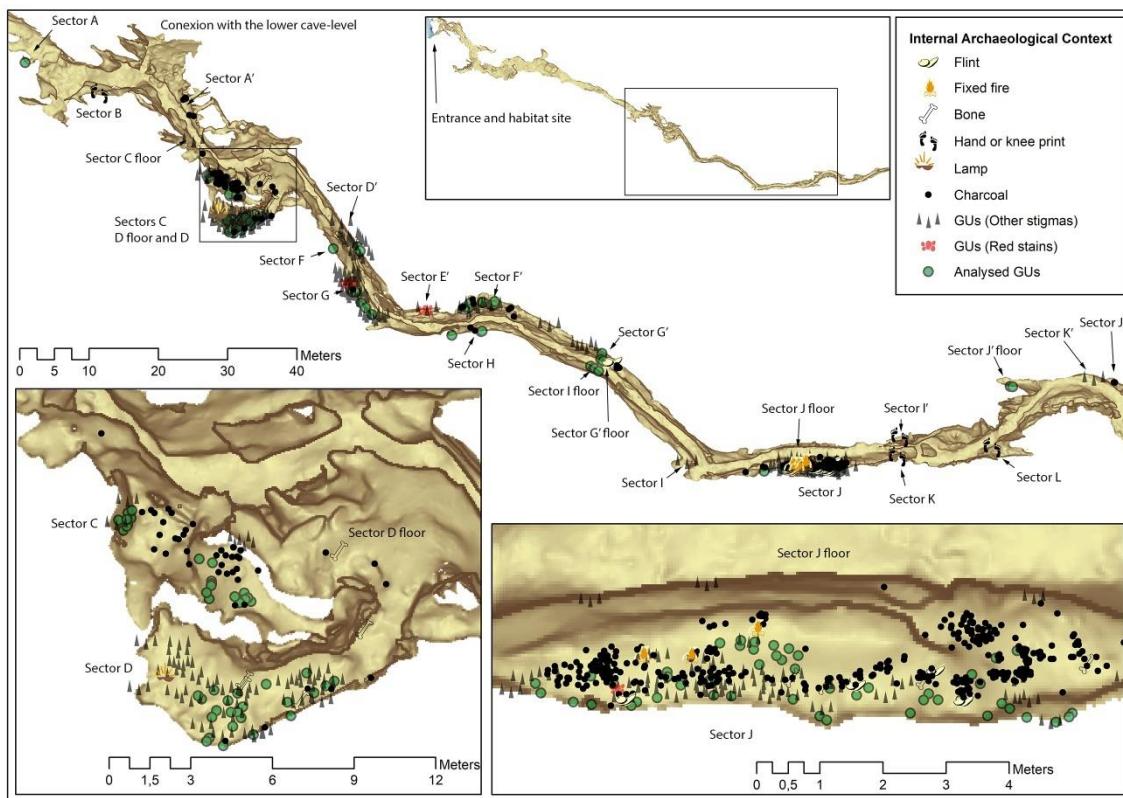
**Figure S1-20.** **A)** Sector G, looking from Sector D' in the main gallery. **B)** The path to Sector G', Sector F' and Sector H, looking from the main gallery. **S1-20 Irudia.** **A)** G Sektorea, galeria nagusiko D' sektoretik begiratuta. **B)** G', F' eta H Sektoreetarako ibilbidea, galeria nagusitik ikusia.



**Figure S1-21.** A) Sector H, looking from Sector F', in several ledges over the main gallery (O. Rivero, Tracings: S. Salazar). B) The main gallery, looking towards the cornices with Sectors D', F and G (D. Garate). A) *H Sektorea, F' Sektoretik ikusia, galeria nagusiko zenbait erlaitzeten* (O. Rivero, Kalkoa: S. Salazar). B) *Galeria nagusia, D', F eta G sektoreak dituzten erlaitzei begira* (D. Garate).



**Figure S1-22.** Main gallery, in the zone of Sector J or the “Ledge of the Horses” in Atxurra cave (X. Gezuraga). *S1-22 Irudia. Galeria Nagusia, J Sektorea edo “Zaldien Erlaitza”-ren zonaldean* (X. Gezuraga).



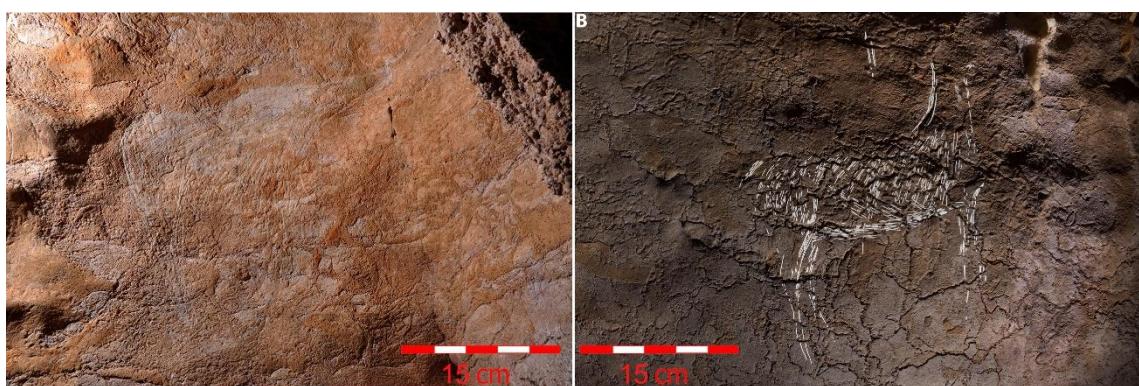
**Figure S1-23.** Topographic plan of the cave of Atxurra, showing the archaeologic evidence (I. Intxaурbe over 3D survey of GIM Geomatics). *S1-23 Irudia. Atxurrako haitzuloko plano topografikoak, aztarna arkeologikoak erakusten dituena* (I. Intxaурbe, GIM Geomatics-en 3D-az baliatuz).

## The cave art

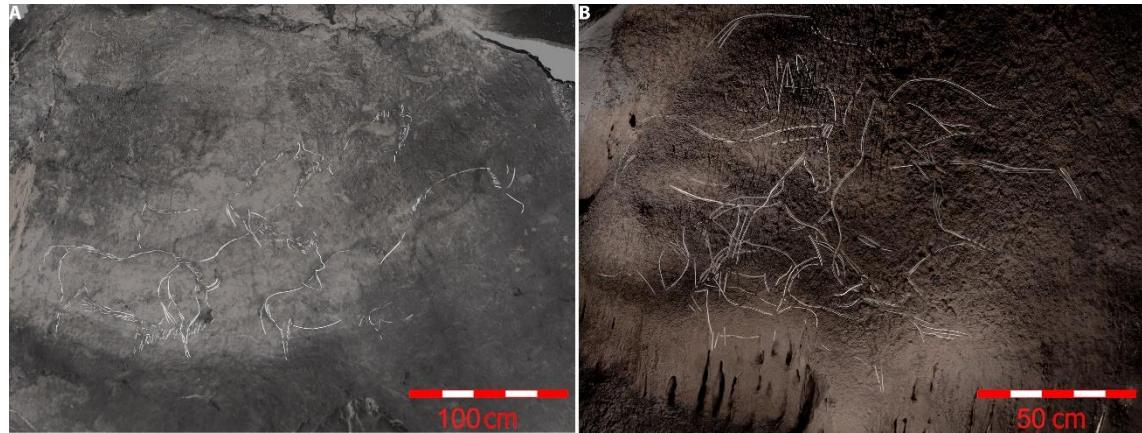
The cave art of the cave was found in 2015 (Garate et al., 2020e), and a complete inventory has not been published yet. However, there are some partial inventories (Intxaurbe et al., 2020; Garate et al., 2023). The GUs of the cave were found in 18 sectors, among them 7 also contained superficial archaeological remains (scattered charcoals, fixed fires, a probable grease lamp and/or flint pieces), and there are also 5 additional sectors with only archaeological remains (mainly scattered charcoals). The sectors with rock art are A, C floor, C or the “Alcove of the Bear Claw marks”, D floor, D or the “Hall of the Bison”, D’, F, G, E’, H, F’, G’, G’ floor, I floor, J or the “Ledge of the Horses”, J floor, J’ floor and K’.

The rock art in the cave consists of 256 individualised graphic units (GU's), of which 48 represent bison, 34 ibex, 25 zoomorphic figures hard to identify, 11 horses, 4 hinds, 3 probable stylized female figures (FFS) interpreted cautiously as undefined animals, 2 deers, 2 bears and 2 aurochs. There are also 4 isolated arrows and three complex signs (meander form engravings and a probable claviform) and involuntary or very simple traces (113 isolated or non-figurative lines and 5 stains of red pigment). The paintings were created mostly with black pigment made from charcoal, although shallow engraving was also used (sometimes combined with the paintings) as well as red pigment probably made by iron oxide. The engravings are mostly fine and superficial, although there are cases that go deeper. Finger engraving could be seen in one of the GUs, and scraping was also used, combining sometimes with other techniques (thin engraving, black painting, etc.).

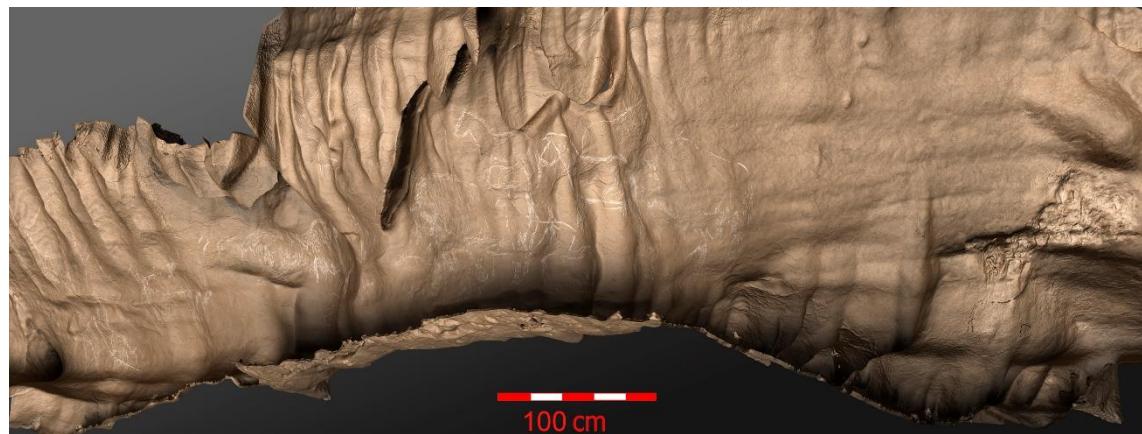
Owing to the similarity of the ensemble to other portable and parietal art dated directly and contextually, especially because of the presence of some ibex in frontal view, it can be firmly attributed to the Final/Upper Magdalenian (ca. 15-13.5 ka). This chronological proposal coincides with the contextual dates obtained for one of the phases of use in the cave (14.7-13.9 ka), obtained from dating several scattered charcoals and a fixed fire beneath the panels. One of the most representative samples was found attached to one of the flint tools (a blade) that was found under the main panel of the cave (Sector J) and whose traces of use confirm that it was probably used to make some figures of the same panel (Garate et al., 2023).



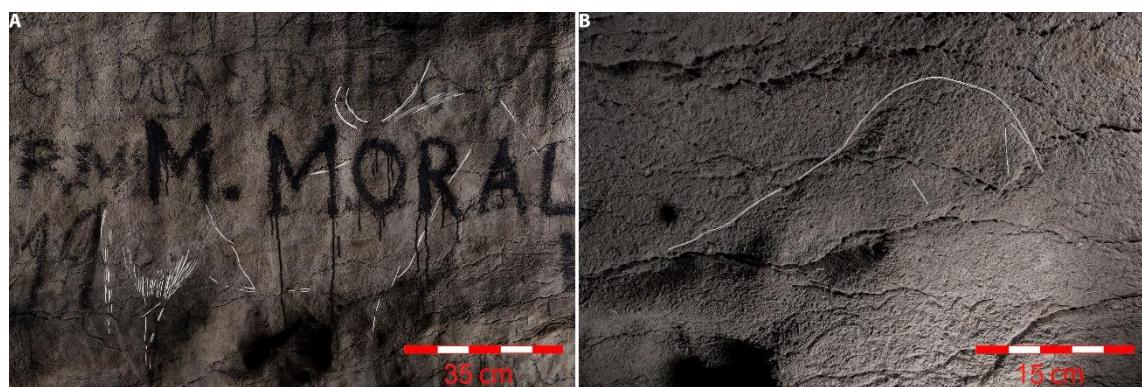
**Figure S1-24.** A) Bear or Reindeer engraved and painted in black Atr.G.II.01 (D. Garate). B) Engraved goat Atr.F'.III.06 (D. Garate; Tracing: S. Salazar). **SI-24 Irudia.** A) *Atr.G.II.01 beltzez margotu eta grabatutako hartza edo elur-oreina.* B) *Grabaturiko Atr.F'.III.06 ahuntza.*



**Figure S1-25.** A) Panels D.IV, D.V and D.VI, with bison and horses engraved and painted in black, in Sector D or the “Hall of the Bison” (O. Rivero). B) C.I Panel with bear claw marks, covered with engravings of goats, bison and a horse in Sector C or the “Alcove of the Claw Marks” (O. Rivero). **SI-25 Irudia.** A) *D sektorean edo “Bisonteen Gelan” grabaturiko eta beltzez margozturiko bisonteak eta zaldiak dituzten D.IV, D.V eta D.VI panelak (O. Rivero).* B) *Hartzen atzaparkadez beteriko C.I panela, grabaturiko ahuntzak, bisonteak eta zaldiak dituena C sektorean edo “Hatzapar Marken Ganbarara”-n (O. Rivero).*



**Figure S1-26.** Panels J.I and J.II with bison, horses, goats, hinds, deers and undefined animals and signs in the Sector J or the “Ledge of the Horses” (Photogrammetry and render: J. F. Ruiz-López, Tracings: O. Rivero, S. Salazar, I. Intxaurebe). **SI-26 Irudia.** *J Sektore edo “Zaldien Erlaitzeko” J.I eta J.II panelak, bisonteen, zaldien, ahunzen, orein eme eta arren eta zehaztu gabeko animali zein zeinuen grabatuak dituena (Fotogrametria eta renderizazioa: J. F. Ruiz-López, Kalkoak: O. Rivero, S. Salazar, I. Intxaurbe).*



**Figure S1-27.** A) Engraved horse, bison and an undefined animal in the panel I floor.I in the Sector I floor (it's located in the main passage level of the main gallery, and therefore is fully covered of graffiti) (O. Rivero). B) Engraved horse, using the shape of the rock J'floor.I.02 (S. Salazar). Its conservation is better, because it's located in a small side gallery. **SI-27 Irudia.** A) *Grabaturiko zaldia, bisonta eta animalia zehaztugabe bat Ifloor.I panelean, Ifloor sektorean (galeria nagusiaren pasabide nagusian dago, eta, beraz, grafitiz beteta dago) (O. Rivero).* B) *Zaldi grabatua, J'floor.I.02 harriaren forma erabiliz. (S. Salazar).* Kontserbazioa hobea da alboko galeria txiki batean dagoelako.

#### 4. EKAIN

##### Location

**ETRS89 / UTM ZONE 30N      X: 558775      Y: 4787273      Z: 90**

The cave of Ekain is located in the reef limestones with rudists and corals from the lower Aptian-Albian of the eastern slope of the hill of Ekain, inside the municipality of Deba (Gipuzkoa), at 90 metres above sea level, in the union of the valleys formed by the Sastarrain and Goltzibar streams (tributaries of Urola), at a distance of 6.6 km from the current coastline.

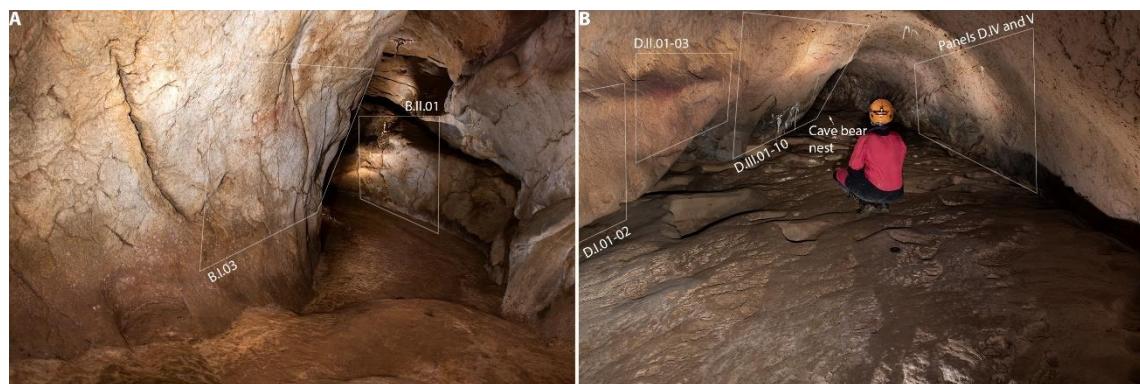
##### Brief topographic description

It is a network of horizontal galleries (although it is possible to find some subsidence and sudden changes in level creating several wells and cornices) of about 420 metres of development, and a general upward trend, which allows to gain differences in level of up to 17 metres with respect to the entrance (Galán, 1992). The direction of the galleries is rather variable, and because of the changes in gradient, as well as the numerous forms of erosion and paragenesis (roof channels, pendants, etc.), the cave seems to be a large maze of passages. In any case, we could distinguish the cave topographically, describing it as a large central room (“Erdialde”) from which numerous branches branch off in various directions. One of them allows access to the vestibule and the main entrance, where a prehistoric site was located, with levels from the transition moments between the middle and upper Palaeolithic (Châtelperronian), the Aurignacian, lower, middle and upper Magdalenian (these last two with elements of portable art), Azilian, Mesolithic and Neolithic (Altuna, 1984; 2019; Rios-Garaizar, 2011).

Regarding to the deep areas of the cave with archaeological remains, the access used by the Magdalenian societies surely started from the same vestibule, through a passage located at a lower level. This required crawling for about 10 metres (called by us Sector A), where we have recently located a small unpublished stain of red pigment on its southern side. Once passed, the cave continues through an ascending phreatic tube called “Erdibide” or Sector B, whose floor is formed by a stalagmitic flowstone, and where the first figurative representations are located, among which a bison painted in red stands out. A little further on, the tube through which we are accessing would join transversely with a larger descending gallery. Inside “Erdialde”, on its north wall there is a very narrow conduit that if we follow it will allow us to reconnect with the gallery that cuts it transversally. If we continue ascending this last gallery, we will find ourselves again at a crossroads of galleries, called Sector C, which contains a relatively flat low ceiling where there is a panel that contains a figure of a horse's head, a back line of a bison in black and an unpublished large bison painted in red. The gallery that starts orthogonally from there is “Ahuntzei” or Sector D, with engraved figures of deer and hind, black drawings of ibex and salmon, and dots and spots in red, and which runs parallel to the access tube or “Erdibide”. If instead of entering “Ahuntzei” we continued ascending, we would enter the “Erdialde” room or Sector E, whose west side stands out for containing several bear nests in the clay of the soil, as well as marks produced by the rubbing of torches, charcoals

on the ground, a painting of a horse in black and several shapeless stains in red, among which a simple sign (dot) and an indeterminate figure can be distinguished. If we cross it, maintaining the direction of the gallery through which we entered the room, we will enter a sector that runs in a southerly direction called Sector F, and whose roof descends progressively forming a crawlway, whose roof is full of remains of red pigment and torch marks. However, if instead of advancing to Sector F we follow a “path” outlined by a stalagmitic flowstone that formed the floor of several previous sectors (B, C and D), we will turn 90° to enter a new ascending gallery whose first section, still inside of the large “Erdialde” room, but distinguished by several side cornices and blocks, is called “Zaldei”, with several spectacular panels with polychrome, monochrome (in red and black) and engraved figures of horses, bison, ibex, deer and fish. Several branches depart from there, some of which contain archaeological remains and have been sectored by us as Sector G (with an engraved and painted bison, charcoal and fingerprints in the clay), H (or “Hartzei”, with two bears painted in black), I (with several stains of red pigment), J (or “Azkenzaldei” with several figures of horses and probable bison), K (or “La Fontana” with clay engravings of horses). This gallery would end in a bend called Sector L, with several figures engraved in the clay, and a couple of stains in red and black, where there would be a clogged access to the outside, practicable for several small animals that accumulate waste and organic material there.

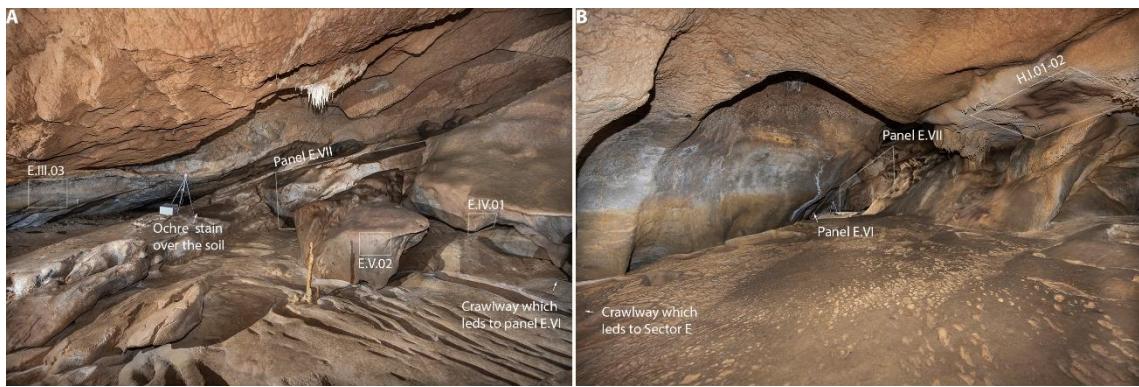
Outside of the sectors with archaeological materials, the cave presents other areas of geological and paleontological interest. The maze of galleries that is accessed by descending from the gallery that cut orthogonally the passage called “Erdibide” stands out, and that allows access to a lower sector from where it is possible to reach two semi-blocked entrances that connect with the outside<sup>57</sup>. Another entrance to the interior of the Ekain cave, today artificially filled, allowed connection with an exterior cave through a very narrow passage that started from a bear nest located in “Ahuntzei”.



**Figure S1-28.** A) Sector B or “Erdibide”. B) Sector D or “Ahuntzei” (showing the rock art). [SI-28 Irudia. A\) B sektorea edo “Erdibide”. B\) D edo “Ahuntzei” sektorea \(labar-artearen kokapena zehaztuz.](#)

<sup>57</sup> On February 8, 2024, while exploring this network to look for the collapsed entrances, S. Salazar and I. Intxaurbe located a labyrinth of extremely narrow meandering galleries full of shapeless red ochre stains (provisionally nicknamed the U.S.S.R. gallery because of the colour) that demonstrated that prehistoric visitors explored them. As there is a long section without archaeological remains between this area and the last archaeological zones (sector B), and there appear to be collapsed or blocked entrances nearby, we are waiting for more studies to understand the functioning of this new network.

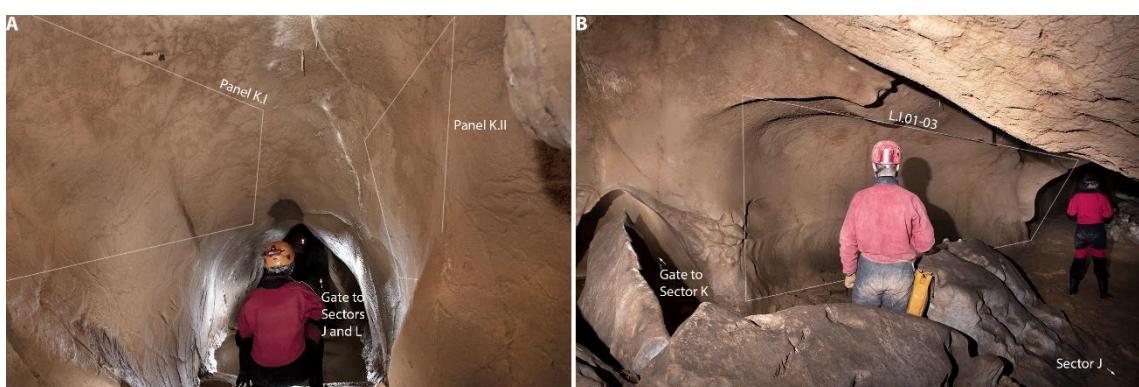
PAPER V: SUPPLEMENTARY MATERIALS – MATERIAL OSAGARRIAK



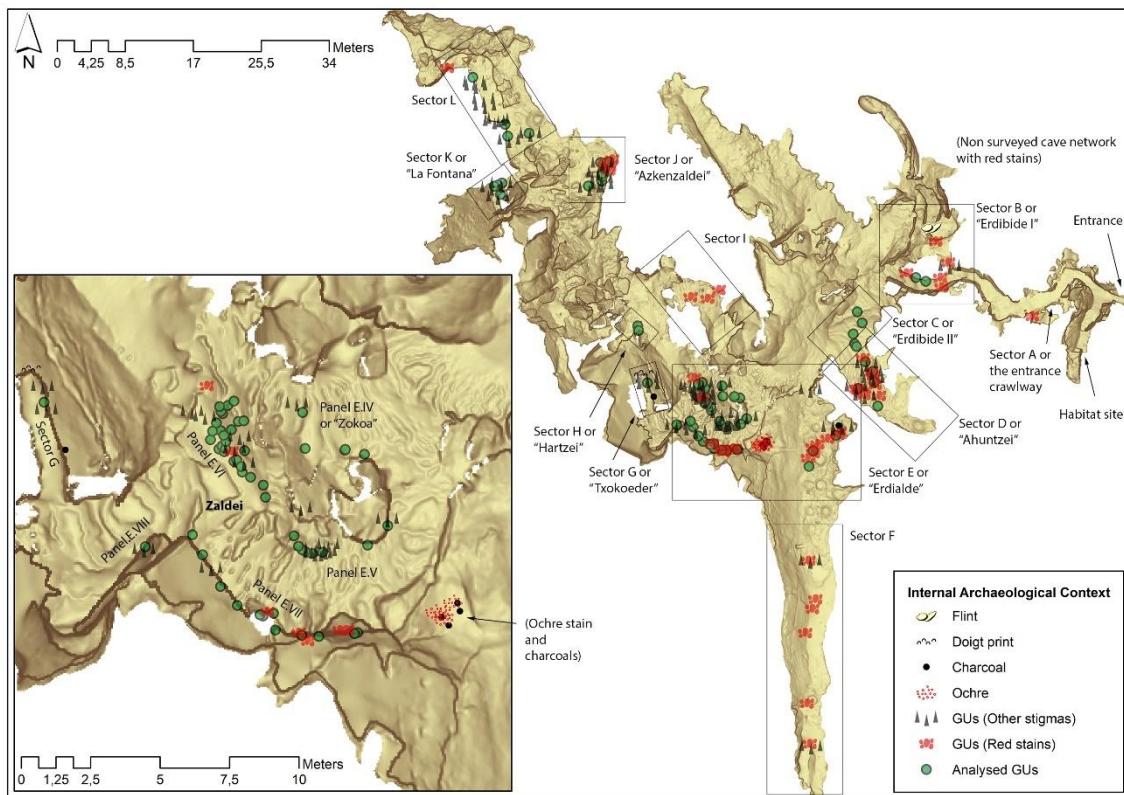
**Figure S1-29.** A) Sector E or the hall “Erdialde” (S. Salazar). B) Sector H or “Hartzei”, looking forward Sector E (S Salazar). *S1-29 Irudia. A) E Sektorea edo “Erdialde” gela (S. Salazar). B) H edo “Hartzei” sektorea, E Sektorerantz begira (S. Salazar).*



**Figure S1-30.** Zone “Zaldei” of the cave of Ekain (part of Sector E), where the most impressive panels are located, with polychrome paintings and engravings. The ground is covered by *gours*, but there are also remains of the stratified and inclined rock (S. Salazar). *S1-30 Irudia. Ekaingo haitzuloko “Zaldei” eremua (E sektorearen zati bat). Bertan daude panel ikusgarrienak, margo polikromatu eta grabatuekin. Lurra gours-ez estalita dago, baina haitz estratifikatu eta inklinatuaren testiguak ere badaude (S. Salazar).*



**Figure S1-31.** Last sectors of Ekain: A) Sector K or “La Fontana”. B) Sector L, looking from “Azkenzaldei” (Sector J). *S1-31 Irudia. Ekaingo azken sektoreak: A) K edo “La Fontana” sektorea. B) L sektorea, “Azkenzaldei”-tik begiratuta (J sektorea).*



**Figure S1-32.** Topographic plan of the cave of Ekain, showing the archaeologic evidence (I. Intxaурbe over 3D survey of GIM Geomatics). *SI-32 Irudia. Ekaingo leizeko plano topografikoak, aztarna arkeologikoak erakusten dituena (I. Intxaурbe, GIM Geomatics-en 3D-az baliatuz).*

### The cave art

The group of rock art known today in Ekain is the result of numerous reviews and specific visits that have added new discoveries (Altuna & Apellaniz, 1978; González Sainz et al., 1999; Altuna & Mariezkurrena, 2008; Fano et al., 2012; Garate et al., 2015c; Ochoa et al., 2018; 2019). In the visits carried out within the framework of the project directed by M. Arriolabengoa, we have located numerous unpublished evidence, some of them figurative (such as a large bison painted in red in Sector C, or an indeterminate animal motif in a vertical position on the main panel Ek.E. VI). That is why for our study we have made a provisional inventory. The GUs of the cave were found in 12 sectors, among them 3 also contained superficial archaeological remains (scattered charcoals, fingerprints, a flint blade, and a big ochre stain): A, B, C, D, E, F, G, H, I, J, K and L. The rock art in the cave consists of 180 individualised graphic units (GU's), of which 44 represent horses, 18 bison, 6 ibex, 4 indeterminable zoomorphic figures, 3 hinds, 2 bears, 1 deer, 1 reindeer, 1 salmon and 1 fish. There are also 9 dots and a set of finger flutings. Regarding to the involuntary or very simple traces, there are 57 stains of red or black colour and 32 isolated or non-figurative lines. The paintings were created mostly with black pigment made from charcoal, although manganese pigment was used in some cases (Chalmin et al., 2002). Shallow engraving was also used (sometimes combined with the paintings), as well as finger engravings in soft surfaces, or scraping on some altered surfaces. The engravings are mostly fine and superficial.

Regarding to the chronology, we can propose two different moments for the decoration of the cave. A large part of the rock art of Ekain fits very well with some dated parietal or portable art of the Cantabrian and Pyrenean region, which attribute it to a phase that It would go from the middle Magdalenian to the beginning of the upper Magdalenian (17.5-14.5 ka). On the other hand, the goats in frontal view of the “Ahuntzei” gallery fit better with the advanced and final moments of the Magdalenian (15-13.5 ka). Several direct dates for the representations were obtained in the cave. Excluding those that are discardable due to insufficient treatment to eliminate modern contamination (H. Valladas, Personal Communication), given priority for the sake of conservation of the sample, one of the horses (Ek.E.VI.26) was dated in the Upper Magdalenian (15.161-14.275 ka), while the humic fraction gave a date for the beginning of the Middle Magdalenian (18.202-17.071 ka) (González Sainz, 2005b). We are waiting to know if the results of the new sampling carried out on the horse Ek.E.VI.20, in the same panel (Ochoa et al., 2021a), provide more information on this issue. In the visits carried out within the framework of the project directed by M. Arriolabengoa, we located several scattered charcoals on the surface of Sector E, some of them associated with a torch-mark existing there. In this room, in its central area, we located a large stain of ochre on the surface (similar to the one existing in Lumentxa), with some remains of scattered charcoal, unfortunately very poorly preserved due to the constant trampling of visitors, who have covered it with clay. On the other hand, in Sector G, M. Medina-Alcaide discovered charcoal adhered to the wall, and there are known traces produced by the introduction of fingers into a clay fill, covered by a stalagmitic flow. These remains add to a flint blade on a cornice that exists in Sector B (Altuna, 1997), whose use-traces were compatible with its use as a tool for engraving stone surfaces (J. Rios-Garaizar, Personal Communication). As no other post-Palaeolithic uses or visits are known in the cave (for example, funerary uses during the Holocene), it is very likely that these remains are contemporary with the graphic activity, so their dating could also help shed light on the chronology of the rock art.



**Figure S1-33.** A) Bison painted in black which uses the shape of the box-rock strata taking to depict the hump Ek.E.V.08. B) Brown bears painted with manganese Ek.H.I.01-02. **S1-33 Irudia.** A) Ek.E.V.08 beltzez margoturiko bisonteak, bere konkorra irudikatzeko kutxa-arroka estratifikatuaren formaz baliatzen dena maisuki. B) Manganesoz margoturiko hartz arreak Ek.H.I.01-02.



**Figure S1-34.** Polychrome and engraved horses, bison, goat and a fish, in the main panel “Zaldei” (Ek.E.VI) of the cave of Ekain (S. Salazar). **S1-34 Irudia.** Grabaturiko eta kolore anitzez margotutako zaldi, bisonte, ahuntz eta arrainak, Ekaingo “Zaldei” panel nagusian (Ek.E.VI) (S. Salazar).



**Figure S1-35.** Polychrome and engraved horses in the panel “Azkenzaldei” (Ek.J.I) of the cave of Ekain (S. Salazar). **S1-35 Irudia.** Grabaturiko eta kolore anitzez margotutako zaldiak Ekaingo “Azkenzaldei” panelean (Ek.J.I) (S. Salazar).

## 5. ALTXERRI

### Location

**ETRS89 / UTM ZONE 30N      X: 570214      Y: 4791021      Z: 25**

The Altxerri cave (Aia, Gipuzkoa) is on the eastern slope of Mount Beobetagaña, above the valley of the Altxerri river, a tributary of the Oria. The cavern develops in calcareous breccia and micritic limestone from the Maastrichtian – Danian period, alternating with bands of reddish and grey marl, 2.5 km from the current shoreline and 25 metres above sea level.

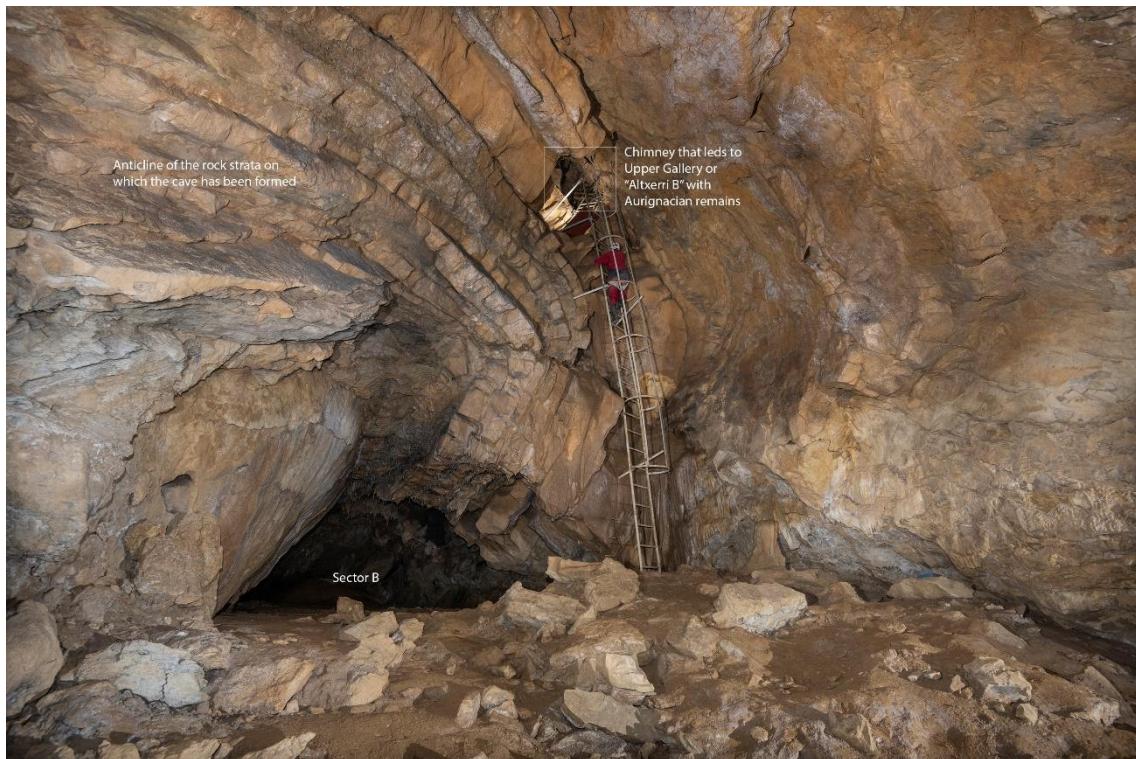
### Brief topographic description

The cave of Altxerri is a speleological network of 2.5 km developed in at least three levels (Galán, 2011). The conduits are highly conditioned by the stratification of the narrow bands of box rock (calcareous marls and sandstones). This gives a “squared” appearance to many of the galleries. In other sectors, the folding of strata has favoured structural weaknesses that have caused sporadic collapses. In fact, it is curious how the morphologies of the intermediate floor (through which the system is currently accessed) are repeated 16 metres higher (on the upper floor) but displaced from the lower axis by about 20 metres due to a dip of 45°. It seems that the anticline present in the stratification favoured both the width of the spaces (through collapses) and the connection between the floors. Given the unique structural characteristic of the massif into which the cave opens, water flows relatively easily through various points of the system, favouring the washing and deposition of fine materials. These are normally associated with open (semi) vertical conduits between the different levels, in whose most horizontal and lowest areas there are deposits of clay and silt. Other areas present lower infiltration water activity, with more sporadic active speleothems. There are also old generations of speleothems, mainly dome shaped formations, and ground flowstones.

In the areas closest to the artificial hole opened in 1956 which actually is the only access-point to the system, there would be the archaeological zone, which would occupy approximately the first 120 metres of the cave. In this area, the galleries are arranged in at least 3 main levels, with some sub-levels, connected to each other through vertical wells and/or very steep ramps, favoured by the geological structure on which the cave is based (especially by the stratification and the folding of stone supports) and the fillings of allochthonous materials that are preserved forming hanging floors. Through the current entrance we will reach an intermediate fossil level of the cave. In this area we can find the vestibule of the cave, which, based on the quantity and typology of the evidence located, does not seem to have been used as a habitat. A little further on there is a gallery that borders two sinkholes. Once past the second, the classical decorated sector would begin, composed of several groups of engravings and paintings, in addition to a set of two bison located in the lower part of a 6-metre well (which was called “Grupo de La Sima”). The stylistic conventions present in these first sectors are typical of the last phases of the Magdalenian. Shortly after passing the initial room of the cavern, a chimney develops in favour of the stratification of the lithology and an anticlinal fold. This initial climb of 12

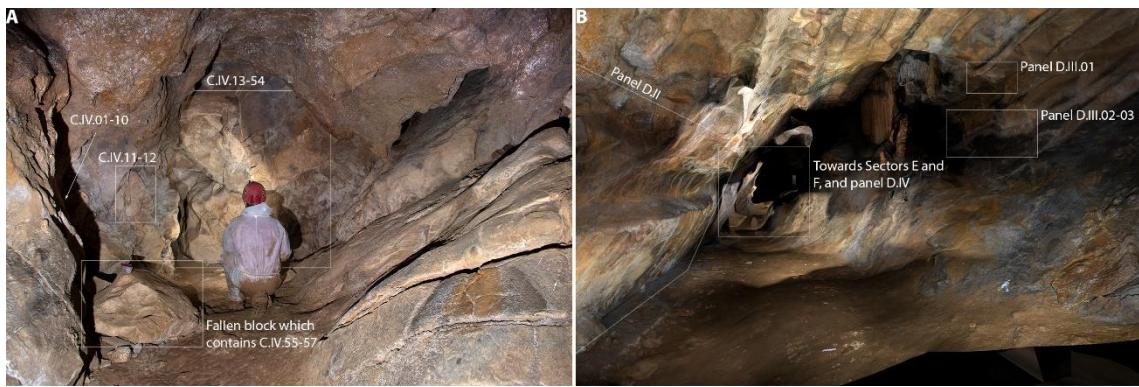
metres allows us to reach a higher level located at a height of +22 metres with respect to the current artificial entrance. In this upper sector, made up of two or three superimposed sub-levels and interconnected through vertical steps, there is another archaeological set, with superficial archaeological remains (burned bones, bones, charcoal, ochre, flint) and paintings (exclusively made in reddish or purple pigments). The radiocarbon dating and the stylistic parallels of the figures attribute this group to the Aurignacian period (González Sainz et al., 2013). In any case, it seems obvious to think that the two sets described (the lower and the upper) acted as two independent cave-sites, each with its respective entrances, currently collapsed. That is why it was decided to name the upper sector as Altzerri B (with an Aurignacian frequentation), independent of the lower level called Altzerri A (frequented -at least- during the Magdalenian).

Starting from the “Grupo de La Sima”, a low pass leaves us at the head of two galleries. Continuing towards the entrance, but at a lower level, we could reach a section of the active section of the cavern, which ends in a siphon located near (but 21 metres below) the current entrance, right in contact with the red insoluble sandstones. If we continue in the opposite direction, a low pass leaves us at the head of a ramp leads us to the active zone again (but in a section upstream). From here, we can go up to a deep development of the cavern, made up of a maze of active and fossils galleries located at different heights. Despite the geological and biological interest of these sectors, no elements of prehistoric anthropic origin are known in them, so it does not seem that they were frequented by human societies in the past.



**Figure S1-36.** Sector A, looking towards sector B that goes to the sectors with Magdalenian rock art (S. Salazar). To the left of the image you can see the fold of the strata that have conditioned the development and evolution of the cave. On the right is the contact of non-permeable permeable materials (Palaeocene siliceous sandstones). *A sektorea, Madeleine aldiko labar-arterea duten sektoreetara zuzentzen den B sektoreari begira (S. Salazar). Irudiaren ezkerrean, haitzuloaren garapena eta bilakaera baldintzatu duten geruzen tolestura ikus daiteke. Eskuinean, iragazkorraez diren material iragazkorren kontaktua dago (hareharri silizeoak, Paleozoikoa).*

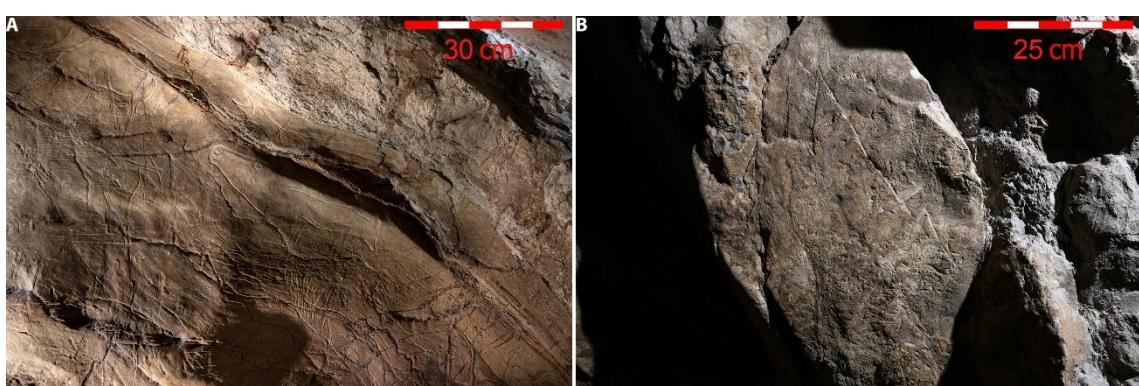
PAPER V: SUPPLEMENTARY MATERIALS – MATERIAL OSAGARRIAK



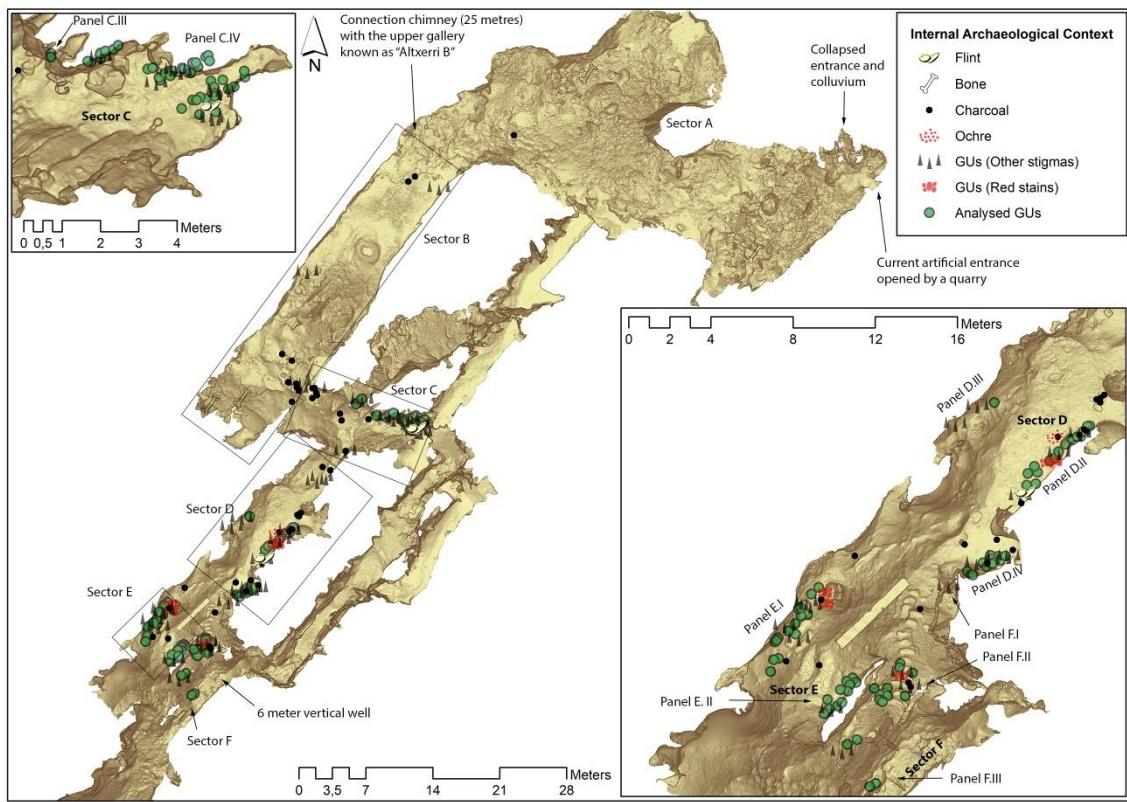
**Figure S1-37.** A) Sector C or “Group I”. B) Sector D or “Groups II and III” (towards the interior). *SI-37 Irudia. A) C sektorea edo “I Taldea”. B) D sektorea edo “II eta III Taldeak” (kobazuloaren sakonerantz begira).*



**Figure S1-38.** Last decorated sectors of Altzerri (E and F), around a chasm that connects with two lower levels. In sector F there is a 6 metre well, below which is the last panel F.III (S. Salazar). *SI-38 Irudia. Altzerriko azken sektore apainduak (E eta F), bi maila baxuagoekin lotzen duen amildegia baten inguruan. F sektorean 6 metroko putzu bat dago, eta haren azpian dago F.III (S. Salazar) azken panela.*



**Figure S1-39.** A) Engravings of bison, anthropomorphic, reindeer and fox Alt.C.IV.06-10 (D. Garate). B) Flounders Alt.C.IV.11-12 (D.Garate). *SI-39 Irudia. A) Bisonteen, antropomorfoaren, elur-oreinaren eta azeriaren grabatuak Alt.C.IV.06-10 (D. Garate). B) Alt.C.IV.11-12 Platuxak (D. Garate).*



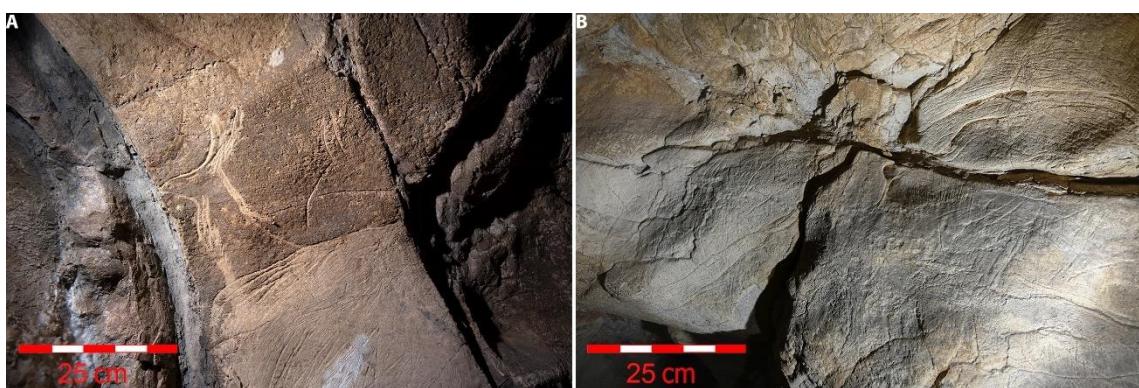
**Figure S1-40.** Topographic plan of the cave of Altzerri, showing the archaeologic evidence (I. Intxaурbe over 3D survey of GIM Geomatics). **S1-40 Irudia. Altzerriko leizeko plano topografikoa, aztarna arkeologikoak erakusten dituena (I. Intxaурbe, GIM Geomatics-en 3D-az baliatuz).**

### The cave art

Starting from the latest inventory of Paleolithic rock art carried out in Altzerri (Ruiz-Redondo, 2014), and limiting ourselves to the sector with Magdalenian art named as “Altzerri A”, we have prepared a database of graphic elements to which we have added some new identified motif in the latest projects carried out in the cave (protection and geomorphological study led by D. Garate, and study of the archaeological context, led by M.Á. Medina-Alcaide). Among the discoveries would be two possible stylized female figures, and several spots of red paint, unpublished until now in the part with Magdalenian art. The GUs of the cave were found in 5 sectors, among them 4 also contained superficial archaeological remains (scattered charcoals, two flint pieces, bones, and some probable chips of ochre): B, C, D, E and F. The rock art in the cave consists of 166 individualised graphic units (GU's), of which 70 represent bison, 8 indeterminable zoomorphic figures, 7 reindeers, 5 ibex, 3 chamois, 2 anthropomorphic (1 male and 1 ambiguous), 2 stylized female figures (FFS), 2 aurochs, 2 hind, 2 saiga antelope, 2 flounders, 1 salmon, 1 undeterminable fish, 1 bird, 1 bear, 1 snake, 1 fox and 1 deer. There are also 12 complex signs: 4 sets of paired strokes, 2 arrows, 2 cross shaped signs, 2 ovoid shape signs, 2 circular or subcircular shaped signs (although an alternative interpretation for one of them could interpretate it as the anus of a male anthropomorphic figure). Regarding to the involuntary or very simple traces, there are 21 isolated or non-figurative lines and 15 stains of red or black colour. The paintings were created mostly with black pigment made from charcoal, although shallow engraving was also used (sometimes combined with the

paintings) as well as red pigment probably made by iron oxide. The engravings are mostly fine and superficial, although there are cases that go deeper. Finger engraving could be seen in some of the GUs, and scraping was also used, combining sometimes with other techniques (thin engraving, black painting, etc.). Two engravings also contain some abrasion in the groove to give it volume.

Owing to the similarity of the ensemble to other portable and parietal art dated directly and contextually, it can be firmly attributed to a time between the Middle Magdalenian and the final Upper Magdalenian (ca. 16.5-13.5 ka). There is no guide fossil, such as goats in frontal view, that determines their belonging to a specific phase. However, the radical schematization when drawing some animals, almost “expressionist” (for example, bison that are reduced to an amalgam of lines that represent the abundance of fur), seems more typical of the final phases of the Magdalenian, with stylistically very close specimens present in the Atxurra cave, dated in the Final Magdalenian (14.7-13.9 ka). On the contrary, Altzerri contains figures of cold fauna that are not known in Atxurra, such as reindeer, which become the second most important theme of the cave, in terms of the number of representations. Therefore, it cannot be ruled out that it contains art that was made at an earlier time (perhaps at the end of the middle Magdalenian). Therefore, it is not ruled out that it contains art that was made at an earlier time (perhaps at the end of the Middle Magdalenian), or even later as could have been a cold oscillation within the Greenland Interstadial 1 (Older Dryas or Dryas II? Between 14-13.5 ka). The discovery of several scattered charcoals within the project led by M.Á. Medina-Alcaide, some discovered under an eroded stalagmitic flowstone, opens the possibility of being able to date a phase of human frequentation that could be linked to the execution of the art. These remains would be added to those located by J.M. Barandiarán (1964a), including the ephemeral occupation layers located at -30 and -80 depth in the vestibule, which contained some charcoals and two fragments of flint in each level (a sheet in the first and a tiny flake in the second).

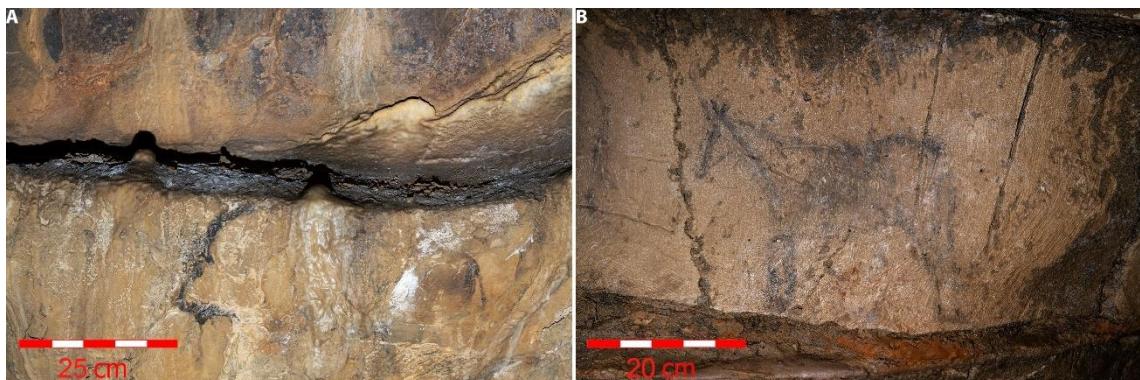


**Figure S1-41.** A) Engraved saiga antelopes Al.C.IV.24-25 (D. Garate). B) Engraved bird and bison Alt.C.IV.34-35 (D. Garate). *SI-41 Irudia. A) Grabaturiko saiga antilopeak Al.C.IV.24-25 (D. Garate). B) Grabaturiko txoria eta bisonteak Al.C.IV.34-35 (D. Garate).*

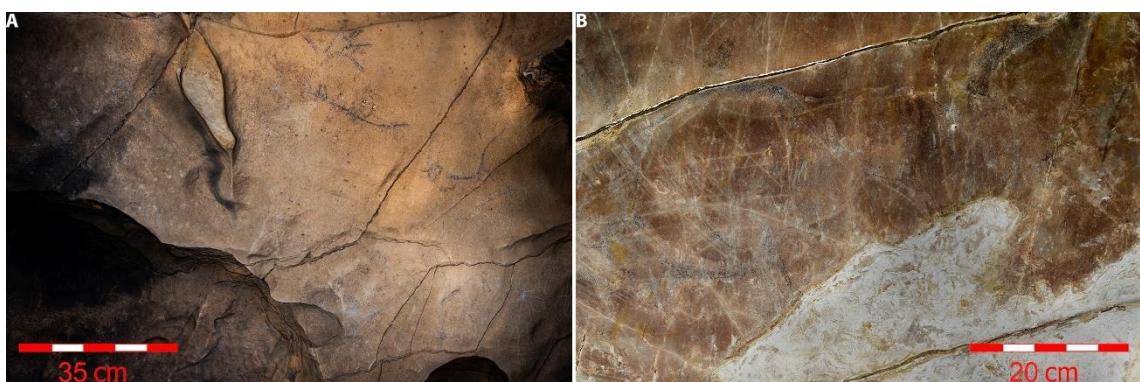
**Figure S1-42 (next page).** A) Engravings of fish (genus *Sparidae* and *Salmonidae*), cross-shaped signs and a vertical bison (with a black painted line on the chest) Al.C.IV.49 and 50-53. B) Bison prints; a male Anthropomorph, with a radiating circular sign at the level of the anus; and three series of paired signs Al.C.IV.42-48 (D. Garate). *SI-42 Irudia. A) Arrainen grabatuak (Sparidae eta Salmonidae generokoak), gurutze itxurako zeinuak eta bisonte bertikal bat (bularrean beltzez margotutako marra batekin) Al.C.IV.49 eta 50-53. B) Grabaturiko bisonteak; Antropomorfo maskulino bat, uzkiaren parean erradiatutako zeinu zirkular batetkin; eta trazatu pareen hiru serie Al.C.IV.42-48 (D. Garate).*



**Figure S1-43.** A) Engraved hare Alt.C.IV.50 (D. Garate). B) Engraved reindeer and snake Alt.E.II.09-10 (D. Garate). **S1-43 Irudia.** A) *Grabaturiko erbia* Alt.C.IV.50 (D. Garate). B) *Grabaturiko elur-oreina eta sugea* (Alt.E.II.09-10) (D. Garate).



**Figure S1-44.** A) Bison painted in black Alt.D.II.18. B) Chamois painted in black over scraped surface Alt.E.I.08 (D. Garate). **S1-44 Irudia.** A) *Alt.D.II.18 beltzez margoturiko bisontea*. B) *Alt.E.I.08 beltzez margoturiko sarrioa karrakatutako gainazealean* (D. Garate).



**Figure S1-45.** A) Deer, bison and aurochs painted in black and engraved Alt.F.II.05-09 (D. Garate). B) Bison in black and sketched Alt.F.III.01-02 (D. Garate). **S1-45 Irudia.** A) *Alt.F.II.05-06 panela* (D. Garate). B) *Panel Alt.F.III.01-02* (D. Garate).

## 6. AITZBITARTE IV

### Location

**ETRS89 / UTM ZONE 30N      X: 589641      Y: 4790572      Z: 223**

The cave of Aitzbitarte IV is opened in the western slope of the hill of the same name (Erreteria, Gipuzkoa), above the valley of the river Landarboso, a tributary of the Urumea. The cavern develops in bioclastic calcarenites, together with smaller areas of massive micritic limestones, limestones with silicifications, and schistose limestones, from the Upper Albian, 8.3 km from the current shoreline and 223 metres above sea level.

### Brief topographic description

The cave of Aitzbitarte IV has 280 metres of development, which forms a cave-system with the nearby Aitzbitarte V, developed in at least two levels and some sub-levels with 54 metres of unevenness. The cavern has several branches that allow access to other sub-floors of the system. On the left side of the entrance hall, it is possible to access to a lower hall where there start some short galleries that end a few metres from a branch that also starts on the left of the entrance to Aitzbitarte III. The same thing happens at the bottom of the cave, where some fissures and vertical sinkholes allow access to semi-active galleries located at the level where the main gallery of Aitzbitarte III opens (Manteca et al., 1997). Other branches, however, start in intermediate sections of the main gallery and access another upper level of caves in the system, where the sector of animals modelled in clay, and the chimney that connects with Aitzbitarte V, are located.

It is the largest of the caves in the massif, with a main entrance 19 m wide by 9 metres high, which gives way to a descending vestibule (Sector A), with a floor full of blocks and whose sediment was emptied resulting from ancient or uncontrolled excavations, as well as space conditioning for military or industrial purposes (mushroom cultivation). In this area there were levels of habitat attributable to at least the Aurignacian (with doubts), Solutrean, Badegoulian, lower, middle and upper Magdalenian, Azilian, Chalcolithic/Bronze Age and Iron Age (Barandiarán Ayerbe, 1961b; 1963a; 1963b; 1964b; 1965; Barandiarán Maestu, 1967; Utrilla, 1981; 1986; Straus, 1983).

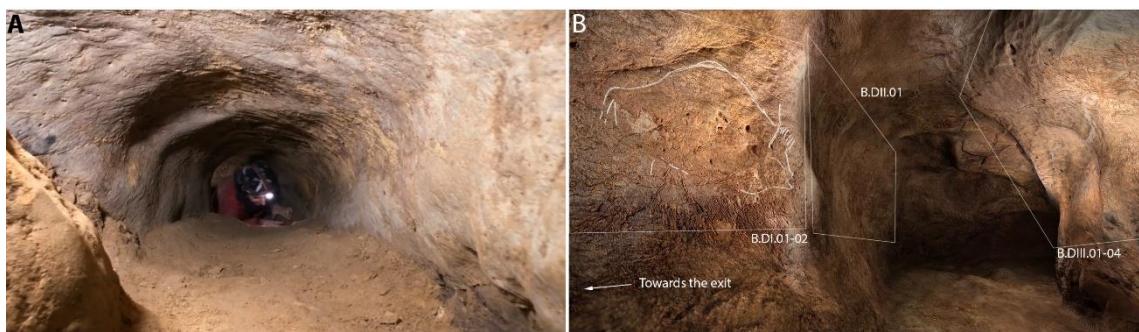
Going inside, we access a large gallery, with the floor occasionally covered with large blocks, and at one point we can observe the presence of a wall that partially closes the gallery, perhaps related to a mycological exploitation that took place in this cavity (Manteca et al., 1997). From this point on, the soil sediment becomes a uniform and compact clay layer, linked to its conditioning for mushroom cultivation at the beginning of the 20th century.

Starting from this gallery, crossed successively by orthogonal fissures (which were filled during the works in the cave for mushroom cultivation), it is possible to access two vertical chimneys. These take us to two floors located at a height of 20 and 25 metres from the gallery floor. Sector B, or the “Chimney of Modelled Clay Animals”, is in one of them. On the other you access Aitzbitarte V, an intermediate area between the entrance and the decorated sectors of this last cavern.

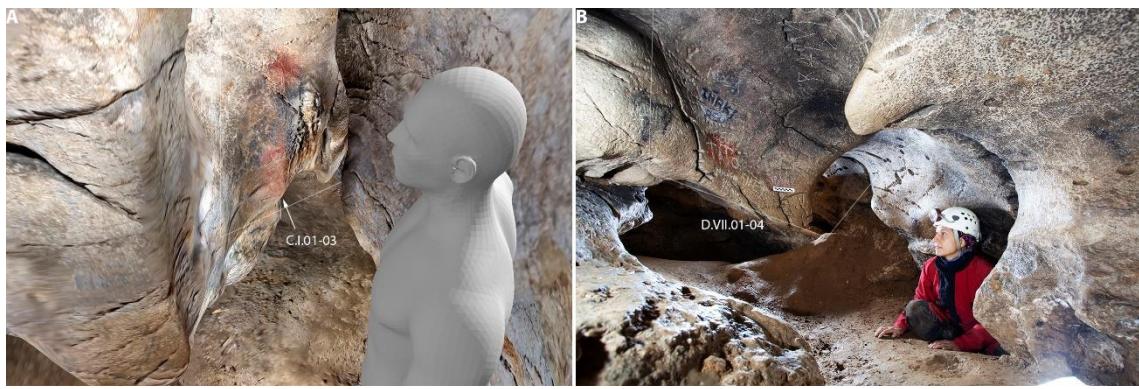
Further inside, a narrow and short gallery excavated geologically on one of the transverse joints allows us to access the final room of the cave, where stairs carved into the rock allow us to descend to the lower final hall of the cave (Sectors C and D). In our incursions we observed the speed with which the infiltration waters reach this gallery of Aitzbitarte IV, forming notable water streams, that subside to lower cave-levels. In this room, in marginal areas that are difficult to access due to their narrowness, there are several panels with rock art made in red paint.



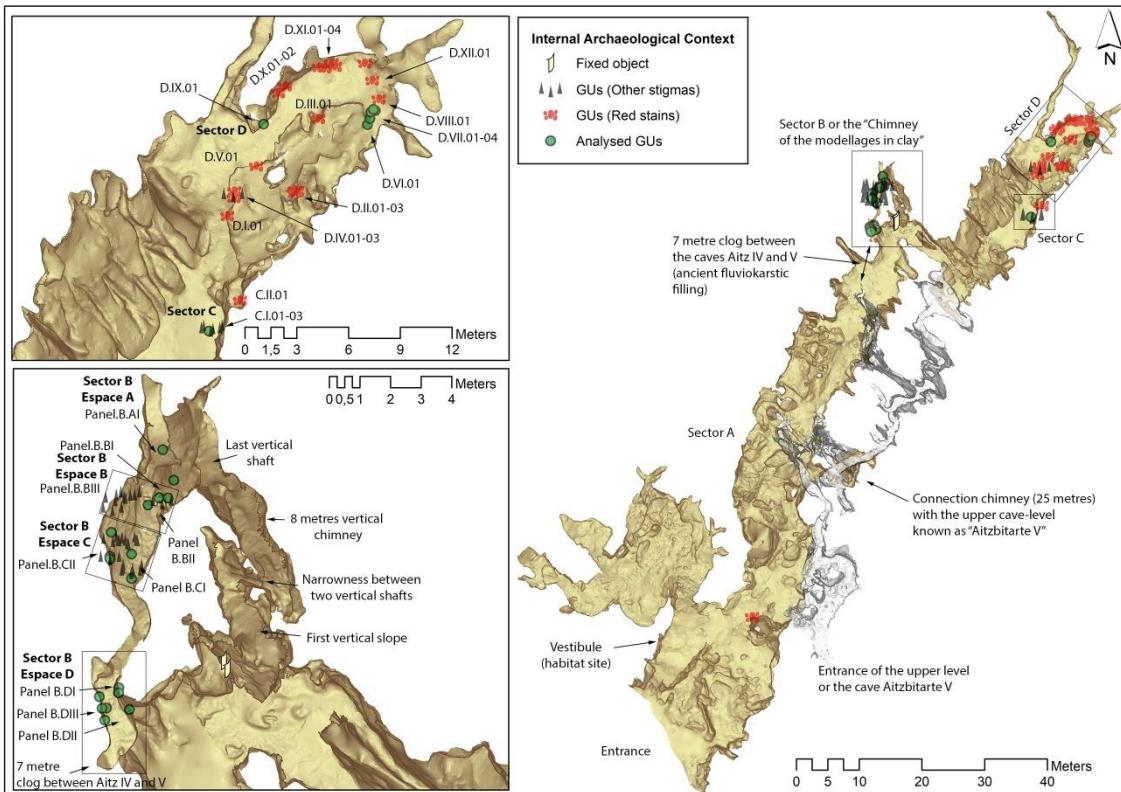
**Figure S1-46.** **A)** 8 metre vertical chimney at the access to sector B, equipped with a ladder to climb (S. Laburu). **B)** Narrowness located between two sections of vertical rise (S. Laburu). **C)** Final section of arrival to sector B (D. Garate). **D)** Access chimney, seen from space “B” of the sector. In the foreground you can see the writing of the small vulva Ait.IV.B.BII.01 (D. Garate). **S1-46 Irudia.** **A)** 8 metroko tximinia bertikala Aitzbitarte IVko B sektorerako sarbidean, igotzeko eskala batekin horritua (S. Laburu). **B)** Igoera bertikaleko bi zatiren arteko estutasuna (S. Laburu). **C)** B sektorerako iristeko azken tartea (D. Garate). **D)** Sarrerako tximinia, sektoreko “B” espaziotik ikusita. Lehen planoan, Ait.IV.B.BII.01 alu txikiaren grafia ikus daiteke (D. Garate).



**Figure S1-47.** **A)** Very narrow inclined crawlway to reach the last panels of Sector B (S. Laburu). **B)** Textured three-dimensional model (GIM Geomatics) seen from the access gate to space. At the end there is a fluvio-karst sediment that plugs the conduit and ends Sector B. After a clogged sector of at least 7 metres, the conduit would connect with a lateral branch of Aitzbitarte V. **A)** *Arrapalan dagoen katazulo oso estua, B sektoreko azken paneletara doana (S. Laburu).* **B)** *Hiru dimentsioko eredu ehundua (GIM Geomatics), espazioa sartzeko katazulotik ikusita. Amaiera sedimentu flubiokarstikoz beteta dago, hodia estali eta B sektoreari amaiera ematen diona. Gutxienez 7 metroko sektore kolmatatu baten ondoren, hodiak Aitzbitarte V-ren alboko adar batekin lotuko luke.*



**Figure S1-48.** A) Paragenetic lateral meander containing panel C.I (S. Laburu). B) Deepest part of the Sector D (S. Laburu). **S1-48 Irudia.** A) C.I panela duen meandro parageneetikoa (S. Laburu). B) D sektoreko sakoneneko sektorea (S. Laburu).



**Figure S1-49.** Topographic plan of the cave of Aitzbitarte IV, showing the archaeological evidence (I. Intxaubre over 3D survey of GIM Geomatics). **S1-49 Irudia.** Aitzbitarte IV leizeko plano topografikoa, aztarna arkeologikoak erakusten dituena (I. Intxaubre, GIM Geomatics-en 3D-az baliatuz).

### The cave art

The first evidence of rock art was discovered in 2012, and later, in 2017, an important set of animal figures engraved and modelled in clay was found in a chimney more than 20 metres from the current floor of the gallery. While the research projects have lasted, specific discoveries have been added, especially in a final room of the cave, and a complete inventory has not been published yet. However, there are some partial inventories (Garate et al., 2013d; 2020d). The GUs of the cave were found in 4 sectors (in one of them we have also distinguished 4 sub-sectors). The sectors with rock art are A (the vestibule), B (the “Chimney of Modelled Clay Animals”, with its 4 sub-sectors: B.A; B.B; B.C and B.D), C and D (the last two located in the last hall of the cave).

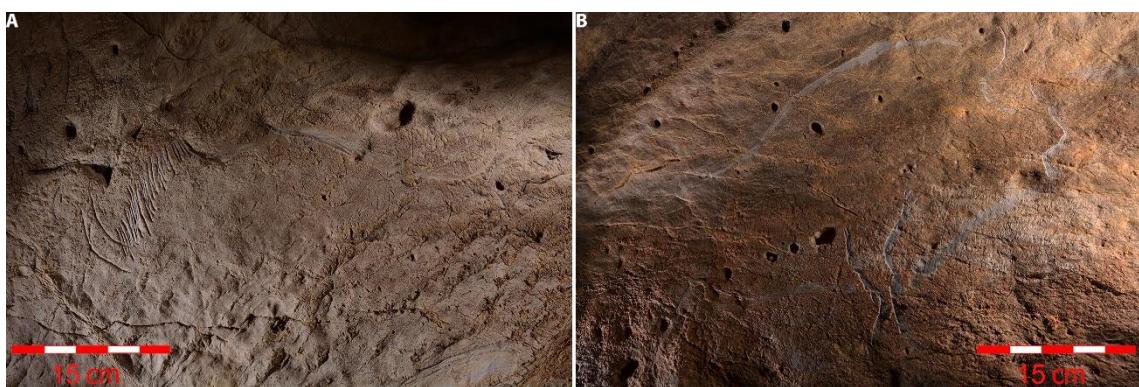
The rock art in the cave consists of 59 individualised graphic units (GU's), of which 11 represent bison, 3 horses, 2 zoomorphic figures hard to identify, 2 vulvas, 1 reindeer and 1 ibex. There are also four signs (1 rectangular shaped sign and 3 dots), 3 series of finger flutings and involuntary or very simple traces (13 isolated or non-figurative lines and 19 stains of red pigment). The paintings were probably made by iron oxide. In some places where the wall had a layer of alteration that produces a decalcification clay, finger engravings were used, as well as extractions and modelling using the hands to create volume. In harder walls there are some engravings which are mostly fine and superficial, although there are cases that go deeper, especially when the support is softer. Scraping was also used in some cases, and some figures were made combining sometimes several techniques.

An attempt was made to date contextually the engravings of the Sector B (the "Chimney of Modelled Clay Animals"), trying to date one of the two bones and animal teeth which were found inserted on fissures where the chimney starts, with no success. However, because of the similarity with other dated portable and rock art, it can be firmly attributed to a time between the Middle Magdalenian and the first phase of the Upper Magdalenian (ca. 17.5-14.5 ka). For example, the way to represent the closed eye or the foreleg of bison, could be found in other directly dated representations in the Middle Magdalenian (e.g., Covaciella, 17.3-16.9 ka). Representations executed on clay are frequent in other groups mainly located in the Pyrenees (Tuc d'Audoubert, Montespan, Bedeilhac, Erberua, Oxocelhaya, Fontanet, Labouïche and Etxeberri), although they are also known in the Cantabrian Sea (La Garma and El Castillo) and Dordogne (e.g., Les Combarelles and La Calevie). In the cases in which the groups have been contextually dated (Tuc d'Audoubert, Etxeberri, Fontanet and La Garma), the dates are from the Middle Magdalenian.

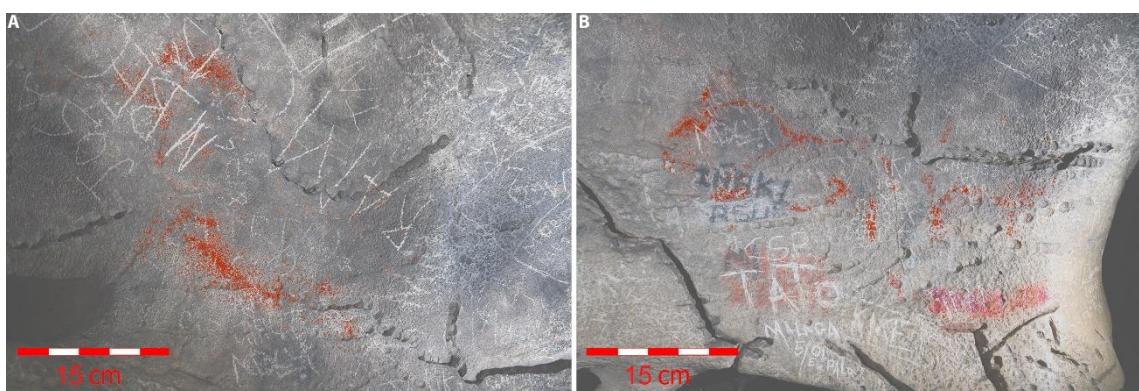
Regarding to the rock art painted in red that appears in the final room, it has raised many doubts since its discovery in 2012, especially on its chronology. In the Cantabrian region, caves decorated in red paint are common and belong to a chronology prior to the Magdalenian (mainly Aurignacian and Gravettian, perhaps Solutrean). That is why at first the figures seemed to belong to that time frame. However, there are also known caves almost exclusively decorated in this color (red) that belong to the Magdalenian, such as Lumentxa. The discovery of a group of three animals (a horse, a bison, and an animal that is difficult to determine, perhaps an ibex) in 2020 shed light on this question: The way of representing the bison, with a sinuous "S"-shaped horn and two legs in perspective, seemed more typical of late chronologies of the Palaeolithic (Magdalenian). We believe that the initial doubts must be understood by the painful conservation of the set of red paintings, which prevents a correct interpretation of the figures, in a could have also occurred in the cave of Morgota (Garate et al., 2015a).



**Figure S1-50.** Bison and reindeer Ait.IV.B.Cl.03-06 engraved and modelled in clay (S. Laburu). A 3D model can be consulted in: <https://skfb.ly/6RQ8G>. **S1-50 Irudia.** Grabatu eta buztinean modelaturiko Ait.IV.B.Cl.03-06 bisonte eta elur-oreina (S. Laburu). 3D modelo bat hurrengoe stekan ikusi daiteke: <https://skfb.ly/6RQ8G>.



**Figure S1-51.** A) Engraved bison Ait.IV.B.DIII.02 (O. Rivero), very similar to the bison n° 8 of the deepest gallery of Combarelles III (Cleyet-Merle et al., 2016). B) Engraved bison Ait.IV.B.DIII.04 (O. Rivero). The support is covered with a thin clay layer which makes the figures very visible. **S1-51 Irudia.** A) Bisonte grabatua Ait.IV.B.DIII.02 (O. Rivero), Combarelles IIIko galeria sakoneneko 8. bisontearen oso antzekoa (Cleyet-Merle et al., 2016). B) Bisonte grabatua Ait. IV.B.DIII.04 (O. Rivero). Euskarria buztinezko geruza mehe batez estalita dago, eta horrek oso agerian uzten ditu irudiak.



**Figure S1-52.** A) Horse painted in red Ait.IV.D.VII.01 (D. Garate; Tracing: I. Intxaурbe). B) Bison, undeterminable animal (goat?) and a rectangular shape sign Ait.IV.D.VII.02-04 (D. Garate; Tracing: I. Intxaурbe). **S1-52 Irudia.** A) Ait.IV.D.VII.01 zaldi gorria (D. Garate; Kalkoa: I. Intxaурbe). B) Ait.IV.D.VII.02-04 Bisonte, animalia ezezaguna (ahuntza?) eta zeinu laukizuzena (D. Garate; Kalkoa: I. Intxaурbe).

## **7. AITZBITARTE V**

### **Location**

**ETRS89 / UTM ZONE 30N      X: 589666      Y: 4790584      Z: 251**

The cave of Aitzbitarte V is opened in the western slope of the hill of the same name (Erreteria, Gipuzkoa), above the valley of the river Landarboso, a tributary of the Urumea. The cavern develops in bioclastic calcarenites, together with smaller areas of massive micritic limestones, limestones with silicifications, and schistose limestones, from the Upper Albian, 8.3 km from the current shoreline and 251 metres above sea level.

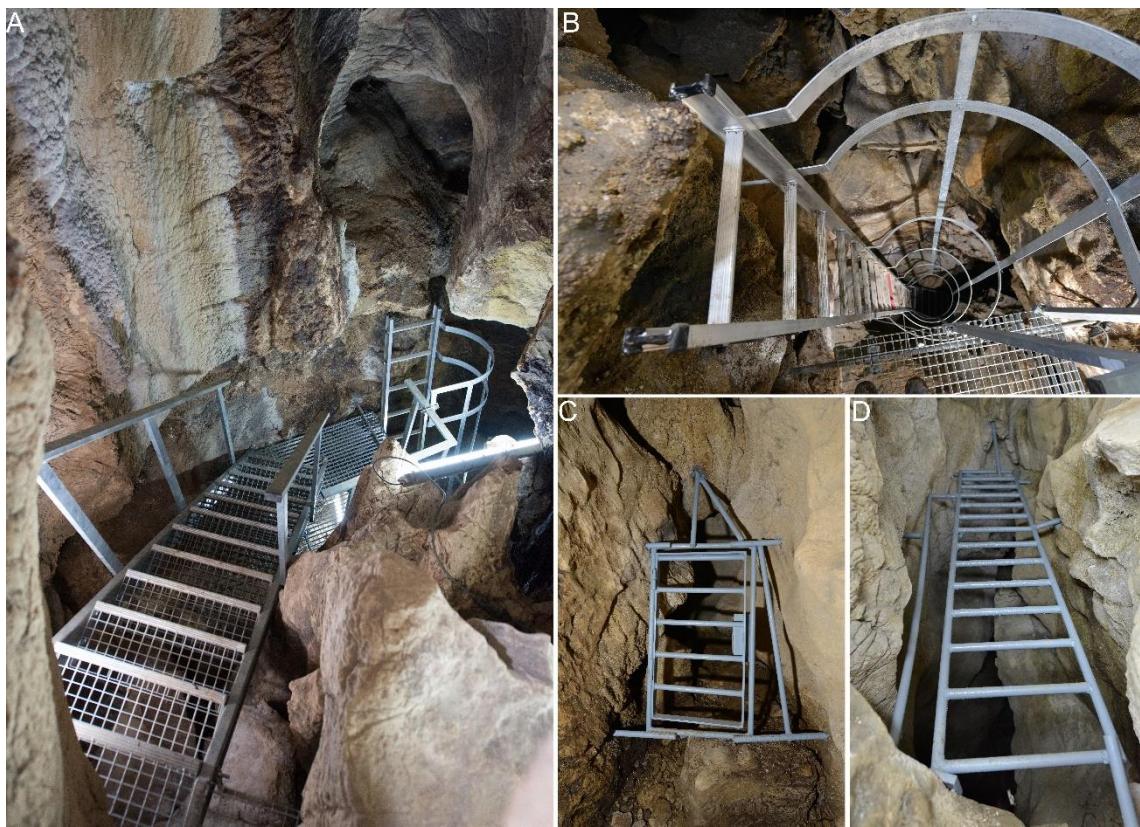
### **Brief topographic description**

The cave of Aitzbitarte V has 95 metres of development, which forms a cave-system with the nearby Aitzbitarte IV, developed in at least two levels and some sub-levels with 54 metres of unevenness. It was originally described as a single meandriform conduit of about 25 m in development, about 3 m in width and about 2.20 in height (Manteca et al., 1997). In its deepest part, some obstructed crawlways were observed. The surveys carried out within the karstic system showed that these blocked passaged were very close to the end of what is known as the “Gallery of the Bears”, which was accessed through a vertical chimney of about 25 metres from Aitzbitarte IV. In the entrance hall of this cave, there were found some remains of lithic industry, pottery, remains of macrofauna, molluscs and a fragment of human skull (Altuna et al., 1995). Later, within the framework of the opening of the blocked crawlway carried out by the Felix Ugarte Elkarte speleological group in 2015, abundant prehistoric pottery fragments were found, some of them probably from the Bronze Age, as well as a sheet of large flint blade obtained by pressure flaking. Ceramic remains have also been found on the other side of the crawlway and even at the foot of the chimney that connects with Aitzbitarte IV.

It has been observed that this originally blocked crawlway that allowed the connection between the entrance and the deep sectors bifurcates into two ways, allowing access to two differentiated sectors that meet again farther. On the one hand, the left branch connects with the upper part of the vertical chimney that connects Aitzbitarte IV and V. On the other hand, the branch on the right connects directly with the “Gallery of the Bears”, allowing easier and more direct access to the decorated area of it.

This gallery was named as that because of the multitude of cave-bear nests that are preserved on the floor of the cave, as well as to the numerous claw marks which could be observed in its walls. The first section of the gallery after the well maintains minimum dimensions of 2 m wide and 3 m high, and a total development of about 60 metres.

In the final section, a small climb allows access to an interconnected sector through ledges and phreatic tubes. The first sector (Sector A) would be composed of a ledge that connects the “Gallery of the Bears” with the deepest areas using a hanged passage. The Sector B is a narrow hallway accessible by a phreatic tube under Sector A. A final climb allows to reach the Sector C, a narrow passage which connects with the final hall of the cave, Sector D.

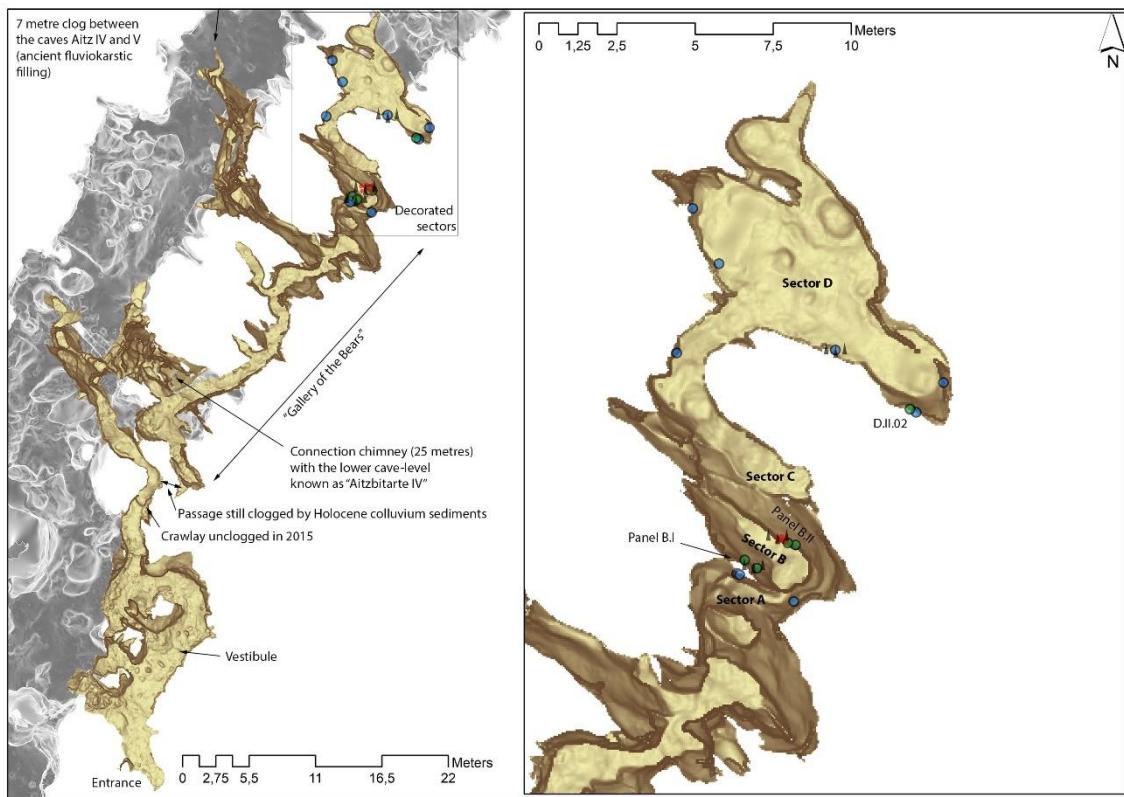


**Figure S1-53.** Current aspect of the chimney connecting the cavities of Aitzbitarte IV and V: **A)** and **B)**, vertical section of the chimney, **C)** and **D)** current closure existing from Aitzbitarte IV (S. Laburu). *SI-53 Irudia. A) eta B) Aitzbitarte IV eta V barrunbeak lotzeko tximiniaren egungo itxura, tximiniaren zati berikala, C) eta D) gaur egungo itxitura, Aitzbitarte IVtik ikusita (S. Laburu).*



**Figure S1-54.** **A)** Threshold of access to the decorated sectors, showing the arch leading to sector B (1). **B)** Image of the view from sector C, showing the window (2) and the arch leading to Sector B (1). **C)** Sector B, with the access arch (1) (S. Laburu). *SI-54 Irudia.*

A) A) Dekoratutako sektoreetara sartzeko atalasea eta B sektorera daraman arkua (1). B) C sektoretik egindako bisa, B eta A sektoreen arteko leihoa (2) eta (1) arkua ikusiz; C) B sektorea eta sarrera-arkua (1) (S. Laburu).



**Figure S1-55.** Topographic plan of the cave of Aitzbitarte V, showing the archaeological evidence (I. Intxaubur over 3D survey of GIM Geomatics). **S1-55 Irudia. Aitzbitarte V leizeko plano topografikoa, aztarna arkeologikoak erakusten dituena (I. Intxaubur, GIM Geomatics-en 3D-az baliatuz).**

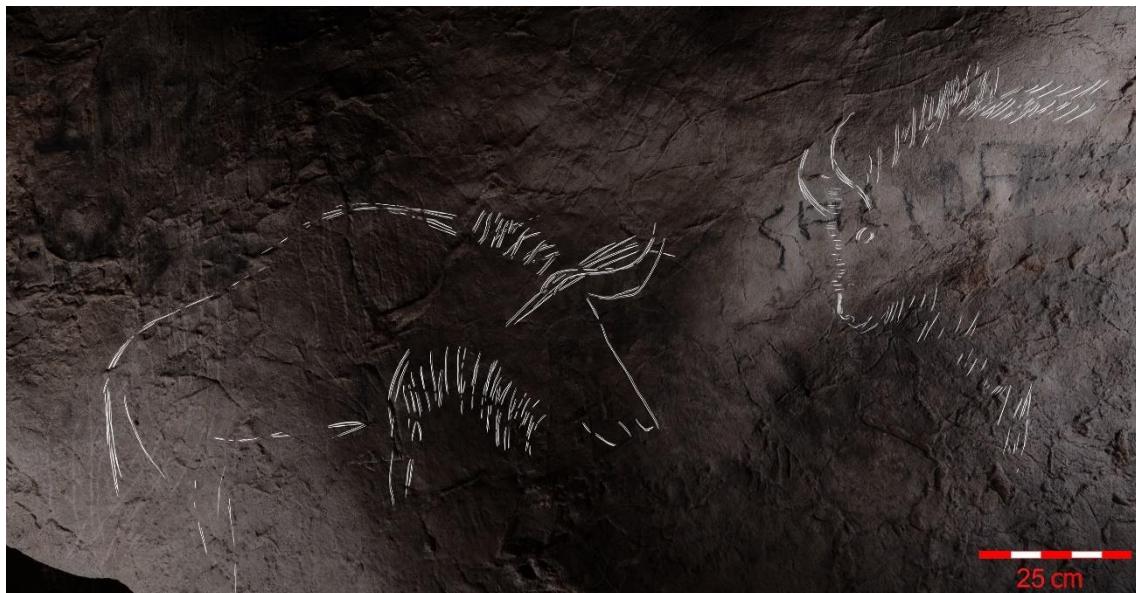
### The cave art

The rock art in this cave was initially located in 2015, limited to Sector B, which contained 4 bison engraved in Magdalenian style, and some lines that were difficult to interpret (Garate et al., 2016c). In 2017, new evidence was found in Sectors A and D, with parallels in Gravettian art, which turned Aitzbitarte V into a diachronic or long-traditional complex. Finally, in 2020, more engravings were found in Sectors C and D, all of them assignable to the first graphic cycle of the cave, although one of the figures in the last sector (two sinuous horns in the shape of an "S") present technical parallels (the use of a similar tool) and stylistics (sinuous horns and in correct perspective) with the Magdalenian bison of Sector B (Garate et al., 2020c).

The rock art in the cave consists of 18 individualised graphic units (GU's), of which 11 represent bison and 1 zoomorphic figure hard to identify. There are also two signs (1 ogee shaped sign), 1 series of finger flutings and involuntary or very simple traces (3 isolated or non-figurative lines and a red stain). The paintings were probably made by iron oxide. The engravings are mostly fine and superficial, although there are cases that go deeper. Finger engraving could be seen in one of the GUs.

As we have previously indicated, some of the graphics in sectors A, C and D have parallels in terms of theme -mainly bison- and style -absence of perspective- in the movable and parietal art of Gravettian chronology (30-23 ka) in the area. of the French

south/west (Isturitz, Gargas, Cussac, etc.), or style -absence of perspective- of a larger territory that covers the Mediterranean (Cosquer, El Parpalló, etc.) and greater chronological (also Solutrean) (Garate et al., 2020a). The whole of sector B, and perhaps a representation of sector D, presents a greater affinity with the Magdalenian style. Furthermore, the detail of the lines to represent the frontal line of the bison has only been found in specimens from the Middle Magdalenian (17.5-15) (Rivero, 2010).



**Figure S1-56.** Engraved bison and a line (stigma) Ait.V.B.I.01-3 (O. Rivero). *S1-56 Irudia. Ait.V.B.I.01-03 grabaturiko bisonteak eta marra (O. Rivero).*



**Figure S1-57.** **A)** Engraved pair of bison head Ait.V.B.II.01.02 (O. Rivero). **B)** Engraved pair of bison partial parts Ait.V.D.II.01-02 (O. Rivero). The first one (from the left) is Gravettian (Garate et al., 2020c), but the second has different features that support its Magdalenian chronology: first of all, it has been made with a different tool, which leaves a groove in the shape of a "W," instead of a single deep and thin groove that the Gravettian-style engravings in this chamber and the preceding sector (C) have. In fact, this "W"-shaped groove is observed in the Magdalenian-style engravings of Sector B. Furthermore, the style of representing the horns (in perspective and in "S" shape) is more typical (though not exclusive) of Magdalenian chronologies. *S1-57 Irudia. A) Bisonte aurrealde bikote grabatua Ait.V.B.II.01-02 (O. Rivero). B) Bisonte grabatu bikote batzen zati isolatuak Ait.V.D.II.01-02 (O. Rivero). Lehendabizikoa (ezkerretik) Gravette aldikoa da (Garate et al., 2020c), baina bigarrenak ezaugarriz ezberdin batzuk ditu bere Madeleine aldiko kronologiararen alde egiten dutena: lehenik eta behin, erraminta ezberdin batekin egin da, "W" itxurako ildoa uzten duena, areto honetako eta aurreko sektoreko (C) Gravette estiloko grabatuek duten ildo bakar sakon eta fin baten ordez. Izan ere, "W" ko ildo hori B sektoreko Madeleine estiloko grabatuetan ikusten da. Gainera, adarrak irudikatzeko estiloa (perspektibean eta "S" forman) Madeleine aldiko kronologietakoa da (baina ez esklusiboki).*

## **8. ALKERDI 1**

### **Location**

**ETRS89 / UTM ZONE 30N      X: 619828      Y: 4792224      Z: 155**

The cave of Alkerdi 1 is opened in the western slope of a small hill (Urdazubi-Urdax, Nafarroa/Navarra), above a sinkhole where the Urtxume stream enters, in the valley of the Urdazuri or La Nivelle river. The cave develops in red limestones with rudists from the Albian/Turonian, 17.1 km from the current shoreline and 155 metres above sea level.

### **Brief topographic description**

The Alkerdi 1 cave is part of a complex speleological network, which is characterized by the development of more than 5 km in 5 different cave-levels and 80 metres of elevation gain. The cave is situated on the 4th cave-level and has a known development of ca. 160 m and 5 m vertically.

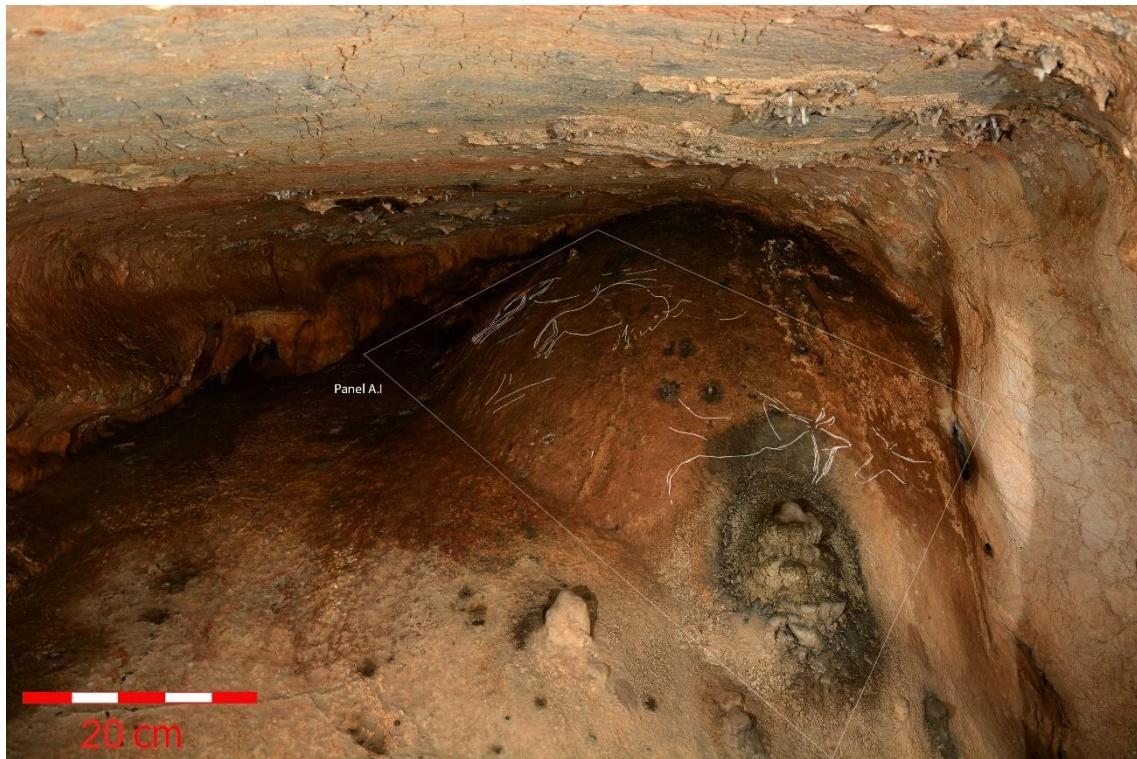
The spacious entrance porch (11 x 5 metres) allows access to the vestibule. Actually, it is a rather uncomfortable space with low ceilings, and the excavations carried out there have only documented a sporadic level of occupation dating back to the Gravettian (Barandiarán Maestu et al., 2010).

In a sector located at the back of the vestibule that D. Garate and O. Rivero (2015a) called Sector C, I. Barandiarán Maestu (1974) pointed out the existence of two anomalous engravings due to their morphology, which have not been recognized again.

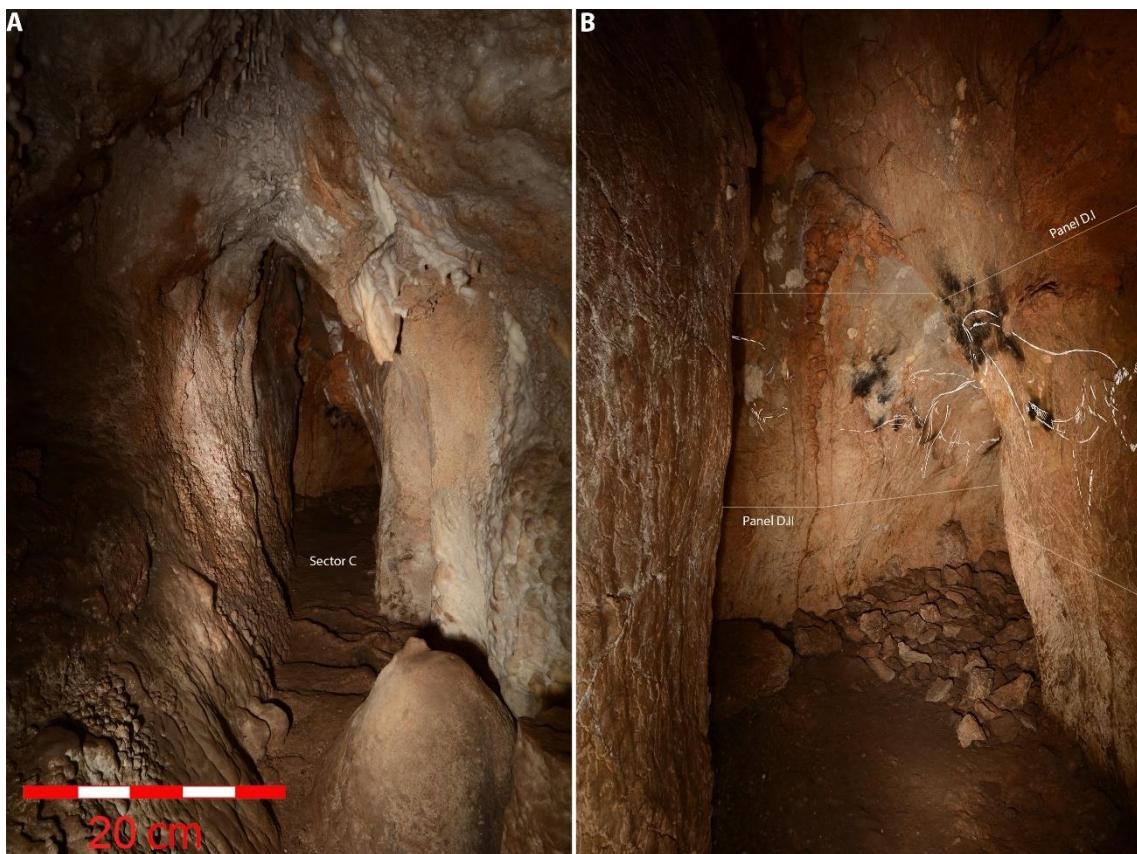
At the back of the hall, in its left area, a gallery begins, at first with a slope produced by the colluvium of sediment that rushes towards a central subsidence, called Sector B, which contains an engraving on its left wall. At the end of this gallery, in a bend there is a stalagmitic formation (a flowstone) in the shape of a dome (Sector A or “Stalagmitic Mogote”) with a set of animal engravings.

If, instead of advancing through the gallery on the left, we continue towards the right of the vestibule, we will cross a rather irregular sector with meanders that start from the ceiling. In this paragenetic conducts (ceiling channels), a tooth of herbivore was found (perhaps belong to an equid). It has yielded an Aurignacian chronology of 38.615 – 37.020 cal ka ( $33600 \pm 270$  uncal BP, Beta-431389). It may have a human origin, but for now we have no more evidence to certify it, so we keep it out of it.

Subsequently, a room with a low ceiling opens, and on one of its walls there is a gallery that reduces in size until it becomes a very narrow meandering duct, called the “Gallery of the Bison” or Sector D, which contains the largest set of engravings. This gallery opens again to the second room of the cave after a very narrow passage.

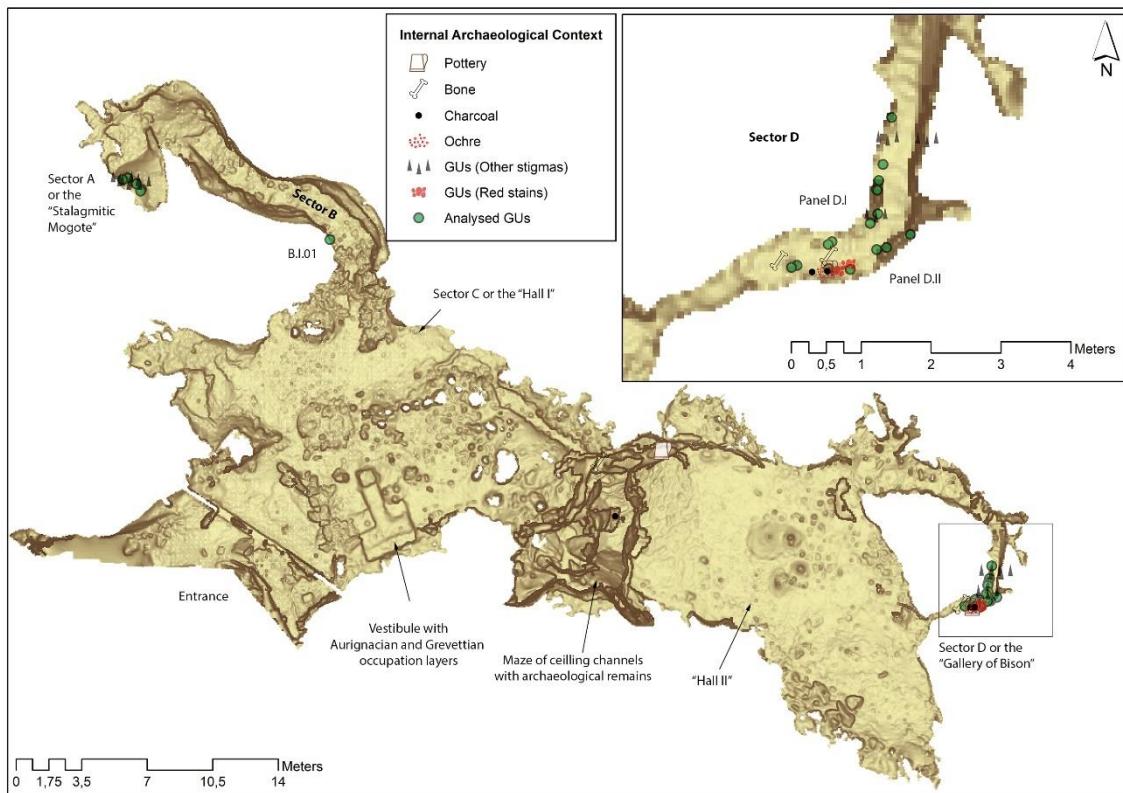


**Figure S1-58.** Sector A of Alkerdi, with the “Stalagmitic Mogote” that gives it its name (D. Garate; Tracing: O. Rivero). *S1-58 Irudia. Alkerdiko A sektorea, izena ematen dion “Mogote Estalagmitikoarekin” (D. Garate; Kalkoa: O. Rivero).*



**Figure S1-59.** **A)** Entrance to the narrow meandiform duct that forms Sector D or the “Bison Gallery” (D. Garate). An active speleothem is observed in the foreground, above an older *gours* pavement. **B)** Area of concentration of engravings from Sector C. The soil is formed by allochthonous clasts, on top of the aforementioned ancient *gours* soil (anthropic contribution?). On the floor there are diachronic materials, reducing cooking pottery fragment, ochre, charcoal, and a bone dated to the middle ancient Magdalenian (D. Garate). *S1-59 Irudia. A) D sektorea edo “Bisonteen galeria” osatzen duen hodi meandriforme estuko sarrera (D. Garate). Lehen*

*planoan espeleotema aktibo bat ikusten da, gours-ez osaturiko zoladura zaharrago baten gainean. B) C sektoreko grabatuen kontzentrazio-eremuia. Lurra harixka aloktonoz osatuta dago, lehen aipatutako gours-zoru zaharraren gainean (ekarpen antropikoa?). Lurrean material diakronikoak daude, murrizte egostezko zeramika zatia, okrea, ikatza eta erdi Madeleine aro zaharrean dataturiko hezurra (D. Garate).*



**Figure S1-60.** Topographic plan of the cave of Alkerdi 1, showing the archaeologic evidence (I. Intxaarbe over 3D survey of GIM Geomatics). **S1-60 Irudia. Alkerdi 1 harpeko plano topografikoa, aztarna arkeologikoak erakusten dituena (I. Intxaarbe, GIM Geomatics-en 3D-az baliatuz).**

## The cave art

The rock art of this cave is mainly made up of two main sectors, which not only seem spatially distant, but also belong to different ways to make the figures (and perhaps chronological moments): Sector A or the “Stalagmitic Mogote” and Sector D or the “Gallery of the Bison”.

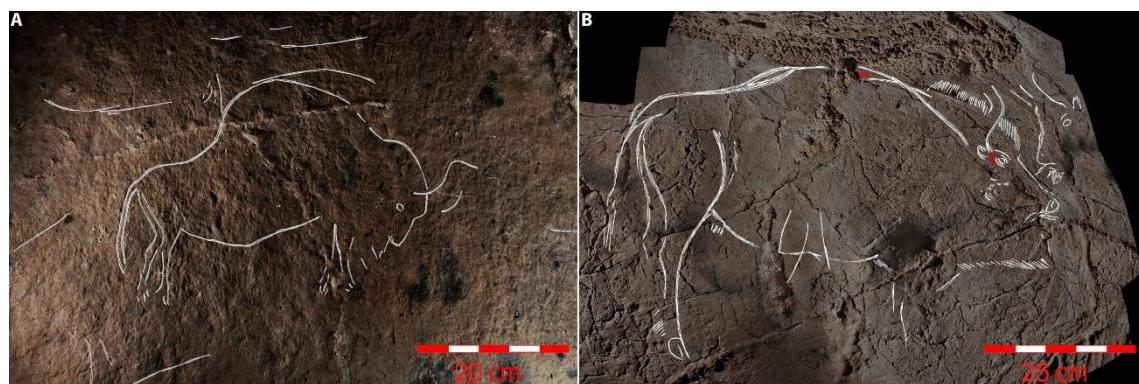
Based on the inventory that was carried out based on the last study of the cave's rock art (Garate & Rivero, 2015b), the cave contains 31 individualised graphic units (GU's), of which 14 represent bison, 4 zoomorphic figures hard to identify, 3 horses, 1 deer and 1 aurochs. There are also one signs (1 series of two dots), and involuntary or very simple traces (6 isolated or non-figurative lines and 1 stain in black pigment). The paintings were probably made by iron oxide and charcoal. The engravings are mostly fine and superficial, although there are cases that go deeper. Some figures were made with a combination of several techniques.

Regarding its chronology, the (re)discovery of the "Gallery of the Bison" and its study already pointed to the differences in style between sectors A and D. The bison in the first sector have a hump and lack of signage of the fur, something more typical of the central area of the Cantabrian Sea such as in Hornos de la Peña (Garate & Rivero, 2015a). On

the contrary, the bison of Sector D mark their fur profusely, being a characteristic more typical of the Pyrenees, with examples in Trois Frères, Niaux or Marsoulas. In fact, this cave has another similarity with the bison of Alkerdi 1, and it is the way of representing the bison's horns in perspective, with the distant horn located behind the horn in the foreground, when it is usual to see just the contrary. This characteristic is not only exclusive to Marsoulas, but is also observed in the Dordogne area (Rouffignac or Font-de-Gaume) and the Cantabrian Region (Altamira). All these representations (especially in the case of Altamira, Font-de-Gaume and Marsoulas) have been dated to recent times of the Lower Magdalenian, or early Middle Magdalenian. This assessment has been confirmed by the contextual dating of a long bone, probably bovid, with cut marks located just below the figures of Sector D, in a place with complicated access and close spatial relationship, in 18.425-18.12 ka.

As for the second set (Sector A), the chronology that was traditionally assigned to it in the Lower Magdalenian (e.g., Barandiarán Maestu et al., 2010), was based on the presence of a deer with a "striated" head. Although this characteristic, traditionally attributed to the lower Magdalenian of the Cantabrian Region, does not seem exclusive to these chronologies (Rivero et al., 2019a), with more recent known examples in Atxurra or Altzterri, nor regional (e.g., Marsoulas, Fritz et al., 2016a), the way of representing the bison, as we have previously mentioned, is more typical of the Cantabrian Region. The contextual dating obtained in the Hornos de la Peña cave, with figures of that style (bison with rounded hump without representing the fur), also covers a chronological period similar to that of Sector D (18.646-18.036 ka) (Medina-Alcaide, 2020).

In summary, and without excluding the possibility that the art of Alkerdi 1 was also made in more recent phases of the Magdalenian, we believe that there is sufficient evidence to propose that it contains the oldest artistic group that we have included in our study.



**Figure S1-61.** **A)** Engraved bison Alk.A.I.03 (D. Garate & O. Rivero) from the Sector A, or the “Stalagmitic Mogote”. **B)** Engraved pair of bison and red points Alk.D.II.05-08 (D. Garate & O. Rivero). Note the way to represent the horn in the back part of the one in the foreground, characteristic visible in other caves as Marsoulas, Font-de-Gaume, Rouffignac or Altamira. **SI-61 Irudia. A) “Mogote Estalagmitikoaren”, edo A sektoreko Alk.A.I.03 bisonte grabatua (D. Garate & O. Rivero). B) “Bisonteen galeria” edo D sektoreko bisonte grabatuak eta puntu gorriak Alk.D.II.05-08 (D. Garate & O. Rivero), egin kasu adarrak egiteko era bereziari, bat aurreneko planoan dagoenaren atzean baitago, Marsoulas, Font-de-Gaume, Rouffignac edo Altamira bezalako haitzuloetan errepikatzen den ezaugarria.**

## **9. ETXEBERRIKO KARBIA**

### **Location**

**ETRS89 / UTM ZONE 30N      X: 669350      Y: 4776457      Z: 448**

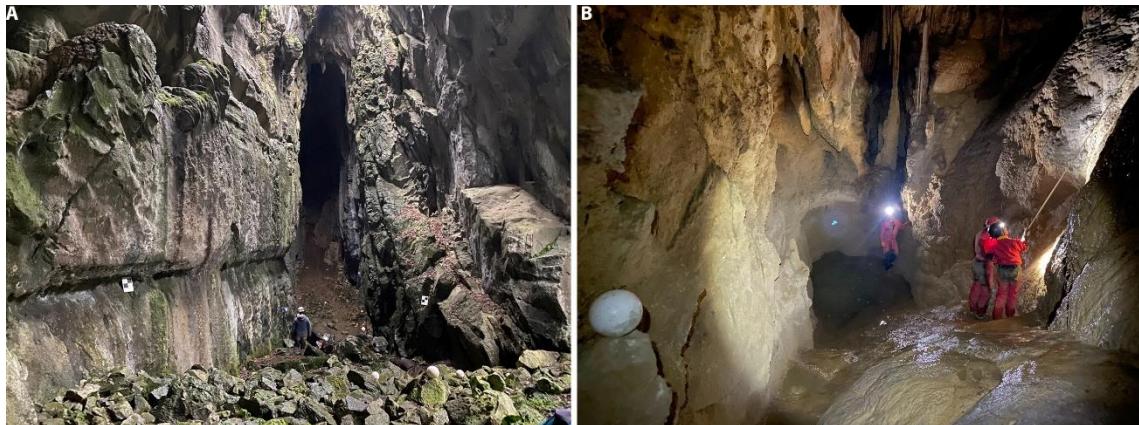
Etxeberriko Karbia opens in the Upper Aptian Urgonian limestones of the “Ascune” series (Vanara, 2000), on the eastern slope of Hardegainxardeka (or "Axkoargibela" mountain) (852 metres), located in the municipality of Gamere-Zihiga (Zuberoa), at an altitude of 448 metres above sea level and 66 kilometres from the current shoreline.

### **Brief topographic description**

Etxeberriko karbia has the shape of a large rectilinear canyon of approximately 240 metres of longitudinal development, with a height that sometimes reaches 30 metres, but a width of less than 10 metres, with few exceptions. This gallery is filled in some points by collapses and detrital and lithochemical sedimentation, which forms large, steep slopes, and basins that fill with infiltration water at various points, forming temporary lakes. It presents a known topographic development of 541 metres and a cumulative difference in altitude of 63.5 metres, +12 and -51.5 metres with respect to the entrance level. On both sides of the gallery is possible to see terracing in the form of horizontal notches, as well as hanging horizontal floors.

Firstly, there would be the entrance hall of the cave (Sector A), whose floor is covered with large fallen blocks, and soon a steep ascent begins until reaching the “Gallery of the Gour-s” (Sector B). At the top of this gallery, just after a protection fence placed there, the conduit begins to descend towards the “Gallery of the Lakes” (Sector D). The first two lakes were full of water for at least a good part of the last century. The temporary water current that feeds them begins right at the point where the fence is located and coincides with a place where excavations were carried out that confirmed the existence of occupation layers from the Neolithic to the Roman era (Ebrard, 2013a). Currently, the water course has been diverted so that it flows towards the “Gallery of the Gour-s” first, reaching the vestibule afterwards, where the stream disappears between the blocks. The third lake is fed by infiltration waters that fall from a large flowstone located there (so it is only possible to find it half empty in the summer), and these end up in a lower network accessible through vertical sinkholes of between 7 and 10 metres located shortly after. If we continue along a risky elevated passage over these vertical jumps, but surmountable using the opposition technique (exerting pressure on both walls) and secured with a rope, we will reach the foot of a stalagmitic flowstone. If we climb this obstacle (6 metres), we will reach a ledge from which a very narrow crawlway begins. This ends abruptly in a jump of two vertical metres, which leaves us in the “Salle des Peintures” (Sector E), the main sector of the cave, regarding to the rock art and archaeological remains. Descending a steep, almost vertical 7 metres ramp, we will reach the “Room of the Sinkhole” (Sector F), named as this because of the sinkhole of the “Angel”, an impressive 16-metre abyss. Near this topographical accident are located the last four decorated sectors: the “Narrowness” (Sector G), the “Decorated Fissure” (Sector H), the “Cornice of the horse engraved in clay” (Sector I) and the “Sinkhole of the Angel” itself (Sector J).

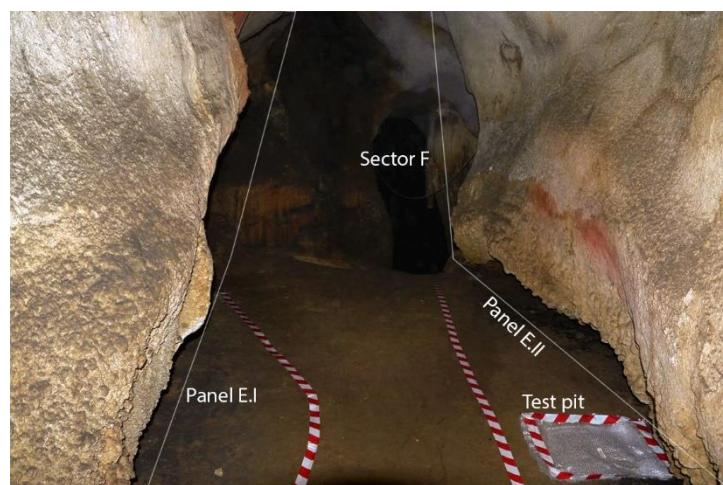
At the bottom of this abyss, we will find a temporary lake called “Sea of the Niphargus”. From some ledges located a little further forward, it is possible to reach a narrow window that takes us to a network of vertical shafts 20 metres deep that allow us to reach the last room of the cavern, located just below the “Salle des Peintures”, but 70 metres below: the “Room of Discs”, named after the unique geological formations.



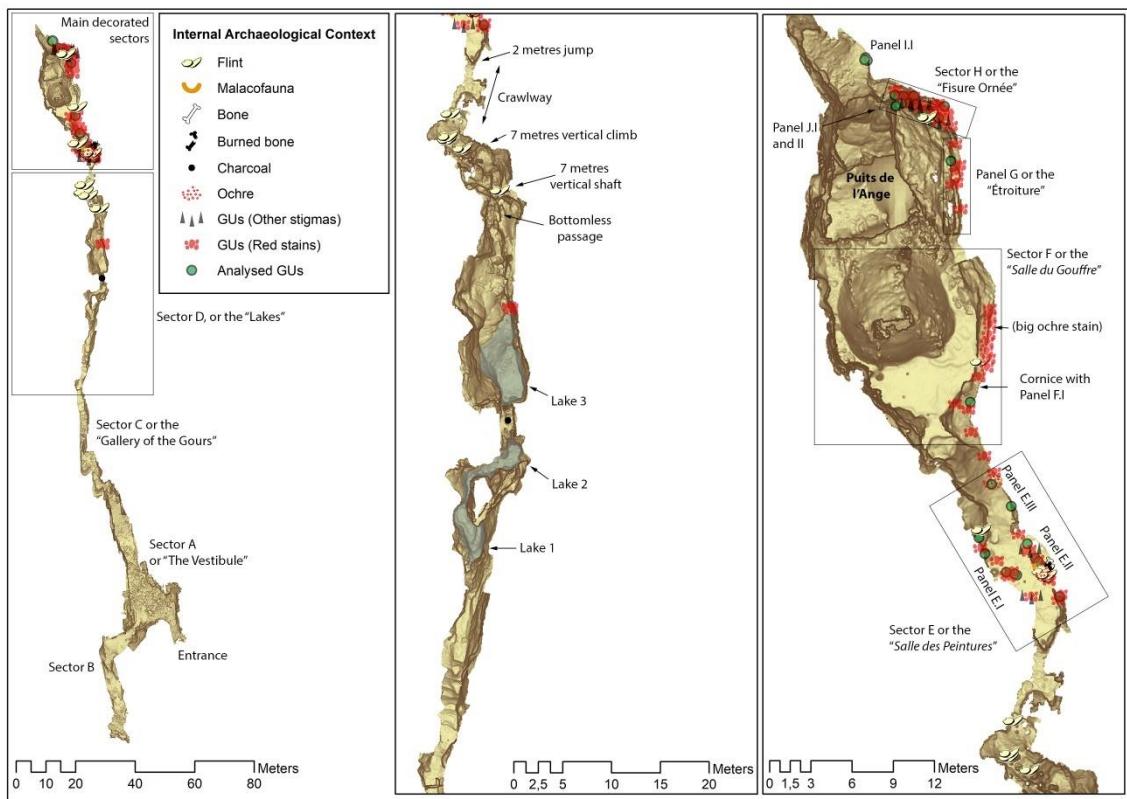
**Figure S1-62.** A) Canyon-shaped entrance hall (J. Herrera). B) Sector D, in the “Lake III”, towards the exit (J. Herrera). *S1-62 Irudia. A) Arroila itxurako ataria (J. Herrera). B) D sektorea, “3. Lakua”-ren inguruan, kanporuntz begira (J. Herrera).*



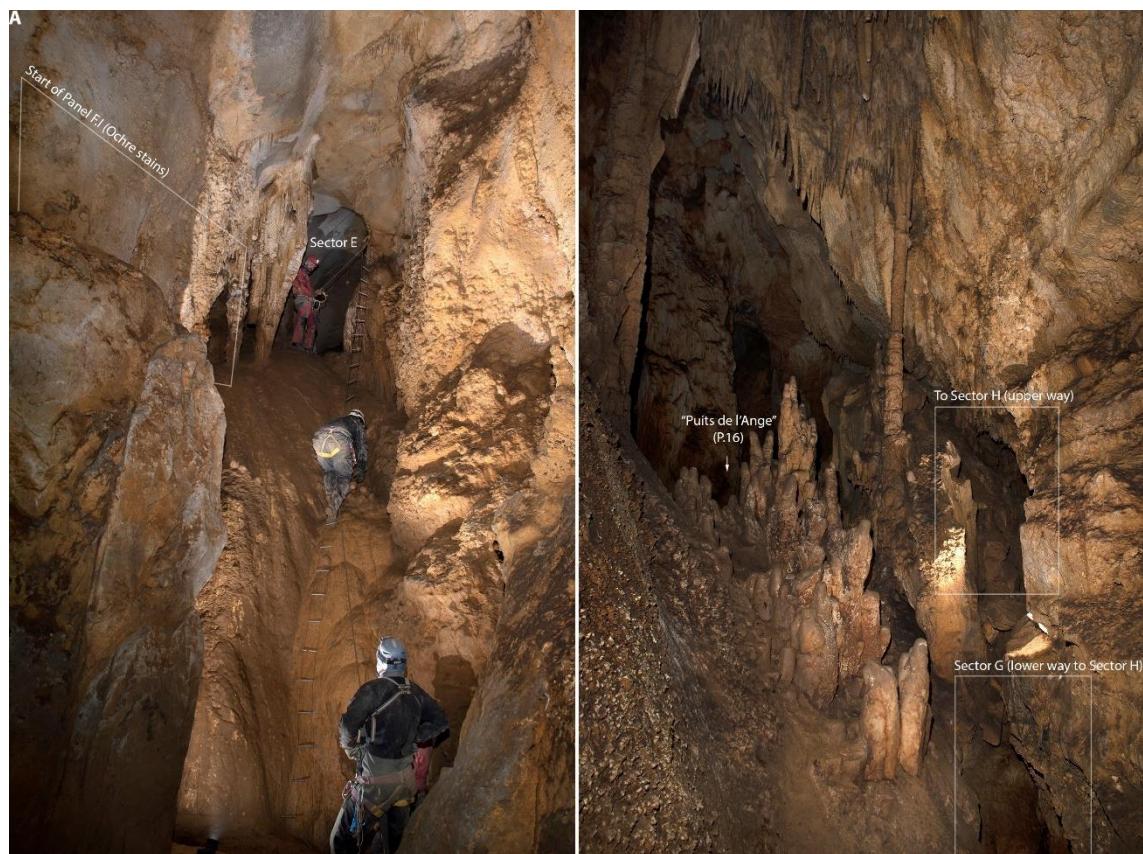
**Figure S1-63.** A) Bottomless passages and B) climb of 7 metres in Sector D. Extremely narrow crawlway seen from Sectors D (C) and E (D). *S1-63 Irudia. A) Hondorik gabeko galeria eta 7 metroko eskalada D sektorean. Katazulo oso estua, D (C) eta E (D) sektoreetatik ikusia.*



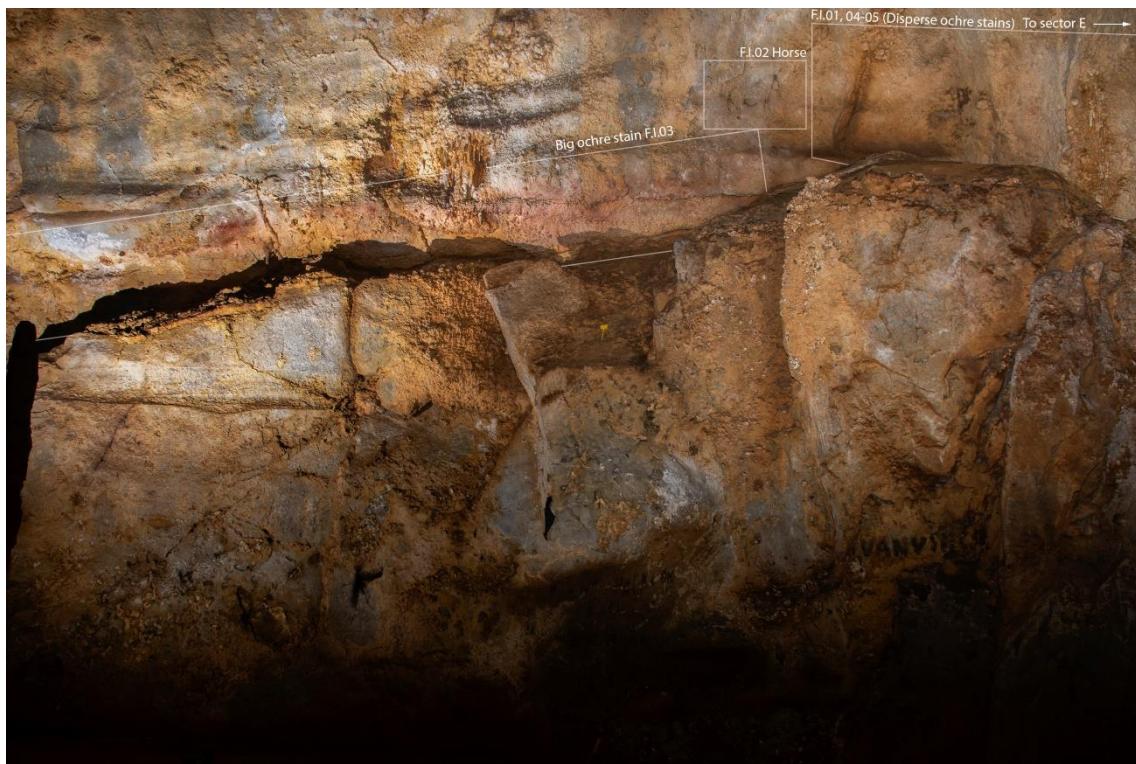
**Figure S1-64.** Sector E or “Salle des Peintures”, looking towards the interior (D. Garate). *S1-64 Irudia. A) E sektorea edo “Pinturen Gela”, barrualderantz begira (D. Garate).*



**Figure S1-65.** Topographic plan of the cave of Etxeberri, showing the archaeologic evidence (I. Intxaubre over 3D survey of GIM Geomatics). **S1-65 Irudia. Etxeberriko karbiako harpeko plano topografikoa, aztarna arkeologikoak erakusten dituena (I. Intxaubre, GIM Geomatics-en 3D-az baliatuz).**



**Figure S1-66. A)** Vertical of 7 meters between sectors E and F. **B)** Looking from sector F towards Puits de l'Ange (and last sectors). **A)** 7 metroko bertikala E eta F sektoreen artean. **B)** F sektoretik Aingeruaren putzurantz begira (sakoneko sektoreetara bidea).



**Figure S1-67.** Sector F, showing the ochre stains in the cornice or “le Vire”, as well as the black horse F.I.02. *SI-67 Irudia. F sektorea, okrezko orbanak erakusten, beltzez margoturiko F.I.02 zaldia bezala.*



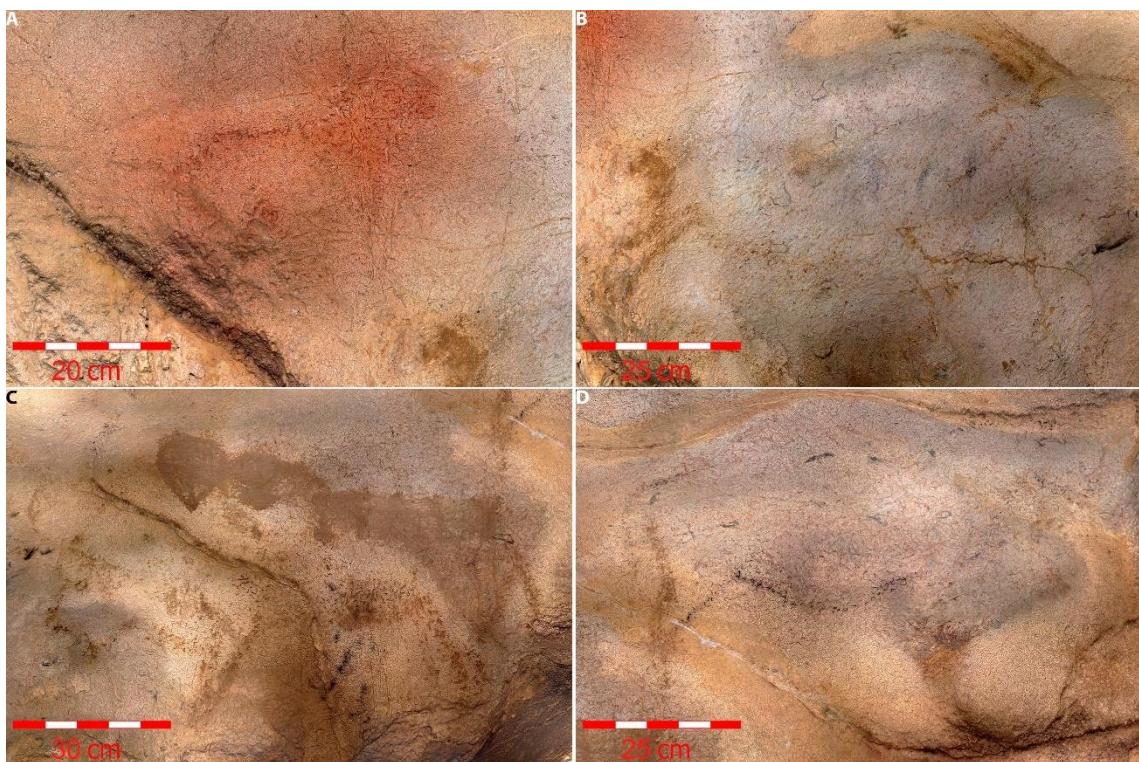
**Figure S1-68.** A) “Puits de l’Ange”, an immense completely vertical cliff of 16 meters, with several sectors in its vicinity, with very difficult access. In the foreground, you can see the formation that gives its name to the well (a stegamite?: Webb, 1991), it has been formed in the direction of the fractures. B) Sector H or “Fissure Ornée” looking towards the vertical access of 7 metres, which wall is covered with ochre stains. *SI-68 Irudia. A) “Aingeruaren putzua”, 16 metroko amildegia bertikal izugarria, inguruaren hainbat sektore dituena, oso sarbide zailekin. Lehen planoan, putzuari izena ematen dion formazioa ikus daiteke (estegamita bat?: Webb,*

1991), frakturen norabidean hazi da. B) H edo “Fisura Apaindua” sektorea, 7 metroko sarbide bertikalera begira, zeinen horma okrez beterik duen.

## The cave art

The rock art in the cave consists of 77 individualised graphic units (GU's), of which 15 represent horses, together with 4 animals hard to identify, 3 bison, 1 ibex, several signs (1 rectangular shaped sign, 1 angle shaped sign, 1 possible claviform, 2 paired strokes and 4 points) and involuntary or very simple traces (38 stains and 8 isolated or non-figurative lines). They are placed in 6 different sectors: the “Salle des Peintures” (Sector E), the main decorated sector of the cave, the “Room of the Sinkhole” (Sector F), the “Narrowness” (Sector G), the “Decorated Fissure” (Sector H), the “Cornice of the horse engraved in clay” (Sector I) and the “Sinkhole of the Angel” (Sector J). The black paintings were created mostly with black pigment made from charcoal, in some cases probably conifer, the red painting made with iron oxides, sometimes mixed with aluminosilicates (clay), and the marron colour was made using the clay of the cave, sometimes mixed with burned bones (Laval et al., 2017). In the case of the engravings, shallow engraving was also used (in a case combined with a black painting). They are mostly fine and superficial, although there are cases that go deeper, when the support is soft. The stroke used to be single. Finger engraving was also used in soft surfaces made with clay.

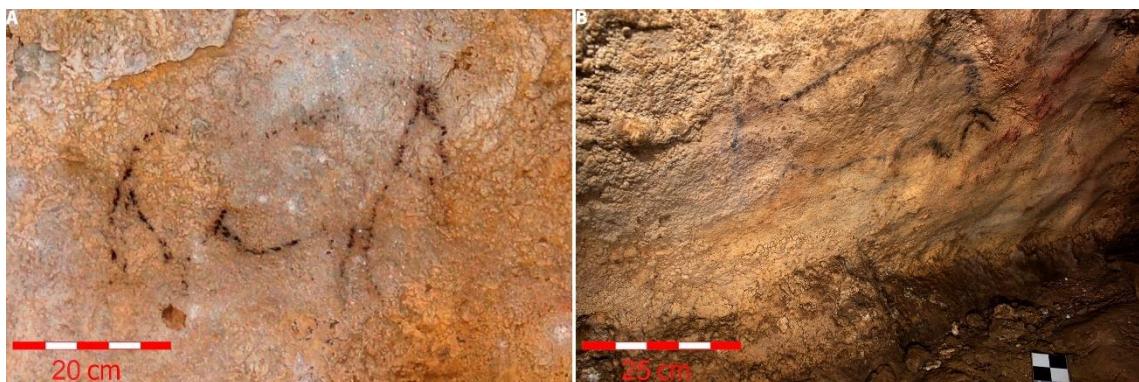
Because of the similarity with other dated portable and rock art, it can be firmly attributed to a time between the Middle Magdalenian and the first phase of the Upper Magdalenian (ca. 17.5-14.5 ka). For example, the way to represent the closed eye or the foreleg of bison, could be found in other directly dated representations in the Middle Magdalenian (e.g., Covaciella, 17.3-16.9 ka). In the case of the great bison in the painting room (Etx.E.II.08), there is a representation very similar to it in the Tito Bustillo cave, which was dated to 15.275-16.454 ka (Fortea, 2007). Besides, representations executed on clay are frequent in other groups mainly located in the Pyrenees (Tuc d'Audoubert, Montespan, Bedeilhac, Erberua, Oxocelhaya, Fontanet, Labouïche and Etcheberri), although they are also known in the Cantabrian Sea (La Garma and El Castillo) and Dordogne (e.g., Les Combarelles and La Calevie). In the cases in which the groups have been contextually dated (Tuc d'Audoubert, Etcheberri, Fontanet and La Garma), the dates are from the Middle Magdalenian. Finally, the study of the archaeological context yielded a series of radiocarbon dating coinciding with the estimated chronology for the parietal art, based on the technical and stylistic characteristics that we have mentioned above (Garate & Bourrillon, 2012). An indeterminate burned bone fragment from level I of the survey returned a date of 16.284 to 15.729 ka cal BP (Beta-284730). Another indeterminable burnt bone fragment from level II from the same survey offered a slightly older date of 16.958 to 16.425 ka cal BP (Beta-284733) and the *Littorina obtusata* shell fragment mentioned above, a date 2,500 years older than 20.212 eta 19.625 ka cal BP (Beta-284731). In summary, we can assume that the Etcheberri parietal complex is assigned to the Middle Magdalenian, without multiple phases being excludable within that chronoculture.



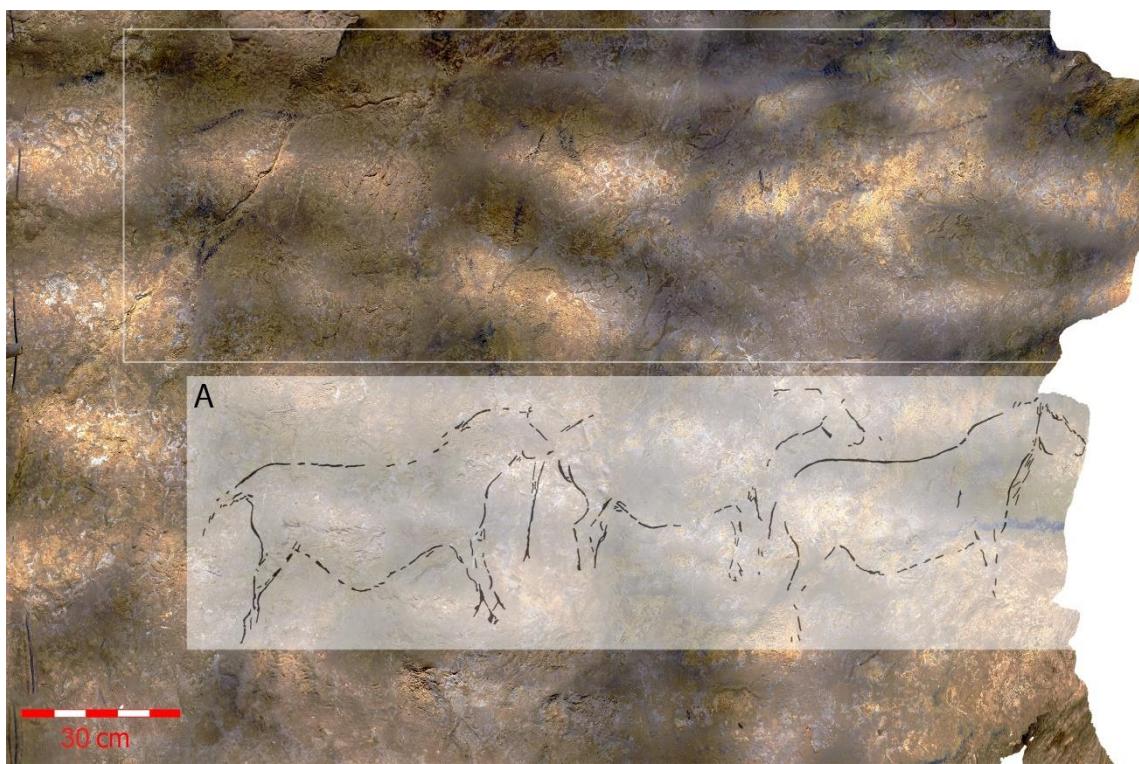
**Figure S1-69.** **A)** Horse and paired strokes painted in red Etx.E.II.02 and 03. **B)** Ibex painted with clay Etx.E.II.04. **C)** Bison painted with clay and black Etx.E.II.08; **D)** Horse painted with clay and black Etx.E.II.11. **SI-69 Irudia.** **A)** Etx.E.II.02 eta 03 zaldia eta trazua parea gorriaz margotutua. **B)** Etx.E.II.04 ahuntza, buztinez margoztua. **C)** Buztinez eta betzez margoztutako bisonteoa Etx.E.II.08. **D)** Buztinez eta beltzez margoztutako zaldia Etx.E.II.11.



**Figure S1-70.** **A)** Polychrome horse Etx.E.I.06. **B)** Horse painted with clay Etx.E.I.04. **SI-70 Irudia.** **A)** Etx.E.I.06 zaldi polikromoa. **B)** Buztinez margotutako Etx.E.I.04 zaldia.



**Figure S1-71.** **A)** Horse painted in black Etx.F.I.02 (D. Garate). **B)** Bison painted in black and red stains Etx.H.I.04-05. **SI-71 Irudia.** **A)** Etx.F.I.02 beltzez margotutako zaldia (D. Garate). **B)** Etx.H.I.04-05 beltzez margotutako bisonteoa eta orban gorriak.



**Figure S1-72.** Frise of horses painted in black and partially engraved Etx.H.II.07-09, unfortunately very damaged nowadays, because of the use of the cave as a speleology school. **A)** Tracing of G. Laplace of the horses in 1952. (For a 3D model look: <https://skfb.ly/oECTM>) **SI-72 Irudia. Etx.H.II.07-09 beltzez margotutako eta grabatutako zaldien frisoa, zoritzarrez gaur egun oso gaulduak daudenak, koba espeleologia eskola bezala erabili zelako A) G. Laplacek 1952 egindako kalkoa. (3D eredu bat ikusteko bisita ezazu: <https://skfb.ly/oECTM>).**



**Figure S1-73.** Digital restitution of the horses engraved and painted in black Etx.H.I.10-11. **SI-73 Irudia. A) Etx.H.I.10-11 grabatu eta beltzez margotutako zaldien berreskuratze digitala.**

**S2: Table of the analysed Graphic Units (GUs)**

**1. SANTIMAMIÑE**

We have included 55 figures of the cave in our analysis excluding the simplest elements: simple engraved or painted lines, pigment stains, etc. ([Table 1, S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
S.A.I.01	1.1.1.	González- Sainz & Ruiz-Idarraga, 2010	24 (4.6)	Point(s)	Red P..
S.A.I.02	1.1.2	González- Sainz & Ruiz-Idarraga, 2010	24 (4.6)	Paired strokes	Red P.
S.B.I.01	2.0.1	González- Sainz & Ruiz-Idarraga, 2010	25 (4.8)	Bison	Black P.
S.B.IV.01	2.0.4	González- Sainz & Ruiz-Idarraga, 2010	26 (4.11)	Ibex	Black P.
S.C.I.02	3.1.5	González- Sainz & Ruiz-Idarraga, 2010	30 (4.13)	Unknown	Black P.
S.C.I.03	3.1.3	González- Sainz & Ruiz-Idarraga, 2010	29 (4.15)	Bison	Black P.
S.C.I.04	3.1.4	González- Sainz & Ruiz-Idarraga, 2010	30 (4.15)	Bison	Black P.
S.C.I.06	3.1.6	González- Sainz & Ruiz-Idarraga, 2010	30 (4.17)	Bison	Black P.
S.C.II.01	3.2.1	González- Sainz & Ruiz-Idarraga, 2010	32 (4.21)	Horse	Black P.
S.C.II.04	3.2.4	González- Sainz & Ruiz-Idarraga, 2010	35 (4.21)	Horse	Black P.; Simple Engr.
S.C.II.05	3.2.5	González- Sainz & Ruiz-Idarraga, 2010	35 (4.24)	Horse	Black P.; Simple Engr.; Multiple Engr.
S.C.II.06	3.2.6	González- Sainz & Ruiz-Idarraga, 2010	36 (4.25)	Bison	Black P.
S.C.II.08	3.2.8	González- Sainz & Ruiz-Idarraga, 2010	36 (4.27)	Unknown	Black P.
S.C.III.01	3.3.1	González- Sainz & Ruiz-Idarraga, 2010	38 (4.33)	Bison	Black P.
S.C.III.02	3.3.2	González- Sainz & Ruiz-Idarraga, 2010	40 (4.35)	Bison	Black P.
S.C.III.03	(New)	(Unpublished)	-	Unknown	Black P.
S.D.I.01	4.1.1	González- Sainz & Ruiz-Idarraga, 2010	44 (4.38)	Horse	Black P.
S.D.I.02	4.1.2	González- Sainz & Ruiz-Idarraga, 2010	44 (4.38)	Horse	Black P.
S.D.I.03	4.1.3	González- Sainz & Ruiz-Idarraga, 2010	45 (4.38)	Unknown	Black P.
S.D.II.01	4.2.1	González- Sainz & Ruiz-Idarraga, 2010	51 (4.46)	Bison	Black P.; Simple Engr.; Multiple Engr.
S.D.II.02	4.2.2	González- Sainz & Ruiz-Idarraga, 2010	52 (4.46)	Bison	Black P.; Simple Engr.
S.D.II.03	4.2.3	González- Sainz & Ruiz-Idarraga, 2010	54 (4.47)	Bison	Simple Engr.; Multiple Engr.
S.D.II.04	4.2.4	González- Sainz & Ruiz-Idarraga, 2010	55 (4.48)	Bison	Simple Engr.; Multiple Engr.
S.D.II.05	4.2.5	González- Sainz & Ruiz-Idarraga, 2010	56 (4.49)	Bison	Simple Engr.; Multiple Engr.
S.D.II.06	4.2.6	González- Sainz & Ruiz-Idarraga, 2010	56 (4.50)	Bison	Simple Engr.; Multiple Engr.
S.D.III.01	4.3.1	González- Sainz & Ruiz-Idarraga, 2010	63 (4.55)	Bison	Black P.
S.D.III.02	4.3.2	González- Sainz & Ruiz-Idarraga, 2010	63 (4.55)	Bison	Black P.
S.D.III.03	4.3.3	González- Sainz & Ruiz-Idarraga, 2010	63 (4.57)	Bison	Black P.
S.D.III.04	4.3.4	González- Sainz & Ruiz-Idarraga, 2010	65 (4.57)	Bison	Black P.
S.D.III.05	4.3.5	González- Sainz & Ruiz-Idarraga, 2010	65 (4.59)	Bison	Black P.
S.D.III.06	4.3.6	González- Sainz & Ruiz-Idarraga, 2010	67 (4.61)	Horse	Black P.
S.D.III.07	4.3.7	González- Sainz & Ruiz-Idarraga, 2010	69 (4.64)	Bison	Black P.
S.D.III.08	4.3.8	González- Sainz & Ruiz-Idarraga, 2010	71 (4.67)	Bison	Black P.; Simple Engr.
S.D.III.09	4.3.9	González- Sainz & Ruiz-Idarraga, 2010	74 (4.70)	Bison	Black P.
S.D.III.10	4.0.1	González- Sainz & Ruiz-Idarraga, 2010	78 (4.73)	Bison	Black P.
S.D.III.11	w/n	González-Sainz, 2016/17	102 (2)	Bison	Simple Engr.; Multiple Engr.
S.D.IV.01	VIII. 1 <sup>a</sup>	Aranzadi et al., 1925	31 (18)	Horse	Black P.
S.D.IV.02	4.4.2	González- Sainz & Ruiz-Idarraga, 2010	80 (4.46)	Bear	Black P.; Simple Engr.

S.D.IV.03	4.4.3	González- Sainz & Ruiz-Idarraga, 2010	81 (4.46)	Deer	Black P.
S.D.IV.04	4.4.4	González- Sainz & Ruiz-Idarraga, 2010	82 (4.46)	Ibex	Black P.
S.D.V.01	4.5.1	González- Sainz & Ruiz-Idarraga, 2010	85 (4.80)	Bison	Black P.
S.D.V.02	4.5.2	González- Sainz & Ruiz-Idarraga, 2010	85 (4.80)	Bison	Black P.
S.D.V.03	4.5.3	González- Sainz & Ruiz-Idarraga, 2010	86 (4.80)	Bison	Black P.
S.D.VI.01	4.6.1	González- Sainz & Ruiz-Idarraga, 2010	87 (4.84)	Bison	Black P.
S.D.VI.02	4.6.2	González- Sainz & Ruiz-Idarraga, 2010	88 (4.84)	Bison	Black P.
S.D.VII.01	4.7.1	González- Sainz & Ruiz-Idarraga, 2010	89 (4.86)	Bison	Black P.
S.D.VII.02	4.7.2	González- Sainz & Ruiz-Idarraga, 2010	89 (4.86)	Unknown	Black P.
S.D.VIII.01	4.8.1	González- Sainz & Ruiz-Idarraga, 2010	90 (4.88)	Unknown	Black P.
S.D.VIII.02	4.8.2	González- Sainz & Ruiz-Idarraga, 2010	90 (4.88)	Unknown	Black P.
S.D.VIII.03	4.8.3	González- Sainz & Ruiz-Idarraga, 2010	91 (4.90)	Ibex	Black P.
S.E.0.01	(New)	(Umpublished)	-	Point(s)	Red P.
S.E.I.01	5.1.1	González- Sainz & Ruiz-Idarraga, 2010	94 (4.93)	Ibex	Black P.
S.E.I.02	5.1.2	González- Sainz & Ruiz-Idarraga, 2010	95 (4.95)	Bison	Black P.
S.E.II.01	5.2.1	González- Sainz & Ruiz-Idarraga, 2010	96 (4.97)	Horse	Black P.
S.E.III.01	5.2.2	González- Sainz & Ruiz-Idarraga, 2010	96 (4.99)	Bison	Black P.

**Table 1, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzerri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>. **1, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzerri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaурbe/espatial-detroi-comunicion-relatedo-magdalenian-cave-art>.

## 2. LUMENTXA

We have included 6 figures of the cave in our analysis excluding the simplest elements: simple engraved or painted lines, pigment stains, etc. (**Table 2, S2**).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
Lum.C.I.01	C.I.1	Garate et al., 2013b	13 (6)	Point(s)	Red P.
Lum.D.II.01	D.II.1	Garate et al., 2013b	19 (7)	Bison	Red P.
Lum.D.II.02	D.II.2	Garate et al., 2013b	19 (7)	Bison	Red P.
Lum.D.II.03	D.II.3	Garate et al., 2013b	19 (7)	Horse	Red P.
Lum.D.V.06	D.V.06	Garate et al., 2013b	20 (-)	Point(s)	Red P.
Lum.D.V.07	D.V.07	Garate et al., 2013b	20 (13)	Point(s)	Red P.

**Table 2, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzerri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>. **2, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzerri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaурbe/espatial-detroi-comunicion-relatedo-magdalenian-cave-art>.

### **3. ATXURRA**

We have included 136 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 3](#), [S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
Atr.A.I.01	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.; Multiple Engr.
Atr.C.I.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.C.I.02	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.C.I.03	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.C.I.04	(New)	( <i>Umpublished</i> )	-	Horse	Simple Engr.; Multiple Engr.
Atr.C.I.05	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.; Finger Engr.
Atr.C.I.06	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.
Atr.C.I.07	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.C.I.10	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.C.I.12	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.C.II.01	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.II.02	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.II.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.III.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.C.III.02	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.C.III.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.III.04	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.C.IV.01	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.IV.02	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.IV.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.
Atr.C.IV.04	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.C.IV.05	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.IV.06	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.C.IV.08	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.Dsuelo.I.01	(New)	( <i>Umpublished</i> )	-	Horse	Simple Engr.; Multiple Engr.
Atr.D.I.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.D.I.07	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.; Multiple Engr.
Atr.D.II.01	(New)	( <i>Umpublished</i> )	-	Hind	Simple Engr.
Atr.D.II.03	(New)	( <i>Umpublished</i> )	-	Deer	Simple Engr.
Atr.D.II.05	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.D.II.07	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.
Atr.D.III.02	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.D.IV.02	(New)	( <i>Umpublished</i> )	-	Bison	Black P.; Multiple Engr.
Atr.D.IV.05	(New)	( <i>Umpublished</i> )	-	Bison	Black P.
Atr.D.IV.07	(New)	( <i>Umpublished</i> )	-	Bison	Black P.; Simple Engr.; Multiple Engr.
Atr.D.IV.08	(New)	( <i>Umpublished</i> )	-	Bison	Black P.; Simple Engr.; Multiple Engr.
Atr.D.V.01	(New)	( <i>Umpublished</i> )	-	Bison	Black P.; Simple Engr.; Multiple Engr.
Atr.D.V.02	(New)	( <i>Umpublished</i> )	-	Bison	Black P.
Atr.D.V.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.D.V.05	(New)	( <i>Umpublished</i> )	-	Bison	Black P.; Simple Engr.; Multiple Engr.

Atr.D.V.06	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.D.V.07	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.D.V.08	(New)	( <i>Umpublished</i> )	-	Horse	Black P.
Atr.D.VI.02	(New)	( <i>Umpublished</i> )	-	Unknown	Multiple Engr.
Atr.D.VI.04	(New)	( <i>Umpublished</i> )	-	Horse	Black P.
Atr.D.VI.06	(New)	( <i>Umpublished</i> )	-	Bison	Multiple Engr.
Atr.D.VI.07	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.D.VI.08	(New)	( <i>Umpublished</i> )	-	Bison	Black P.; Simple Engr.
Atr.D'.II.01	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.; Multiple Engr.
Atr.D'.II.03	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.D'.II.04	(New)	( <i>Umpublished</i> )	-	Horse	Simple Engr.
Atr.F.I.01	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.
Atr.G.I.06	(New)	( <i>Umpublished</i> )	-	Aurochs	Simple Engr.
Atr.G.I.10	(New)	( <i>Umpublished</i> )	-	Horse	Simple Engr.; Multiple Engr.
Atr.G.II.01	(New)	( <i>Umpublished</i> )	-	Bear	Black P.; Simple Engr.; Multiple Engr.
Atr.G.II.03	(New)	( <i>Umpublished</i> )	-	Sign	Simple Engr.; Multiple Engr.
Atr.G.II.04	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.G.II.05	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.G.II.06	(New)	( <i>Umpublished</i> )	-	Bear	Multiple Engr.
Atr.G.III.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.G.III.07	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.H.I.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.H.II.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.H.II.02	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.
Atr.F'I.01	(New)	( <i>Umpublished</i> )	-	Arrow	Simple Engr.
Atr.F'I.02	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.; Multiple Engr.
Atr.F'I.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.F'II.01	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.
Atr.F'II.02	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.; Multiple Engr.
Atr.F'III.01	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.F'III.02	(New)	( <i>Umpublished</i> )	-	Arrow	Simple Engr.
Atr.F'III.03	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Atr.F'III.04	(New)	( <i>Umpublished</i> )	-	Arrow	Simple Engr.
Atr.F'III.05	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.; Multiple Engr.
Atr.F'III.06	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.; Multiple Engr.
Atr.F'IV.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.; Multiple Engr.
Atr.G'I.01	(New)	( <i>Umpublished</i> )	-	Ibex	Simple Engr.; Multiple Engr.
Atr.G'-suelo.I.01	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.G'-suelo.I.02	(New)	( <i>Umpublished</i> )	-	Aurochs	Simple Engr.; Multiple Engr.
Atr.I'-suelo.I.02	(New)	( <i>Umpublished</i> )	-	Horse	Simple Engr.; Multiple Engr.
Atr.I'-suelo.I.03	(New)	( <i>Umpublished</i> )	-	Bison	Simple Engr.; Multiple Engr.
Atr.I'-suelo.I.05	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.; Multiple Engr.
Atr.J.I.01	(New)	Garate et al., 2023	-	Bison	Black P.
Atr.J.II.02	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.03	(New)	Garate et al., 2023	-	Ibex	Simple Engr.

**PAPER V: SUPPLEMENTARY MATERIALS – MATERIAL OSAGARRIAK**

Atr.J.II.04	(New)	Garate et al., 2023	-	Bison	Simple Engr.
Atr.J.II.06	(New)	Garate et al., 2023	-	Ibex	Simple Engr.; Multiple Engr.
Atr.J.II.08	(New)	Garate et al., 2023	-	Ibex	Simple Engr.; Multiple Engr.
Atr.J.II.09	(New)	Garate et al., 2023	-	Bison	Multiple Engr.
Atr.J.II.10	(New)	Garate et al., 2023	-	Unknown	Simple Engr.
Atr.J.II.12	(New)	Garate et al., 2023	-	Unknown	Simple Engr.
Atr.J.II.13	(New)	Garate et al., 2023	-	Hind	Simple Engr.; Multiple Engr.; Scraping
Atr.J.II.15	(New)	Garate et al., 2023	-	Sign	Multiple Engr.
Atr.J.II.16	(New)	Garate et al., 2023	-	Unknown	Simple Engr.
Atr.J.II.17	(New)	Garate et al., 2023	-	Hind	Simple Engr.
Atr.J.II.18	(New)	Garate et al., 2023	-	Deer	Simple Engr.; Multiple Engr.
Atr.J.II.19	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.
Atr.J.II.20	(New)	Garate et al., 2023	-	Unknown	Simple Engr.
Atr.J.II.23	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.
Atr.J.II.24	(New)	Garate et al., 2023	-	Unknown	Simple Engr.; Multiple Engr.
Atr.J.II.28	(New)	Garate et al., 2023	-	Bison	Black P.; Simple Engr.; Multiple Engr.
Atr.J.II.29	(New)	Garate et al., 2023	-	Horse	Simple Engr.
Atr.J.II.30	(New)	Garate et al., 2023	-	Unknown	Simple Engr.
Atr.J.II.31	(New)	Garate et al., 2023	-	Unknown	Multiple Engr.
Atr.J.II.33	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.34	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.35	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.39	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.40	(New)	Garate et al., 2023	-	Ibex	Simple Engr.; Multiple Engr.
Atr.J.II.41	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.42	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.44	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.46	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.47	(New)	Garate et al., 2023	-	Ibex	Simple Engr.; Multiple Engr.
Atr.J.II.48	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.49	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.53	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.
Atr.J.II.54	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.; Scraping
Atr.J.II.57	(New)	Garate et al., 2023	-	Unknown	Simple Engr.
Atr.J.II.59	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.
Atr.J.II.65	(New)	Garate et al., 2023	-	Horse	Black P.; Simple Engr.; Multiple Engr.; Scraping
Atr.J.II.66	(New)	Garate et al., 2023	-	Ibex	Simple Engr.
Atr.J.II.68	(New)	Garate et al., 2023	-	Ibex	Black P.; Multiple Engr.; Scraping
Atr.J.II.70	(New)	Garate et al., 2023	-	Hind	Simple Engr.; Multiple Engr.
Atr.J.II.71	(New)	Garate et al., 2023	-	Horse	Simple Engr.; Multiple Engr.; Scraping
Atr.J.II.74	(New)	Garate et al., 2023	-	Horse	Simple Engr.; Multiple Engr.; Scraping
Atr.J.II.76	(New)	Garate et al., 2023	-	Unknown	Multiple Engr.; Scraping
Atr.J.II.80	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.
Atr.J.II.81	(New)	Garate et al., 2023	-	Bison	Simple Engr.; Multiple Engr.
Atr.J.II.83	(New)	Garate et al., 2023	-	Unknown	Simple Engr.; Multiple Engr.

Atr.J.II.84	(New)	Garate et al., 2023	-	Ibex	Simple Engr.; Multiple Engr.
Atr.J'-suelo.I.01	(New)	(Unpublished)	-	Horse	Simple Engr.
Atr.J'-suelo.I.02	(New)	(Unpublished)	-	Horse	Simple Engr.

**Table 3, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>.

**3, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriaz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaурbe/espatial-detroi-comunicion-relatedo-magdalenian-cave-art>.

#### 4. EKAIN

We have included 91 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 4, S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
Ek.B.I.02	UG2	Ochoa et al., 2019	67 (1)	Unknown	Red P.
Ek.B.I.03	UG3	Ochoa et al., 2019	67 (3)	Bison	Red P.
Ek.C.I.01	2	Altuna & Apellaniz, 1978	17 (2)	Bison	Black P.
Ek.C.I.02	(New)	(Unpublished)	-	Bison	Red P.
Ek.C.I.03	3	Altuna & Apellaniz, 1978	18 (3)	Horse	Black P.
Ek.D.I.01	4	Altuna & Apellaniz, 1978	20 (4)	Deer	Simple Engr.; Multiple Engr.
Ek.D.I.02	4bis	Altuna & Apellaniz, 1978	20 (4)	Hind	Multiple Engr.
Ek.D.II.03	5	Altuna & Apellaniz, 1978	24 (5)	Salmon	Black P.
Ek.D.III.03	w/n	Fano et al., 2011	339 (1)	Ibex	Black P.
Ek.D.III.04	5bis	Altuna & Apellaniz, 1978	25 (5 bis)	Ibex	Black P.
Ek.D.III.07	6b	Altuna & Apellaniz, 1978	25 (6)	Ibex	Black P.
Ek.D.III.08	6c	Altuna & Apellaniz, 1978	25 (6)	Ibex	Black P.
Ek.D.IV.01	7	Altuna & Apellaniz, 1978	28 (7)	Ibex	Black P.
Ek.D.V.01	w/n	Altuna & Mariezkuurrena, 2008	32 (27)	Point(s)	Red P.
Ek.E.II.05	w/n	Altuna & Mariezkuurrena, 2008	32 (30)	Point(s)	Red P.
Ek.E.III.03	9	Altuna & Apellaniz, 1978	29 (9)	Horse	Black P.
Ek.E.III.06	w/n	Altuna & Mariezkuurrena, 2008	32 (31)	Unknown	Red P.
Ek.E.IV.01	11	Altuna & Apellaniz, 1978	34 (11)	Horse	Black P.
Ek.E.IV.02	11bis	Altuna & Apellaniz, 1978	34 (11a)	Bison	Black P.
Ek.E.V.01	12	Altuna & Apellaniz, 1978	35 (12)	Bison	Black P.
Ek.E.V.02	13	Altuna & Apellaniz, 1978	36 (13)	Horse	Black P.
Ek.E.V.03	(New)	(Unpublished)	-	Point(s)	Red P.
Ek.E.V.05	(New)	(Unpublished)	-	Point(s)	Black P.
Ek.E.V.06	(New)	(Unpublished)	-	Point(s)	Red P.
Ek.E.V.08	14	Altuna & Apellaniz, 1978	36 (14)	Bison	Black P.
Ek.E.V.12	14	Altuna & Apellaniz, 1978	36 (14)	Point(s)	Black P.
Ek.E.V.14	15	Altuna & Apellaniz, 1978	39 (15)	Horse	Black P.
Ek.E.V.15	15a	Altuna & Apellaniz, 1978	39 (15)	Hind	Black P.; Simple Engr.

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Ek.E.V.16	15a	Altuna & Apellaniz, 1978	39 (15)	Bison	Black P.
Ek.E.V.17	w/n	Altuna & Mariezkurrena, 2008	24 (14)	Unknown	Black P.
Ek.E.VI.01	16	Altuna & Apellaniz, 1978	40 (16)	Hind	Black P.
Ek.E.VI.02	(New)	( <i>Umpublished</i> )	-	Point(s)	Red P.
Ek.E.VI.04	17	Altuna & Apellaniz, 1978	43 (17)	Bison	Black P.; Multiple Engr.
Ek.E.VI.05	18	Altuna & Apellaniz, 1978	45 (18)	Bison	Red P.; Black P.; Multiple Engr.
Ek.E.VI.06	19	Altuna & Apellaniz, 1978	46 (19)	Bison	Black P.
Ek.E.VI.07	20	Altuna & Apellaniz, 1978	47 (20)	Horse	Red P.; Black P.; Simple Engr.; Multiple Engr.
Ek.E.VI.10	21	Altuna & Apellaniz, 1978	51 (21)	Horse	Red P.
Ek.E.VI.11	22	Altuna & Apellaniz, 1978	52 (22)	Horse	Black P.
Ek.E.VI.12	23	Altuna & Apellaniz, 1978	52 (22)	Bison	Black P.
Ek.E.VI.13	24	Altuna & Apellaniz, 1978	52 (24)	Ibex	Black P.
Ek.E.VI.14	24	Altuna & Apellaniz, 1978	52 (24)	Horse	Black P.
Ek.E.VI.15	25	Altuna & Apellaniz, 1978	53 (25)	Horse	Black P.; Scraping
Ek.E.VI.16	25bis	Altuna & Apellaniz, 1978	53 (25)	Horse	Black P.
Ek.E.VI.17	25b	González Sainz et al., 1999	154 (1)	Bison	Multiple Engr.; Scraping
Ek.E.VI.19	26	Altuna & Apellaniz, 1978	54 (26)	Horse	Black P.; Scraping
Ek.E.VI.21	(New)	( <i>Umpublished</i> )	-	Unknown	Simple Engr.
Ek.E.VI.22	27	Altuna & Apellaniz, 1978	57 (27)	Horse	Red P.; Black P.; Simple Engr.; Multiple Engr.; Scraping
Ek.E.VI.23	27	Altuna & Apellaniz, 1978	57 (27)	Horse	Black P.
Ek.E.VI.24	(New)	( <i>Umpublished</i> )	-	Unknown	Red P.
Ek.E.VI.25	28	Altuna & Apellaniz, 1978	60 (28)	Horse	Black P.
Ek.E.VI.26	29	Altuna & Apellaniz, 1978	60 (29)	Horse	Red P.; Black P.
Ek.E.VI.27	30	Altuna & Apellaniz, 1978	61 (30)	Horse	Black P.
Ek.E.VI.28	(New)	( <i>Umpublished</i> )	-	Point(s)	Red P.
Ek.E.VI.29	31	Altuna & Apellaniz, 1978	62 (31)	Horse	Black P.
Ek.E.VI.30	32	Altuna & Apellaniz, 1978	64 (32)	Horse	Black P.
Ek.E.VI.31	33	Altuna & Apellaniz, 1978	64 (33)	Bison	Red P.
Ek.E.VI.32	34	Altuna & Apellaniz, 1978	66 (34)	Flounder	Black P.
Ek.E.VII.01	36	Altuna & Apellaniz, 1978	68 (36)	Bison	Black P.
Ek.E.VII.02	35	Altuna & Apellaniz, 1978	67 (36)	Bison	Black P.
Ek.E.VII.03	37	Altuna & Apellaniz, 1978	67 (37)	Horse	Black P.
Ek.E.VII.04	39	Altuna & Apellaniz, 1978	71 (39)	Horse	Black P.
Ek.E.VII.09	41	Altuna & Apellaniz, 1978	71 (41)	Horse	Black P.
Ek.E.VII.10	42	Altuna & Apellaniz, 1978	71 (42)	Horse	Black P.
Ek.E.VII.12	43	Altuna & Apellaniz, 1978	71 (43)	Horse	Black P.
Ek.E.VII.13	43	Altuna & Apellaniz, 1978	71 (43)	Point(s)	Red P.
Ek.E.VII.14	44	Altuna & Apellaniz, 1978	74 (44)	Horse	Black P.; Scraping
Ek.E.VII.15	45	Altuna & Apellaniz, 1978	74 (45)	Horse	Black P.
Ek.E.VII.17	w/n	Garate et al., 2015c	289 (7)	Bison	Red P.
Ek.E.VII.18	46	Altuna & Apellaniz, 1978	77 (46)	Horse	Black P.
Ek.E.VIII.01	50	Altuna & Apellaniz, 1978	79 (50)	Horse	Red P.
Ek.G.I.01	47	Altuna & Apellaniz, 1978	79 (47)	Bison	Black P.; Simple Engr.
Ek.H.I.01	51	Altuna & Apellaniz, 1978	82 (51)	Bear	Black P.
Ek.H.I.02	52	Altuna & Apellaniz, 1978	82 (52)	Bear	Black P.

Ek.J.I.02	53	Altuna & Apellaniz, 1978	86 (53)	Horse	Black P.
Ek.J.I.04	54	Altuna & Apellaniz, 1978	86 (54)	Horse	Red P.; Black P.; Simple Engr.
Ek.J.I.06	55	Altuna & Apellaniz, 1978	89 (55)	Horse	Black P.; Simple Engr.
Ek.J.I.07	56	Altuna & Apellaniz, 1978	91 (56)	Horse	Black P.; Simple Engr.
Ek.J.I.08	57	Altuna & Apellaniz, 1978	93 (57)	Horse	Black P.; Simple Engr.
Ek.J.I.09	(New)	(Unpublished)	-	Horse	Red P.
Ek.J.I.10	59	Altuna & Apellaniz, 1978	93 (59)	Horse	Simple Engr.
Ek.J.I.11	58	Altuna & Apellaniz, 1978	94 (58)	Horse	Black P.; Simple Engr.
Ek.J.I.15	60	Altuna & Apellaniz, 1978	95 (60)	Bison	Black P.
Ek.J.I.16	61	Altuna & Apellaniz, 1978	95 (61)	Horse	Red P.; Simple Engr.
Ek.K.I.01	GU1	Ochoa et al., 2018	147 (3)	Horse	Finger Engr.
Ek.K.I.03	GU3	Ochoa et al., 2018	147 (3)	Horse	Finger Engr.
Ek.K.I.04	GU4	Ochoa et al., 2018	149 (3)	Horse	Finger Engr.
Ek.K.II.01	GU7	Ochoa et al., 2018	149 (3)	Horse	Finger Engr.

**Table 4, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/Inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>. **4, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakotzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/Inakiintxaурbe/espatial-detroi-comunicion-relatedo-magdalenian-cave-art>.

## 5. ALTXERRI

We have included 130 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. (**Table 5, S2**).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
Al.C.II.01	I.1.01	Ruiz Redondo, 2014	89 (6-2)	Arrow	Simple Engr.; Multiple Engr.
Al.C.II.02	I.1.02-03	Ruiz Redondo, 2014	90 (6-2)	Unknown	Black P.; Scraping
Al.C.II.03	I.1.04	Ruiz Redondo, 2014	90 (6-2)	Bison	Multiple Engr.
Al.C.III.01	I.2.05	Ruiz Redondo, 2014	91 (6-3)	Bison	Simple Engr.; Multiple Engr.
Al.C.III.02	I.2.06	Ruiz Redondo, 2014	93 (6-3)	Bison	Simple Engr.; Multiple Engr.
Al.C.IV.01	I.3.07	Ruiz Redondo, 2014	94 (6-4)	Ibex	Simple Engr.; Multiple Engr.
Al.C.IV.02	I.3.08	Ruiz Redondo, 2014	95 (6-4)	Bison	Simple Engr.
Al.C.IV.03	I.3.09	Ruiz Redondo, 2014	96 (6-4)	Bison	Simple Engr.; Multiple Engr.; Scraping
Al.C.IV.05	I.3.11	Ruiz Redondo, 2014	97 (6-4)	Unknown	Simple Engr.; Multiple Engr.
Al.C.IV.06	I.3.12	Ruiz Redondo, 2014	98 (6-4)	Bison	Simple Engr.; Multiple Engr.; Scraping
Al.C.IV.07	I.3.13	Ruiz Redondo, 2014	99 (6-4)	Anthrop.	Multiple Engr.
Al.C.IV.08	I.3.14	Ruiz Redondo, 2014	99 (6-4)	Unknown	Simple Engr.
Al.C.IV.09	I.3.15	Ruiz Redondo, 2014	100 (6-5)	Reindeer	Simple Engr.; Multiple Engr.; Abrasion
Al.C.IV.10	I.3.16	Ruiz Redondo, 2014	101 (6-5)	Fox	Simple Engr.; Multiple Engr.; Abrasion
Al.C.IV.11	I.4.17	Ruiz Redondo, 2014	102 (6-6)	Flounder	Simple Engr.; Multiple Engr.
Al.C.IV.12	I.4.18	Ruiz Redondo, 2014	104 (6-6)	Flounder	Simple Engr.; Multiple Engr.
Al.C.IV.14	I.5.20	Ruiz Redondo, 2014	105 (6-7)	Sign	Multiple Engr.

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AI.C.IV.15	I.5.21	Ruiz Redondo, 2014	106 (6-7)	Bison	Simple Engr.; Multiple Engr.; Scraping
AI.C.IV.16	I.5.22	Ruiz Redondo, 2014	106 (6-8)	Sign	Simple Engr.
AI.C.IV.17	I.5.23	Ruiz Redondo, 2014	108 (6-8)	Bison	Simple Engr.; Multiple Engr.
AI.C.IV.18	I.5.24	Ruiz Redondo, 2014	108 (6-8)	Bison	Simple Engr.; Multiple Engr.
AI.C.IV.19	I.5.25	Ruiz Redondo, 2014	109 (6-8)	Sign	Simple Engr.
AI.C.IV.21	I.5.27	Ruiz Redondo, 2014	110 (6-8)	Arrow	Simple Engr.; Multiple Engr.
AI.C.IV.22	I.5.28	Ruiz Redondo, 2014	110 (6-9)	Bison	Simple Engr.; Multiple Engr.; Scraping
AI.C.IV.24	I.6.30	Ruiz Redondo, 2014	113 (6-11)	Saiga	Simple Engr.; Multiple Engr.
AI.C.IV.25	I.6.31	Ruiz Redondo, 2014	115 (6-11)	Saiga	Simple Engr.
AI.C.IV.26	I.6.32-35	Ruiz Redondo, 2014	115 (6-11)	Bison	Simple Engr.; Multiple Engr.; Scraping
AI.C.IV.27	I.6.33	Ruiz Redondo, 2014	116 (6-11)	Bison	Black P.; Simple Engr.; Multiple Engr.
AI.C.IV.28	I.6.34	Ruiz Redondo, 2014	116 (6-11)	Horse	Black P.; Simple Engr.; Multiple Engr.
AI.C.IV.29	I.7.36	Ruiz Redondo, 2014	118 (6-12)	Bison	Simple Engr.; Multiple Engr.
AI.C.IV.30	I.7.37-38	Ruiz Redondo, 2014	119 (6-13)	Bison	Black P.; G simplea; Multiple Engr.; Karraktua
AI.C.IV.31	I.7.39	Ruiz Redondo, 2014	121 (6-14)	Hind	Simple Engr.
AI.C.IV.32	I.8.40	Ruiz Redondo, 2014	123 (6-15)	Bison	Black P.; Multiple Engr.; Scraping
AI.C.IV.33	I.8.41	Ruiz Redondo, 2014	125 (6-16)	Bison	Black P.; Simple Engr.; Multiple Engr.; Scraping
AI.C.IV.34	I.8.42	Ruiz Redondo, 2014	125 (6-17)	Bird	Simple Engr.; Multiple Engr.
AI.C.IV.35	I.8.43	Ruiz Redondo, 2014	126 (6-17)	Bison	Multiple Engr.; Scraping
AI.C.IV.38	I.9.46	Ruiz Redondo, 2014	129 (6-20)	Sign	Simple Engr.
AI.C.IV.39	I.9.47	Ruiz Redondo, 2014	130 (6-21)	Reindeer	Simple Engr.; Multiple Engr.
AI.C.IV.40	I.9.48	Ruiz Redondo, 2014	131 (6-22)	Ibex	Simple Engr.; Multiple Engr.
AI.C.IV.42	I.9.50	Ruiz Redondo, 2014	133 (6-23)	Paired strokes	Simple Engr.
AI.C.IV.43	I.9.50	Ruiz Redondo, 2014	133 (6-23)	Paired strokes	Simple Engr.
AI.C.IV.44	I.9.50	Ruiz Redondo, 2014	133 (6-23)	Paired strokes	Simple Engr.
AI.C.IV.45	I.9.50	Ruiz Redondo, 2014	133 (6-23)	Paired strokes	Simple Engr.
AI.C.IV.46	I.9.51	Ruiz Redondo, 2014	134 (6-23)	Sign	Simple Engr.
AI.C.IV.47	I.9.52	Ruiz Redondo, 2014	135 (6-23)	Anthrop.	Simple Engr.
AI.C.IV.48	I.9.53	Ruiz Redondo, 2014	135 (6-24)	Bison	Simple Engr.
AI.C.IV.49	I.9.54	Ruiz Redondo, 2014	137 (6-25)	Fish	Simple Engr.; Scraping
AI.C.IV.50	I.9.55	Ruiz Redondo, 2014	137 (6-26)	Hare	Simple Engr.; Scraping
AI.C.IV.51	I.10.56	Ruiz Redondo, 2014	138 (6-27)	Bison	Black P.; Simple Engr.; Multiple Engr.; Scraping
AI.C.IV.52	I.10.57	Ruiz Redondo, 2014	139 (6-27)	Salmon	Simple Engr.; Scraping
AI.C.IV.53	I.10.58	Ruiz Redondo, 2014	140 (6-27)	Sign	Simple Engr.
AI.C.IV.54	I.10.59	Ruiz Redondo, 2014	142 (6-28)	Hind	Simple Engr.
AI.C.IV.57	I.49	Barandiarán Ayerbe, 1964a	115 (1 b-49)	Unknown	Black P.; Simple Engr.; Multiple Engr.; Scraping
AI.D.II.01	II.1.01	Ruiz Redondo, 2014	146 (6-31)	Bear	Simple Engr.; Multiple Engr.
AI.D.II.02	II.1.02	Ruiz Redondo, 2014	147 (6-32)	Bison	Black P.; Simple Engr.
AI.D.II.03	II.1.03	Ruiz Redondo, 2014	149 (6-33)	Bison	Black P.
AI.D.II.04	II.1.04	Ruiz Redondo, 2014	150 (6-33)	Bison	Black P.
AI.D.II.05	II.1.05	Ruiz Redondo, 2014	150 (6-34)	Bison	Black P.
AI.D.II.06	II.1.06	Ruiz Redondo, 2014	152 (6-34)	Bison	Black P.; Multiple Engr.
AI.D.II.07	II.1.07	Ruiz Redondo, 2014	153 (6-35)	Bison	Black P.
AI.D.II.08	II.1.08	Ruiz Redondo, 2014	153 (6-36)	Bison	Black P.; Simple Engr.

AI.D.II.09	II.1.09	Ruiz Redondo, 2014	155 (6-37)	Bison	Black P.; Simple Engr.
AI.D.II.10	II.1.11	Ruiz Redondo, 2014	156 (6-39)	Ibex	Simple Engr.; Multiple Engr.
AI.D.II.11	II.1.12	Ruiz Redondo, 2014	157 (6-40)	Bison	Black P.
AI.D.II.13	II.1.14	Ruiz Redondo, 2014	159 (6-42)	Unknown	Black P.
AI.D.II.14	II.1.15	Ruiz Redondo, 2014	159 (6-43)	Aurochs	Black P.
AI.D.II.16	II.1.17	Ruiz Redondo, 2014	161 (6-44)	Bison	Multiple Engr.
AI.D.II.17	II.1.18	Ruiz Redondo, 2014	162 (6-45)	Reindeer	Black P.
AI.D.II.18	II.1.19	Ruiz Redondo, 2014	163 (6-46)	Bison	Black P.
AI.D.II.19	II.1.20	Ruiz Redondo, 2014	164 (6-47)	Bison	Black P.
AI.D.II.20	II.1.21	Ruiz Redondo, 2014	165 (6-48)	Bison	Black P.; Multiple Engr.
AI.D.III.01	II.2.01	Ruiz Redondo, 2014	169 (6-51)	Bison	Black P.; Multiple Engr.; Scraping
AI.D.IV.01	II.3.1	Ruiz Redondo, 2014	174 (6-55)	Bison	Black P.; Multiple Engr.; Scraping
AI.D.IV.02	II.3.2	Ruiz Redondo, 2014	175 (6-55)	Bison	Black P.; Scraping
AI.D.IV.03	II.3.3	Ruiz Redondo, 2014	176 (6-56)	Bison	Black P.; Simple Engr.; Multiple Engr.
AI.D.IV.04	II.3.4	Ruiz Redondo, 2014	177 (6-56)	Bison	Multiple Engr.; Scraping
AI.D.IV.05	II.3.5	Ruiz Redondo, 2014	178 (6-56)	Bison	Black P.; Multiple Engr.; Scraping
AI.D.IV.06	II.3.6	Ruiz Redondo, 2014	179 (6-56)	Bison	Simple Engr.
AI.D.IV.08	II.3.8	Ruiz Redondo, 2014	180 (6-56)	Bison	Black P.; Multiple Engr.
AI.D.IV.09	II.3.9	Ruiz Redondo, 2014	180 (6-57)	Bison	Simple Engr.; Multiple Engr.
AI.D.IV.10	II.3.10	Ruiz Redondo, 2014	181 (6-58)	Bison	Black P.; Multiple Engr.
AI.D.IV.12	II.3.12	Ruiz Redondo, 2014	184 (6-59)	Bison	Black P.; Simple Engr.; Multiple Engr.
AI.D.IV.13	II.3.13	Ruiz Redondo, 2014	185 (6-60)	Bison	Black P.; Simple Engr.; Multiple Engr.
AI.D.IV.14	II.3.14	Ruiz Redondo, 2014	185 (6-60)	Bison	Black P.; Simple Engr.; Multiple Engr.
AI.D.IV.15	II.3.15	Ruiz Redondo, 2014	187 (6-61)	Bison	Black P.
AI.D.IV.16	II.3.16	Ruiz Redondo, 2014	187 (6-61)	Bison	Black P.; Scraping
AI.D.IV.17	II.3.17	Ruiz Redondo, 2014	188 (6-61)	Bison	Black P.; Scraping
AI.E.I.01	II.4.1	Ruiz Redondo, 2014	191 (6-63)	Bison	Black P.
AI.E.I.02	II.4.2	Ruiz Redondo, 2014	193 (6-64)	Bison	Black P.
AI.E.I.04	II.4.4	Ruiz Redondo, 2014	195 (6-66)	Horse	Finger Engr.; Simple Engr.
AI.E.I.05	II.4.5	Ruiz Redondo, 2014	196 (6-67)	Chamois	Black P.; Scraping
AI.E.I.06	II.4.6	Ruiz Redondo, 2014	197 (6-67)	Chamois	Black P.; Scraping
AI.E.I.08	II.4.8	Ruiz Redondo, 2014	199 (6-69)	Chamois	Black P.
AI.E.I.09	II.4.9	Ruiz Redondo, 2014	199 (6-70)	Bison	Black P.; Multiple Engr.; Scraping
AI.E.I.10	II.4.10	Ruiz Redondo, 2014	200 (6-70)	Bison	Black P.; Simple Engr.; G simplea; Scraping
AI.E.I.11	II.4.11	Ruiz Redondo, 2014	202 (6-71)	Bison	Simple Engr.; Multiple Engr.; Scraping
AI.E.I.12	II.4.12	Ruiz Redondo, 2014	202 (6-71)	Bison	Black P.; Scraping
AI.E.I.13	II.4.14	Ruiz Redondo, 2014	203 (6-73)	Horse	Black P.
AI.E.I.15	II.4.15	Ruiz Redondo, 2014	205 (6-74)	Bison	Black P.
AI.E.I.16	II.4.16	Ruiz Redondo, 2014	206 (6-74)	Bison	Black P.
AI.E.I.17	II.4.17	Ruiz Redondo, 2014	206 (6-75)	Bison	Black P.; Multiple Engr.
AI.E.I.18	(New)	(Unpublished)	-	SFF	Simple Engr.
AI.E.I.19	(New)	(Unpublished)	-	SFF	Simple Engr.
AI.E.II.01	II.5.1	Ruiz Redondo, 2014	210 (6-77)	Bison	Black P.
AI.E.II.02	II.5.2	Ruiz Redondo, 2014	210 (6-77)	Bison	Black P.
AI.E.II.03	II.5.3	Ruiz Redondo, 2014	211 (6-77)	Reindeer	Black P.

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A.I.E.II.04	II.5.4	Ruiz Redondo, 2014	212 (6-78)	Bison	Black P.
A.I.E.II.05	II.5.5-6-7	Ruiz Redondo, 2014	213 (6-78)	Unknown	Black P.; Simple Engr.; Multiple Engr.
A.I.E.II.06	II.5.8	Ruiz Redondo, 2014	214 (6-80)	Unknown	Black P.; Simple Engr.
A.I.E.II.07	II.5.9	Ruiz Redondo, 2014	215 (6-81)	Reindeer	Simple Engr.; Multiple Engr.
A.I.E.II.08	II.5.10	Ruiz Redondo, 2014	217 (6-81)	Reindeer	Simple Engr.; Multiple Engr.
A.I.E.II.09	II.5.11	Ruiz Redondo, 2014	217 (6-81)	Reindeer	Simple Engr.; Multiple Engr.
A.I.E.II.10	II.5.12	Ruiz Redondo, 2014	218 (6-81)	Snake	Simple Engr.
A.I.E.II.11	II.5.13	Ruiz Redondo, 2014	219 (6-82)	Unknown	Black P.
A.I.E.II.12	II.5.14	Ruiz Redondo, 2014	220 (6-83)	Bison	Black P.
A.I.E.II.14	II.5.16	Ruiz Redondo, 2014	220 (6-84)	Bison	Black P.
A.I.F.II.01	III.1.1	Ruiz Redondo, 2014	225 (6-86)	Ibex	Black P.
A.I.F.II.02	III.1.2	Ruiz Redondo, 2014	226 (6-87)	Horse	Black P.
A.I.F.II.03	III.1.3	Ruiz Redondo, 2014	226 (6-88)	Ibex	Black P.
A.I.F.II.04	III.1.4	Ruiz Redondo, 2014	228 (6-89)	Deer	Black P.; Multiple Engr.
A.I.F.II.05	III.1.5	Ruiz Redondo, 2014	229 (6-90)	Bison	Black P.
A.I.F.II.06	III.1.6	Ruiz Redondo, 2014	230 (6-91)	Bison	Black P.; Simple Engr.
A.I.F.II.07	III.1.7	Ruiz Redondo, 2014	231 (6-92)	Aurochs	Black P.
A.I.F.II.08	III.1.8	Ruiz Redondo, 2014	232 (6-93)	Bison	Black P.
A.I.F.II.09	III.1.9	Ruiz Redondo, 2014	233 (6-94)	Bison	Black P.; Simple Engr.; Multiple Engr.
A.I.F.II.10	III.1.10	Ruiz Redondo, 2014	235 (6-95)	Bison	Simple Engr.; Multiple Engr.
A.I.F.II.11	III.1.11	Ruiz Redondo, 2014	235 (6-96)	Bison	Simple Engr.
A.I.F.II.12	III.1.12	Ruiz Redondo, 2014	236 (6-97)	Horse	Simple Engr.; Multiple Engr.
A.I.F.III.01	III.2.1	Ruiz Redondo, 2014	239 (6-99)	Bison	Black P.; Scraping
A.I.F.III.02	III.2.2	Ruiz Redondo, 2014	240 (6-99)	Bison	Black P.

**Table 5, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaurbe/spatial-organization-patterns-related-to-magdalenian-cave-art>.

**5, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriaz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaurbe/espatial-detroi-comunicion-relatedo-magdalenian-cave-art>.

## 6. AITZBITARTE IV

We have included 24 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 6, S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
AitIV.B.AI.01	A.I.01	Garate et al., 2020d	5	Bison	Finger Engr.
AitIV.B.AI.02	A.I.02	Garate et al., 2020d	6	Bison	Finger Engr.; Modelled
AitIV.B.BI.01	B.I.01	Garate et al., 2020d	6	Bison	Finger Engr.
AitIV.B.BII.01	B.I.03	Garate et al., 2020d	6 (9)	Vulva	Simple Engr.
AitIV.B.BII.02	B.I.04	Garate et al., 2020d	6	Vulva	Simple Engr.; Modelled; Scraping
AitIV.B.CI.03	C.I.03	Garate et al., 2020d	6 (5)	Reindeer	Clay P.; Simple Engr.; Multiple Engr.; Finger Engr.; Modelled
AitIV.B.CI.06	C.I.06	Garate et al., 2020d	7 (6)	Bison	Simple Engr.; Multiple Engr.; Finger Engr.; Modelled

AitIV.B.CII.01	C.II.01	Garate et al., 2020d	5	Ibex	Finger Engr.
AitIV.B.CII.02	C.II.02	Garate et al., 2020d	7 (7)	Horse	Simple Engr.; Multiple Engr.; Finger Engr.; Modelled
AitIV.B.CII.05	C.II.05	Garate et al., 2020d	7 (7)	Point(s)	Finger Engr.
AitIV.B.DI.01	D.I.01	Garate et al., 2020d	8	Bison	Simple Engr.
AitIV.B.DI.02	D.I.02	Garate et al., 2020d	8	Bison	Simple Engr.
AitIV.B.DII.01	D.II.03	Garate et al., 2020d	8	Bison	Multiple Engr.; Finger Engr.
AitIV.B.DIII.01	D.II.01	Garate et al., 2020d	8	Bison	Simple Engr.
AitIV.B.DIII.02	D.II.02	Garate et al., 2020d	8	Bison	Simple Engr.; Multiple Engr.; Finger Engr.
AitIV.B.DIII.03	D.II.03	Garate et al., 2020d	8	Horse	Multiple Engr.; Scraping
AitIV.B.DIII.04	D.II.04	Garate et al., 2020d	8 (8)	Bison	Simple Engr.; Multiple Engr.; Scraping
AitIV.C.I.02	II.1-2-3	Garate et al., 2013d	38 (5)	Unknown	Red P.
AitIV.D.VI.01	(New)	(Unpublished)	-	Point(s)	Red P.
AitIV.D.VII.01	(New)	(Unpublished)	-	Horse	Red P.
AitIV.D.VII.02	(New)	(Unpublished)	-	Bison	Red P.
AitIV.D.VII.03	(New)	(Unpublished)	-	Unknown	Red P.
AitIV.D.VII.04	(New)	(Unpublished)	-	Sign	Red P.
AitIV.D.IX.01	(New)	(Unpublished)	-	Point(s)	Red P.

**Table 6, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>.

**6, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriaz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaурbe/espatial-detroi-comunicon-relatedo-magdalenian-cave-art>.

## 7. AITZBITARTE V

We have included 5 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. and GUs from other chronologies ([Table 7, S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
AitV.B.I.01	AitV.B.I.01	Garate et al., 2020c	326 (4)	Bison	Simple Engr.; Multiple Engr.
AitV.B.I.03	AitV.B.I.03	Garate et al., 2020c	327 (4)	Bison	Simple Engr.; Multiple Engr.
AitV.B.II.01	AitV.B.II.01	Garate et al., 2020c	327 (7)	Bison	Simple Engr.; Multiple Engr.
AitV.B.II.02	AitV.B.II.02	Garate et al., 2020c	327 (7)	Bison	Simple Engr.
AitV.D.III.02	AitV.B.III.02	Garate et al., 2020c	330 (10)	Bison	Simple Engr.

**Table 7, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>.

**7, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berriaz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaурbe/espatial-detroi-comunicon-relatedo-magdalenian-cave-art>.

## 8. ALKERDI 1

We have included 23 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 8, S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
Alk.A.I.01	11	Barandiarán Maestu, 1974	31 (8)	Bison	Simple Engr.; Multiple Engr.
Alk.A.I.02	(New)	(Unpublished)	-	Bison	Simple Engr.
Alk.A.I.03	12	Barandiarán Maestu, 1974	32 (8)	Bison	Simple Engr.; Multiple Engr.
Alk.A.I.07	16	Barandiarán Maestu, 1974	36 (8)	Deer	Simple Engr.; Multiple Engr.
Alk.A.I.08	17	Barandiarán Maestu, 1974	39 (8)	Aurochs	Simple Engr.; Multiple Engr.
Alk.B.I.01	(New)	(Unpublished)	-	Unknown	Simple Engr.
Alk.D.I.01	31	Barandiarán Maestu, 1974	36 (26)	Horse	Simple Engr.; Multiple Engr.
Alk.D.I.02	A.2-4	Garate & Rivero, 2015a	24 (7)	Unknown	Multiple Engr.
Alk.D.I.03	A.3	Garate & Rivero, 2015a	24 (7)	Bison	Simple Engr.; Multiple Engr.
Alk.D.I.04	A.5	Garate & Rivero, 2015a	26 (8)	Horse	Simple Engr.; Multiple Engr.
Alk.D.I.05	A.6	Garate & Rivero, 2015a	26 (9)	Bison	Simple Engr.
Alk.D.I.07	18	Barandiarán Maestu, 1974	39 (21)	Bison	Simple Engr.; Multiple Engr.
Alk.D.I.08	A.9	Garate & Rivero, 2015a	27 (12)	Unknown	Simple Engr.; Multiple Engr.
Alk.D.I.09	A.10	Garate & Rivero, 2015a	27 (12)	Bison	Simple Engr.; Multiple Engr.
Alk.D.I.10	A.11	Garate & Rivero, 2015a	28 (13)	Bison	Simple Engr.; Multiple Engr.
Alk.D.II.02	B.2	Garate & Rivero, 2015a	28 (15)	Bison	Simple Engr.; Multiple Engr.
Alk.D.II.03	B.3	Garate & Rivero, 2015a	29 (16)	Horse	Simple Engr.; Multiple Engr.
Alk.D.II.04	B.4	Garate & Rivero, 2015a	30 (17)	Bison	Red P.; Simple Engr.; Multiple Engr.
Alk.D.II.05	B.5	Garate & Rivero, 2015a	30 (18)	Bison	Red P.; Simple Engr.; Multiple Engr.
Alk.D.II.06	B.6	Garate & Rivero, 2015a	30 (18)	Point(s)	Red P.
Alk.D.II.07	B.6	Garate & Rivero, 2015a	30 (18)	Point(s)	Red P.
Alk.D.II.08	B.7	Garate & Rivero, 2015a	32 (18)	Bison	Simple Engr.; Multiple Engr.
Alk.D.II.09	B.8	Garate & Rivero, 2015a	33 (20)	Bison	Simple Engr.
Alk.D.II.10	B.9	Garate & Rivero, 2015a	33 (21)	Bison	Simple Engr.; Multiple Engr.

**Table 8, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi I; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaubur/spatial-organization-patterns-related-to-magdalenian-cave-art>.

**8, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi I; Etx: Etxeberri), bigarrena sektoreari, eta hirugarrena, berri, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaubur/espacial-detroi-comunicon-relatedo-magdalenian-cave-art>.

## 9. ETXEBERRIKO KARBIA

We have included 32 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 9, S2](#)).

GU	Last. Inv.	Reference	Page (Fig.)	Theme	Tehcnique (s)
Etx.E.I.02	E.IV.01	Garate & Bourrillon, 2017	53 (43)	Sign	Black P.
Etx.E.I.04	E.V.01	Garate & Bourrillon, 2017	56 (45)	Horse	Clay P.
Etx.E.I.05	E.V.02; 07	Garate & Bourrillon, 2017	56 (45)	Unknown	Black P.; Clay P.
Etx.E.I.06	E.V.03	Garate & Bourrillon, 2017	57 (47)	Horse	Red P.; Black P.
Etx.E.I.07	E.V.04; 13	Garate & Bourrillon, 2017	57 (45)	Horse	Clay P.
Etx.E.I.08	E.V.08	Garate & Bourrillon, 2017	59 (51)	Unknown	Red P.; Black P.; Clay P.
Etx.E.I.09	E.V.05	Garate & Bourrillon, 2017	58 (49)	Horse	Clay P.
Etx.E.I.14	E.VI.05-07	Garate & Bourrillon, 2017	62 (53)	Unknown	Black P.; Clay P.
Etx.E.II.02	E.II.01	Garate & Bourrillon, 2017	47 (35)	Horse	Red P.
Etx.E.II.03	E.II.02	Garate & Bourrillon, 2017	47 (36)	Paired strokes	Red P.
Etx.E.II.05	E.II.04	Garate & Bourrillon, 2017	48 (38)	Ibex	Clay P.
Etx.E.II.08	E.II.07	Garate & Bourrillon, 2017	49 (40)	Bison	Black P.; Clay P.
Etx.E.II.09	E.II.08	Garate & Bourrillon, 2017	51 (40)	Bison	Black P.; Clay P.
Etx.E.II.11	E.III.01	Garate & Bourrillon, 2017	51 (42)	Horse	Black P.; Clay P.
Etx.E.III.01	E.VII.01	Garate & Bourrillon, 2017	64 (57)	Sign	Red P.; Black P.; Clay P.
Etx.E.III.02	E.VIII.01	Garate & Bourrillon, 2017	66 (58)	Point(s)	Red P.
Etx.F.I.02	F.I.02	Garate & Bourrillon, 2017	69 (66)	Horse	Black P.
Etx.G.II.01	G.II.01	Garate & Bourrillon, 2017	78 (77)	Point(s)	Red P.
Etx.H.I.05	H.I.05	Garate & Bourrillon, 2017	84 (85)	Bison	Black P.
Etx.H.I.08	H.II.01	Garate & Bourrillon, 2017	87 (89)	Sign	Red P.
Etx.H.I.10	H.II.03	Garate & Bourrillon, 2017	87 (90)	Horse	Black P.
Etx.H.I.11	H.II.04	Garate & Bourrillon, 2017	88 (91)	Horse	Simple Engr.
Etx.H.I.13	H.II.06	Garate & Bourrillon, 2017	89 (92)	Point(s)	Red P.
Etx.H.I.14	H.II.07	Garate & Bourrillon, 2017	89 (93)	Unknown	Black P.
Etx.H.II.02	H.III.02	Garate & Bourrillon, 2017	90 (94)	Point(s)	Red P.
Etx.H.II.07	H.IV.04	Garate & Bourrillon, 2017	91 (97)	Horse	Black P.
Etx.H.II.08	H.IV.05	Garate & Bourrillon, 2017	92 (97)	Horse	Black P.
Etx.H.II.09	H.IV.06	Garate & Bourrillon, 2017	92 (98)	Horse	Black P.
Etx.H.II.10	H.IV.07	Garate & Bourrillon, 2017	93 (99)	Horse	Black P.
Etx.I.I.01	I.I.01	Garate & Bourrillon, 2017	95 (102)	Horse	Finger Engr.
Etx.I.I.02	I.I.02	Garate & Bourrillon, 2017	97 (102)	Paired strokes	Finger Engr.
Etx.J.II.01	(New)	(Unpublished)	-	Horse	Simple Engr.

**Table 9, S2 – Table of the analysed Graphic Units (GUs).** \* The first letter of the code corresponds to the cave where they are located (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), the second to the sector, and the third to the number of the panel or composite unit. The last number is the code of each graphic unit in this panel. There is a more developed table on <https://github.com/inakiintxaurbe/spatial-organization-patterns-related-to-magdalenian-cave-art>. **9, S2 Taula – Aztertutako unitate grafikoen (UG) taula.** \* Kodeko lehen hizkia kobak dauden haitzuloari dagokio (S: Santimamiñe; Lum: Lumentxa; Atr: Atxurra; Ek: Ekain; Al: Altzterri; AitzIV: Aitzbitarte IV; AitzV: Aitzbitarte V; Alk: Alkerdi 1; Etx: Etxeberri), bigarrena sektoreari, eta hirugarren, berriaz, panelaren edo unitate grafikoari. Azken zenbakia panel honetako unitate grafiko bakoitzaren kodea da. Badago taula garatuago bat esteka honetan <https://github.com/inakiintxaurbe/espatial-detroi-comunicon-relatedo-magdalenian-cave-art>.

**S3: 3D Scanning process in each cave****1. SANTIMAMIÑE**

Local government authorities commissioned a three-dimensional laser scan of Santimamiñe in 2007, carried out by the Virtualware company. A second scan in 2016 by GIM Geomatics was limited to the Antechamber and Chamber and was completed with photogrammetry. That work followed grosso modo the workflow defined beforehand by the specialists at GIM Geomatics (Bayarri et al., 2021). In this way, a three-dimensional replica of the cave was created as a point cloud, using a FARO® LS 880 laser scanner (in 2007), able to make 120,000 measurements per second and a FARO® Focus3D X-130 (in 2016) capable of 960,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m (3mm per 10m in 2007), with a reflectance of 85%. A total of 185 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. The model was georeferenced using a GPS from a Redmi Note 11 mobile phone device. Using those scans, we have processed the raw data with CloudCompare, after a first manual edition of the point clouds. To make the process more agile, the cave was divided into several segments with continuous stations. These were loaded into the software and merged later. Once all the clouds were joined in a single cluster, the points were normalised by triangulation (using the ‘scan grids’ with the sensor and the same method for the orientation, and with a ‘k nearest neighbour’ value of six ‘minimum spanning tree’). The normalised point cloud was later turned into a mesh with the ‘Poisson surface reconstruction’ process (with an ‘octree depth’ of 8, and a mean resolution of 0.05 metres). Finally, the different segments were loaded into the MeshLab programme and joined together; then the geometries in common were cleaned up and any errors were removed. This map has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

**2. LUMENTXA**

After the discovery of the rock art in 2012, the cave was scanned by the researchers (Garate et al., 2013b). In 2016, the cave was scanned again by the company GIM Geomatics, using a FARO® Focus3D X-130 laser scanner, capable of 960,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m, with a reflectance of 85%. A total of 111 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygons made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate

increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. A 3D model was created by GIM Geomatics, with a geometric precision of 0.05 metres. This model has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

### **3. ATXURRA**

After the discovery of the rock art in 2015, the cave was scanned by the company GIM Geomatics, using a FARO® Photon 20/120 laser scanner, capable of 976,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m, with a reflectance of 90%. A total of 538 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygonals made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. A 3D model was created by GIM Geomatics, with a geometric precision of 0.05 metres. This model has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

### **4. EKAIN**

A part of the Ekain cave was subjected to laser scanning by the companies ALFA arte and ZK Productions between 1998 and 2005 for the construction of its replica (called “Ekainberri”), using a VIVID 910/VI-910 from Minolta™ (the cave was registered only partially in some areas of interest). In 2021, the cave was scanned again by the company GIM Geomatics, using a FARO® Focus3D X-330 laser scanner, capable of 976,000 measurements per second. Regarding the operational precision, its error was estimated to

be 2mm per 25m, with a reflectance of 90%. A total of 245 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygonals made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. A 3D model was created by GIM Geomatics, with a geometric precision of 0.05 metres. Besides, some parts of the cave (especially the Sector B) were processed by I. Intxaurbe to gain precision, using the software CloudCompare, after a first manual edition of the point clouds. Once all the clouds were joined in a single cluster, the points were normalised by triangulation (using the ‘scan grids’ with the sensor and the same method for the orientation, and with a ‘k nearest neighbour’ value of six ‘minimum spanning tree’). The normalised point cloud was later turned into a mesh with the ‘Poisson surface reconstruction’ process (with an ‘octree depth’ of 8, and a mean resolution of 0.05 metres). Finally, the different models were loaded into the MeshLab programme and joined together; then the geometries in common were cleaned up and any errors were removed. This model has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

## **5. ALTXERRI**

The cave was partially scanned with a laser scanner by the company CONSULTORES INDEPENDIENTES EN GESTIÓN DE RESURSOS NATURALES, S.A. (CRN) using a i-site 4400 laser scanner from Matpek™, and the company GIM Geomatics in 2011, to complete previous documentation carried out by the company CRN. In 2021, GIM Geomatics was hired again to carry out a new scan of the cave. A FARO® LS 880 laser scanner was used in 2011, able to make 120,000 measurements per second and a FARO® Focus3D X-330 in 2021, capable of 960,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m (3mm per 10m in 2007), with a reflectance of 85%. A total of 260 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygonals made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with

integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. A 3D model was created by GIM Geomatics, with a geometric precision of 0.05 metres. This model has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

## **6. AITZBITARTE IV**

After the discovery of the rock art in the “Chimney of Modelled Clay Animals” in 2017, the cave was scanned by the company GIM Geomatics, using a FARO® Focus3D X-330 laser scanner, capable of 960,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m, with a reflectance of 85%. A total of 251 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygonals made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. A 3D model was created by GIM Geomatics, with a geometric precision of 0.05 metres. This model has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

## **7. AITZBITARTE V**

After the discovery of the rock art in 2015, the cave was scanned by the company GIM Geomatics, using a FARO® Focus3D X-130 laser scanner, capable of 960,000

measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m, with a reflectance of 85%. A total of 118 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygons made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. A 3D model was created by GIM Geomatics, with a geometric precision of 0.05 metres. This model has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

## **8. ALKERDI 1**

After the discovery of the gallery of the Bison in 2014, the cave was scanned by the company GIM Geomatics, using a FARO® Photon 20/120 laser scanner, capable of 976,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m, with a reflectance of 90%. A total of 74 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygons made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. Using those scans, we have processed the raw data with CloudCompare, after a first manual edition of the

point clouds. To make the process more agile, the cave was divided into several segments with continuous stations. These were loaded into the software and merged later. Once all the clouds were joined in a single cluster, the points were normalised by triangulation (using the ‘scan grids’ with the sensor and the same method for the orientation, and with a ‘k nearest neighbour’ value of six ‘minimum spanning tree’). The normalised point cloud was later turned into a mesh with the ‘Poisson surface reconstruction’ process (with an ‘octree depth’ of 8, and a mean resolution of 0.05 metres). Finally, the different segments were loaded into the MeshLab programme and joined together; then the geometries in common were cleaned up and any errors were removed. This map has been used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

## **9. ETXEBERRIKO KARBIA**

The cave was scanned in September 2022, within the project “Ilunpeetako Sekretuak Argiztatzen”, led by I. Intxaurbe, using a FARO® Focus3D X-330 laser scanner, capable of 976,000 measurements per second. Regarding the operational precision, its error was estimated to be 2mm per 25m, with a reflectance of 90%. A total of 172 stations were used to measure the shape of the underground space, using reference spheres and targets to orientate the points cloud. For the georeferencing of the model, a series of bases were established outside each cave that served as the departure and arrival of the polygons made. These bases were observed using a dual-frequency L1+L2 GPS-GNSS brand TOPCON model HIPER SR with integrated GPS+GLONASS receiver for REAL TIME (RTK) and centimetre precision (error below 2 cm).

The observation method used has been the differential through both static and real-time RTK observations from reference stations, obtaining the baselines and coordinate increments in the WGS84 global system from the reference equipment to the observed point.

The observation times have been determined by the number and geometry (GDOP) of the operational satellites, the disturbances of the ionosphere and by the length of the baselines. The data processing for the calculation of the baselines and resolution of ambiguities has been carried out using the equipment's software, obtaining from the GPS observations the coordinates of all the points in the ETRS89 system. Using those scans, we have processed the raw data with CloudCompare, after a first manual edition of the point clouds. To make the process more agile, the cave was divided into several segments with continuous stations. These were loaded into the software and merged later. Once all the clouds were joined in a single cluster, the points were normalised by triangulation (using the ‘scan grids’ with the sensor and the same method for the orientation, and with a ‘k nearest neighbour’ value of six ‘minimum spanning tree’). The normalised point cloud was later turned into a mesh with the ‘Poisson surface reconstruction’ process (with an ‘octree depth’ of 8, and a mean resolution of 0.05 metres). Finally, the different segments were loaded into the MeshLab programme and joined together; then the geometries in common were cleaned up and any errors were removed. This map has been

**PAPER V: SUPPLEMENTARY MATERIALS – *MATERIAL OSAGARRIAK***

used to create a plan of the soils, cutting the ceilings, and converting the file in a .wrl file, to be opened in ArcGIS®.

#### **S4: Reconstruction of the landscape 13.5 - 18.5 ka ago**

##### **1. SANTIMAMIÑE**

The cave of Santimamiñe is generally distinguished by the numerous speleothems that have concealed the original bondable rock and the erosive and paragenetic morphologies in many places. There are also a few deposits of detrital sediments and several witnesses of the terraces of allochthonous sandstones along the gallery. All this has changed the original topography of the tube, by interspersing obstructions and enlargements (at some points up to twenty metres), producing vertical jumps and remarkable ramps, as well as numerous side passages. Most of this evidence already existed in the Magdalenian, and we can only point out some later changes, such as the growth of Holocene formations on the floors of some galleries (gours, flowstones, etc.), as well as specific lithochemical reconstructions. It is not ruled out that a part of the formations that closed the entrance to the Ancient Room of Paintings had growth layers dating back to the Holocene, but the general appearance of the passage would be very similar to the current one (Intxaurbe et al., 2023b).

At present, the path is relatively easy thanks to the stairs, railings, passages, and artificially flats, but if it were to maintain its original appearance, speleological installations of security and vertical progression (ropes, anchors, scales, etc.) would be necessary to visit the cave. Obviously, all these modern alterations did not exist in the Magdalenian, and it was necessary to remove them from the 3D model of the cave to obtain a model as close as possible to the Paleolithic cavern.

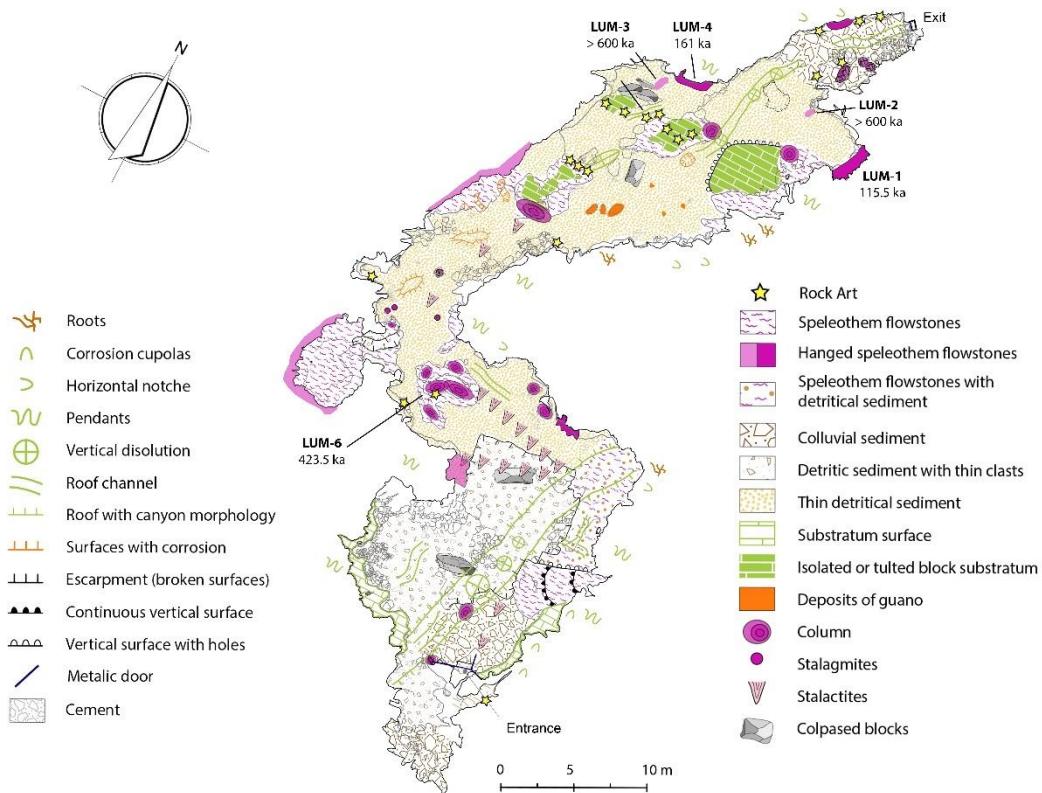
*Information regarding the geomorphologic study and the reconstruction of this cave can be found at the following link:*



<https://doi.org/10.1016/j.jasrep.2023.104219>

## 2. LUMENTXA

Lumentxa is a cave-level in a senile phase, with generations of very old speleothems. New generations of important active speleothems are barely visible. Furthermore, corrosive forms abound in the cave, perhaps due to the existence of two entrances at each end of the passage, and thin thickness between the cave ceiling and the outside, that introduce numerous biofilms and fungi into the gallery. As we have pointed before, there are some blocks in the last part of the gallery. The antiquity of the collapses is proved by the phreatic erosive forms which were formed when a stream crossed again the cavern, after a first vadose phase (paragenesis). In summary, is difficult to assess exactly the form that would have the cave in the past (and particularly during the Magdalenian), but the main changes would be located near the two entrances (colluvial type sedimentation and human-occupation remains). In the other parts of the cave, we can assume a lower ground level in some parts of the gallery (especially due to active flowstones and thin materials introduced by laminar type water streams produced by infiltration), but they would not affect the passage of humans considerably. Nor can we rule out the existence of subsidence in some points of materials that move to lower levels, as would surely happen in the vestibule (Castaños, 2022; Gómez-Olivencia et al., 2022; 2023). The main changes produced by the archaeological excavations have been modified to obtain a model as close as possible to the Palaeolithic appearance of the cave.



**Figure S4-1.** Geomorphologic plan of Lumentxa Cave (M. Arriolabengoa & I. Intxaurbe; plan after 3D survey of GIM Geomatics).  
**S4-1 Irudia. Lumentxako haitzuloaren planta geomorfologikoa (M. Arriolabengoa & I. Intxaurbe, GIM Geomatics-en 3Dtik ateratako planoa).**

Sample	$^{238}\text{U}$	$^{232}\text{Th}$	$^{230}\text{Th} / ^{232}\text{Th}$	$d^{234}\text{U}^*$	$^{230}\text{Th} / ^{238}\text{U}$	$^{230}\text{Th}$ Age (yr)	$^{230}\text{Th}$ Age (yr)	$d^{234}\text{U}_{\text{Initial}}^{**}$	$^{230}\text{Th}$ Age (yr BP)***
Number	(ppb)	(ppt)	(atomic $\times 10^{-9}$ )	(measured)	(activity)	(uncorrected)	(corrected)	(corrected)	(corrected)
LUM-1	16.5 $\pm 0.0$	31374 $\pm 631$	10 $\pm 0$	364.1 $\pm 6.3$	1,1027 $\pm 0.0136$	159312 $\pm 4435$	<b>115574 <math>\pm 34411</math></b>	505 $\pm 49$	<b>115503 <math>\pm 34411</math></b>
LUM-2	48.6 $\pm 0.2$	27939 $\pm 564$	38 $\pm 1$	172.0 $\pm 5.2$	1,3217 $\pm 0.0112$				>600ka
LUM-3	43.7 $\pm 0.2$	61781 $\pm 1261$	15 $\pm 0$	178.2 $\pm 7.2$	1,2802 $\pm 0.0131$				>600ka
LUM-4	40.5 $\pm 0.1$	677 $\pm 14$	1213 $\pm 24$	492.8 $\pm 2.8$	1,2293 $\pm 0.0031$	161544 $\pm 1093$	<b>161270 <math>\pm 1107</math></b>	777 $\pm 5$	<b>161199 <math>\pm 1107</math></b>
LUM-6	15.1 $\pm 0.0$	7171 $\pm 144$	42 $\pm 1$	171.3 $\pm 4.0$	1,2127 $\pm 0.0125$	432806 $\pm 51772$	<b>423650 <math>\pm 48218</math></b>	566 $\pm 80$	<b>423579 <math>\pm 48218</math></b>

**Table S4-1.**  $^{230}\text{Th}$  dating results for Lumentxa Cave (the sampling points can be seen in Figure S4-1). The error is 2s error. Laboratory: University of Xi'an Jiaotong. U decay constants:  $\lambda_{238} = 1.55125 \times 10^{-10}$  (Jaffey et al., 1971) and  $\lambda_{234} = 2.82206 \times 10^{-6}$  (Cheng et al., 2013). Th decay constant:  $\lambda_{230} = 9.1705 \times 10^{-6}$  (Cheng et al., 2013). \* $d^{234}\text{U} = (\lambda_{234}\text{U} / ^{238}\text{U})_{\text{activity}} - 1 \times 1000$ . \*\*  $\delta^{234}\text{U}_{\text{initial}}$  was calculated based on  $^{230}\text{Th}$  age (T), i.e.,  $\delta^{234}\text{U}_{\text{initial}} = \delta^{234}\text{U}_{\text{measured}} \times e^{(\lambda_{234} \times T)}$ . Corrected  $^{230}\text{Th}$  ages assume the initial  $^{230}\text{Th}/^{232}\text{Th}$  atomic ratio of  $4.4 \pm 2.2 \times 10^{-6}$ . Those are the values for a material at secular equilibrium, with the bulk earth  $^{232}\text{Th}/^{238}\text{U}$  value of 3.8. The errors are arbitrarily assumed to be 50%. \*\*\*B.P. stands for “Before Present” where the “Present” is defined as the year 1950 A.D.



**Figure S4-2.** A) Geomorphologic plan of the exit of Lumentxa. B) Photograph of the exit sector of the cave of Lumentxa, with the excavation which was made by J. L. Arribas-Pastor (1985/86), finding sterile levels. In another one, closer to the entrance, it found remains of a hearth 30 cm beneath the current soil level. It's noteworthy that J.M. Barandiaran pointed out the existence of flint pieces on the surface, and in a test pit, he found flint pieces and fishes bones (Arribas Pastor, 1985/86). C) Digital reconstruction with Blender®. The X marks the position of the LUM-1 sample, 30 cm over the current ground level. The colluvium which comes from the outside would be less developed than nowadays. **S4-2 Irudia.** A) Lumentxako irteeraren plano geomorfologikoa. B) Lumentxa haitzuloaren irteera-sektorearen argazkia, J. L. Arribas-Pastorrek (1985/86) egindako indusketarekin, maila antzuak aurkituz. Beste batean, sarreratik hurbilago, sutondo batzen arrastoa aurkitu zituen egungo zorua baino 30 cm beherago. Aipagarria da J.M. Barandiaranek azaleran suharri-piezak zeudela adierazi zuela, eta eskabazio-hobi batean suharri-zatiak eta arrain-hezurrak aurkitu zituela (Arribas Pastor, 1985/86). C) Berreraikuntza digitala Blender® erabiliz. X-k LUM-1 laganaren posizioa markatzen du, 30 cm-koak lurrazen egungo mailaren gainean. Kanpotik datorren kolubioia ez litzateke gaur egun bezain garatua egongo.

### **3. ATXURRA**

The geomorphological study carried out in the cave (Arriolabengoa et al., 2020) identified several phases of sedimentation that occurred in times after the Magdalenian frequentation of the cave. These would correspond to lithochemical formations identified at various points (mainly paving type, such as gours and superficial flowstones), as well as fills of karstic origin, produced by low-power infiltration waters. On the other hand, the access points to the endokarst contributed colluvial sediments, which would be added to those contributed by human occupations in the cave (and the Holocene fills that we mentioned above).

All this allows us to limit the subsequent modifications to the late-glacial human use of the cave, surely linked only to symbolic activities in the case of the deep areas, mainly to the outermost sectors of the two cave floors (Atxurra and Armiña). That is, the ground level would be lower than the current level, and this made it possible to cross the existing low-ceiling passages in numerous points in a simpler way than today. On the other hand, in the decorated area the greatest changes would occur in the lowest points of the gallery, so the sectors with rock art would have hardly noticed any changes since their use in the Magdalenian. All identified changes were edited to obtain a model that was as faithful as possible to the cave known to ancient human groups.

*Information regarding the geomorphologic study of this cave can be found at the following link:*



<https://onlinelibrary.wiley.com/doi/10.1002/jqs.3225>



**Figure S4-3.** **A)** Geomorphologic plan of the sector of Armiña. **B)** Photograph of the exit sector of the cave of Armiña, with the excavation which was made by J. Rios-Garaizar et al. (2020), finding a sporadic Magdalenian occupation level 40/50 cm below the current ground level. It's noteworthy that J.M. Barandiaran also found some pieces here, like those found by J. Rios-Garaizar et al., proposing that the cave was closed from the outside, and that it was used for other purposes (symbolic?). **C)** Digital reconstruction with Blender®. The first square signals the Magdalenian level, 40 cm below nowadays. The second square signals the zone of the entrance, originally, the cave was not opened there (it was opened by roadworks). The continuation of the ceiling channel has been drawn, closing the cave by a colluvium from the entrance finally. **S4-3 Irudia.** **A)** Armiñako sektorearen plano geomorfologikoa. **B)** Armiñako haitzuloaren irteera-sektorearen argazkia, J. Rios-Garaizar et al. (2020)-ek egindako indusketa erakusten, Madeleine garaiaiko noizbehinkako opakazioa aurkituz gaur egungo lurzoruaren maila baino 40/50 cm beherago. Aipatzeko da J. M. Barandiaranek ere aurkitu zituela hemen zenbait pieza, J. Rios-Garaizar et al.-ek aurkitutakoentzakoak, haitzuloa kanpotik itxita zegoela eta beste helburu batuetarako (sinbolikoa?) erabiltzen zela proposatuz. **C)** Berreraikuntza digitala Blender® erabiliz. Lehen karratuak Madeleine aldko maila adierazten du, 40 cm beherago gaur egun. Bigarren laukiak sarreraren ingurua seinalatzen du, hasiera batean, haitzuloa ez zen han ireki (errepide lanen bidez ireki zen). Sabaiko kanalaren jarraipena marraztu da, eta azkenean kolubio batek itxi du haitzuloa sarreratik.

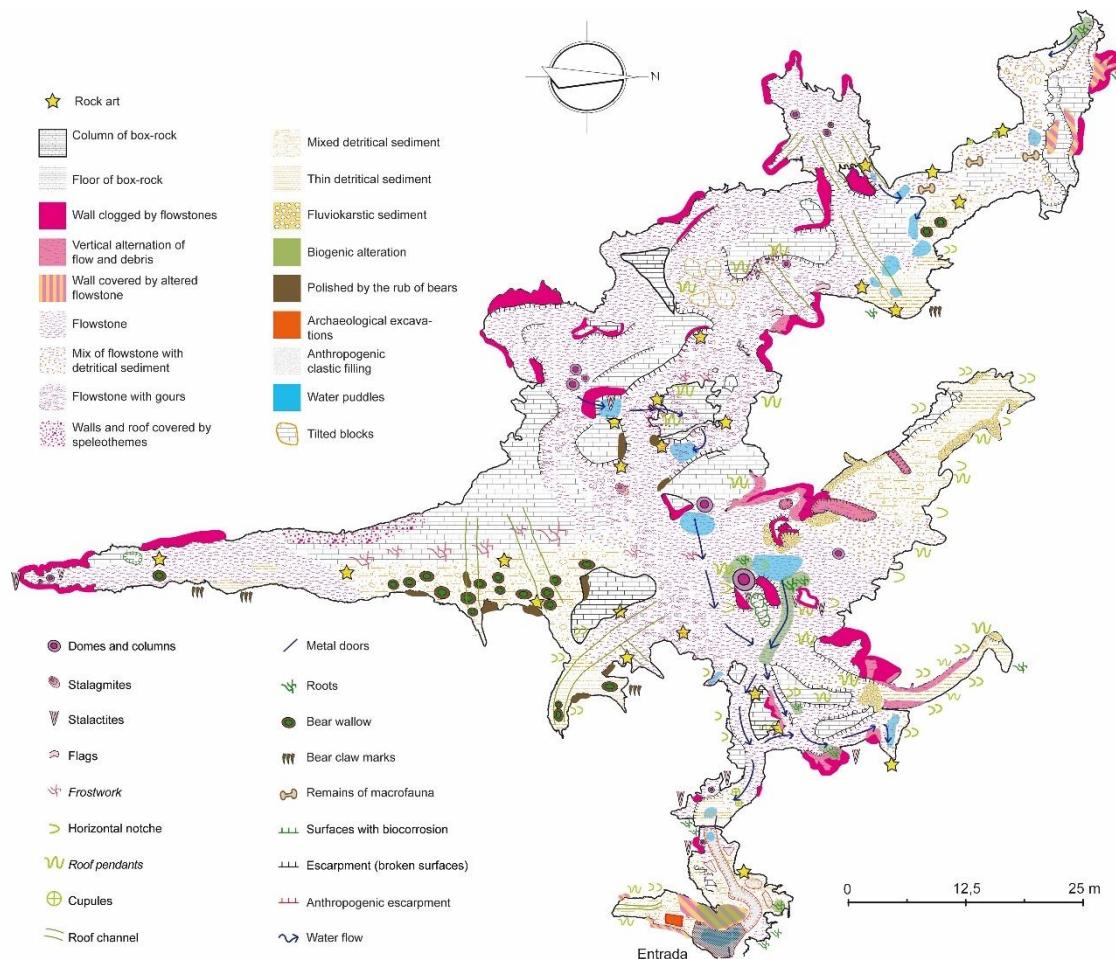


**Figure S4-4.** **A)** Geomorphologic plan of the sector of the crawlway of the upper gallery of Atxurra. **B)** Photograph of the crawlway of the upper gallery of Atxurra, with the test pit made by M. Arriolabengoa and I. Intxaурbe to know its width. There have been found charcoals, thin fluvikarstic layers and flowstones and gours beneath. There is a post-Magdalenian width around 30 cm. **C)** Digital reconstruction with Blender®. The first square signals the Magdalenian level, 30 cm below nowadays, so the crawlway conduct would be more comfortable than today. **S4-4 Irudia.** **A)** Atxurrako goiko galeriako laminadoreko sektorearen plano geomorfologikoa. **B)** Atxurrako goiko galeriako laminadoreko argazkia, M. Arriolabengoa eta I. Intxaurbek haren zabalera ezagutzeko egindako frogahobiarekin. Azpian ikatzak aurkitu dira, geruza flubikartiko meheak, eta koladekin tartekatuta. Madeleine garai osteko betekinaren zabalera 30 cm ingurukoa da. **C)** Berreraikuntza digitala Blender® erabiliz. Lehen karratuak Madeleine aldko maila adierazten du, gaur egun baino 30 cm beherago. Beraz, herrestan ibiltzea gaur egun eroosoagoa litzateke.

#### 4. EKAIN

The cavern of Ekain presents several deposits of allochthonous sediments, some of fluvial origin (detrital, pebbles, etc.) and different generations of speleothems. There are numerous active processes in Ekain, among which we highlight the entry of infiltration waters, and several active parietal and surface formations (gours, flowstones, etc.) that hide some surfaces that existed during the Magdalenian.

Besides, the cave has not been modified to facilitate the visits, so it continues to appear like when it was discovered in 1969, excepting for the first crawlway, which was enlarged by digging a trench. However, this conditioning allowed us to know the stratigraphy of this passage, so we know that it was composed of a width of several archaeologically sterile levels interspersed with bones of *Ursus Spelaeus*, except in the first 10 centimetres, where there could be more recent contributions, perhaps the result of removals caused by animals that entered the cave (Altuna, 2019). Having this in mind, the main changes produced by these archaeological excavations have been modified to obtain a model as close as possible to the Palaeolithic appearance of the cave.



**Figure S4-5.** Geomorphologic plan of Ekain Cave (M. Arriolabengoa & J. González; plan after 3D survey of GIM Geomatics). **S4-5 Irudia. Ekaingo leizearen planta geomorfologikoa** (M. Arriolabengoa & J. González, GIM Geomatics-en 3Dtik ateratako planoa).



**Figure S4-6.** A) Geomorphological map of the entrance to the Ekain cave. B) Photographs of the vestibule of the Ekain cave from the passage to the decorated areas (S. Salazar), with the excavation made by J. M. Barandiaran and J. Altuna (2019). In this area they found sterile levels with cave bears (before the Magdalenians), minus 10 cm post-Palaeolithic (removed by animals). C) Digital reconstruction with Blender®. The rectangle marks a ramp produced by a colluvium that would descend from the vestibule that would have existed in the Magdalenian, before entering a cathole from where the decorated areas would be accessed. **S4-6 Irudia.** A) *Ekaingo haitzuloaren sarreraren mapa geomorfologikoa.* B) *Ekain haitzuloko atondoaren argazkiak, dekoratutako eremuetarako pasabidetik* (S. Salazar), J. M. Barandiaran eta J. Altunak (2019) egindako indusketairekin. Eremu horretan, haitzuloetako hartzentzat aztarnak zituzten maila antzuak aurkiutu zituzten (Madeleine garai aurrekoak), Paleolito ostekoak zen 10 cm-ko goieneko geruza bat izan ezik (animaliek mugiaraziak). C) *Berreraikuntza digitala Blender® erabiliz. Laukizuzenak kolubioi batek sortutako arrapala bat markatzendu, Madeleine aldiko atarrik jaitsiko litzatekeena, gatera batera sartu aurretik, handik dekoratutako guneetara sartzeko.*



**Figure S4-7.** A) Geomorphological map of the second gate of Ekain. B) Photograph of the second door of the Ekain cave from Sector B (S. Salazar). C) Digital reconstruction with Blender®. The first rectangle marks the gap where the current wall and the door are, and the second shows the narrowest area of the crawlway, which would have to be crossed while lying down even in the Magdalenian, since the lower levels are older levels with remains of cave-bears. **S4-7 Irudia.** A) *Ekaingo bigarren atearen mapa geomorfologikoa.* B) *Ekain haitzuloko bigarren atearen argazkia, B sektoretik* (S. Salazar). C) *Berreraikuntza digitala Blender® erabiliz. Lehenengo laukizuzenak horma eta egungo atea dauden hutsunea adierazten du, eta bigarrenak, berri, katalzoaren alderik estuena, Madeleine aldian ere etzanda zeharkatu beharko litzatekeena, beheko mailak haitzuloetako hartz-hondarrak dituzten maila zaharragoak baitira.*



**Figure S4-8.** A) Geomorphological map of the "Zaldei" area of Ekain. B) Photograph of the area of the large panel "Zaldei" of Ekain. Active *gours* are observed in the soil (Holocene), but remains of the box rock also emerge, which, being stratified and dipped, makes it predictable to know its original situation. C) Digital reconstruction with Blender®. The rectangle marks an emerged stratified and dipped rock in the same area without Holocene *gours*, up to the box rock (following the slope of the dip). In the Magdalenian it would continue to be a descending conduit, although somewhat wider than today. **S4-8 Irudia.** A) *Ekaingo "Zaldei" zonaldearen mapa geomorfologikoa.* B) *Ekaingo "Zaldei" panel handiaren eremuaren argazkia.* Gours aktiboak ikusten dira lurrean (Holozenokoak), baina arroka-kutxaren hondarrak ere azaleratzen dira, eta geruzatuta eta buzatuta dagoenez, aurreikus daiteke jatorrizko egoera zein litzatekeen. C) *Berreraikuntza digitala Blender® erabiliz. Laukizuzenak aurreko argazkian irretzen ari zen harri buzatua markatzendu Holozenoko gours-ik gabeko eremuan, harri kaxaraino (buzamenduaren maldari jarraituz).* Madeleine aldian beheranzko bidea izaten jarraituko luke, baina gaur egun pixka bat zabalagoa..

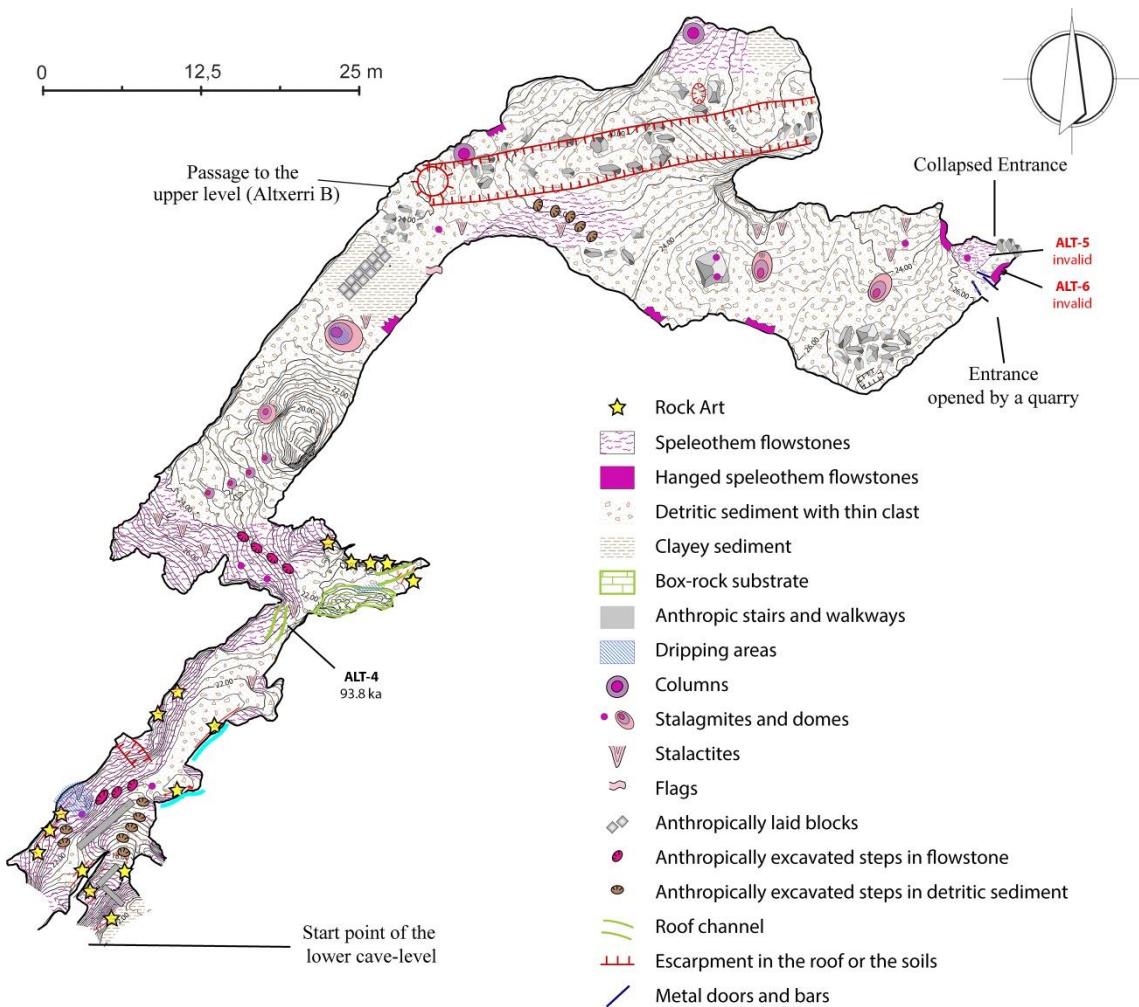
## 5. ALTXERRI

Given the unique lithology in which the cave opens, it is quite difficult to know exactly what the cave would have looked like in prehistoric times. There are numerous collapses and subsidence due to structural weaknesses in the bedrock that are practically impossible to date in relative stratigraphy. In any case, in other cases, we can know whether or not they existed at the time the galleries of Altzerri were decorated.

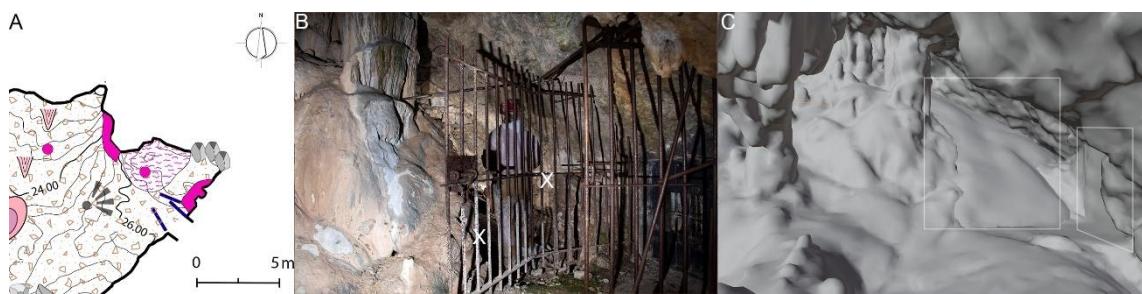
For example, and limiting ourselves only to Altzerri A (the cave frequented during the Magdalenian), we know that at least one fragment that contained engravings in the first group of figures was detached at a later time, just above a flint scraper/point that It was probably used to make some of the engravings (as indicated by J.M. Barandiarán in his personal diary). Besides, in the area closest to the vestibule there are sedimentation processes of fine materials (clays and silts) produced by infiltration water, alternated by thin lamellar layers of calcium carbonate that sealed at least two moments of ephemeral prehistoric frequentation (probably Palaeolithic). On the other hand, the collapse that exists before the decorated sectors must have already existed in the Magdalenian, since its surface contained remains of charcoal located under the most superficial layer of the flowstone that covers it. As for the entrance through which the Magdalenian groups probably entered, it is difficult to know its appearance, since the levels of colluvial materials that close it are archaeologically sterile (except for a level located -20 from the flowstone on where the workers opened a trench under the orders of J.M. Barandiarán in 1962, which contains a few charcoals visible in stratigraphy). We can propose two hypotheses: that it was a large entrance, or that, on the contrary, it was a very small and discreet size. Seeing the absence of remains of prehistoric habitat in Altzerri, as well as there is few evidence that attests to other human uses after the Magdalenian period (only a torch mark dated in the Neolithic, M. Á. Medina-Alcaide, pers. com.), and considering that the cave is located in a strategic location over the river Oria, we believe the second hypothesis is more likely. Taking this into account, the model of the cave was modified to show an appearance as close as possible to what it would have had in the Palaeolithic.

230Th dating results. The error is 2σ error.												
Sample	238U	232Th	230Th / 232Th	δ234U*	230Th / 238U	230Th Age (yr)	230Th Age (yr)	δ234Uinitial**	230Th Age (yr BP)***			
Number	(ppb)	(ppt)	(atomic x10 <sup>-6</sup> )	(measured)	(activity)	(uncorrected)	(corrected)	(corrected)	(corrected)			
ALT-4	148,5 ±0,2	20630 ±414	155 ±3	1103,9 ±2,5	1,3089 ±0,0039	95546 ±452	93878 ±1262	1439 ±6	93807 ±1262			
ALT-5	42,5 ±0,2	166400 ±3382	4 ±0	246,8 ±6,1	0,9124 ±0,0106	134218 ±3232	-60411 ±254901	208 ±120	-60482 ±254901			
ALT-6	43,6 ±0,2	74271 ±1507	4 ±0	280,0 #####	0,3981 ±0,0056	40033 ±798	-7192 ±36903	274 ±30	-7263 ±36903			

**Table S4-2.** 230Th dating results for Altzerri Cave (the sampling points can be seen in Figure S4-9. Datings made in Altzerri B are not shown here). The error is 2s error. Laboratory: University of Xi'an Jiaotong. U decay constants:  $l_{238} = 1.55125 \times 10^{-10}$  (Jaffey et al., 1971) and  $l_{234} = 2.82206 \times 10^{-6}$  (Cheng et al., 2013). Th decay constant:  $l_{230} = 9.1705 \times 10^{-6}$  (Cheng et al., 2013). \* $d^{234}\text{U} = ([^{234}\text{U}/^{238}\text{U}]_{\text{activity}} - 1) \times 1000$ . \*\*  $\delta^{234}\text{U}_{\text{initial}}$  was calculated based on 230Th age (T), i.e.,  $\delta^{234}\text{U}_{\text{initial}} = \delta^{234}\text{U}_{\text{measured}} \times e^{l^{234}\text{U} \times T}$ . Corrected 230Th ages assume the initial 230Th/232Th atomic ratio of 4.4 ±2.2 ×10<sup>-6</sup>. Those are the values for a material at secular equilibrium, with the bulk earth 232Th/238U value of 3.8. The errors are arbitrarily assumed to be 50%. \*\*\*B.P. stands for “Before Present” where the “Present” is defined as the year 1950 A.D.



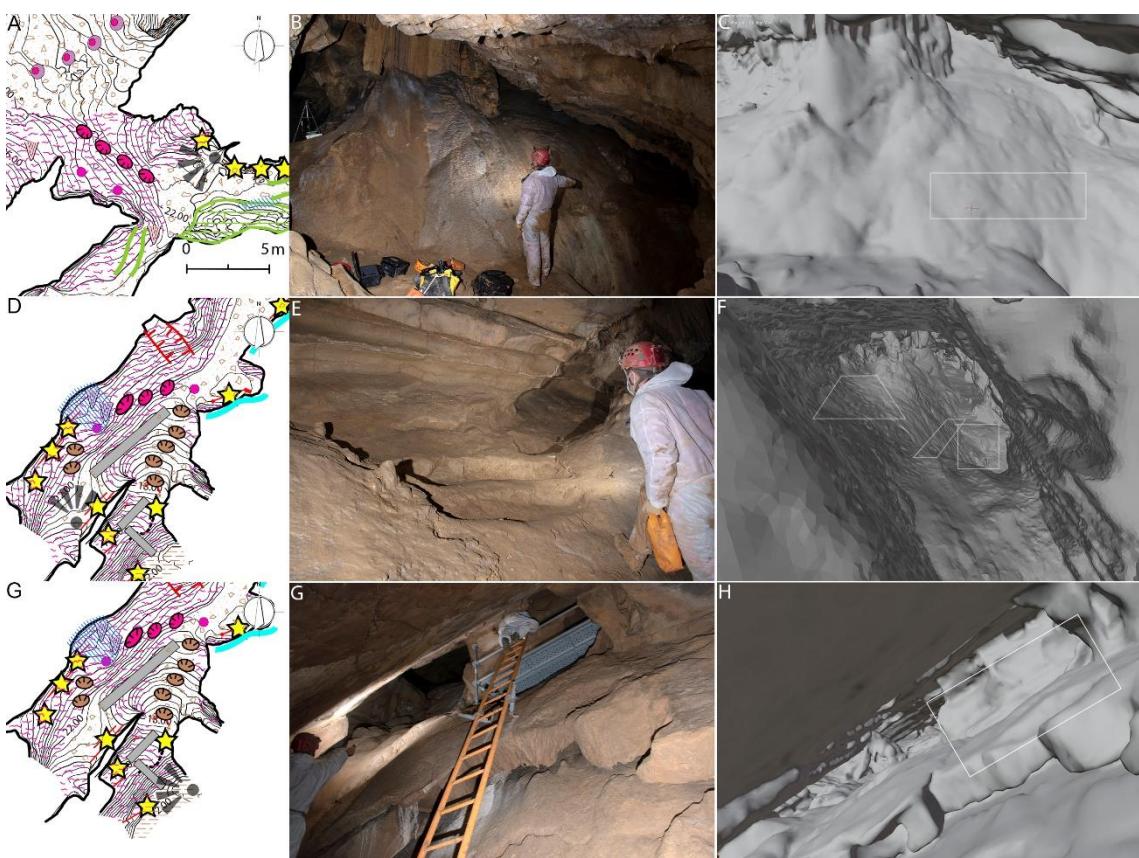
**Figure S4-9.** Geomorphologic plan of Altzerri Cave (M. Arriolabengoa & I. Intxaurbe; plan after L. Teira). *S4-9 Irudia. Altzerriko leizearen planta geomorfologikoa (M. Arriolabengoa & I. Intxaurbe, L. Teira-renetik ateratako planoa).*



**Figure S4-10.** **A)** Geomorphologic plan of the entrance of Altzerri. **B)** Photograph of the entrance of Altzerri, with the excavation ordered by J. M. Barandiaran in 1962, in the colluvial cone with flowstones which clogged an ancient entrance. Some charcoals were found 20 cm below the current surface of the cone, but there are not other remains. An attempt was made to date the lower part of the debris (ALT-5) and one of the last entrances of allochthonous material (ALT-6). However, despite uncorrected dates are coherent stratigraphically, the high correction due to the high level of detrital thorium invalidates the results. **C)** Digital reconstruction with Blender®. The rectangle of the right shows the current entrance opened by a quarry, and the other the reconstruction of the colluvium which existed during the Magdalenian, at least 20 cm below the current one, the small entrance is in the upper part. *S4-10 Irudia. A) Altzerriko sarraren plano geomorfologikoa. B) Altzerriko leizearen atariko argazkia, J. M. Barandiaranek 1962an agindutako indusketa erakutsiz, zeina antzinako sarrera bat ixten zuen kolubioean egin zen. -20 zentimetro azpian dauden ikatz batzuk izan ezik, maila antzuak ziren. Saiakera bat egin zen konoaren goiko (ALT-5) zein azpiko (ALT-6) geruzak datatzeko, baina datazioak oker atera ziren torio detritiko maila altuak derrigortutako zuzenketagatik, estratigrafikoki koharenteak izan arren. C) Berreraikuntza digitala Blender® erabiliz. Lehen karratuak gaur egungo sarrera artifiziala seinalatzen du, eta ezkerrekoak, ordea Madeleine aldiko kolubioia, gaurkoa baino 20 cm beherago. Orduko sarrera txikia goian lego.*



**Figure S4-11.** A) Geomorphologic plan of the Sector C. B) Photograph of the Sector C (O. Spaey), showing the block which contained GUs C.IV.55-57. It has fallen after the Magdalenian, because it buried a scraper/point used for engraving (J. Rios-Garaizar, pers. com.). C) Digital reconstruction with Blender®. The rectangle marks the original position of the fallen block, identifiable by a small notch in the lower part and the shape of the rock. One of the figures (C.IV.57) has been analysed in this original position. **S4-11 Irudia.** A) C sektoreko plano geomorfologikoa. B) C sektorearen argazkia (O. Spaey), C.IV.55-57 UG-ak zituen bloke eroria ikusten. Berau Madeleine ostean erori zen punta/karrakagailu bat lurperatu baitzituen, grabatuak egiteak utzitako markak zituena (J. Rios-Garaizar kom. perts.). C) Berreraikuntza digitala Blender® erabiliz. Laukizuzenak blokearen jatorrizko posizioa seinalatzen du, azpialdean duen koskagatik identifikagarria. Irudi bat (C.IV.57) bloke honetan zuen jatorrizko tokia kontuan hartuz neurtu da.



**Figure S4-12.** A), D) and G) Geomorphologic plan of the decorated sectors of Altzerri. B), E) and G) Photograph of the decorated zones, there can be seen the modifications to the cave to facilitate the transit of researchers (steps in the flows and ramps of detrital sediments, ramps, stairs, etc.). C), F) and H) Digital reconstruction with Blender® of those obstacles as they would have looked in the Magdalenian. White rectangles mark some of the main changes. **S4-12 Irudia.** A), D) eta G) Altzerriko sektore dekoratuen plano geomorfologikoa. B), E) eta G) Dekoratutako guneen argazkia. Bertan, kobazuloaren aldaketak ikus daitezke, ikertzaileen joan-etorria errazteko (jalkin detritikoen, arrapaletan egindako zuloak, eskailerak, pasarelak eta abar). C), F) eta H) Berreraikuntza digitala Blender® erabiliz, Madeleine aldian izango zuketen itxura erakusteko. Laukizuzen zuriek markatzen dituzte aldaketa nagusietako batzuk.

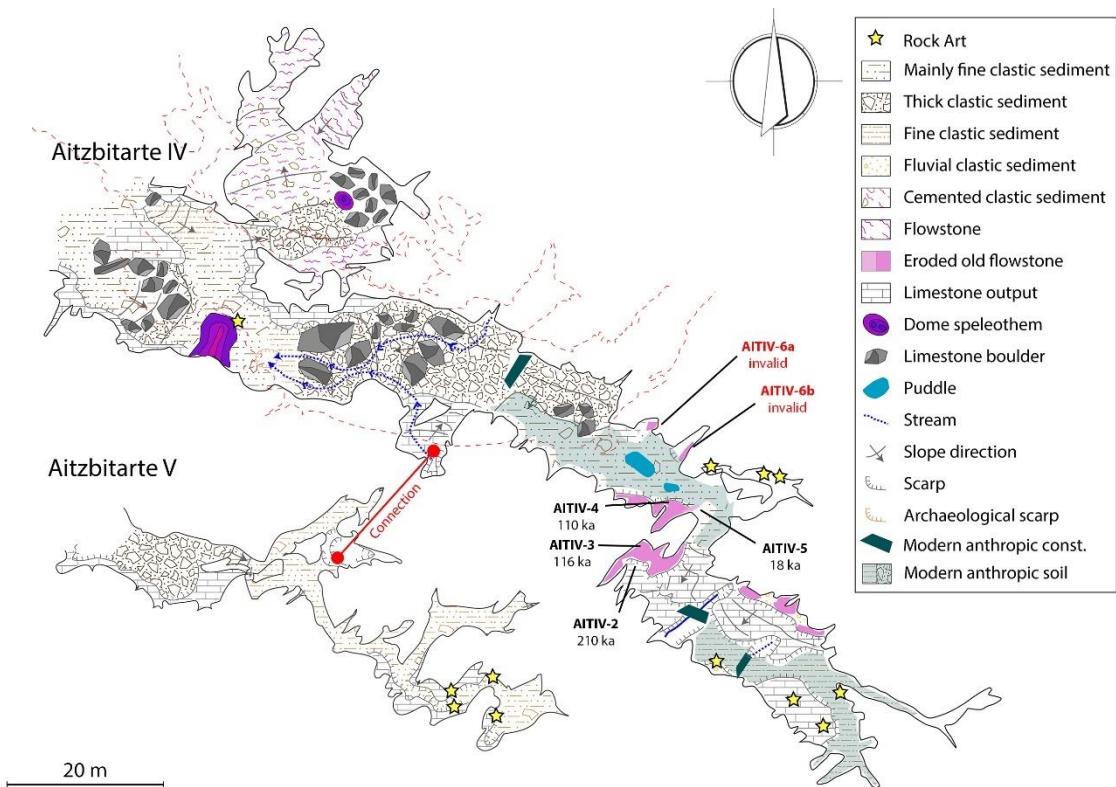
## **6. AITZBITARTE IV**

The cave of Aitzbitarte IV has suffered numerous alterations throughout its history, which have completely altered the morphology it may have had in the Upper Palaeolithic. These processes could be due in part to natural processes, but above all, they are of anthropic origin (military or industrial use of the cave, vandalism, archaeological looting, washing without archaeological supervision, etc.).

The current ground level of the cave, in most of the main gallery development, dates from the early 20th century. At that time, a large part of the original sediment was emptied to cover, in addition to other clasts and rock fragments extracted from the cave itself with explosives, some lateral fissures that successively and orthogonally cut the gallery (making it dangerous to walk through it), and to expand available space for industrial purposes. In addition, the soil was filled with organic detritus to grow the mushrooms. The edges of the walls and crops were disinfected using lime, which left a visible whitish mark along the gallery. Nowadays, all the soil has been compacted by the constant visits that the cave has suffered until the discovery of the engravings modelled in clay in 2017, when the entrance was closed.

At a variable height between 1.50 metres and 2 metres high, it is possible to observe the presence of a lithochemical crust with very specific hanged sediment remains in it (with bones of *Ursus Sp.*), which represented the ancient floor-level of the cave. Furthermore, on the roofs immediately above that witness, several black marks and charcoal deposits are observed that were dated between the 11th and 13th centuries AD, attesting that the medieval frequentations used this ancient floor-level (Garate et al. 2013d). There is no doubt that the Upper Palaeolithic floor was at this level, because of the presence of the ours remains. This data was confirmed by radiometric dating extracted from the geomorphological study carried out by M. Arriolabengoa and I. Intxaurbe. We want to point again that the original path in the main gallery was crossed successively by many dangerous sinkholes. Also, the ceilings were at a lower height in many sites, so it would be difficult to walk in the paleotopography of Aitzbitarte IV.

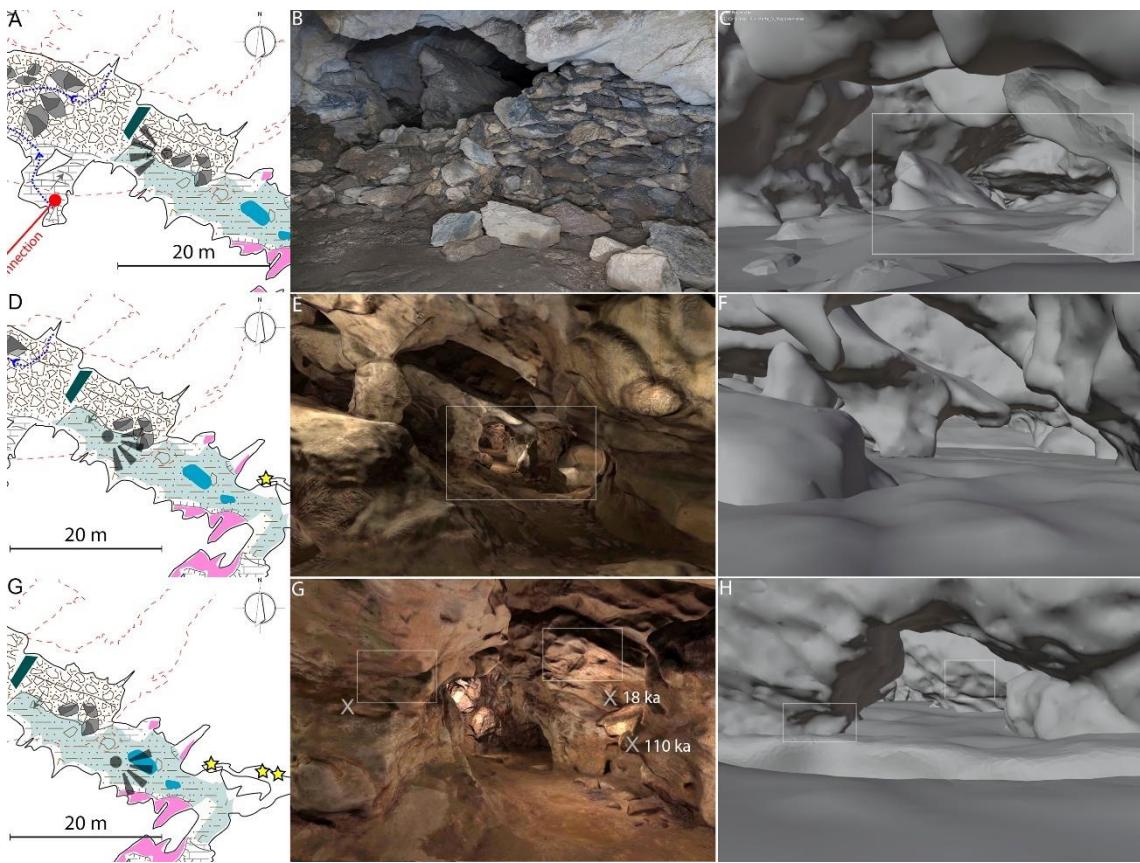
Furthermore, it cannot be ruled out that there have also been biocorrosion processes (produced by the abundant chiropteran fauna that inhabits the gallery) in Holocene times, which, together with the anthropic washing processes with Kärcher (pressure water cleaner) that the cave suffered during the last decade of the 20th century they may have destroyed numerous archaeological evidence, including rock art. In fact, the appearance of the main decorated sectors seems more typical of terminal sectors of a larger decorated cave (O. Rivero, Personal Communication). Taking all this into account, and using the data extracted from a geophysical study carried out by V. Bayarri and J. Herrera (GIM Geomatics) to establish the deep of the sinkholes that originally crossed the cavern, we have modified the model of the cave to show an appearance closer to what it would have had in the Magdalenian, when it was visited and decorated.



**Figure S4-13.** Geomorphologic plan of Aitzbitarte IV and V Cave (M. Arriolabengoa & I. Intxaurbe; plan after 3D survey of GIM Geomatics). **S4-13 Irudia. Aitzbitarte IV eta V-eko haitzuloen planta geomorfologikoa (M. Arriolabengoa & I. Intxaurbe, GIM Geomatics-en 3Dtik ateratako planoa).**

Sample	$^{238}\text{U}$	$^{232}\text{Th}$	$^{230}\text{Th} / ^{232}\text{Th}$	$d^{234}\text{U}^*$	$^{230}\text{Th} / ^{238}\text{U}$	$^{230}\text{Th}$ Age (yr)	$^{230}\text{Th}$ Age (yr)	$d^{234}\text{U}_{\text{Initial}}^{**}$	$^{230}\text{Th}$ Age (yr BP)***
Number	(ppb)	(ppt)	(atomic $\times 10^{-6}$ )	(measured)	(activity)	(uncorrected)	(corrected)	(corrected)	(corrected)
IV-1	1412,2 $\pm 31,2$	1808260 $\pm 56503$	4 $\pm 0$	200,5 $\pm 12,0$ , 0,3273 $\pm 0,0085$	34386 $\pm 1120$	-1820 $\pm 27066$	199 $\pm 19$	-1891 $\pm 27066$	
IV-2	35,7 $\pm 0,3$	119986 $\pm 2516$	7 $\pm 0$	408,8 $\pm 7,6$ , 1,4200 $\pm 0,0144$	284537 #####	210197 $\pm 81093$	740 $\pm 159$	210126 $\pm 81093$	
IV-3	31,0 $\pm 0,2$	12156 $\pm 249$	40 $\pm 1$	344,4 $\pm 6,5$ , 0,9527 $\pm 0,0076$	124554 $\pm 2113$	116582 $\pm 5990$	479 $\pm 12$	116511 $\pm 5990$	
IV-4	28,0 $\pm 0,2$	18226 $\pm 377$	27 $\pm 1$	525,6 $\pm 9,1$ , 1,0840 $\pm 0,0077$	122264 $\pm 2013$	110744 $\pm 8428$	718 $\pm 21$	110673 $\pm 8428$	
IV-5	977,8 $\pm 9,9$	1244490 $\pm 37839$	9 $\pm 0$	1642,5 $\pm 11,8$ , 0,7077 $\pm 0,0173$	32900 $\pm 924$	18611 $\pm 10356$	1731 $\pm 52$	18540 $\pm 10356$	
IV-6a	47,6 $\pm 0,3$	233019 $\pm 4787$	4 $\pm 0$	552,8 $\pm 8,9$ , 1,1594 $\pm 0,0139$	132892 $\pm 3208$	-60047 $\pm 204463$	467 $\pm 242$	-60118 $\pm 204463$	
IV-6b	50,4 $\pm 0,5$	275312 $\pm 5815$	4 $\pm 0$	543,4 $\pm 12,8$ , 1,2833 $\pm 0,0178$	163404 $\pm 5628$	-60535 $\pm 254241$	458 $\pm 285$	-60606 $\pm 254241$	

**Table S4-3.**  $^{230}\text{Th}$  dating results for Aitzbitarte IV and V caves (the sampling points can be seen in Figure S4-13). Datings made in Aitzbitarte III and IX are not shown here). The error is 2s error. Laboratory: University of Xi'an Jiaotong. U decay constants:  $l_{238} = 1.55125 \times 10^{-10}$  (Jaffey et al., 1971) and  $l_{234} = 2.82206 \times 10^{-6}$  (Cheng et al., 2013). Th decay constant:  $l_{230} = 9.1705 \times 10^{-6}$  (Cheng et al., 2013). \* $d^{234}\text{U} = (^{234}\text{U}/^{238}\text{U})_{\text{activity}} - 1 \times 1000$ . \*\*  $\delta^{234}\text{U}_{\text{Initial}}$  was calculated based on  $^{230}\text{Th}$  age ( $T$ ), i.e.,  $\delta^{234}\text{U}_{\text{Initial}} = \delta^{234}\text{U}_{\text{measured}} \times e^{l_{234} \times T}$ . Corrected  $^{230}\text{Th}$  ages assume the initial  $^{230}\text{Th}/^{232}\text{Th}$  atomic ratio of  $4.4 \pm 2.2 \times 10^{-6}$ . Those are the values for a material at secular equilibrium, with the bulk earth  $^{232}\text{Th}/^{238}\text{U}$  value of 3.8. The errors are arbitrarily assumed to be 50%. \*\*\*B.P. stands for “Before Present” where the “Present” is defined as the year 1950 A.D.



**Figure S4-14.** A), D) and G) Geomorphologic plans of several altered parts in the main gallery of Aitzbitarte IV. B), E) and G) Photograph of several altered parts in the main gallery of Aitzbitarte IV, there can be seen the modifications to the cave to create a mycological farm at the beginning of the 20th century (closures of the gallery and recesses in the floor to flatten it and cover the transverse fissures that cut it). C), F) and H) Digital reconstruction with Blender® of those obstacles as they would have looked in the Magdalenian. White rectangles mark some of the main changes. **S4-14 Irudia.** A), D) eta G) Aitzbitarte IVko galeria nagusian gehien eraldaturiko zonen plano geomorfologikoa. B), E) eta G) Aitzbitarte IV-aren galeria nagusian aldatutako zenbait zatiren argazkia. XX. mendearen hasieran industria mikologikoa bat sortzeko haitzuloak izan zituen aldaketak ikus daitezke (galeriaren itxiturak eta zoru mailaren jaitsierak, hura lautzeo eta ebakitzentzen zuten zeharkako pitzadurak estaltzeko). C), F) eta H) Berreraikuntza digitala Blender® erabiliz, Madeleine aldian izango zuketen itxura erakusteko. Laukituzen zuriek markatzen dituzte aldaketa nagusietako batzuk.



**Figure S4-15.** A) Geomorphologic plan of the Sector C and D. B) Photograph of a bridge and fillings made in a fissure that cuts the gallery. C) Digital reconstruction with Blender®. The rectangle marks the position of the bridge, and the aspect of the transversal fissure which cut the gallery. **S4-15 Irudia.** A) C eta D sektoreko plano geomorfologikoa. B) Galeria zeharkatzen duen pitzadura batean egindako zubiaren eta betekinen argazkia. C) Berreraikuntza digitala Blender® erabiliz. Laukituzenak zubiaren posizioa seinalatzen du, eta azpaldean duen pitzaduraren jatorrizko itxura, galeria moztu egiten zuena.

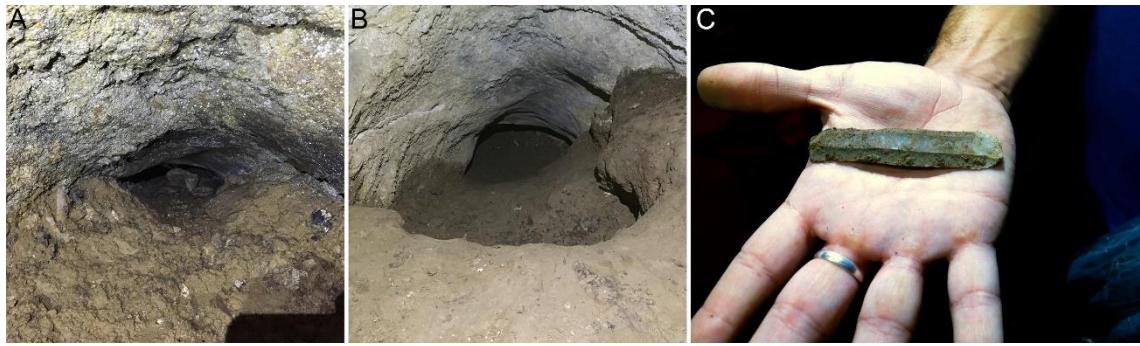
## 7. AITZBITARTE V

The cave presents two very different sectors in terms of the modifications that have occurred since its use in Prehistory. On the one hand, the entrance sectors have undergone post-Palaeolithic use that has introduced sedimentation into the cavern. Furthermore, the crawlway that the members of “Félix Ugarte Elkarte” unclogged in 2015, and which was sealed by materials from the Holocene (probably from the Bronze Age, including a pressure carving flint blade) has a bifurcation in its first part, and the right branch (plugged currently with materials in colluvium displaced by the slope) would allow direct (and infinitely easier) access to the deepest sectors of the cave. Currently, only the left branch was unclogged, so currently it's necessary to cross a difficult sector hanged over the 25-metre sinkhole that connects with the lower level to reach the "Bear's Gallery".

On the other hand, the multitude of bear traps and the claws that mark the walls of the “Gallery of the Bears” indicate that these deep sectors of the cave have barely received sedimentary contributions for about 25k years. Of course, we must highlight the strong alterations caused by vandalism (graffiti, creation of large hearths, accumulation of garbage, etc.), surprising considering the difficult access to this sector (a 25-metre vertical chimney). Fortunately, these processes have not altered the morphology of the gallery.

Finally, before accessing the final sector of the cave (where the panels decorated with rock art from Gravettian and Middle Magdalenian chronology are located) there is a branch that starts on the left side of the gallery, and that allows access to a very narrow final point, in which there is a filling of detrital (fluviokarstic) and speleothem flows interspersed. This filling coincides in height with the final decorated room of the sector of clay-modelled animals in Aitzbitarte IV, with a distance of 7 metres between these two sectors. This filling was not dated (although it seems to belong to old paragenesis phases), since it was observed that the very narrow dimensions (even if we eliminated some of the most recent phases of stalagmitic formation) would make it impossible for a person to transit between the two caves. Therefore, this would confirm that the Magdalenian groups accessed to the decorated place from the main gallery of Aitzbitarte IV, as accessed today.

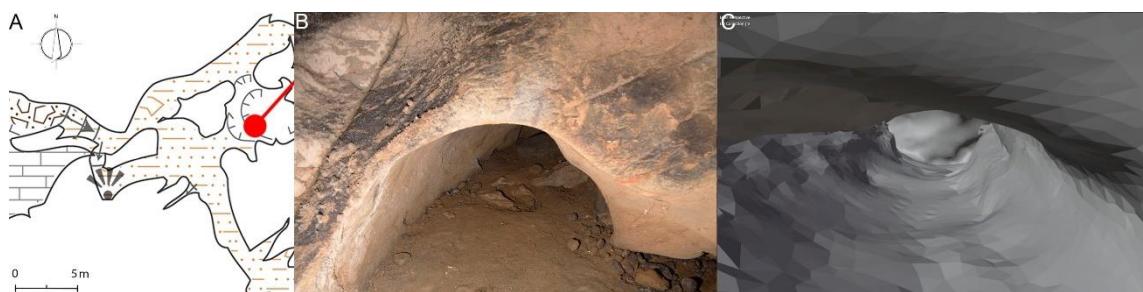
Taking this into account, the 3D model of the cave has been modified to show an appearance as close as possible to the cave that the human groups knew during the Magdalenian.



**Figure S4-16.** A) Aspect of the crawlway that connected the "Bear Gallery" with the entrance hall of Aitzbitarte V, before the 2015 intervention (Felix Ugarte Elkartea). B) Appearance of the crawlway after the 2015 intervention (D. Garate). C) A pressure-cut flint sheet, probably from the Bronze Age, that appeared along with other Holocene materials in the colluvial sedimentary fill that sealed the crawlway before 2015 (Felix Ugarte Elkartea). **S4-16 Irudia.** A) "Hartzen galeria" eta Aitzbitarte Veko ataria batzen zituen katazuloaren itxura, 2015eko interbentziō aurretik (Felix Ugarte Elkartea). B) Katazulo beraren itxura, 2015 interbentziōaren ostean (D. Garate). C) Katazuloa ixten zuen kolubioi bidezko betekin sedimentarioan agertu zen presio bidez zizelkaturiko sukarrizko xaflaren argazkia, seguraski Brontze Arokoa, Holozengo beste material batzuekin batera agertu zena (Felix Ugarte Elkartea).



**Figure S4-17.** A) Geomorphologic plan of the crawlway of Aitzbitarte V. B) Photograph of the crawlway of Aitzbitarte V, showing the appearance after removing the Holocene colluvial sediment. At the point where the speleologist leaves, the open path turns to the left, connecting later (after a difficult path) with the deep sectors of the cave. Towards the right, there is a more direct passage, although currently blocked by sediment. C) Digital reconstruction with Blender®. **S4-17 Irudia.** A) Aitzbitarte Veko katazuloaren plano geomorfologikoa. B) Aitzbitarte Veko katazuloaren argazkia, Holozengo kolubioi bidezko sedimentazioa kendu ostean zuen itxura erakutsiz. Espeleologoa agertzen den puntuari, irekitako pasabideak ezkerrerantz egiten du, pasabide zail baten ostean berriro helduz Aitzbitarte Veko sektore sakonetara. Eskinera pasabide zuzenago bat dago, gaur egun sedimentuek oraindik blokeatzen dutena. C) Berreraikuntza digitala Blender® erabiliz.



**Figure S4-18.** A) Geomorphologic plan of the crawlway of Aitzbitarte V. B) Photograph of the crawlway of Aitzbitarte V, from the "Gallery of the Bears", showing the passage currently clogged by Holocene colluvial sediments. It directly connects the vestibule with the deep sectors, avoiding crossing a very difficult and dangerous passage over the vertical chimney that connects Aitzbitare IV and V. C) Digital reconstruction with Blender®, after removing the Holocene sedimentation. **S4-18 Irudia.** A) Aitzbitarte Veko katazuloaren plano geomorfologikoa. B) Aitzbitarte Veko katazuloaren argazkia, gaur egun Holozengo betekin kolubial batek itxi egiten duen pasabidea erakutsiz. Kobazuloko ataria zuzenean lotzen du sektore sakonekin, Aitzbitare IV eta V lotzen dituen tximinia bertikalaren gainetik pasabide oso zaila eta arriskutsua gurutzatzea sailestuz. C) Berreraikuntza digitala Blender® erabiliz. Holozengo sedimentazioa kendu ostean.

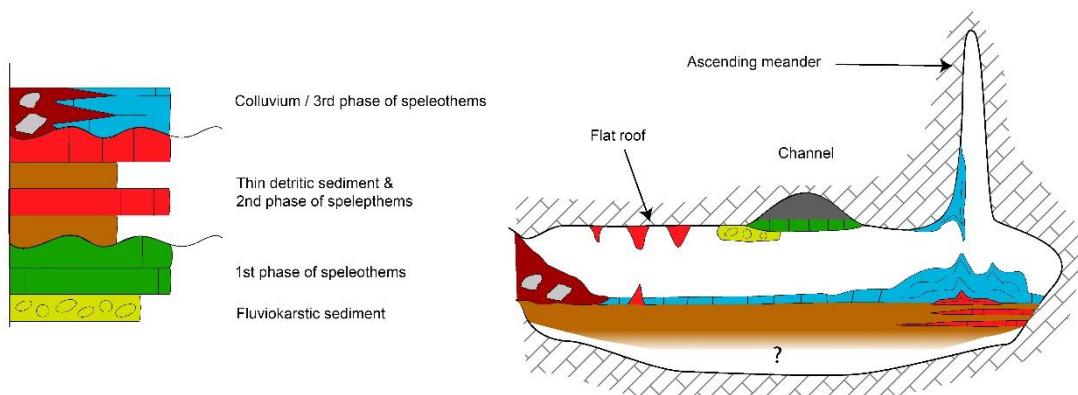
## 8. ALKERDI 1

Throughout the galleries of Alkerdi 1, different geomorphological and sedimentary features are observed, such as flat roofs, ceiling-channels (which sometimes form meandriform galleries), hanged sediments and stalagmitic formations (pavementary or parietal flowstones, some of them active). The allostratigraphic units after the passage of the societies that decorated Alkerdi 1 (Magdalenians) would make up the second unit, and would be composed mainly of several flowstones, some of them currently active (Aranzadi Zientzia Elkartea, 2016).

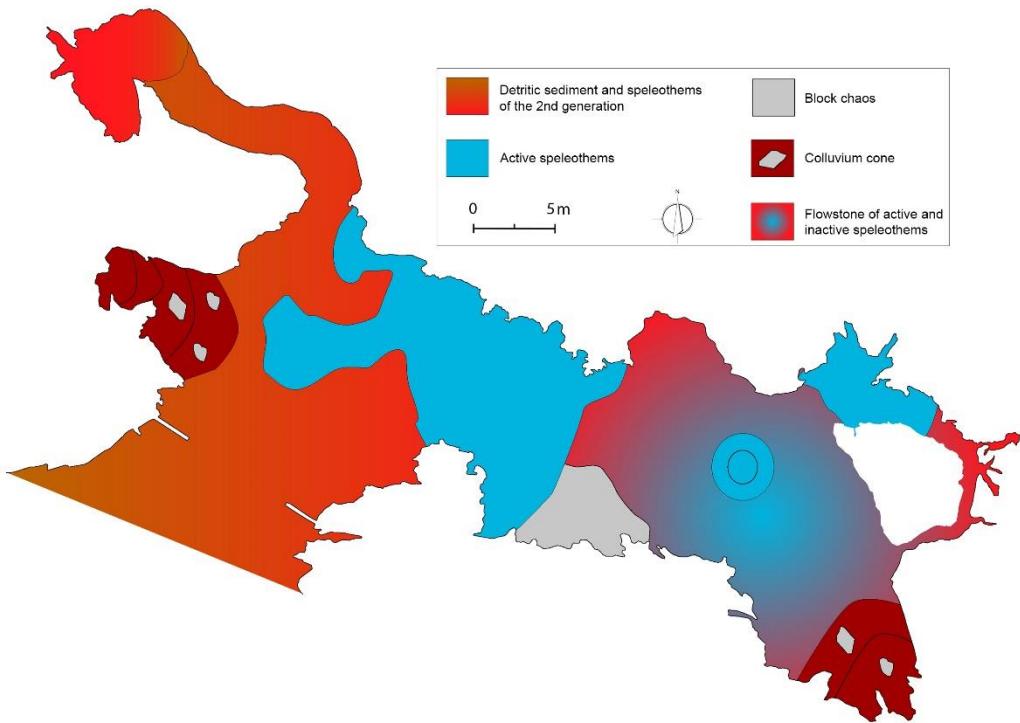
The vestibule is a rather uncomfortable space with a low ceiling, and the excavations carried out at that point have only documented levels of occupation dated to the Aurignacian and Gravettian, so we know that this space was already quite clogged with sediments in the Magdalenian.

As for the branch on the left that allows access to the “Stalagmitic Mogote” (Sector A), the soil is composed of detrital and stalagmitic sediment of the second generation, but we believe that in any case it is prior to the Magdalenian, as indicated by the lava flow located at the end of the gallery, which was used by Palaeolithic societies to decorate a rock art set on it.

As for the central area of the cave, it is covered with active speleothems that would have been smaller in size, or would not have existed in the Magdalenian, so passage through this area would be somewhat easier than today. This assessment is also partially fulfilled in the next room and at the beginning of Sector D or the “Gallery of the Bison”. However, the final zone of this gallery is composed of a detrital soil with clasts that would belong to the second allostratigraphic unit. Even so, as there are archaeological materials attributable to Palaeolithic phases (charcoal, ochre, bones, etc.), some of them dated to an age attributable to engravings and paintings, we know that the morphology has changed very little. Taking this into account, the 3D model of the cave has been modified to show an appearance as close as possible to the cave that the human groups knew during the Magdalenian.



**Figure S4-19.** Geomorphologic cut of Alkerdi 1 Cave (Aranzadi Zientzia Elkartea; plan after 3D survey of GIM Geomatics). **S4-19 Irudia. Alkerdi 1eko haitzuloaren ebaki geomorfologikoa (Aranzadi Zientzia Elkartea; GIM Geomatics-en 3Dtik ateratako planoaren gainean).**



**Figure S4-20.** Geomorphologic plan of Alkerdi 1 Cave (Aranzadi Zientzia Elkartea; plan after 3D survey of GIM Geomatics). **S4-20 Irudia. Alkerdi 1-eko haitzuloen planta geomorfologikoa (Aranzadi Zientzia Elkartea, GIM Geomatics-en 3Dtik ateratako planoa).**



**Figure S4-21.** A) Geomorphologic plan of the gallery of the cave (Aranzadi Zientzia Elkartea). B) Photograph of the gallery of the cave (Aranzadi Zientzia Elkartea), showing a passage very modified by currently active speleothems (gours, columns, etc.). C) Digital reconstruction with Blender®. The active gours, as well as some stalagmites have been removed, because they are currently active. **S4-21 Irudia. A) Kobazuloko galeriaren planta geomorfologikoa (Aranzadi Zientzia Elkartea). B) Kobazuloko galeriaren argazkia (Aranzadi Zientzia Elkartea), gaur egun aktibo dauden espeleotema batzuek (gours-ak, zutabeak, etc.) asko eraldatutako pasabide bat erakutsiz. C) Berreraikuntza digitala Blender® erabiliz. Gours aktiboak, estalagmita batzuekin batera, kenduak izan dira, gaur egun aktibo daudelako.**

## **9. ETXEBERRIKO KARBIA**

Through a geomorphological study we tried to identify the sedimentation and erosion processes of the cave and develop a relative chronology through stratigraphy.

As a particular characteristic of the cave, there are large areas altered by biocorrosion, but although we have observed the presence of recent deposits of bat guano in the cavity, we believe that these are ancient processes, prior in any case to the passage of Paleolithic societies for it. We have reached this conclusion because stratigraphically, the formations most affected by biocorrosion belong to ancient generations of speleothems. Furthermore, there is evidence of the use of surfaces already corroded beforehand to make there the Magdalenian rock art, as in the case of the sign E.I.01.

On the other hand, the subsidence and collapses are mainly abundant in the areas immediately at the entrance, since, in the deeper areas, despite there being traces of collapses (for example, in the “Hall of the Sinkhole”), they are covered with speleothems, so it is possible place them in a relative chronology of the cave formation events, thanks to the general stratigraphy of the processes. That is why we have decided to begin our spatial analysis from an area immediately behind the current vestibule, since it is impossible for us to know with certainty what it would have looked like in the Magdalenian.

Among the modifications posterior to the Magdalenian frequentation that we can observe inside the cave would be the large stalagmitic flowstone that covers the floor of the slope that descends from the “Gallery of the Gour-s”. At the top of this gallery, near the intermittent upwelling that exists there, a survey was carried out that allowed us to know the sedimentation of the area, proving that there is at least 1-metre-wide detrital sedimentation attributable to the Holocene, between which phases of Gour-shaped lithochemical reconstruction would alternate, with episodes of sporadic frequentation, apparently linked to funerary activities dated between the Chalcolithic and the Roman Period (Ebrard, 2013a).

In the sector of the three intermittent lakes, it is difficult to know exactly what shape these spaces would have had in the Palaeolithic, since the flooding episodes have deposited fine detrital material in the form of silt and clay in these basins, and the flowstones that poured into them have deposited superficial layers of calcium carbonate. In any case, we do not believe that the modifications that have occurred in these spaces since the Magdalenian era changed the accessibility features of the decorated sectors excessively. Furthermore, the existence of two possible elements of the internal archaeological context (remains of a possible fire between lakes II and III and the decorated panel D.I.01-03 in the vicinity of the third lake) ensure that these specific spaces have hardly suffered any modifications.

Another of the interesting issue is the stalagmitic formation that closed the crawlway that must be passed to access the “*Salle des Peintures*”. We think that stratigraphically this formation belongs to an ancient generation older than the Magdalenian period, but it raises some doubts. The last part of the cave, beyond this obstacle, was discovered in 1934. The explorers who discovered it stated that they opened the second section of the

narrowness with “*Coup de marteau*” (hammer blows) (J. Labeyrie, Personal Communication). Currently, at the end of the crawlway we can see the scar of the stalagmite/column that closed it. As a hypothesis, we can state that when humans from the Magdalenian period arrived, they found the passage closed by this column/stalagmite belonging to an ancient generation. But the gap that remained clearly showed that the cave continued, so the passage was opened by them. In this sense, the study of the traces of use of flint pieces found in the internal archaeological context of the cave allows us to affirm with a high degree of certainty that these pieces were used to drill/work stalagmites (Rios-Garaizar et al., 2017).

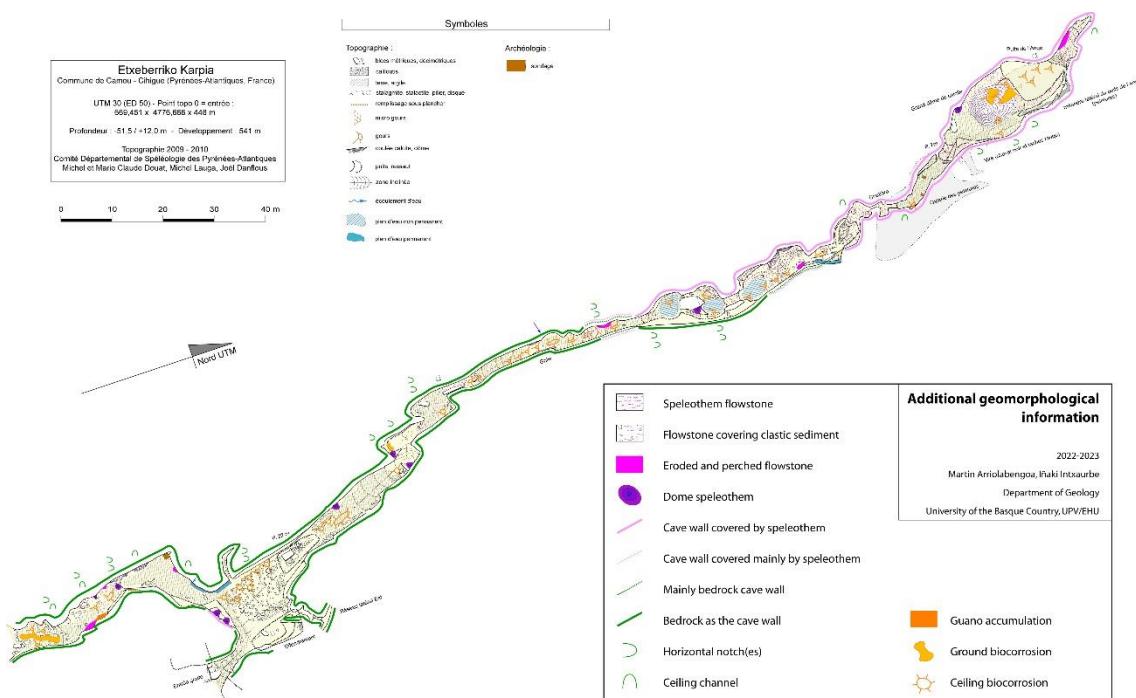


**Figure S4-22.** Photogrammetry of the final passage of the Etxeberriko karbia cathole, showing the fractured speleothem to allow passage. *S4-22 Irudia. Etxeberriko karbiako katazuloaren azken zatiaren fotogrametria, pasabidea ahalbidetzeko espeleotema hautsia erakutsiz.*

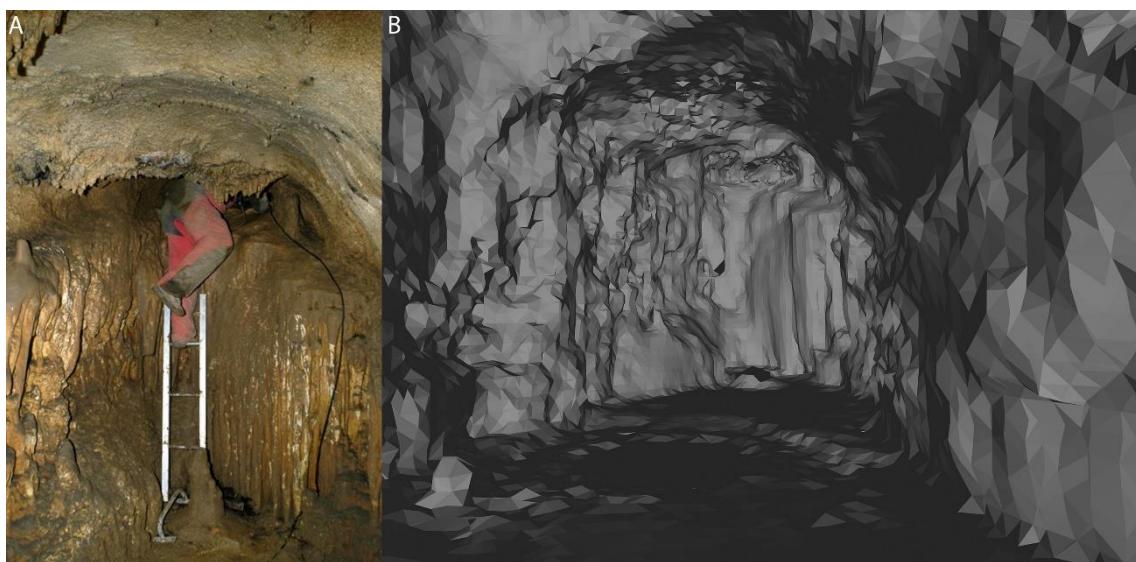
Later, with the arrival of the Holocene, some new speleothems grew throughout the cave and other old ones were reactivated, generating new layers and new formations on them. It is possible that post-Tardiglacial drips (during the Holocene?) would have used the scar of the broken speleothem by Magdalenian humans to circulate more easily through it and would have created a new stalagmitic column in the same place. This new formation would be the one that cavers broke in the 1930s.

Finally, we must highlight the alterations produced by humans in the cave in modern times. In May 1950, the cave art of Etxeberriko Karbia was discovered, and the alteration processes began that have largely mutilated the historical heritage of this cave (even though it was closed, and that the existence of cave art was known by the speleological groups that frequented it). In addition to the inscriptions and graffiti that abound in the “*Salle des Peintures*” (Sector E) and the “*Salle du Gouffre*” (Sector F), with some specific testimonies in the “*Fissure Ornée*” (Sector H), we must highlight above all the alterations produced by people rubbing against the decorated surfaces of sectors H and J (“*Puits de l’Ange*”). Practically 100% of the graphic units catalogued in these sectors have suffered some type of damage since their discovery. Some of these damages are almost impossible to avoid due to the situation of the figures. Those in Sector H are arranged in a meander just 50 centimetres wide located above a 16-metre sinkhole, so the harnesses (indispensable due to the presence of the vertical obstacle) rub against the rock art. The figures of sector J are located on the only route to Sector I, so their friction is very difficult to avoid.

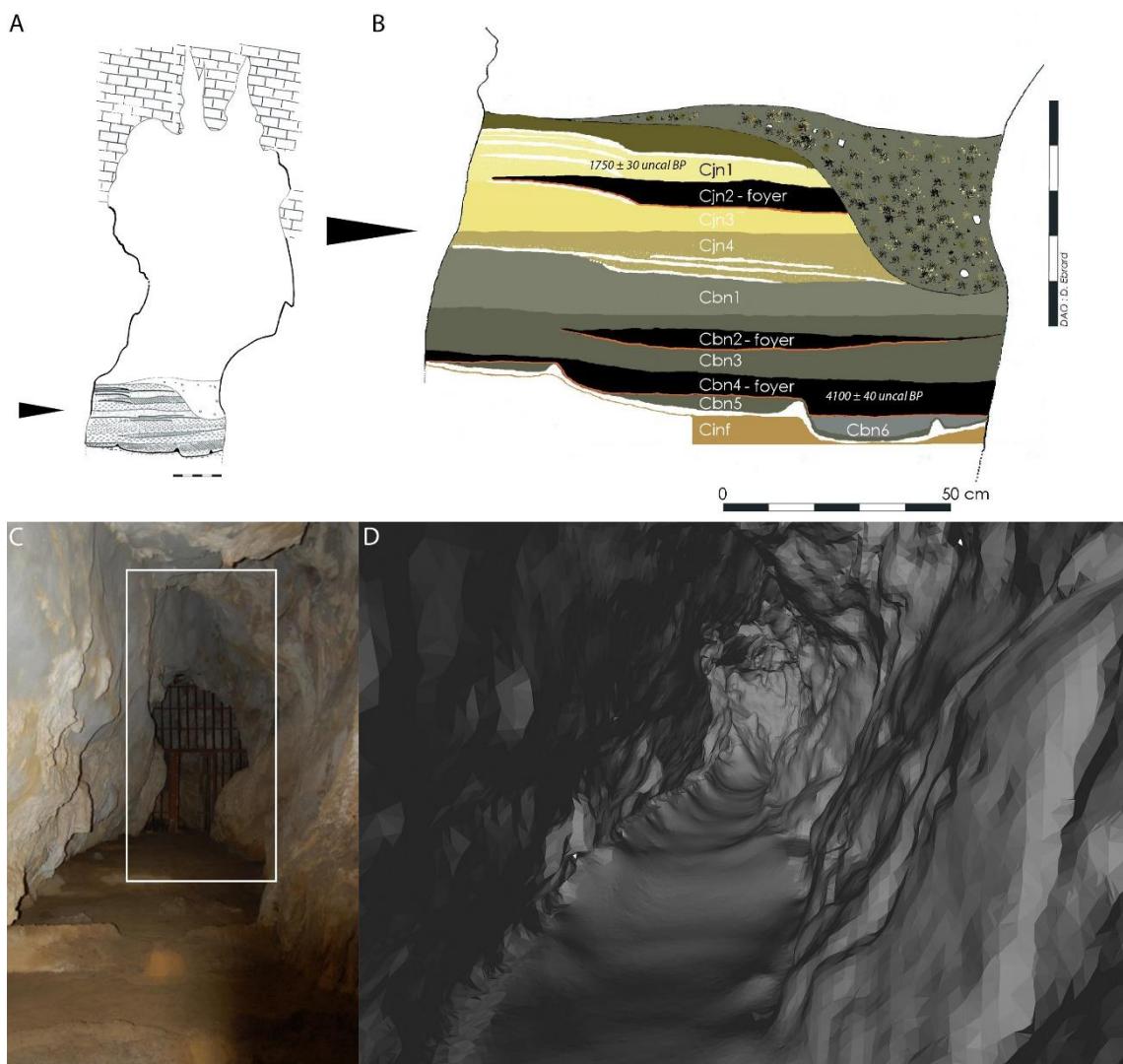
Taking this into account, the 3D model of the cave has been modified to show an appearance as close as possible to the cave that the human groups knew during the Magdalenian.



**Figure S4-23.** Geomorphologic plan of Etxeberriko Karbia (M. Arriolabengoa & I. Intxaubre; plan after survey of the Comité Départemental de Spéléologie des Pyrénées-Atlantiques. Made by M. and M.C. Douat, M. Lauga and J. Danflous). *S4-23 Irudia. Etxeberriko karbiako planta geomorfologikoa (M. Arriolabengoa & I. Intxaubre, Comité Départemental de Spéléologie des Pyrénées-Atlantiques-eko, M. eta M.C. Douat, M. Lauga eta J. Danflous-ek egindako plano gainean).*



**Figure S4-24.** Changes in the existing crawlway before the "Painting Room" of the Etxeberri karbia. **A)** Photograph of the ladder (D. Garate) that helps overcome a jump of about 2 meters at the end of the crawlway. **B)** Reconstruction using the Meshlab® program, explaining its appearance without stairs. This vertical jump after passing the crawlway greatly hinders the route. *S4-24 Irudia. Etxeberriko karbiako "Margoen Gela" aurretik dagoen katazuloan izandako aldaketak. A) Argazkia, katazulo amaieran dagoen 2 metro inguruko saltoa gainditzen lagunten duen eskailera ikusi daiteke (D. Garate). B) Meshlab® programa bidez egindako berreraiketa, eskailerarik gabe izango lukeen itxura azalduz. Katazuloa igaro ostein egin beharreko jauzi bertikal honetako oztopaten du ibilbidea.*



**Figure S4-25.** Post-Paleolithic modifications in the Gour's gallery in Etxeberriko karbia. **A)** and **B)** the excavation levels that were carried out in the local sporadic source (adapted from Ebrard, 2013a). **C)** Appearance and current closure of the gallery, indicating the excavation area (D. Garate). The same point of view, detailing its situation in the Palaeolithic (the level of the Gours would be lower) made with Meshlab®. **S4-25 Irudia. Etxeberriko Karbiako Gours-en galerian paleolito ostean egondako aldaketak. A) eta B) bertako noizbehinkako iturrian egin ziren indusketen mailak (Ebrard, 2013a-tik moldatua). C) galeriaren gaur egungo itxura eta itxitura, indusketa zonaldea seinalatuz (D. Garate). Ikuspuntu bera, Paleolitoan izango zuen egoera zehatzuz (Gours-ak dauden maila baxuago egongo litzateke) Meshlab® bidez egina.**

### S5: Analysis of the spatial patterns

Using a Python script through ArcMap 10.5 software, the following spatial characteristics of the figures were analysed. The python script which includes all the analysis is accessible in <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>.

The system to install the script is indicated in the script itself, in the readme file and in previous works (Intxaурbe et al., 2021; 2022).

We have made a table with the results of the spatial analysis for each GU of each cave, as well as four maps with these data: the accumulated access difficulty map, as well as the main access difficulties of each cave on the optimal route to the furthest figure and/or the most expensive figure (in terms of difficulty access).

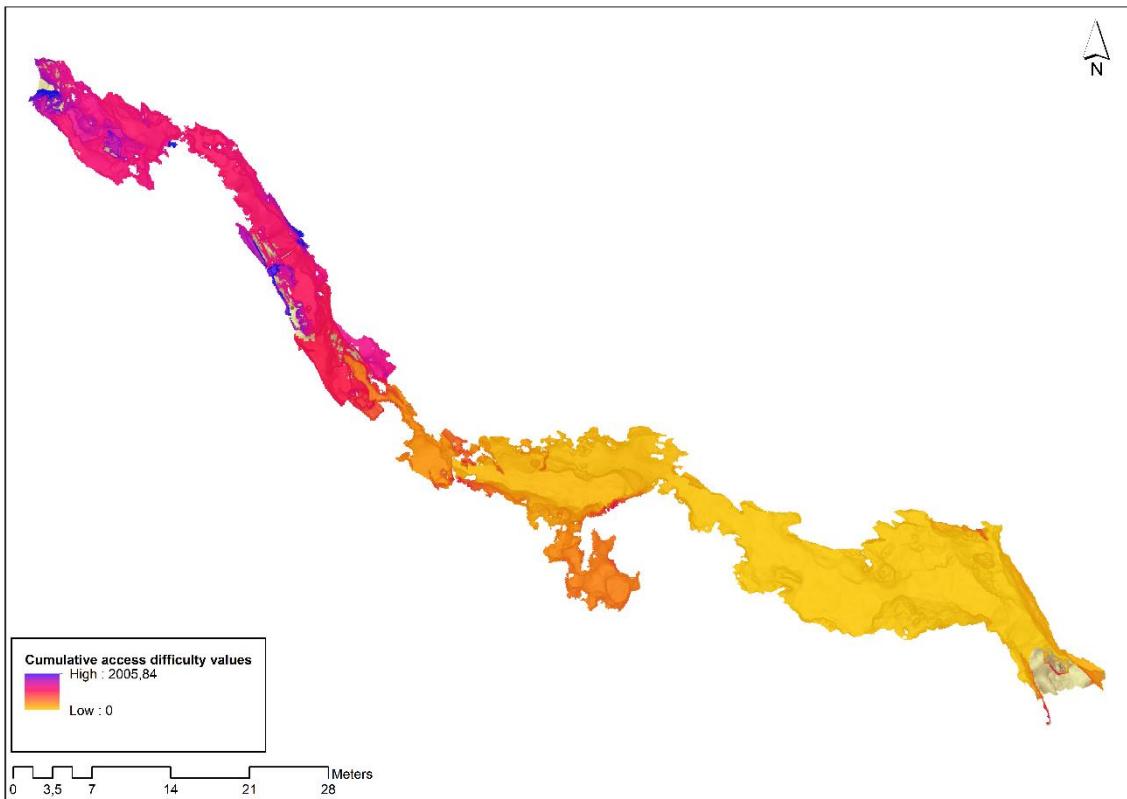
#### 1. SANTIMAMIÑE

We have analysed 55 figures of the cave in our analysis excluding the simplest elements: simple engraved or painted lines, pigment stains, etc. (Table 1, S5).

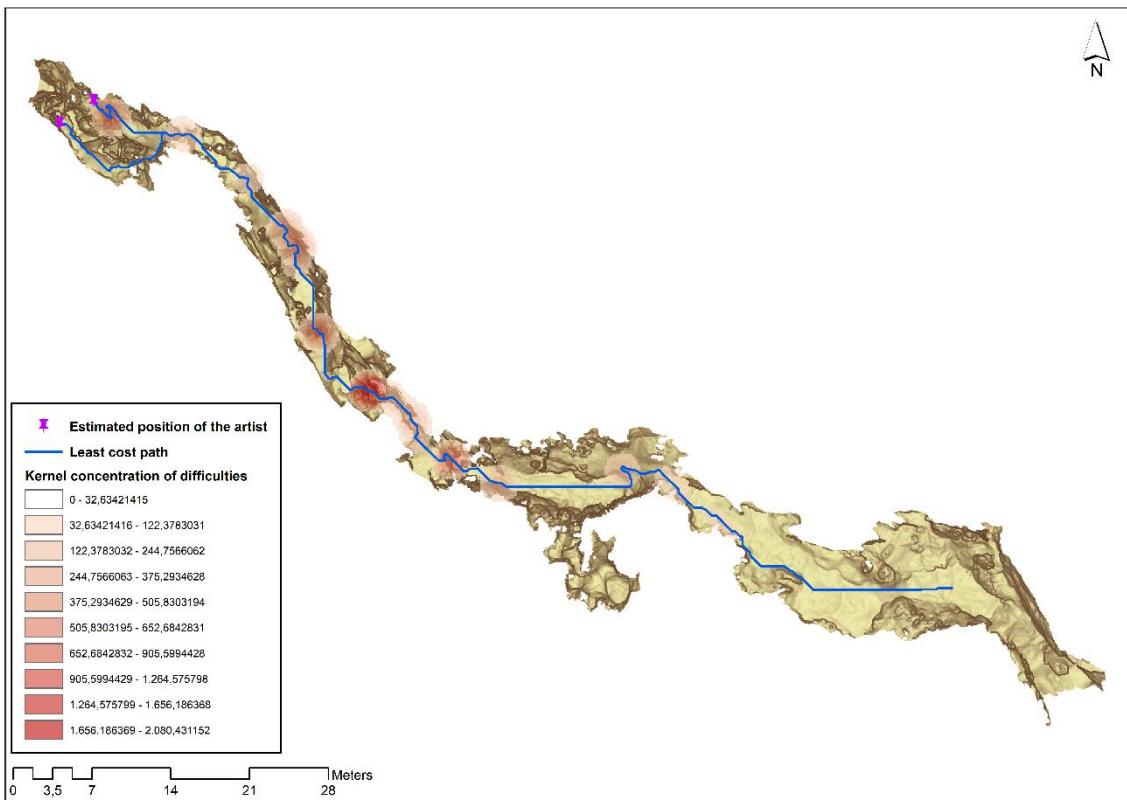
GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
S.A.I.01	0,83	11,95	0,15	1,42	Leaning/Upright	9	1	0	10
S.A.I.02	0,74	12,03	0,15	1,47	Leaning/Upright	12	1	0	13
S.B.I.01	63,87	33,28	1,44	0,55	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
S.B.IV.01	53,87	42,36	1,5	2,31	Elevated	2	0	0	2
S.C.I.02	268,27	51,86	6,51	2,15	Elevated	2	2	0	4
S.C.I.03	268,26	51,73	6,51	1,91	Elevated	2	2	0	4
S.C.I.04	268,33	52,17	6,67	2,09	Elevated	3	2	0	5
S.C.I.06	268,26	51,75	6,51	2,63	Elevated	3	1	0	4
S.C.II.01	272,84	53,9	6,65	1,12	Leaning	3	2	0	5
S.C.II.04	272,84	53,9	6,65	1,54	Leaning/Upright	3	1	0	4
S.C.II.05	272,86	54,48	6,65	1,14	Leaning	3	2	0	5
S.C.II.06	272,86	54,48	6,65	0,79	Crouching/Kneeling/Sitting/Lying down	3	2	0	5
S.C.II.08	272,94	54,7	6,67	1,6	Leaning/Upright	2	1	0	3
S.C.III.01	260,32	52,3	6,35	1,61	Leaning/Upright	2	2	0	4
S.C.III.02	261,65	53,05	6,37	1,45	Leaning/Upright	2	1	0	3
S.C.III.03	261,41	52,44	6,36	1,09	Leaning	2	2	0	4
S.D.I.01	310,69	58,86	8	2,28	Elevated	6	1	0	7
S.D.I.02	310,69	59,04	8,07	2,27	Elevated	7	1	0	8
S.D.I.03	310,69	58,86	8	2,15	Elevated	7	1	0	8
S.D.II.01	302,84	59,19	7,58	0,43	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
S.D.II.02	302,84	59,19	7,58	0,57	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
S.D.II.03	302,8	57,89	7,61	0,46	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
S.D.II.04	302,84	59,19	7,58	0,42	Crouching/Kneeling/Sitting/Lying down	5	0	0	5

S.D.II.05	302,84	59,19	7,58	0,41	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
S.D.II.06	302,84	59,19	7,58	0,28	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
S.D.III.01	302,8	57,89	7,61	2,03	Elevated	6	0	0	6
S.D.III.02	302,8	57,89	7,61	1,93	Elevated	6	0	0	6
S.D.III.03	302,8	57,89	7,61	2,16	Elevated	6	0	0	6
S.D.III.04	302,95	57,84	8,12	2,24	Elevated	5	0	0	5
S.D.III.05	302,8	57,89	7,61	2,08	Elevated	6	0	0	6
S.D.III.06	302,84	59,19	7,58	2,6	Elevated	5	0	0	5
S.D.III.07	302,84	59,19	7,58	2,38	Elevated	5	0	0	5
S.D.III.08	302,86	59,55	7,58	2,91	Elevated	4	0	0	4
S.D.III.09	329,28	63,81	8,14	0,38	Crouching/Kneeling/Sitting/Lying down	2	0	0	2
S.D.III.10	321,21	63,68	7,98	0,88	Crouching/Kneeling/Sitting/Lying down	2	0	0	2
S.D.III.11	321,21	63,68	7,98	1,03	Leaning	0	0	0	0
S.D.IV.01	302,88	60,14	7,58	1,61	Leaning/Upright	6	0	0	6
S.D.IV.02	302,88	60,19	7,59	1,64	Leaning/Upright	7	0	0	7
S.D.IV.03	302,89	60,36	7,6	1,71	Upright	7	1	0	8
S.D.IV.04	302,9	60,5	7,6	1,47	Leaning/Upright	7	0	0	7
S.D.V.01	302,92	61	7,84	1,55	Leaning/Upright	6	0	0	6
S.D.V.02	302,93	61,17	7,74	1,48	Leaning/Upright	6	0	0	6
S.D.V.03	302,93	61,17	7,74	1,09	Leaning	6	0	0	6
S.D.VI.01	349,25	63,91	8,5	1,41	Leaning/Upright	6	0	0	6
S.D.VI.02	349,68	63,54	8,85	1,16	Leaning	5	0	0	5
S.D.VII.01	302,95	61,9	7,6	1,91	Elevated	5	0	0	5
S.D.VII.02	302,95	61,97	7,6	1,45	Leaning/Upright	5	0	0	5
S.D.VIII.01	302,89	59,33	7,63	1,68	Leaning/Upright	6	1	0	7
S.D.VIII.02	302,88	59,6	7,59	1,8	Upright	6	0	0	6
S.D.VIII.03	303,02	59,46	7,87	1,59	Leaning/Upright	6	0	0	6
S.E.0.01	863,41	119,82	18,06	1,66	Leaning/Upright	2	0	0	2
S.E.I.01	863,47	121,66	18,08	1,41	Leaning/Upright	4	0	0	4
S.E.I.02	863,47	121,66	18,08	1,21	Leaning	4	0	0	4
S.E.II.01	970,81	131,34	20,41	0,95	Crouching/Kneeling/Sitting/Lying down	2	0	0	2
S.E.III.01	908,16	135,48	19,95	0,74	Crouching/Kneeling/Sitting/Lying down	1	1	0	2

**Table 1, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **1, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* iristeko zaitasunik handiena duen Uga seinalatua da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).



**Figure S5-1.** Map of the accumulated access difficulty value of the Santimamiñe cave, made with ArcMap®. *S5-1 Irudia. Santimamiñeko haitzuloan metatutako iristeko zaitasun balioen mapa, ArcMap®-en bidez egina.*



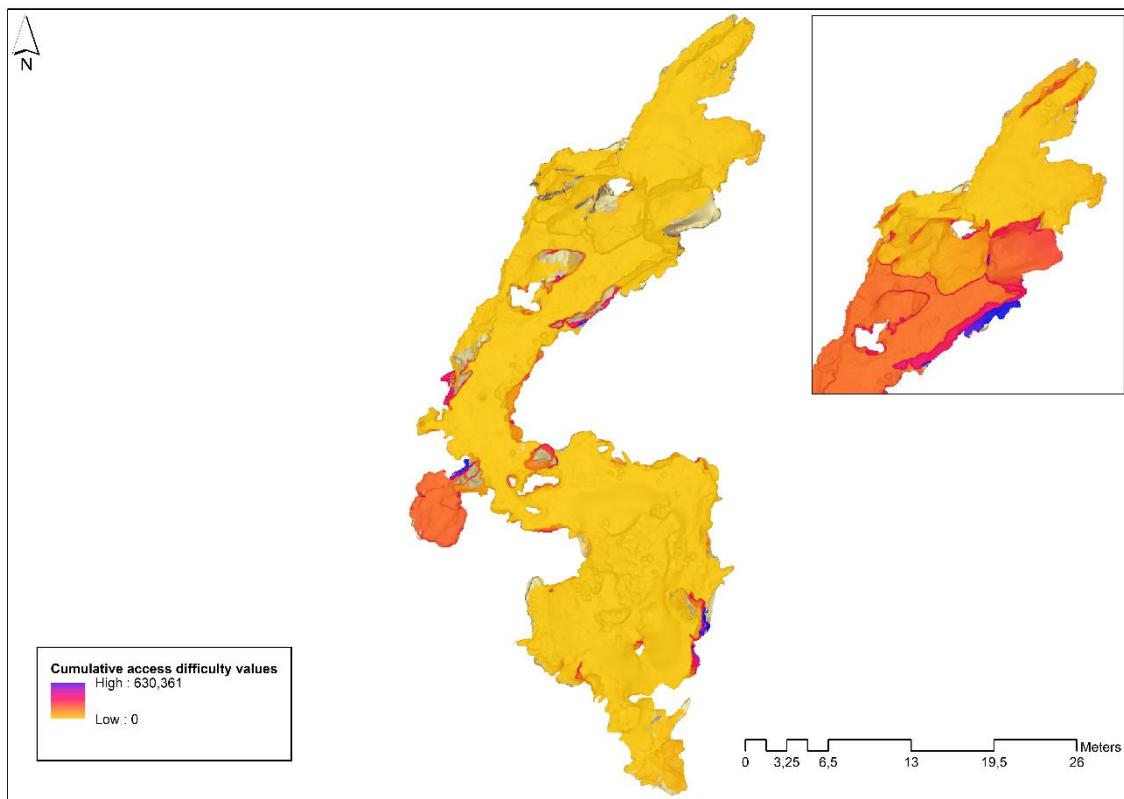
**Figure S5-2.** Map of the optimal access routes to the most difficult and remote figures of Santimamiñe, made with ArcMap®. *S5-2 Irudia. Santimamiñen urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## 2. LUMENTXA

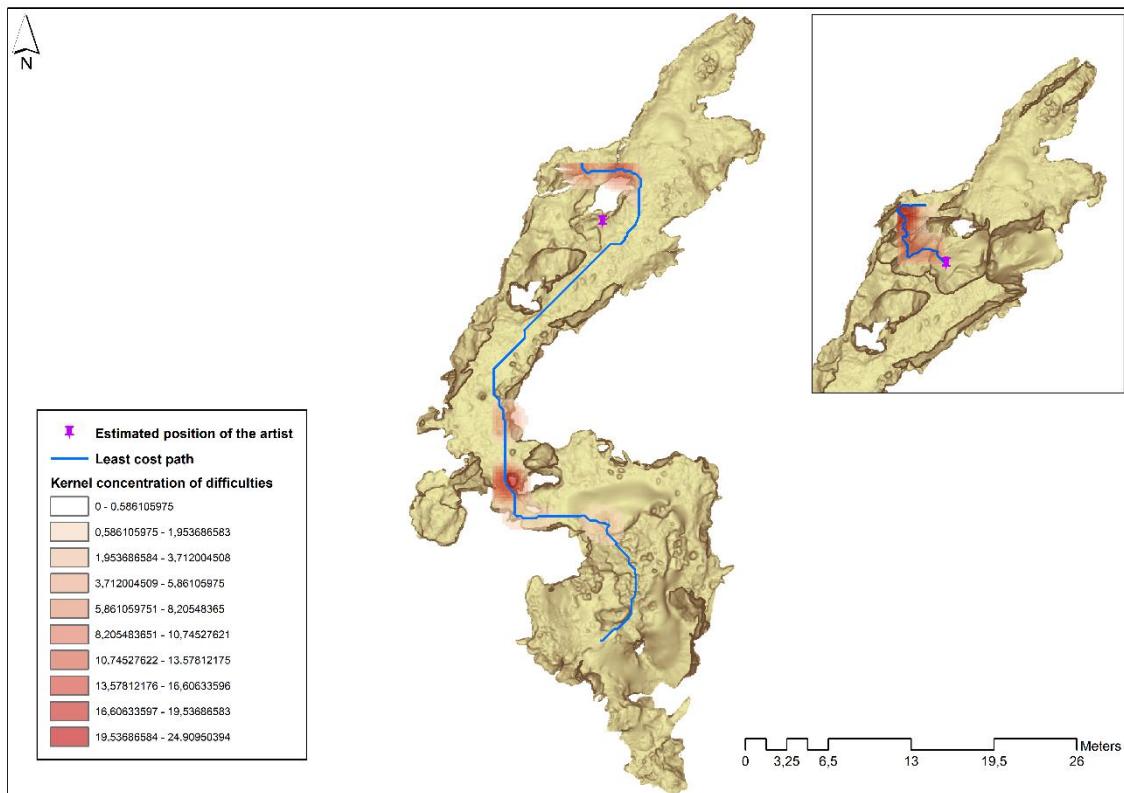
We have analysed 6 figures of the cave in our analysis excluding the simplest elements: simple engraved or painted lines, pigment stains, etc. ([Table 2, S5](#)).

GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
Lum.C.I.01	0,98	20,88	1	1,23	Leaning	4	1	0	5
Lum.D.II.01	2,03	46,85	1,41	2,03	Elevated	13	2	0	15
Lum.D.II.02	2,12	49,22	1,06	1,34	Leaning/Upright	10	3	0	13
Lum.D.II.03	2,13	49,45	1,06	1,14	Leaning	9	2	0	11
Lum.D.V.06	44,69	71,13	1,91	0,91	Crouching/Kneeling/Sitting/Lying down	0	7	2	9
Lum.D.V.07	46,63	71,5	1,96	0,91	Crouching/Kneeling/Sitting/Lying down	1	8	2	11

*Table 2, S5 – Table of the spatial results for each GU.* \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). *2, S5 Taula – UG bakoitzaren emaitza espazialen taula.* \* *iristeko zaitasunik handiena duen Uga seinalatu da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).*



**Figure S5-3.** Map of the accumulated access difficulty value of the Lumentxa cave, made with ArcMap®. *Lumentxako haitzuloan metatutako iristeko zailtasun balioen mapa, ArcMap®-en bidez egina.*



**Figure S5-4.** Map of the optimal access routes to the most difficult and remote figures of Lumentxa, made with ArcMap®. *S5-4 Irudia. Lumentxan urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

### **3. ATXURRA**

We have analysed 136 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 3](#), [S5](#)).

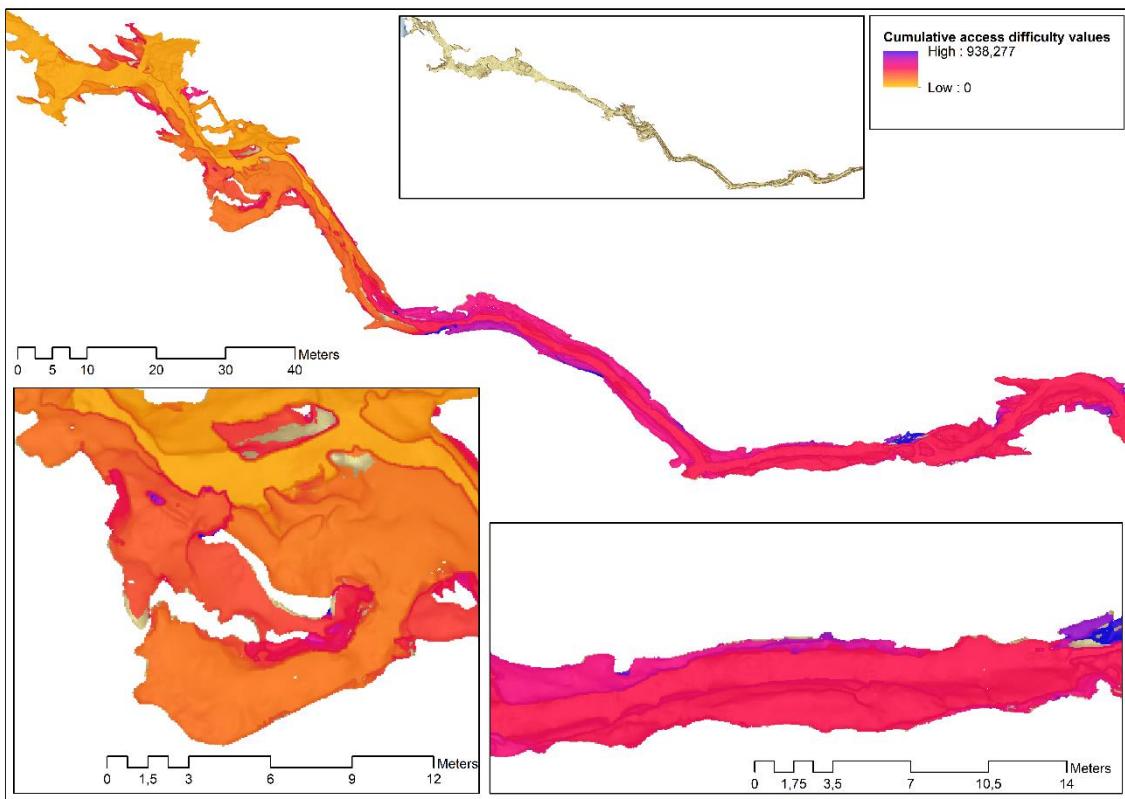
GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
Atr.A.I.01	76,23	197,76	5,58	0,8	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Atr.C.I.01	177,61	238,47	11,9	0,75	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
Atr.C.I.02	177,62	238,59	11,9	0,89	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
Atr.C.I.03	177,58	237,72	11,89	0,76	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
Atr.C.I.04	177,62	238,59	11,9	1,09	Leaning	5	0	0	5
Atr.C.I.05	177,58	237,61	11,89	1,11	Leaning	5	0	0	5
Atr.C.I.06	218,23	240,99	12,86	0,2	Crouching/Kneeling/Sitting/Lying down	4	0	0	4
Atr.C.I.07	177,58	237,61	11,89	0,7	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
Atr.C.I.10	177,62	238,59	11,9	0,7	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
Atr.C.I.12	177,61	238,34	11,9	1,06	Leaning	5	0	0	5
Atr.C.II.01	191	243,09	12,12	1,19	Leaning	3	2	0	5
Atr.C.II.02	190,82	243,01	12,16	1,14	Leaning	3	2	0	5
Atr.C.II.03	190,82	243,01	12,16	1,14	Leaning	3	2	0	5
Atr.C.III.01	187,62	242,62	12,07	0,83	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.III.02	187,88	242,62	12,07	0,55	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.III.03	185,06	242,22	12,07	0,88	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.III.04	186,65	242,43	12,04	1,01	Leaning	0	2	1	3
Atr.C.IV.01	194,72	243,76	12,18	0,58	Crouching/Kneeling/Sitting/Lying down	0	3	1	4
Atr.C.IV.02	196,09	244,02	12,2	0,69	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.IV.03	196,72	244,27	12,2	0,9	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.IV.04	197,181	244,22	12,21	0,64	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.IV.05	196,79	244,17	12,2	0,6	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.IV.06	193,63	243,77	12,16	0,57	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.C.IV.08	195,71	244,05	12,22	0,54	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.D.I.03	140,9	249,58	11,01	1,85	Elevated	8	3	0	11
Atr.D.I.07	140,98	251,26	11,03	1,81	Elevated	10	6	0	16
Atr.D.II.01	141,04	248,81	11	1,21	Leaning	7	4	0	11
Atr.D.II.01	135,06	258,65	16,5	1,47	Leaning/Upright	3	0	0	3
Atr.D.II.03	141,22	249,27	11	1,22	Leaning	7	3	0	10
Atr.D.II.03	135,09	259,37	16,57	0,42	Crouching/Kneeling/Sitting/Lying down	3	0	0	3
Atr.D.II.04	135,09	259,37	16,57	0,26	Crouching/Kneeling/Sitting/Lying down	4	0	0	4
Atr.D.II.05	141,08	249,99	11,02	1,28	Leaning	7	3	0	10
Atr.D.II.07	141,6	250,88	11,04	1,4	Leaning/Upright	8	5	0	13
Atr.D.III.02	143,08	251,1	11,07	0,53	Crouching/Kneeling/Sitting/Lying down	7	5	0	12
Atr.D.IV.02	142,16	252,52	11,04	1,47	Leaning/Upright	8	7	1	16
Atr.D.IV.05	141,59	252,35	11,28	1,66	Leaning/Upright	8	8	1	17

Atr.D.IV.07	142,28	252,81	11,52	1,46	Leaning/Upright	8	8	1	17
Atr.D.IV.08	142,2	252,21	11,79	1,54	Leaning/Upright	7	8	1	16
Atr.D.V.01	143,32	252,95	11,06	1,27	Leaning	7	7	1	15
Atr.D.V.02	142,75	252,74	11,08	1,36	Leaning/Upright	7	7	1	15
Atr.D.V.03	143,18	253,06	11,19	1,31	Leaning/Upright	7	8	1	16
Atr.D.V.05	144,05	253,41	11,85	1,19	Leaning	6	8	1	15
Atr.D.V.06	145,36	253,66	11,69	1,04	Leaning	6	8	1	15
Atr.D.V.07	144,03	253,8	11,84	1,1	Leaning	6	8	1	15
Atr.D.V.08	144,07	253,91	11,82	1,08	Leaning	6	8	1	15
Atr.D.VI.02	146	253,22	11,12	0,26	Crouching/Kneeling/Sitting/Lying down	5	6	1	12
Atr.D.VI.04	145,09	253,33	11,19	0,98	Crouching/Kneeling/Sitting/Lying down	6	7	1	14
Atr.D.VI.06	150,56	254,23	11,17	0,2	Crouching/Kneeling/Sitting/Lying down	3	6	1	10
Atr.D.VI.07	149,94	254,36	11,28	0,55	Crouching/Kneeling/Sitting/Lying down	4	7	1	12
Atr.D.VI.08	151,01	254,6	11,4	0,4	Crouching/Kneeling/Sitting/Lying down	3	7	1	11
Atr.Dsuelo.II.01	143,06	244,94	11,1	0,74	Crouching/Kneeling/Sitting/Lying down	2	3	0	5
Atr.F.I.01	159,72	269,77	18,02	1,47	Leaning/Upright	2	0	0	2
Atr.F'.I.01	390,74	317,29	34,96	0,66	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Atr.F'.I.02	388,34	316,87	34,93	0,92	Crouching/Kneeling/Sitting/Lying down	0	1	1	2
Atr.F'.I.03	388,63	316,89	34,93	0,86	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Atr.F'.II.01	389,88	316,81	34,93	0,45	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.F'.II.02	386,58	315,06	34,8	0,52	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
Atr.F'.III.01	380,3	314,01	34,87	0,8	Crouching/Kneeling/Sitting/Lying down	0	3	1	4
Atr.F'.III.02	378,88	313,75	34,76	0,88	Crouching/Kneeling/Sitting/Lying down	0	3	1	4
Atr.F'.III.03	372,85	312,49	34,58	0,89	Crouching/Kneeling/Sitting/Lying down	1	3	1	5
Atr.F'.III.04	372,55	312,47	34,58	0,96	Crouching/Kneeling/Sitting/Lying down	0	3	1	4
Atr.F'.III.05	371,28	312,23	34,56	1,05	Leaning	1	3	1	5
Atr.F'.III.06	370,43	312,01	34,56	1,01	Leaning	1	3	1	5
Atr.F'.IV.01	371,94	312,01	34,55	0,88	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
Atr.G'.I.01	379,8	321,98	45,96	1,52	Leaning/Upright	2	1	0	3
Atr.G.I.06	158,18	267,52	17,83	0,79	Crouching/Kneeling/Sitting/Lying down	2	2	0	4
Atr.G.I.10	156,9	265,93	17,81	1,1	Leaning	2	2	1	5
Atr.G.II.01	156,87	267,44	17,81	1,24	Leaning	1	2	0	3
Atr.G.II.03	155,79	267,05	17,79	1,49	Leaning/Upright	1	2	0	3
Atr.G.II.04	156,06	267,15	17,79	1,21	Leaning	2	2	0	4
Atr.G.II.05	156,42	267,24	17,81	1,04	Leaning	1	2	1	4
Atr.G.II.06	156,58	267,27	17,82	0,79	Crouching/Kneeling/Sitting/Lying down	1	2	1	4
Atr.G.III.01	155,62	267,01	17,8	1,5	Leaning/Upright	3	2	0	5
Atr.G.III.07	154,99	269,55	21,55	1,19	Leaning	3	0	0	3
Atr.G.III.10	236,02	274,13	20,89	0,7	Crouching/Kneeling/Sitting/Lying down	3	0	0	3
Atr.G'-suelo.I.01	266,6	306,83	36,93	1,26	Leaning	8	0	0	8
Atr.H.I.01	455,56	320,73	37,29	0,85	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Atr.H.II.01	452,38	315,8	37,2	1,02	Leaning	2	0	0	2

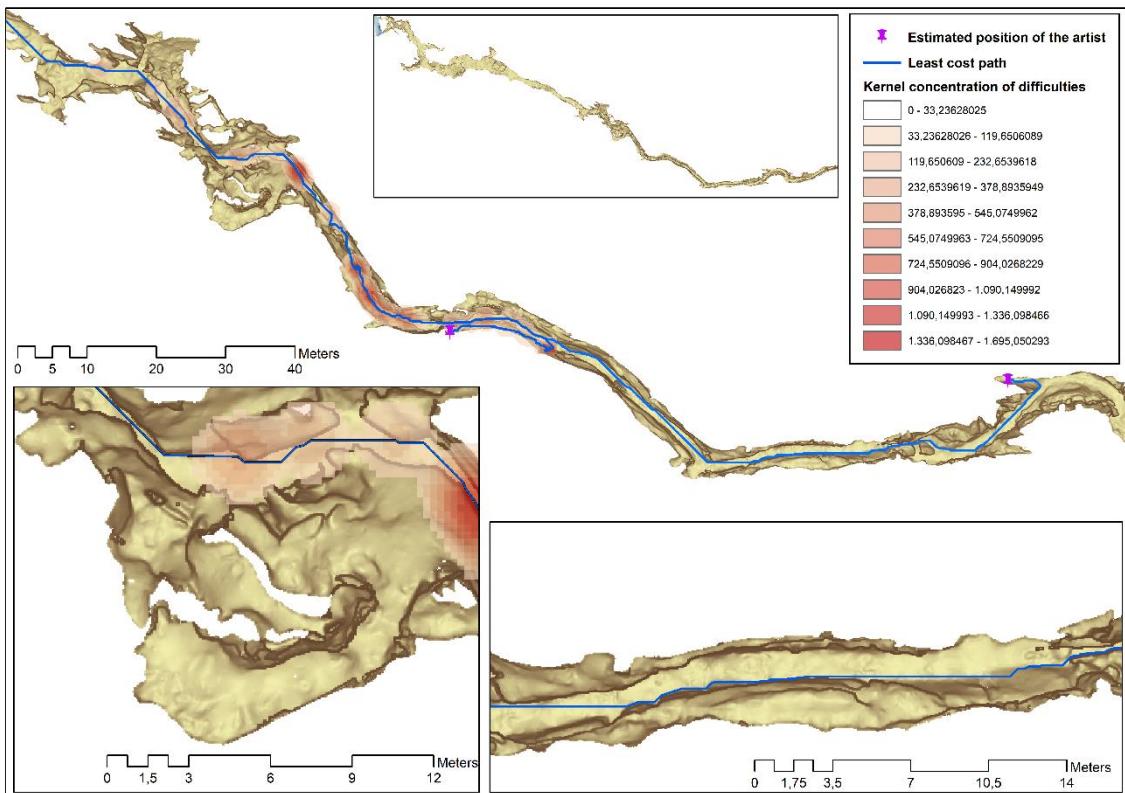
Atr.H.II.02	452,37	315,72	37,2	1,22	Leaning	2	0	0	2
Atr.I'-suelo.I.02	266,58	306,58	36,03	1,52	Leaning/Upright	8	0	0	8
Atr.I'-suelo.I.03	266,58	307,39	36,03	1,64	Leaning/Upright	9	0	0	9
Atr.I'-suelo.I.05	266,62	307,27	37,39	1,48	Leaning/Upright	9	0	0	9
Atr.J.I.01	273,13	373,41	38,39	0,69	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
Atr.J.II.02	270,73	361,73	38,08	0,8	Crouching/Kneeling/Sitting/Lying down	4	2	0	6
Atr.J.II.03	270,73	364,08	38,08	0,88	Crouching/Kneeling/Sitting/Lying down	4	2	0	6
Atr.J.II.04	270,79	361,88	38,08	0,89	Crouching/Kneeling/Sitting/Lying down	4	2	0	6
Atr.J.II.06	269,74	361,88	38,07	1,89	Elevated	3	4	0	7
Atr.J.II.08	269,76	362,3	38,08	1,78	Upright	4	3	0	7
Atr.J.II.09	270,57	362,8	38,1	1,25	Leaning	4	4	0	8
Atr.J.II.10	270,75	362,89	38,09	1,26	Leaning	4	4	0	8
Atr.J.II.12	271,4	362,59	38,1	0,76	Crouching/Kneeling/Sitting/Lying down	4	3	0	7
Atr.J.II.13	271,76	362,96	38,11	0,92	Crouching/Kneeling/Sitting/Lying down	4	4	0	8
Atr.J.II.15	271,76	362,96	38,11	1,01	Leaning	4	4	0	8
Atr.J.II.16	272,59	363,25	38,13	0,79	Crouching/Kneeling/Sitting/Lying down	4	4	0	8
Atr.J.II.17	272,58	363,69	38,13	0,9	Crouching/Kneeling/Sitting/Lying down	4	4	0	8
Atr.J.II.18	273,35	363,85	38,14	0,88	Crouching/Kneeling/Sitting/Lying down	4	5	0	9
Atr.J.II.19	273,13	363,81	38,13	0,92	Crouching/Kneeling/Sitting/Lying down	5	5	0	10
Atr.J.II.20	273,99	363,96	38,14	0,79	Crouching/Kneeling/Sitting/Lying down	4	5	0	9
Atr.J.II.23	275,17	365,11	38,61	1,01	Leaning	4	5	0	9
Atr.J.II.24	275,74	366,73	38,32	0,98	Crouching/Kneeling/Sitting/Lying down	3	4	0	7
Atr.J.II.28	274,15	366,38	38,3	1,21	Leaning	2	4	0	6
Atr.J.II.29	276,19	366,84	38,34	0,77	Crouching/Kneeling/Sitting/Lying down	2	3	0	5
Atr.J.II.30	276,6	366,84	38,34	0,65	Crouching/Kneeling/Sitting/Lying down	2	3	0	5
Atr.J.II.31	275,87	366,78	38,32	0,81	Crouching/Kneeling/Sitting/Lying down	3	4	0	7
Atr.J.II.33	274,08	266,58	38,3	1,18	Leaning	3	5	0	8
Atr.J.II.34	273,37	366,27	38,29	1,35	Leaning/Upright	3	5	0	8
Atr.J.II.35	273,04	366,32	38,29	1,51	Leaning/Upright	3	4	0	7
Atr.J.II.39	273,51	366,57	38,3	1,32	Leaning/Upright	3	3	0	6
Atr.J.II.40	273,05	366,51	38,29	1,5	Leaning/Upright	3	5	0	8
Atr.J.II.41	273,41	366,62	38,3	1,37	Leaning/Upright	3	4	0	7
Atr.J.II.42	274,12	367,05	38,31	1,1	Leaning	3	5	0	8
Atr.J.II.44	273,24	366,95	38,3	1,39	Leaning/Upright	3	4	0	7
Atr.J.II.46	273	388,82	38,45	1,51	Leaning/Upright	3	5	0	8
Atr.J.II.47	273,07	367,02	38,3	1,47	Leaning/Upright	3	4	0	7
Atr.J.II.48	272,89	366,92	38,29	1,59	Leaning/Upright	3	3	0	6
Atr.J.II.49	272,96	367,32	38,46	1,58	Leaning/Upright	3	3	0	6
Atr.J.II.53	275,53	369,23	38,36	0,6	Crouching/Kneeling/Sitting/Lying down	3	5	0	8
Atr.J.II.54	274,38	368,54	38,34	0,88	Crouching/Kneeling/Sitting/Lying down	3	4	0	7
Atr.J.II.57	274,43	368,78	38,34	1,01	Leaning	3	5	0	8
Atr.J.II.59	276	369,08	38,37	0,53	Crouching/Kneeling/Sitting/Lying down	3	5	0	8
Atr.J.II.65	273,36	368,4	38,32	1,28	Leaning	3	3	0	6

Atr.J.II.66	273,74	368,5	38,33	1,16	Leaning	3	3	0	6
Atr.J.II.68	276,1	369,52	38,37	0,65	Crouching/Kneeling/Sitting/Lying down	3	3	0	6
Atr.J.II.70	275,54	368,84	38,36	0,66	Crouching/Kneeling/Sitting/Lying down	3	3	0	6
Atr.J.II.71	276	369,54	38,37	0,52	Crouching/Kneeling/Sitting/Lying down	2	3	0	5
Atr.J.II.74	274,29	370,09	38,37	1,03	Leaning	3	4	0	7
Atr.J.II.76	273,46	369,82	38,35	1,36	Leaning/Upright	2	3	0	5
Atr.J.II.80	274,19	370,82	38,37	1,01	Leaning	4	2	0	6
Atr.J.II.81	275,23	370,92	38,38	0,52	Crouching/Kneeling/Sitting/Lying down	3	3	0	6
Atr.J.II.83	274,96	370,18	38,37	0,54	Crouching/Kneeling/Sitting/Lying down	2	3	0	5
Atr.J.II.84	276,36	370,29	38,4	0,36	Crouching/Kneeling/Sitting/Lying down	2	3	0	5
Atr.J'-suelo.I.01	272,29	389,02	39,43	0,87	Crouching/Kneeling/Sitting/Lying down	0	2	0	2
Atr.J'-suelo.I.02	270,77	388,36	39,41	0,66	Crouching/Kneeling/Sitting/Lying down	1	2	0	3

**Table 3, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **3, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* iristeko zailtasunik handiena duen Uga seinalatua da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).



**Figure S5-5.** Map of the accumulated access difficulty value of the Atxurra cave, made with ArcMap®. *S5-5 Irudia. Atxurrako haitzuloan metatutako iristeko zailtasun balioen mapa, ArcMap®-en bidez egina.*



**Figure S5-6.** Map of the optimal access routes to the most difficult and remote figures of Atxurra, made with ArcMap®. *S5-6 Irudia. Atxurran urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

#### 4. EKAIN

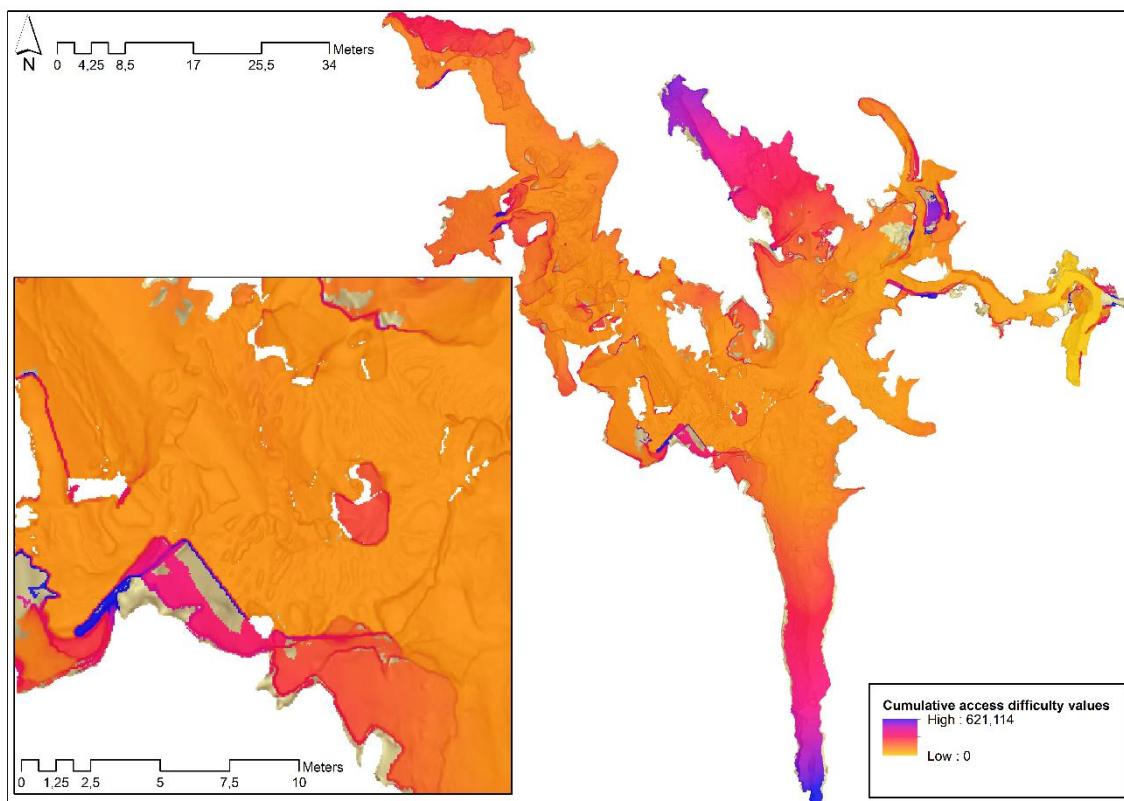
We have analysed 91 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 4](#), [S5](#)).

GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
Ek.B.I.02	50,76	26,81	1,85	1,18	Leaning	6	0	0	6
Ek.B.I.03	50,51	28,42	1,86	1,08	Leaning	7	0	0	7
Ek.C.I.01	51,35	38,65	4,83	1,37	Leaning/Upright	7	3	0	10
Ek.C.I.02	58,19	41,62	4,97	0,76	Crouching/Kneeling/Sitting/Lying down	2	7	2	11
Ek.C.I.03	54,45	45,64	4,95	1,11	Leaning	2	7	1	10
Ek.D.I.01	51,27	45,25	4,91	1,17	Leaning	14	4	0	18
Ek.D.I.02	51,48	45,55	4,91	1	Crouching/Kneeling/Sitting/Lying down	14	5	0	19
Ek.D.II.03	51,43	47,69	4,93	1,35	Leaning/Upright	13	5	0	18
Ek.D.III.03	51,45	49,13	4,96	1,45	Leaning/Upright	10	6	0	16
Ek.D.III.04	52,11	49,27	4,97	1,18	Leaning	9	7	1	17
Ek.D.III.07	51,45	50,32	4,98	1,76	Upright	10	6	1	17
Ek.D.III.08	51,44	50,33	4,98	1,85	Elevated	10	6	1	17
Ek.D.IV.01	52,87	50,84	5,02	1,09	Leaning	11	8	1	20
Ek.D.V.01	52,58	53,84	5,06	1,35	Leaning/Upright	8	7	1	16
Ek.E.II.05	56,95	60,49	5,14	1,46	Leaning/Upright	7	5	2	14
Ek.E.III.03	56,76	60,24	5,15	1,71	Upright	15	2	0	17
Ek.E.III.06	59,68	62,2	5,22	1,21	Leaning	13	12	1	26
Ek.E.IV.01	57,85	60,44	5,23	1,32	Leaning/Upright	9	2	1	12
Ek.E.IV.02	57,59	59,98	5,22	1,24	Leaning	9	3	0	12
Ek.E.V.01	56,68	59,03	5,12	0,99	Crouching/Kneeling/Sitting/Lying down	7	3	0	10
Ek.E.V.02	56,65	58,28	5,1	0,89	Crouching/Kneeling/Sitting/Lying down	16	0	0	16
Ek.E.V.03	56,68	59,03	5,12	1	Crouching/Kneeling/Sitting/Lying down	7	3	0	10
Ek.E.V.05	56,71	59,66	5,11	0,97	Crouching/Kneeling/Sitting/Lying down	17	0	0	17
Ek.E.V.06	56,95	61,01	5,13	0,9	Crouching/Kneeling/Sitting/Lying down	15	0	0	15
Ek.E.V.08	57,12	62,86	5,16	1,65	Leaning/Upright	16	0	0	16
Ek.E.V.12	56,99	62,33	5,16	1,36	Leaning/Upright	14	0	0	14
Ek.E.V.14	56,93	63,62	5,17	1,4	Leaning/Upright	13	0	0	13
Ek.E.V.15	56,91	63,66	5,17	1,5	Leaning/Upright	13	0	0	13
Ek.E.V.16	57,12	63,95	5,17	1,3	Leaning	13	0	0	13
Ek.E.V.17	57,11	64,92	5,2	1,35	Leaning/Upright	11	1	0	12
Ek.E.VI.01	57,49	68,47	5,3	1,76	Upright	14	0	0	14
Ek.E.VI.02	58,25	68,87	5,7	1,32	Leaning/Upright	9	2	0	11
Ek.E.VI.04	57,47	68,95	5,69	1,09	Leaning	12	2	0	14
Ek.E.VI.05	57,09	68,98	5,68	1,27	Leaning	14	2	0	16
Ek.E.VI.06	57,11	69,39	5,68	1,43	Leaning/Upright	14	1	0	15
Ek.E.VI.07	57,2	69,39	5,69	1,19	Leaning	12	4	0	16
Ek.E.VI.10	60,21	69,87	5,77	1,28	Leaning	6	4	0	10

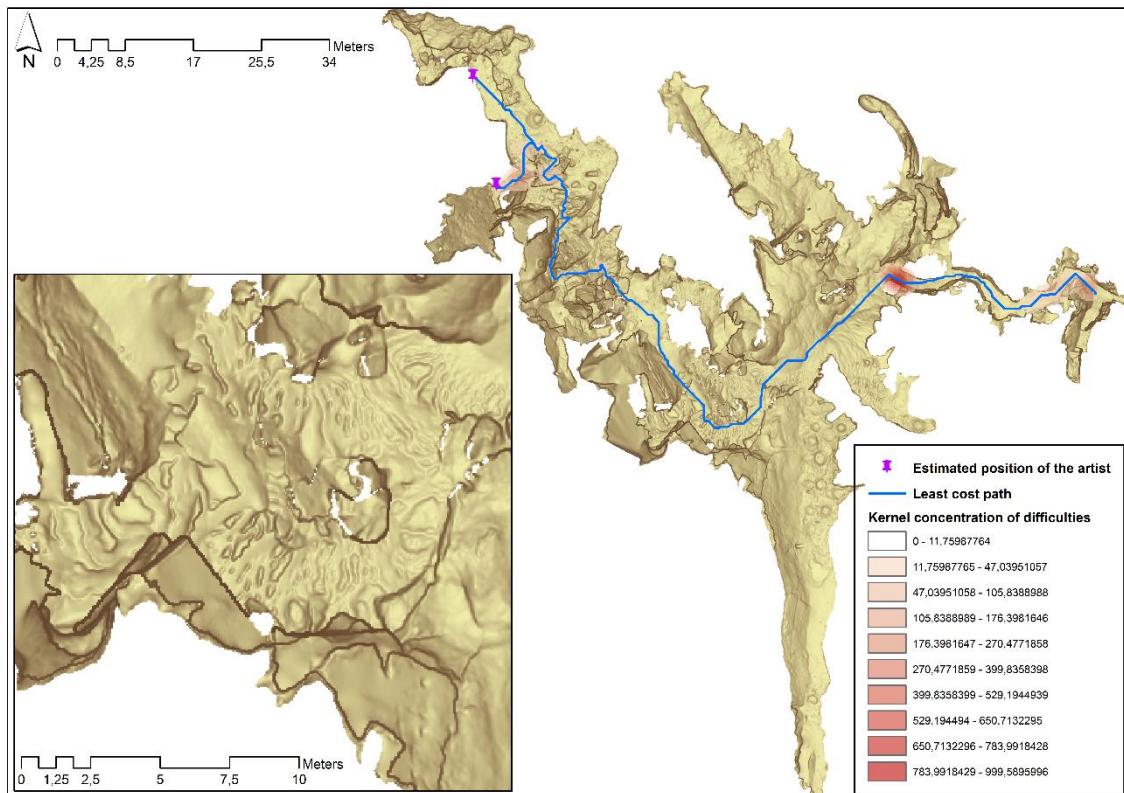
Ek.E.VI.11	57,13	70,07	5,69	1,78	Upright	13	0	0	13
Ek.E.VI.12	57,15	69,88	5,7	1,52	Leaning/Upright	13	2	0	15
Ek.E.VI.13	57,34	70,22	5,69	1,42	Leaning/Upright	13	4	0	17
Ek.E.VI.14	57,39	70,05	5,69	1,37	Leaning/Upright	14	3	0	17
Ek.E.VI.15	58,09	70,47	5,71	1,3	Leaning	10	5	0	15
Ek.E.VI.16	57,87	71,15	5,71	1,38	Leaning/Upright	9	4	0	13
Ek.E.VI.17	58,17	71,11	5,71	1,33	Leaning/Upright	10	5	0	15
Ek.E.VI.19	58,85	71,94	5,75	1,19	Leaning	8	4	0	12
Ek.E.VI.21	59,96	70,72	5,76	1,19	Leaning	6	4	0	10
Ek.E.VI.22	59,2	72,23	5,74	1,22	Leaning	6	4	0	10
Ek.E.VI.23	60,01	72,44	5,76	1,11	Leaning	6	5	0	11
Ek.E.VI.24	57,22	70,57	5,69	1,68	Leaning/Upright	13	3	0	16
Ek.E.VI.25	57,55	70,91	5,71	1,51	Leaning/Upright	9	4	0	13
Ek.E.VI.26	57,67	71,25	5,71	1,39	Leaning/Upright	8	4	0	12
Ek.E.VI.27	57,69	71,74	5,72	1,36	Leaning/Upright	7	4	0	11
Ek.E.VI.28	57,69	71,62	5,72	1,2	Leaning	6	3	0	9
Ek.E.VI.29	58,83	72,2	5,77	1,32	Leaning/Upright	5	5	0	10
Ek.E.VI.30	59,96	72,45	5,83	1,03	Leaning	4	4	0	8
Ek.E.VI.31	58,01	71,7	5,71	1,36	Leaning/Upright	9	4	0	13
Ek.E.VI.32	57,88	72,08	5,73	1,17	Leaning	6	4	0	10
Ek.E.VII.01	56,87	63,6	5,16	1,27	Leaning	13	0	0	13
Ek.E.VII.02	56,87	63,56	5,16	1,78	Upright	13	0	0	13
Ek.E.VII.03	56,91	64,56	5,16	2,04	Elevated	11	0	0	11
Ek.E.VII.04	56,94	65,47	5,17	2,18	Elevated	10	0	0	10
Ek.E.VII.09	56,94	65,34	5,17	2,69	Elevated	10	0	0	10
Ek.E.VII.10	57,98	65,48	5,63	0,72	Crouching/Kneeling/Sitting/Lying down	11	0	0	11
Ek.E.VII.12	57,16	66,14	5,2	0,93	Crouching/Kneeling/Sitting/Lying down	11	0	0	11
Ek.E.VII.13	57,16	66,14	5,2	0,86	Crouching/Kneeling/Sitting/Lying down	11	0	0	11
Ek.E.VII.14	57,01	66,68	5,25	1,17	Leaning	10	0	0	10
Ek.E.VII.15	57,01	66,94	5,2	1,35	Leaning/Upright	11	0	0	11
Ek.E.VII.17	57,03	67,43	5,21	1	Crouching/Kneeling/Sitting/Lying down	14	0	0	14
Ek.E.VII.18	57,06	68,37	5,67	0,8	Crouching/Kneeling/Sitting/Lying down	14	0	0	14
Ek.E.VIII.01	57,22	72,27	5,72	0,67	Crouching/Kneeling/Sitting/Lying down	9	1	0	10
Ek.G.I.01	59,51	81,52	5,9	1,14	Leaning	1	1	0	2
Ek.H.I.01	61,33	85,12	5,52	1,35	Leaning/Upright	2	10	0	12
Ek.H.I.02	62,32	82,04	5,5	1,33	Leaning/Upright	1	9	0	10
Ek.J.I.02	66,32	118,99	6,07	1,25	Leaning	10	7	0	17
Ek.J.I.04	72,01	120,18	6,16	0,92	Crouching/Kneeling/Sitting/Lying down	1	9	0	10
Ek.J.I.06	70,15	121,26	6,11	0,96	Crouching/Kneeling/Sitting/Lying down	4	13	1	18
Ek.J.I.07	68,71	121,34	6,1	1,11	Leaning	4	12	2	18
Ek.J.I.08	67,58	121,17	6,1	1,19	Leaning	4	11	2	17
Ek.J.I.09	68,21	121,31	6,11	1,04	Leaning	4	11	2	17
Ek.J.I.10	67,73	121,17	6,1	1,19	Leaning	4	12	2	18
Ek.J.I.11	68,3	121,35	6,11	1,18	Leaning	3	11	3	17

Ek.J.I.15	66,69	120,85	6,09	1,37	Leaning/Upright	5	12	3	20
Ek.J.I.16	71,44	121,97	6,18	0,91	Crouching/Kneeling/Sitting/Lying down	2	9	3	14
Ek.K.I.01	71,09	136,41	7,24	1,36	Leaning/Upright	3	2	0	5
Ek.K.I.03	77,65	137,31	7,34	1,28	Leaning	2	2	0	4
Ek.K.I.04	71,17	137,02	7,26	1,28	Leaning	2	2	0	4
Ek.K.II.01	70,58	136,55	6,8	1,34	Leaning/Upright	2	2	0	4
Ek.L.I.02	66,66	131,2	6,35	1,63	Leaning/Upright	18	1	0	19
Ek.L.I.03	66,59	132	6,39	1,25	Leaning	15	2	0	17
Ek.L.II.01	66,62	129,37	6,33	1,62	Leaning/Upright	17	8	0	25
Ek.L.III.07	67,13	139,4	6,45	1,48	Leaning/Upright	14	1	0	15

**Table 4, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **4, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* iristeko zailtasunik handiena duen Uga seinalatua da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).



**Figure S5-7.** Map of the accumulated access difficulty value of the Ekain cave, made with ArcMap®. *S5-7 Irudia. Ekaingo haitzuloan metatutako iristeko zailtasun balioen mapa, ArcMap®-en bidez egina.*



**Figure S5-8.** Map of the optimal access routes to the most difficult and remote figures of Ekain, made with ArcMap®. *S5-8 Irudia. Ekainen urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## 5. ALTXERRI

We have analysed 130 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 5](#), [S5](#)).

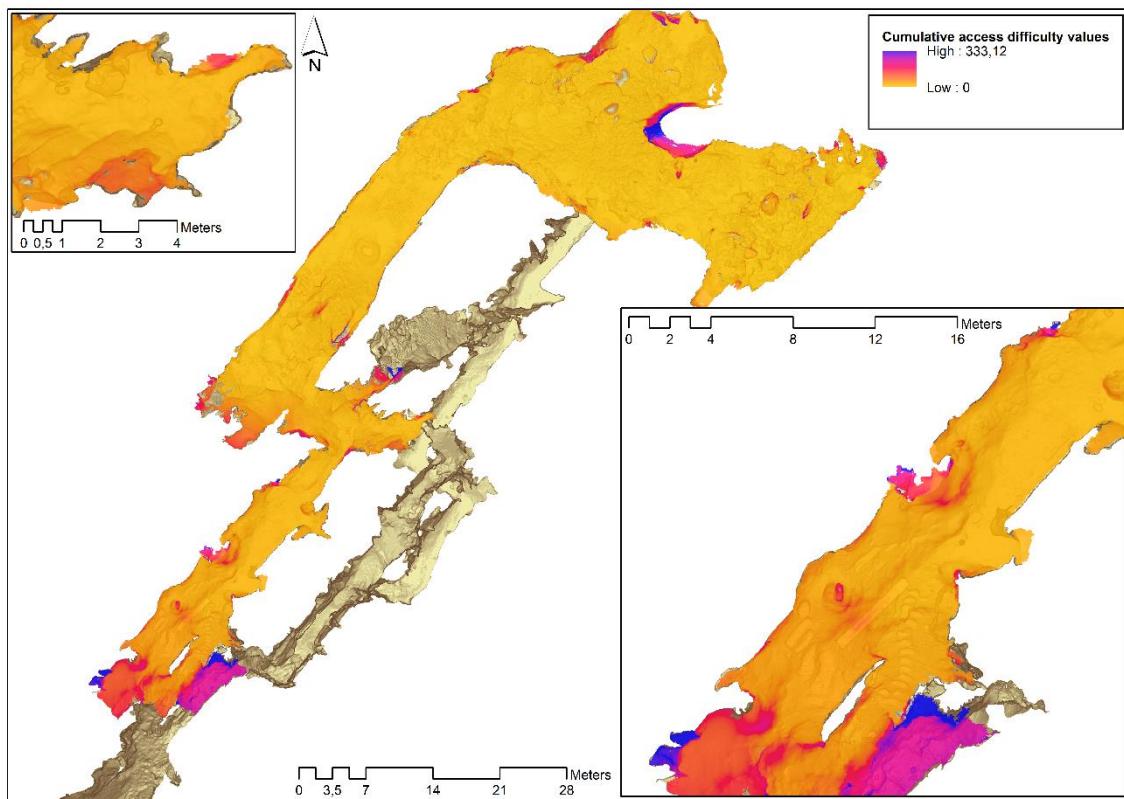
GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
AI.C.II.01	14,58	107,68	1,68	1,34	Leaning/Upright	5	0	0	5
AI.C.II.02	14,58	107,68	1,68	1,23	Leaning	3	0	0	3
AI.C.II.03	14,58	107,68	1,68	1,1	Leaning	3	0	0	3
AI.C.III.01	14,52	108,39	1,65	1,41	Leaning/Upright	5	0	0	5
AI.C.III.02	13,67	109,97	2,01	1,3	Leaning	6	0	0	6
AI.C.IV.01	14,01	109	1,67	1,18	Leaning	6	1	0	7
AI.C.IV.02	17,59	109,13	1,73	2,23	Elevated	6	1	0	7
AI.C.IV.03	17,59	109,13	1,73	2,02	Elevated	6	1	0	7
AI.C.IV.05	14,41	109,77	1,66	1	Crouching/Kneeling/Sitting/Lying down	6	1	0	7
AI.C.IV.06	16,12	111,37	3	2,34	Elevated	4	1	0	5
AI.C.IV.07	17,59	109,13	1,73	2,17	Elevated	5	1	0	6
AI.C.IV.08	14,41	109,77	1,66	1,32	Leaning/Upright	5	1	0	6
AI.C.IV.09	14,41	109,77	1,66	1,17	Leaning	6	1	0	7
AI.C.IV.10	14,41	109,77	1,66	1,08	Leaning	5	1	0	6
AI.C.IV.11	14,77	110,63	1,68	1,14	Leaning	5	1	0	6
AI.C.IV.12	15,35	110,91	1,7	0,89	Crouching/Kneeling/Sitting/Lying down	5	1	0	6
AI.C.IV.14	14,16	110,63	1,68	1,66	Leaning/Upright	3	1	0	4
AI.C.IV.15	13,94	110,83	1,68	1,73	Upright	3	1	0	4
AI.C.IV.16	14,16	110,63	1,68	1,29	Leaning	5	1	0	6
AI.C.IV.17	13,94	110,83	1,68	1,41	Leaning/Upright	3	1	0	4
AI.C.IV.18	13,94	110,83	1,68	1,32	Leaning/Upright	3	1	0	4
AI.C.IV.19	13,95	111,07	1,68	1,32	Leaning/Upright	4	1	0	5
AI.C.IV.21	13,95	111,07	1,68	1,32	Leaning/Upright	4	1	0	5
AI.C.IV.22	13,94	110,83	1,68	1,02	Leaning	4	1	0	5
AI.C.IV.24	13,95	111,07	1,68	2,04	Elevated	4	1	0	5
AI.C.IV.25	13,98	111,83	1,69	2,13	Elevated	4	0	0	4
AI.C.IV.26	13,98	111,83	1,69	1,9	Elevated	3	0	0	3
AI.C.IV.27	13,98	111,83	1,69	1,88	Elevated	4	0	0	4
AI.C.IV.28	13,98	111,83	1,69	1,75	Upright	3	1	0	4
AI.C.IV.29	13,98	111,83	1,69	1,65	Leaning/Upright	2	1	0	3
AI.C.IV.30	13,98	111,83	1,69	1,41	Leaning/Upright	3	1	0	4
AI.C.IV.31	14,01	112,13	1,69	1,11	Leaning	3	0	0	3
AI.C.IV.32	15,98	113,19	1,73	0,62	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
AI.C.IV.33	15,98	113,19	1,73	1,37	Leaning/Upright	2	0	0	2
AI.C.IV.34	15,16	112,79	1,72	1,32	Leaning/Upright	2	0	0	2
AI.C.IV.35	15,16	112,79	1,72	1,22	Leaning	3	0	0	3
AI.C.IV.38	14,01	112,13	1,69	1,91	Elevated	4	0	0	4
AI.C.IV.39	14,14	112,4	1,69	1,68	Leaning/Upright	2	0	0	2

AI.C.IV.40	12,02	112,01	1,69	1,76	Upright	4	0	0	4
AI.C.IV.42	12,02	112,01	1,69	1,62	Leaning/Upright	3	1	0	4
AI.C.IV.43	12,02	112,01	1,69	1,61	Leaning/Upright	3	1	0	4
AI.C.IV.44	12,02	112,01	1,69	1,61	Leaning/Upright	3	0	0	3
AI.C.IV.45	12,24	112,04	1,69	1,59	Leaning/Upright	3	0	0	3
AI.C.IV.46	12,02	112,01	1,69	1,53	Leaning/Upright	3	1	0	4
AI.C.IV.47	12,24	112,04	1,69	1,5	Leaning/Upright	3	0	0	3
AI.C.IV.48	12,24	112,04	1,69	1,41	Leaning/Upright	3	1	0	4
AI.C.IV.49	13,98	111,78	1,69	1,77	Upright	3	1	0	4
AI.C.IV.50	14,05	112	1,69	1,64	Leaning/Upright	2	1	0	3
AI.C.IV.51	13,98	111,78	1,69	2	Elevated	3	0	0	3
AI.C.IV.52	13,99	111,56	1,69	1,95	Elevated	3	1	0	4
AI.C.IV.53	13,99	111,56	1,69	1,84	Elevated	3	1	0	4
AI.C.IV.54	14,18	111,39	1,68	1,66	Leaning/Upright	3	1	0	4
AI.C.IV.57	14,79	112,13	1,7	0,41	Crouching/Kneeling/Sitting/Lying down	3	1	0	4
AI.D.II.01	14,2	116,67	1,9	1,25	Leaning	16	0	0	16
AI.D.II.02	14,37	117,24	1,92	1,28	Leaning	14	0	0	14
AI.D.II.03	14,23	117,39	1,91	1,29	Leaning	14	0	0	14
AI.D.II.04	16,74	117,73	1,99	1,42	Leaning/Upright	15	0	0	15
AI.D.II.05	16,74	117,73	1,99	1,28	Leaning	16	0	0	16
AI.D.II.06	14,25	117,86	1,91	1,5	Leaning/Upright	16	0	0	16
AI.D.II.07	14,4	118,56	1,96	1,53	Leaning/Upright	14	0	0	14
AI.D.II.08	14,35	119,74	1,93	1,81	Elevated	13	0	0	13
AI.D.II.09	14,35	120,17	1,93	1,81	Elevated	11	0	0	11
AI.D.II.10	14,19	116,54	1,91	0,85	Crouching/Kneeling/Sitting/Lying down	13	0	0	13
AI.D.II.11	14,21	116,9	1,91	0,34	Crouching/Kneeling/Sitting/Lying down	8	0	0	8
AI.D.II.13	14,22	117,25	1,94	0,26	Crouching/Kneeling/Sitting/Lying down	8	0	0	8
AI.D.II.14	16,74	117,73	1,99	0,76	Crouching/Kneeling/Sitting/Lying down	14	0	0	14
AI.D.II.16	15,13	118,92	1,94	0,58	Crouching/Kneeling/Sitting/Lying down	10	0	0	10
AI.D.II.17	15,14	119,28	1,94	0,74	Crouching/Kneeling/Sitting/Lying down	11	0	0	11
AI.D.II.18	14,58	120,11	1,93	0,87	Crouching/Kneeling/Sitting/Lying down	11	0	0	11
AI.D.II.19	16,68	120,92	1,99	0,29	Crouching/Kneeling/Sitting/Lying down	7	0	0	7
AI.D.II.20	15,57	121,14	1,97	0,76	Crouching/Kneeling/Sitting/Lying down	8	0	0	8
AI.D.III.01	14,28	118,86	1,89	1,99	Elevated	5	0	0	5
AI.D.IV.01	14,56	124,98	2,01	1,5	Leaning/Upright	5	0	0	5
AI.D.IV.02	14,67	125,15	2,02	1,69	Leaning/Upright	4	0	0	4
AI.D.IV.03	14,55	124,82	2,01	1,91	Elevated	7	0	0	7
AI.D.IV.04	14,56	125,07	2,01	1,6	Leaning/Upright	7	0	0	7
AI.D.IV.05	14,56	125,07	2,01	1,48	Leaning/Upright	7	0	0	7
AI.D.IV.06	14,81	125,3	2,02	1,33	Leaning/Upright	6	0	0	6
AI.D.IV.08	15,42	125,38	2,03	1,15	Leaning	6	0	0	6
AI.D.IV.09	14,84	123,31	2,02	0,82	Crouching/Kneeling/Sitting/Lying down	6	0	0	6
AI.D.IV.10	14,56	125,08	2,01	0,63	Crouching/Kneeling/Sitting/Lying down	6	0	0	6

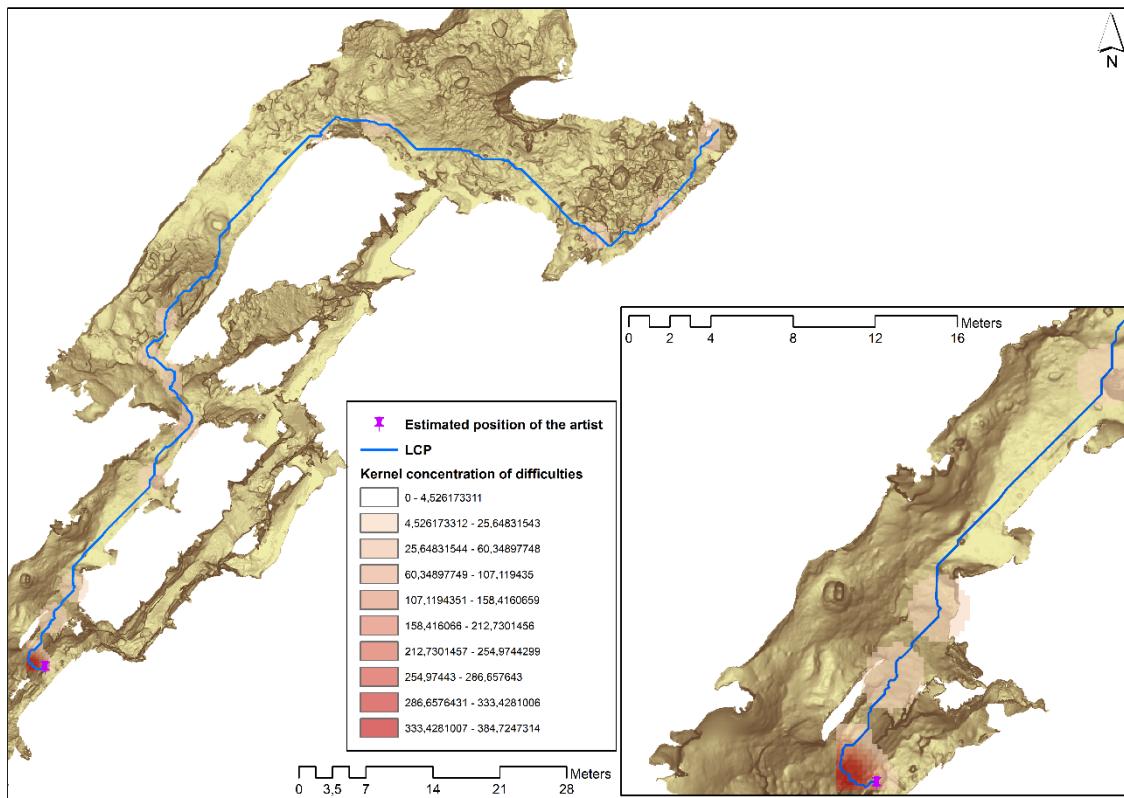
AI.D.IV.12	14,67	125,45	2,01	1,83	Elevated	7	0	0	7
AI.D.IV.13	14,67	125,45	2,01	1,06	Leaning	6	0	0	6
AI.D.IV.14	14,81	125,31	2,02	0,87	Crouching/Kneeling/Sitting/Lying down	6	0	0	6
AI.D.IV.15	15,49	126,18	2,04	1,65	Leaning/Upright	6	0	0	6
AI.D.IV.16	15,49	126,18	2,04	1,29	Leaning	6	0	0	6
AI.D.IV.17	15,49	126,18	2,04	1,12	Leaning	6	0	0	6
AI.E.I.01	19,44	132,68	2,07	1,28	Leaning	1	0	0	1
AI.E.I.02	20,72	133,04	2,09	1,02	Leaning	1	1	0	2
AI.E.I.04	22,87	135,36	2,15	1,22	Leaning	1	1	0	2
AI.E.I.05	22,87	135,36	2,15	1,4	Leaning/Upright	1	1	0	2
AI.E.I.06	22,87	135,36	2,15	1,33	Leaning/Upright	1	1	0	2
AI.E.I.08	22,87	135,36	2,15	1,42	Leaning/Upright	2	0	0	2
AI.E.I.09	22,4	136,58	2,15	1,77	Upright	2	0	0	2
AI.E.I.10	22,56	137,04	2,16	1,44	Leaning/Upright	1	0	0	1
AI.E.I.11	22,56	137,04	2,16	1,56	Leaning/Upright	1	0	0	1
AI.E.I.12	22,56	137,04	2,16	1,54	Leaning/Upright	1	0	0	1
AI.E.I.13	22,38	136,02	2,15	2,35	Elevated	2	0	0	2
AI.E.I.15	22,43	137,35	2,16	2,07	Elevated	1	0	0	1
AI.E.I.16	22,84	137,99	2,18	1,79	Upright	1	0	0	1
AI.E.I.17	22,44	137,61	2,22	1,9	Elevated	2	0	0	2
AI.E.I.18	24,13	133,83	2,14	0,89	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
AI.E.I.19	24,13	133,83	2,14	0,88	Crouching/Kneeling/Sitting/Lying down	1	1	0	2
AI.E.II.01	22,68	140,5	2,22	1,88	Elevated	5	0	0	5
AI.E.II.02	22,67	140,47	2,22	1,91	Elevated	5	0	0	5
AI.E.II.03	22,71	140,54	2,22	1,61	Leaning/Upright	5	0	0	5
AI.E.II.04	23,35	140,43	2,23	1,44	Leaning/Upright	5	0	0	5
AI.E.II.05	22,67	140,1	2,21	1,77	Upright	5	0	0	5
AI.E.II.06	22,65	139,6	2,21	1,84	Elevated	5	0	0	5
AI.E.II.07	24,06	140,38	2,24	1,35	Leaning/Upright	7	0	0	7
AI.E.II.08	23,98	140,42	2,25	1,46	Leaning/Upright	7	0	0	7
AI.E.II.09	23,98	140,42	2,25	1,32	Leaning/Upright	7	0	0	7
AI.E.II.10	23,98	140,42	2,25	1,37	Leaning/Upright	7	0	0	7
AI.E.II.11	23,05	140,83	2,23	0,87	Crouching/Kneeling/Sitting/Lying down	5	0	0	5
AI.E.II.12	23,08	140,24	2,25	0,9	Crouching/Kneeling/Sitting/Lying down	4	0	0	4
AI.E.II.14	22,78	140,49	3,32	1,12	Leaning	4	0	0	4
AI.F.II.01	18,26	133,15	2,13	1,04	Leaning	0	0	0	0
AI.F.II.02	18,15	133,2	2,15	1,67	Leaning/Upright	0	0	0	0
AI.F.II.03	18,15	133,2	2,15	1,3	Leaning	0	0	0	0
AI.F.II.04	21,89	134,68	2,29	1,49	Leaning/Upright	0	0	0	0
AI.F.II.05	35,17	135,04	2,62	1,59	Leaning/Upright	0	0	0	0
AI.F.II.06	21,58	135,52	2,25	2,48	Elevated	0	0	0	0
AI.F.II.07	21,58	135,52	2,25	2,25	Elevated	0	0	0	0
AI.F.II.08	21,58	135,52	2,25	2,23	Elevated	0	0	0	0
AI.F.II.09	35,17	135,04	2,62	1,66	Leaning/Upright	0	0	0	0

AI.F.II.10	23,82	137,24	2,3	1,49	Leaning/Upright	0	0	0	0
AI.F.II.11	21,67	138,67	2,27	2,25	Elevated	0	0	0	0
AI.F.II.12	21,68	138,92	2,27	2,33	Elevated	0	0	0	0
AI.F.III.01	99,9	145,15	3,84	1,83	Elevated	1	1	0	2
AI.F.III.02	99,9	145,15	3,84	2	Elevated	1	1	0	2

**Table 5, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **5, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* *iristeko zaitasunik handiena duen Uga seinalatu da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).*



**Figure S5-9.** Map of the accumulated access difficulty value of the Altzerri cave, made with ArcMap®. *S5-9 Irudia. Altzerri haitzuloan metatutako iristeko zailtasun balioen mapa, ArcMap®-en bidez egina.*



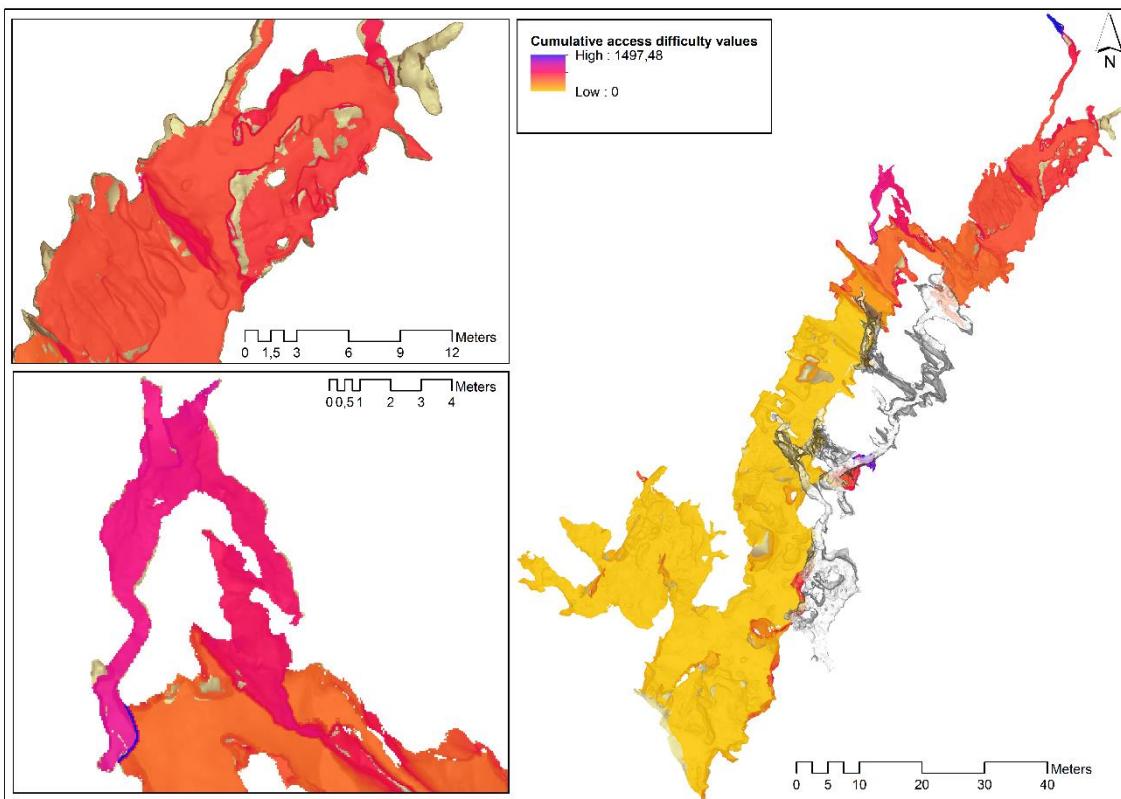
**Figure S5-10.** Map of the optimal access routes to the most difficult and remote figures of Altzerri, made with ArcMap®. *S5-10 Irudia. Altzerri urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## 6. AITZBITARTE IV

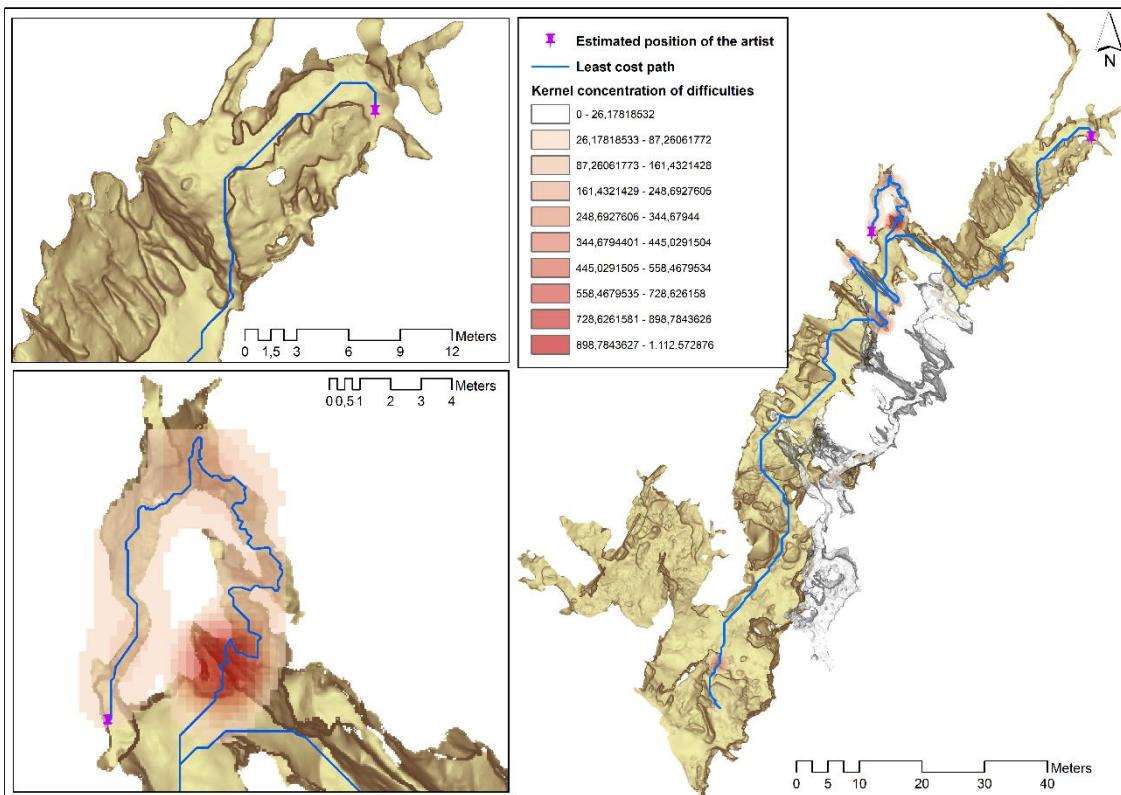
We have analysed 24 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 6, S5](#)).

GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
AitzIV.B.AI.01	596,67	159,77	11,91	3,45	Elevated	0	0	0	0
AitzIV.B.AI.02	606,71	161,59	12,18	0,86	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
AitzIV.B.BI.01	598,8	157,62	11,95	1,9	Elevated	0	1	0	1
AitzIV.B.BII.01	601,94	157,88	12,08	0,61	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
AitzIV.B.BII.02	599,77	158,9	12,04	1,36	Leaning/Upright	0	0	0	0
AitzIV.B.CI.03	609,66	160,81	12,26	1,05	Leaning	0	0	0	0
AitzIV.B.CI.06	612,71	161,6	12,3	0,64	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
AitzIV.B.CII.01	611,41	161,09	12,27	0,55	Crouching/Kneeling/Sitting/Lying down	0	0	1	1
AitzIV.B.CII.02	611,72	161,14	12,29	0,45	Crouching/Kneeling/Sitting/Lying down	0	0	1	1
AitzIV.B.CII.05	610,27	161,02	12,27	1,01	Leaning	0	0	1	1
AitzIV.B.DI.01	643,84	165,99	12,87	0,45	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
AitzIV.B.DI.02	646,58	166,39	12,91	0,37	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
AitzIV.B.DII.01	651,06	167,21	12,97	0,56	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
AitzIV.B.DIII.01	647,41	166,51	12,94	0,45	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
AitzIV.B.DIII.02	649,36	166,89	12,95	0,71	Crouching/Kneeling/Sitting/Lying down	0	1	1	2
AitzIV.B.DIII.03	646,44	166,87	12,95	0,5	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
AitzIV.B.DIII.04	651,34	167,23	12,99	0,62	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
AitzIV.C.I.02	319,5	167,17	10,38	1,35	Leaning/Upright	3	1	0	4
AitzIV.D.IX.01	326,95	181,62	12,24	1,45	Leaning/Upright	11	2	0	13
AitzIV.D.VI.01	342,31	190,06	12,31	0,9	Crouching/Kneeling/Sitting/Lying down	0	2	1	3
AitzIV.D.VII.01	339,92	189,55	12,25	1,17	Leaning	0	2	1	3
AitzIV.D.VII.02	338,25	189,2	12,23	1,02	Leaning	0	2	1	3
AitzIV.D.VII.03	337,89	190,16	12,26	1,01	Leaning	0	2	1	3
AitzIV.D.VII.04	337,59	190,07	12,24	0,8	Crouching/Kneeling/Sitting/Lying down	0	2	1	3

*Table 6, S5 – Table of the spatial results for each GU.* \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). *6, S5 Taula – UG bakoitzaren emaitza espazialen taula.* \* *iristeko zailtasunik handiena duen Uga seinalatua da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).*



**Figure S5-11.** Map of the accumulated access difficulty value of the Aitzbitarte IV cave, made with ArcMap®. **S5-11 Irudia.** *Aitzbitarte IV haitzuloan metatutako iristeko zailtasun balioen mapa, ArcMap®-en bidez egina.*



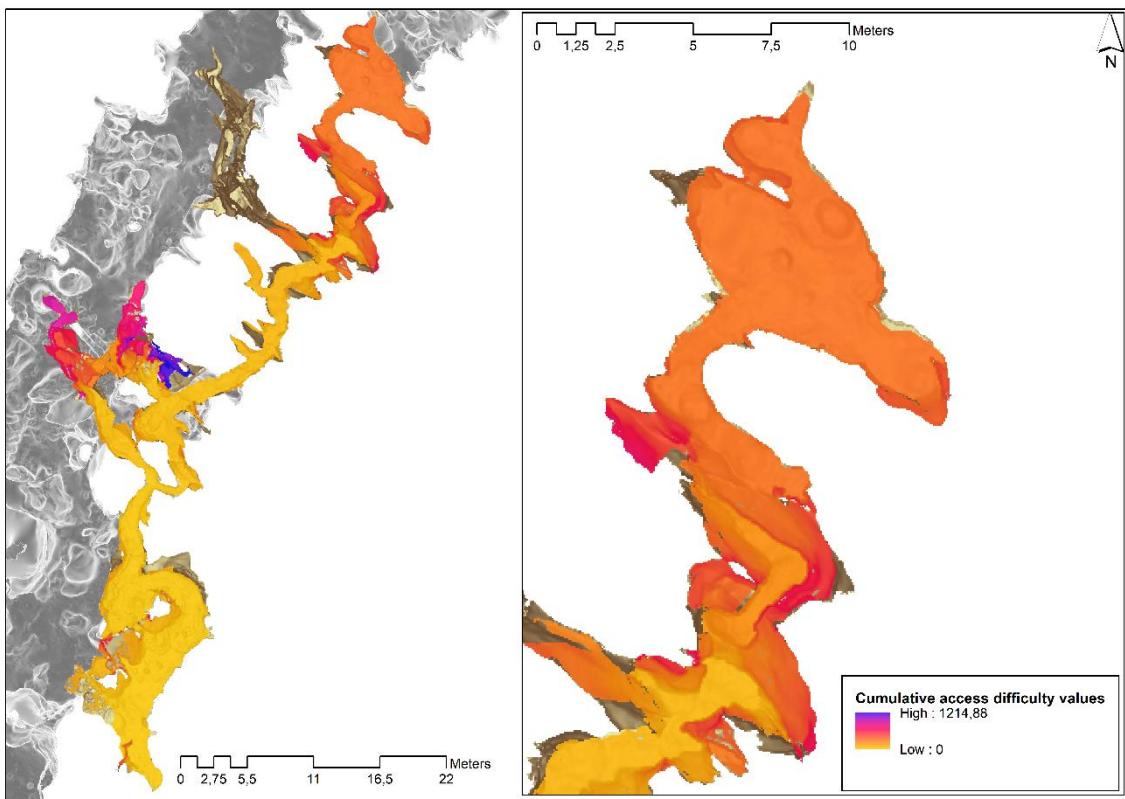
**Figure S5-12.** Map of the optimal access routes to the most difficult and remote figures of Aitzbitarte IV, made with ArcMap®. **S5-12 Irudia.** *Aitzbitarte IV-n urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## 7. AITZBITARTE V

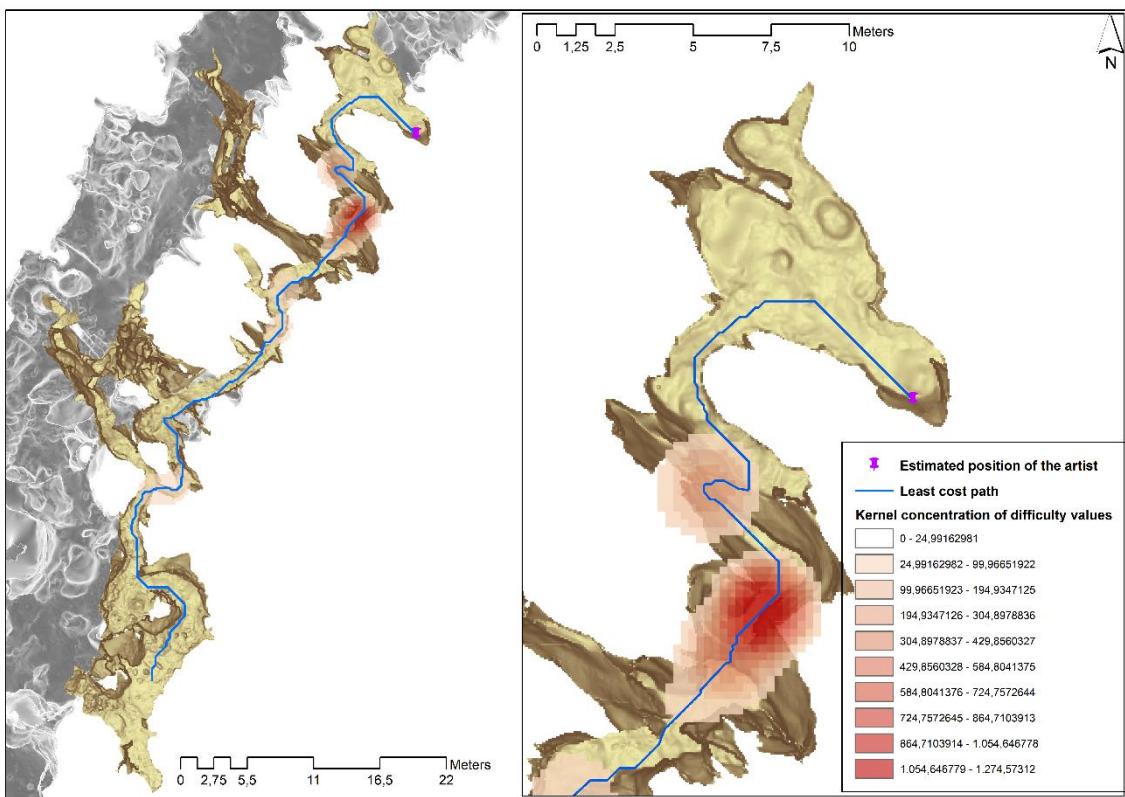
We have analysed 5 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. and GUs from other chronologies ([Table 7, S5](#)).

GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
AitzV.B.I.01	152,39	61,1	6,17	1,28	Leaning	2	0	0	2
AitzV.B.I.03	152,42	61,87	6,38	1,41	Leaning/Upright	2	0	0	2
AitzV.B.II.01	152,41	61,48	6,18	1,55	Leaning/Upright	2	0	0	2
AitzV.B.II.02	152,41	62,52	6,18	1,52	Leaning/Upright	3	0	0	3
AitzV.D.III.02	202,22	81,67	7,37	1,39	Leaning/Upright	4	0	0	4

**Table 7, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **7, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* *iristeko zaitasunik handiena duen Uga seinalatua da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).*



**Figure S5-13.** Map of the accumulated access difficulty value of the Aitzbitarte V cave, made with ArcMap®. *S5-13 Irudia. Aitzbitarte V haitzuloan metatutako iristeko zailtasun balioen mapa, ArcMap®-en bidez egina.*



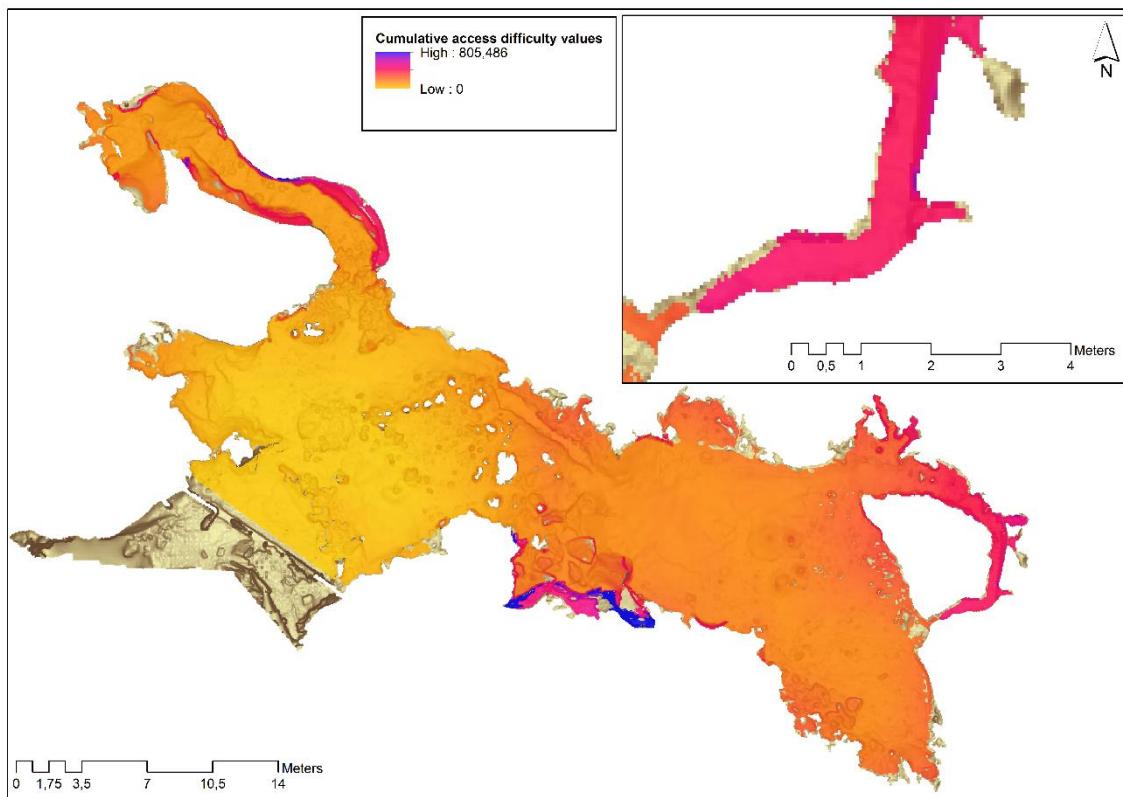
**Figure S5-14.** Map of the optimal access routes to the most difficult and remote figures of Aitzbitarte V, made with ArcMap®. *S5-14 Irudia. Aitzbitarte V-n urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## 8. ALKERDI 1

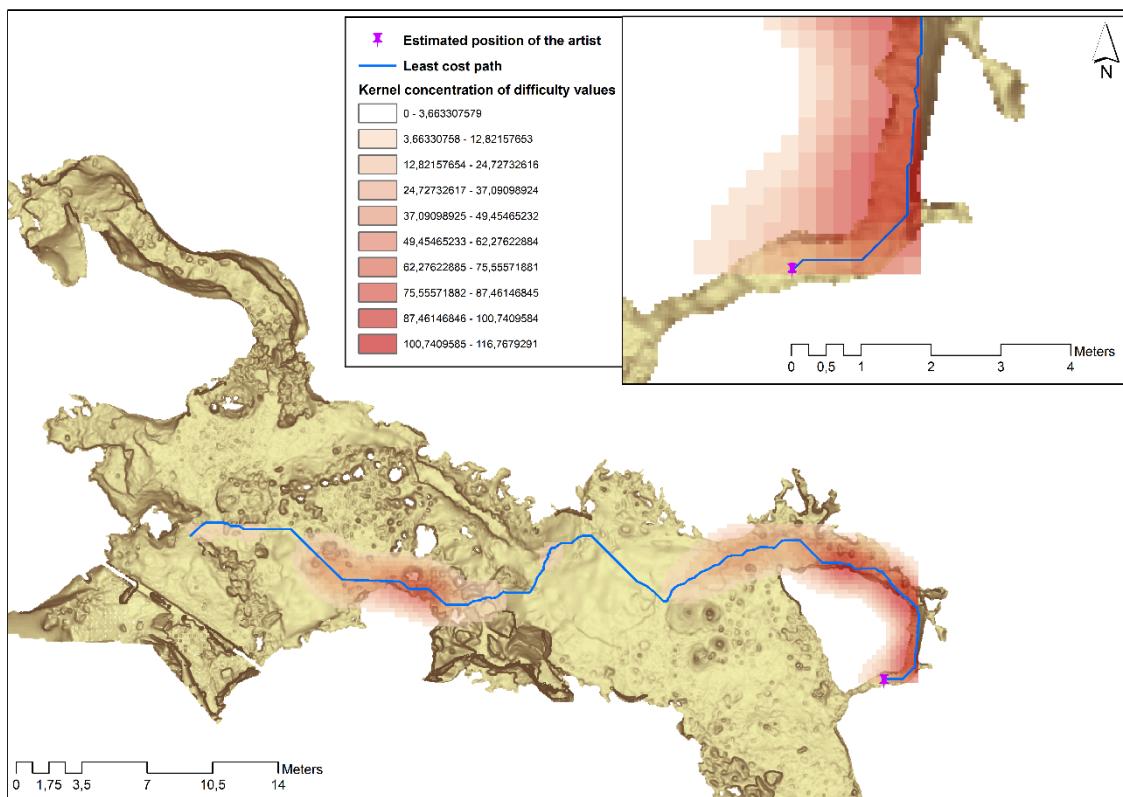
We have analysed 23 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 8, S5](#)).

GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
Alk.A.I.01	46,39	37,28	1,32	0,36	Crouching/Kneeling/Sitting/Lying down	3	1	1	5
Alk.A.I.02	47,21	37,38	1,85	0,42	Crouching/Kneeling/Sitting/Lying down	2	1	1	4
Alk.A.I.03	44,71	37,12	1,31	0,39	Crouching/Kneeling/Sitting/Lying down	3	2	0	5
Alk.A.I.07	43,51	37,05	1,51	0,32	Crouching/Kneeling/Sitting/Lying down	3	2	0	5
Alk.A.I.08	43,51	37,05	1,51	0,26	Crouching/Kneeling/Sitting/Lying down	3	1	0	4
Alk.B.I.01	31,2	17,44	0,68	1,61	Leaning/Upright	9	1	0	10
Alk.D.I.01	106,76	50,29	2,41	0,81	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.02	109,14	51,23	2,25	0,72	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.03	109,14	51,23	2,25	0,72	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.04	109,94	51,62	2,26	0,68	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Alk.D.I.05	110,54	51,8	2,3	0,74	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.07	111,34	52,02	2,46	0,62	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.08	111,34	52,02	2,46	0,47	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.09	116,72	52,97	2,37	0,57	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.I.10	117,05	53,06	2,37	0,71	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Alk.D.II.02	110,8	52,08	2,32	0,77	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Alk.D.II.03	111,48	52,19	2,33	0,59	Crouching/Kneeling/Sitting/Lying down	0	2	0	2
Alk.D.II.04	112,03	52,31	2,34	0,8	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Alk.D.II.05	114,55	52,74	2,35	0,66	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.II.06	114,7	52,75	2,34	0,79	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.II.07	115,91	52,95	2,36	0,66	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.II.08	116,68	53,08	2,37	0,72	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.II.09	119,2	53,52	2,41	0,62	Crouching/Kneeling/Sitting/Lying down	0	1	0	1
Alk.D.II.10	119,64	53,59	2,42	0,77	Crouching/Kneeling/Sitting/Lying down	0	0	0	0

**Table 8, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **8, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* *iristeko zailtasunik handiena duen Uga seinalatu da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).*



**Figure S5-15.** Map of the accumulated access difficulty value of the Alkerdi 1 cave, made with ArcMap®. *S5-15 Irudia. Alkerdi 1 haitzuloan metatutako iristeko zaitasun balioen mapa, ArcMap®-en bidez egina.*



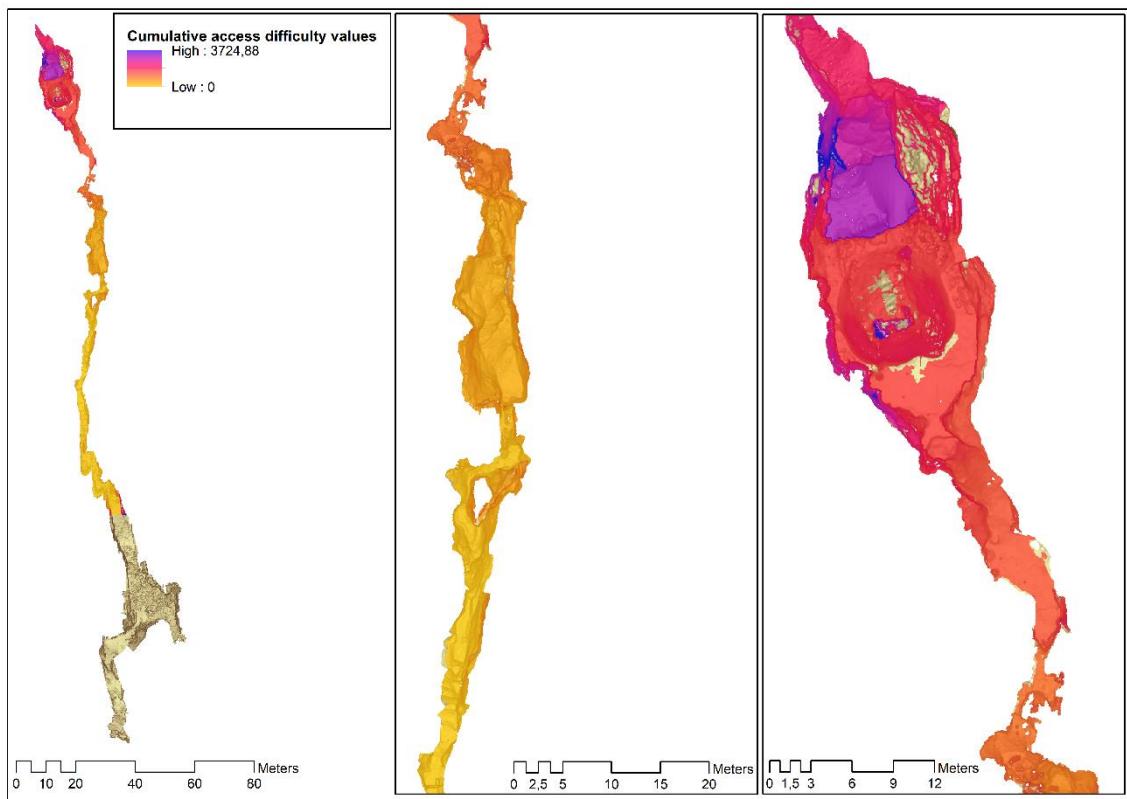
**Figure S5-16.** Map of the optimal access routes to the most difficult and remote figures of Alkerdi 1, made with ArcMap®. *S5-16 Irudia. Alkerdi 1-ean urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## 9. ETXEBERRIKO KARBIA

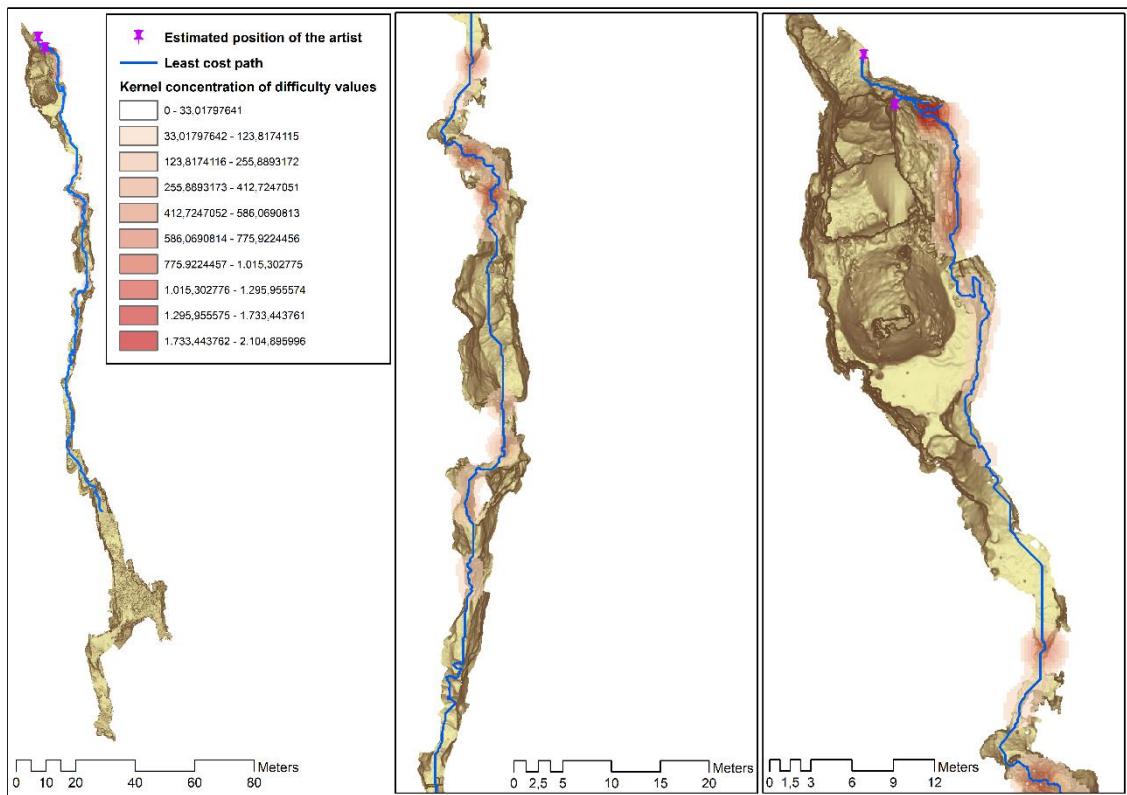
We have analysed 32 figures of the cave in our analysis excluding the simplest elements: simple or non-figurative engraved lines, pigment stains, etc. ([Table 9, S5](#)).

GU	Difficulty value of access	Least cost path length	Estimated time of arrival	Distance to ground	Posture	Viewers upright	Seated viewers	viewers lying down	Total viewers
Etx.E.I.02	785,32	167,89	16,38	1,56	Leaning/Upright	8	0	0	8
Etx.E.I.04	739,77	168,14	16,52	1,39	Leaning/Upright	11	1	0	12
Etx.E.I.05	739,7	168,56	16,88	0,91	Crouching/Kneeling/Sitting/Lying down	9	1	0	10
Etx.E.I.06	739,87	169,18	16,92	0,9	Crouching/Kneeling/Sitting/Lying down	10	1	0	11
Etx.E.I.07	739,86	168,85	16,53	1,85	Elevated	11	1	0	12
Etx.E.I.08	739,66	169,74	16,59	0,95	Crouching/Kneeling/Sitting/Lying down	12	1	0	13
Etx.E.I.09	739,64	169,42	16,56	1,17	Leaning	12	1	0	13
Etx.E.I.14	741	170,92	16,67	1,84	Elevated	13	1	0	14
Etx.E.II.02	754,74	167,26	16,86	1,99	Elevated	11	0	0	11
Etx.E.II.03	740,04	169,35	16,86	1,63	Leaning/Upright	12	1	0	13
Etx.E.II.05	740,01	170,06	16,9	1,36	Leaning/Upright	11	1	0	12
Etx.E.II.08	789,74	171,55	16,54	1,68	Leaning/Upright	14	1	0	15
Etx.E.II.09	739,71	170,89	16,5	1,97	Elevated	12	1	0	13
Etx.E.II.11	739,77	172,18	16,76	2,32	Elevated	8	0	0	8
Etx.E.III.01	742,13	174,48	17,06	1,74	Upright	7	0	0	7
Etx.E.III.02	739,98	176,67	17,1	1,59	Leaning/Upright	4	0	0	4
Etx.F.I.02	754,29	185,62	17,09	0,97	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
Etx.G.II.01	935,74	214,67	23,93	0,45	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Etx.H.I.05	1303,67	227,56	30,84	0,48	Crouching/Kneeling/Sitting/Lying down	2	1	0	3
Etx.H.I.08	1302,15	227,83	30,95	1,11	Leaning	1	0	0	1
Etx.H.I.10	1302,14	227,73	30,89	0,53	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Etx.H.I.11	1302,14	227,72	30,82	0,21	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
Etx.H.I.13	1302,17	228,48	30,83	0,73	Crouching/Kneeling/Sitting/Lying down	1	0	0	1
Etx.H.I.14	1302,17	228,43	30,83	0,63	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Etx.H.II.02	1302,15	227,85	30,84	1	Crouching/Kneeling/Sitting/Lying down	0	0	0	0
Etx.H.II.07	1302,13	227,42	30,82	1,1	Leaning	1	0	0	1
Etx.H.II.08	1302,15	227,84	30,9	1,21	Leaning	1	0	0	1
Etx.H.II.09	1302,18	228,74	30,92	1,5	Leaning/Upright	0	0	0	0
Etx.H.II.10	1319,53	229,5	31,18	1,12	Leaning	0	0	0	0
Etx.I.I.01	1142,87	230,35	30,14	0,1	Crouching/Kneeling/Sitting/Lying down	4	0	0	4
Etx.I.I.02	1142,7	230,19	29,69	0,02	Crouching/Kneeling/Sitting/Lying down	4	0	0	4
Etx.J.II.01	1057,08	223,92	28,07	-0,09	Crouching/Kneeling/Sitting/Lying down	0	0	0	0

**Table 9, S5 – Table of the spatial results for each GU.** \*Pointing out the GU with the highest access difficulty (in pale orange) and the GU furthest from the entrance (in pale blue). **9, S5 Taula – UG bakoitzaren emaitza espazialen taula.** \* iristeko zaitasunik handiena duen Uga seinalatua da (laranja zuriz), baita urrunen dagoena ere (urdin argiz).



**Figure S5-17.** Map of the accumulated access difficulty value of the Etxeberri cave, made with ArcMap®. *S5-17 Irudia. Etxeberriko haitzulora metatutako iristeko zaitasun balioen mapa, ArcMap®-en bidez egina.*



**Figure S5-18.** Map of the optimal access routes to the most difficult and remote figures of Etxeberriko Karbia, made with ArcMap®. *S5-18 Irudia. Etxeberriko Karbia-n urrunen dauden eta iristeko zailenak diren irudietara iristeko bide egokien mapa, ArcMap®-en bidez egina.*

## S6: Statistical analysis. Description of the results

In the next QR code we will add the code of the R studio program with the "Reprex selection" function, accessible in <https://github.com/inakiintxaурbe/spatial-organization-patterns-related-to-magdalenian-cave-art>.



We have included some comments with information that explains the analyses.

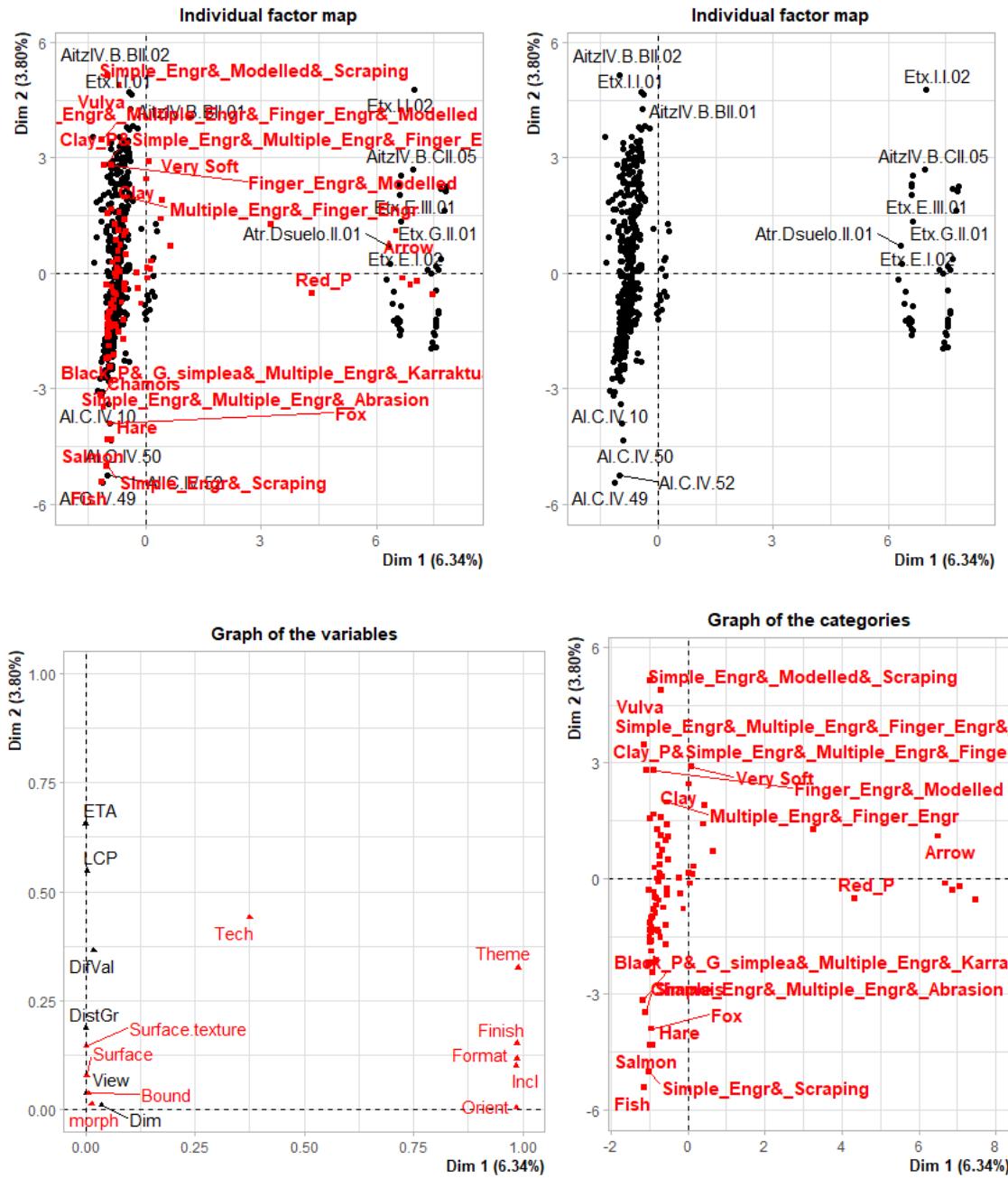
The next part makes a summary of all the individuals and variables, both categorical and quantitative.

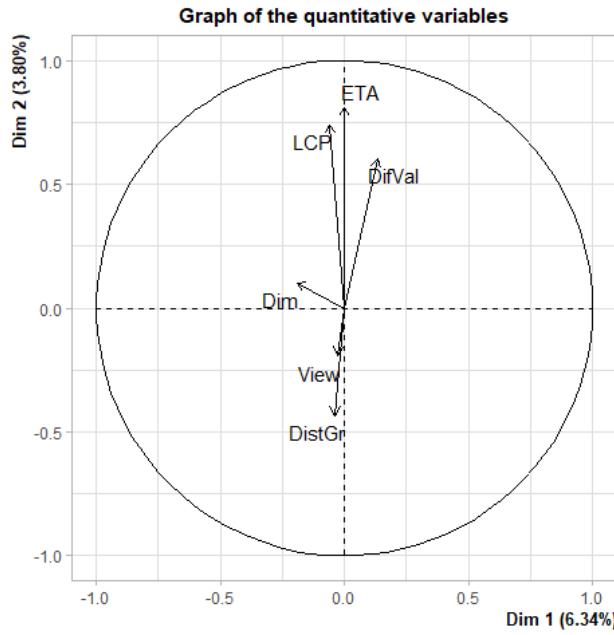
```
#Organize Data

a2<-a[, -1]
row.names(a2)<-a[,1]
summary(a)
#>      GU          Theme          Tech          Surface
#> Length:500    Length:500    Length:500    Length:500
#> Class :character  Class :character  Class :character  Class :character
#> Mode  :character  Mode  :character  Mode  :character  Mode  :character
#>
#>
#>
#> Surface.texture      Format          Finish          Orient
#> Length:500    Length:500    Length:500    Length:500
#> Class :character  Class :character  Class :character  Class :character
#> Mode  :character  Mode  :character  Mode  :character  Mode  :character
#>
#>
#>
#>      Incl          morph          Bound          Dim
#> Length:500    Length:500    Length:500    Min.   : 0.25
#> Class :character  Class :character  Class :character  1st Qu.: 270.50
#> Mode  :character  Mode  :character  Mode  :character  Median  : 742.00
#>                           Mean   : 1379.89
#>                           3rd Qu.: 1711.25
#>                           Max.   :14338.00
#>
#>
#>      DifVal         LCP          ETA          DistGr
#> Min.   : 0.74  Min.   :11.95  Min.   : 0.15  Min.   :0.020
#> 1st Qu.: 23.70 1st Qu.:68.77  1st Qu.: 2.22  1st Qu.:0.880
#> Median  :115.31 Median :125.22  Median : 6.18  Median :1.220
#> Mean    :209.84  Mean   :157.76  Mean   :11.61  Mean   :1.224
#> 3rd Qu.:274.39  3rd Qu.:238.59  3rd Qu.:12.95  3rd Qu.:1.520
#> Max.   :1319.53  Max.   :389.02  Max.   :45.96  Max.   :3.450
```

```
#>      View
#> Min.   : 0.00
#> 1st Qu.: 3.00
#> Median : 5.00
#> Mean   : 6.75
#> 3rd Qu.:10.00
#> Max.   :26.00
```

We performed a first FAMD analysis. We can observe several graphs of the analyzed individuals and their arrangement with respect to dimensions, categories, or a graph of variables (both categorical and numerical).



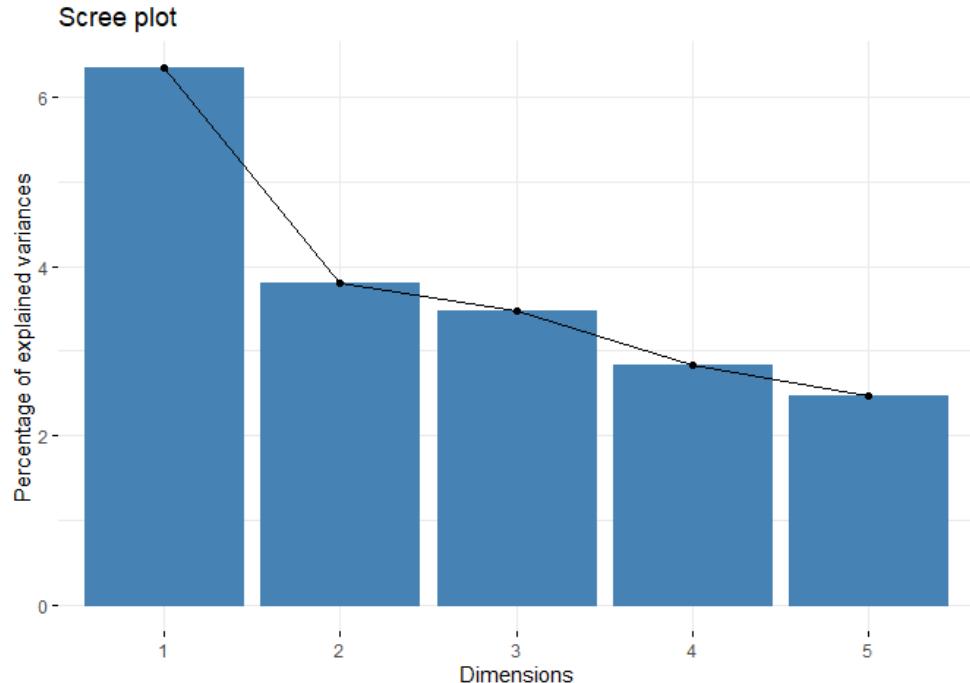


In the next section we compare the dimensions, and the contribution that the variables have on them. Additionally, we show a graph of the following dimensions.

```
#Compare Dimensions (FAMD I)
```

```
get_eigenvalue(res.famd)
#>      eigenvalue variance.percent cumulative.variance.percent
#> Dim.1    5.391183          6.342569                  6.342569
#> Dim.2    3.226669          3.796081                 10.138650
#> Dim.3    2.949101          3.469530                 13.608180
#> Dim.4    2.413583          2.839510                 16.447690
#> Dim.5    2.102230          2.473212                 18.920902
```

```
fviz_screenplot(res.famd)
```

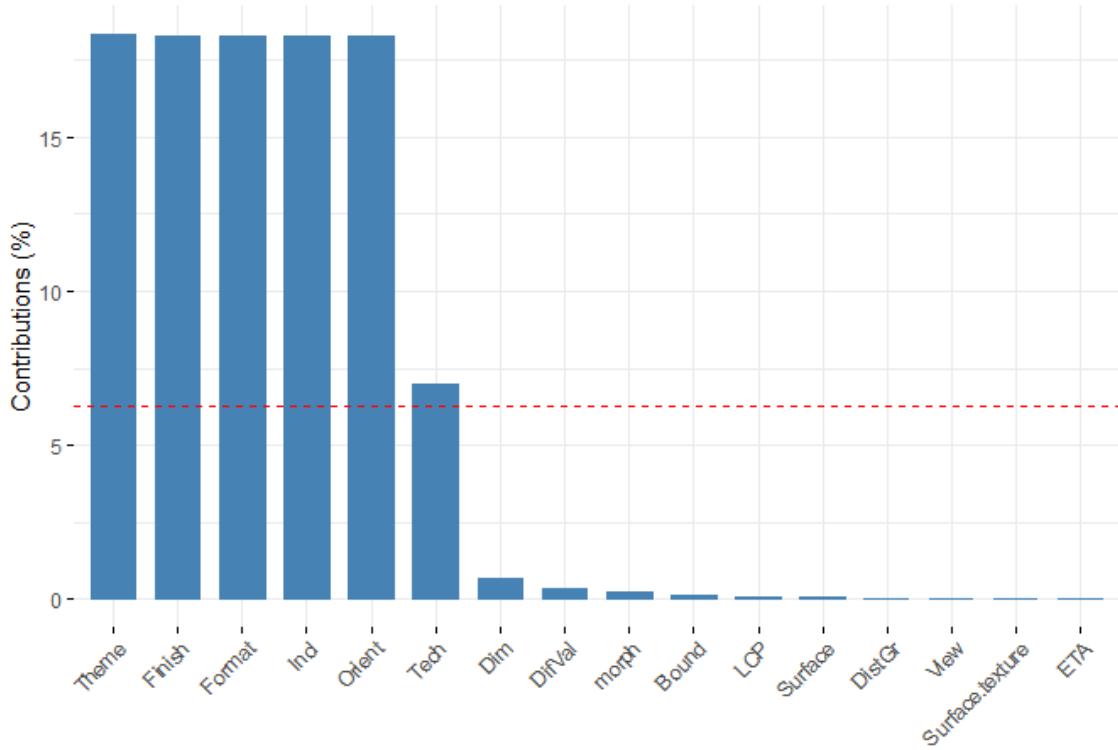


```

dimdesc(res.famd, axes=1, proba=0.001)$Dim.1$quanti
#>      correlation      p.value
#> Dim -0.1911683 1.679625e-05
dimdesc(res.famd, axes=1, proba=1e-5)$Dim.1$category
#>                                Estimate      p.value
#> Incl=NF_I                      6.306390 0.000000e+00
#> Orient=NF_O                     5.214376 0.000000e+00
#> Finish=NF_F                     6.290865 0.000000e+00
#> Format=NF_F                     6.439679 0.000000e+00
#> Theme=Points                    7.040552 4.953008e-77
#> Tech=Red_P                      4.860848 1.444552e-43
#> Theme=Sign                       6.242697 1.903691e-26
#> Theme=Paired_strokes           6.446744 3.789743e-16
#> Theme=Arrow                      6.068998 1.636506e-12
#> Finish=Simple                   -1.434207 3.220616e-07
#> Orient=Right                     -2.601649 1.451818e-09
#> Theme=Bison                      -1.244636 8.757385e-11
#> Orient=Left                      -2.612727 1.331125e-13
#> Format=Complete                  -1.473945 9.872201e-16
#> Incl=Horizontal                 -1.494631 4.455139e-25
dimdesc(res.famd, axes=2, proba=0.001)$Dim.2$quanti
#>      correlation      p.value
#> ETA      0.8097943 2.092297e-117
#> LCP      0.7401794 6.993334e-88
#> DifVal   0.6046972 3.535820e-51
#> View     -0.1936266 1.299938e-05
#> DistGr   -0.4332490 2.700596e-24
dimdesc(res.famd, axes=2, proba=1e-5)$Dim.2$category
#>                                Estimate      p.value
#> Tech=Simple_Engr                1.5949161 2.100539e-17
#> Finish=Simple                   0.9818100 7.873827e-14
#> Surface.texture=Very_Soft       2.1548641 8.807130e-13
#> Theme=Ibex                      2.5093658 1.298862e-11
#> Incl=Horizontal                 0.9381515 6.008388e-11
#> Surface=Clay                     1.6686342 2.490689e-10
#> Theme=Unknown                   2.3255752 5.042479e-10
#> Format=Headless                  0.6905646 3.948490e-08
#> Theme=Bison                      0.4022274 5.408480e-08
#> Tech=Simple_Engr&_Scraping    -4.8167779 1.032007e-06
#> Finish=Detailed                  -0.6339207 6.559992e-07
#> Finish=Very_Detailed            -0.7716899 1.959556e-07
#> Incl=Vertical                   -0.7664386 1.751417e-07
#> Tech=Black_P                     -0.5662021 1.479834e-08
#> Surface.texture=Soft             -1.5382013 7.338768e-09
#> Format=Complete                  -0.9116466 3.996927e-09
fviz_contrib(res.famd, choice = "var", axes = 1, top = 20, palette = "jco")

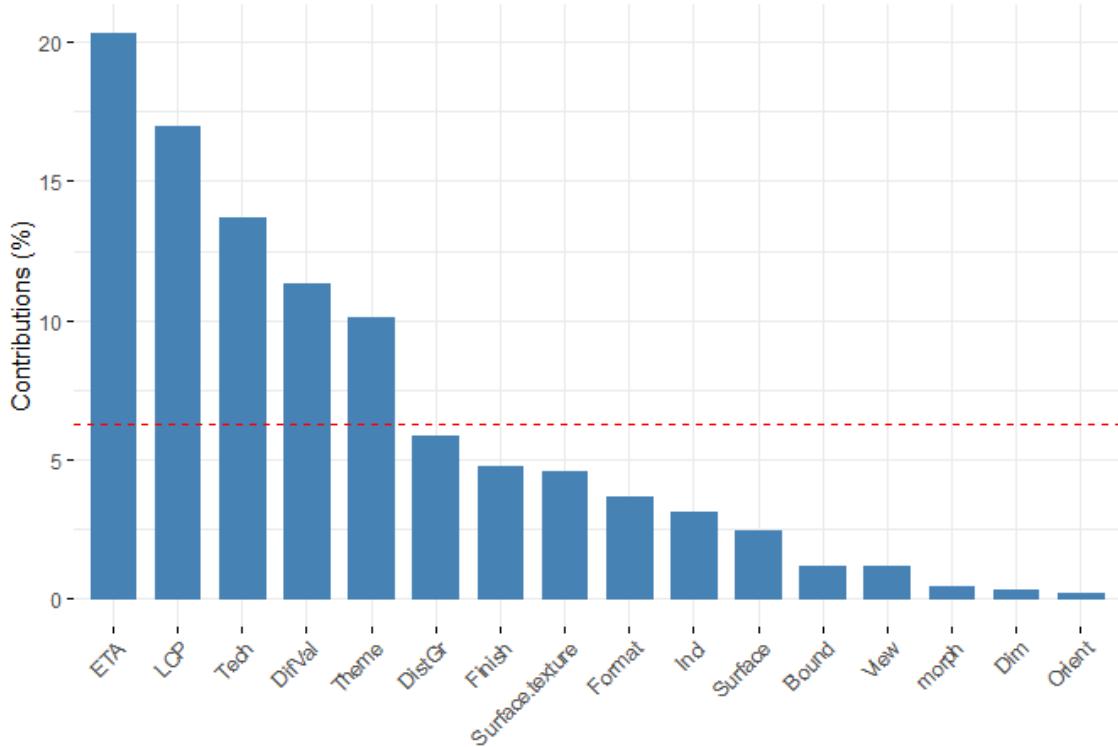
```

**Contribution of variables to Dim-1**



```
fviz_contrib(res.famd, choice = "var", axes = 2, top = 20, palette = "jco")
```

**Contribution of variables to Dim-2**



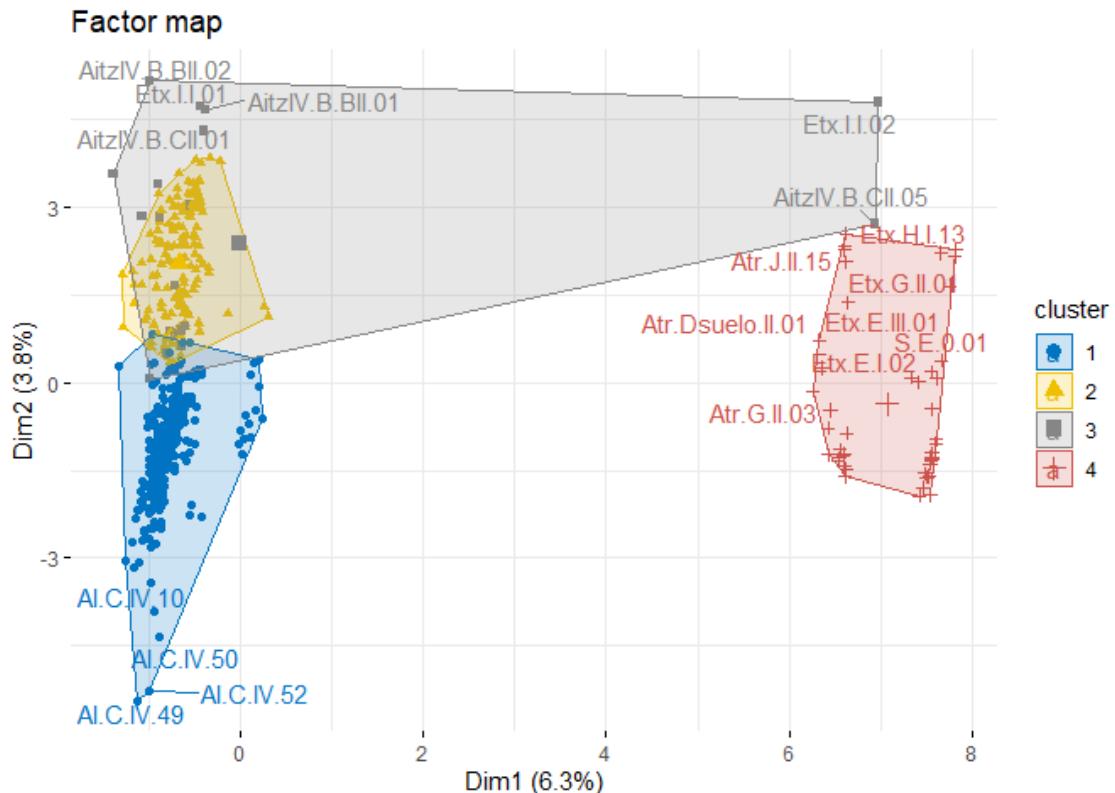
We then performed hierarchical clustering (HCPC).

```
#Execute Hierarchical Clustering (HCPC I)

c <- HCPC(res.famd, nb.clus=-1, graph=FALSE)

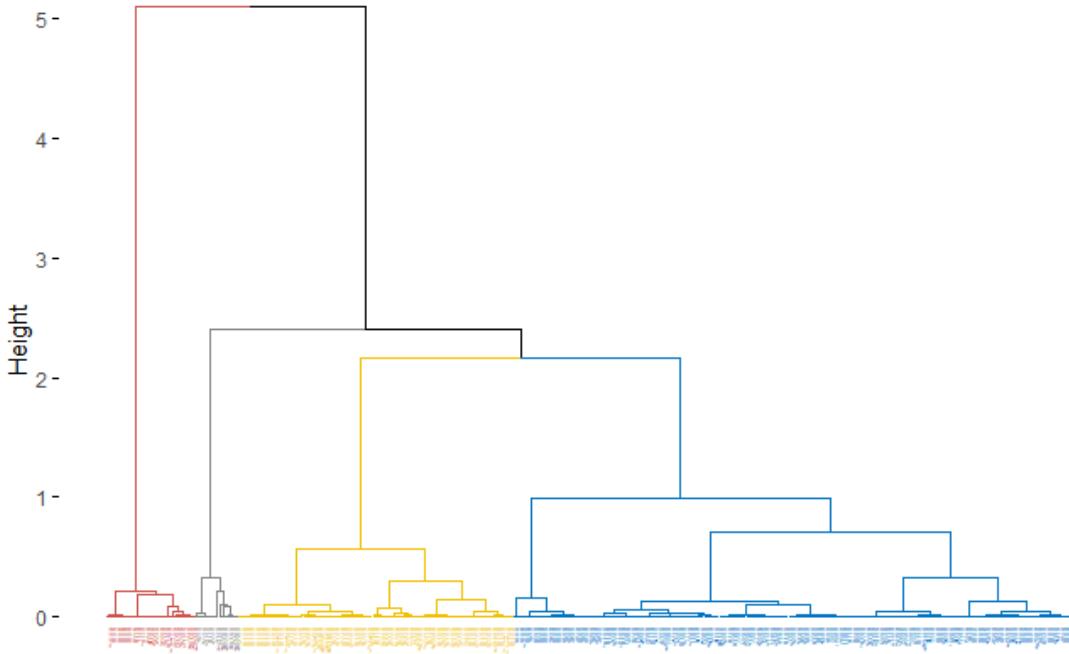
#Output Plot (FAMD HCPC I)

fviz_cluster(c,repel = TRUE,show.clust.cent = TRUE,palette = "jco",ggtheme =
  theme_minimal(),main = "Factor map")
#> Warning: ggrepel: 482 unlabeled data points (too many overlaps). Consider
#> increasing max.overlaps
```



```
fviz_dend(c,cex = 0.1, k_colors = c("#CD534CFF", "#868686FF", "#EFC000FF",
  "#0073C2FF"), labels_track_height = 0.5)
#> Warning: The `<scale>` argument of `guides()` cannot be `FALSE`. Use
"none" instead as
#> of ggplot2 3.3.4.
#> i The deprecated feature was likely used in the factoextra package.
#> Please report the issue at
<https://github.com/kassambara/factoextra/issues>.
#> This warning is displayed once every 8 hours.
#> Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
#> generated.
```

### Cluster Dendrogram



In the next section we describe the contribution of each variable to the definition of each cluster. Cla/Mod. Cla/Mod determines the percentage of individuals that meet this characteristic and that also belong to that cluster. Mod/Cla is the percentage of individuals in the cluster that meet the particular category. Global is the percentage of individuals who meet this category. The p-value is less than 5% when one category is significantly linked to another categories. If the v-test is positive, it means that the category is over-expressed for the category and if the v-test is negative it means that the category is under-expressed for the category.

In numerical variables, the v-test value indicates the same thing, that is, the effect of the variable being positive or negative on the definition of the cluster. As for Mean in category, it indicates the mean of the category, Overall mean is the overall mean, sd in category is the standard deviation in the category, and Overall sd is the overall standard deviation.

```
#Describe clusters (FAMD HCPC I)
```

```
c$desc.var$category
#> $`1`
```

	Cla/Mod	Mod/Cla	Global
#> Tech=Black_P	87.78626	40.0696864	26.2
#> Theme=Bison	76.11940	53.3101045	40.2
#> Format=Complete	70.00000	58.5365854	48.0
#> Incl=Vertical	90.90909	13.9372822	8.8
#> Finish=Very_Detailed	82.85714	20.2090592	14.0
#> Incl=Inclined	80.00000	20.9059233	15.0
#> Tech=Black_P&_Simple_Engr	100.00000	5.5749129	3.2
#> Finish=Detailed	75.90361	21.9512195	16.6
#> Orient=Left	64.51613	55.7491289	49.6

#> Tech=Black_P&_Simple_Engr&_Multiple_Engr	93.75000	5.2264808	3.2	
#> Tech=Black_P&_Scraping	100.00000	3.8327526	2.2	
#> Tech=Black_P&_Multiple_Engr	100.00000	2.7874564	1.6	
#> Format=Protome	68.00000	23.6933798	20.0	
#> Bound=Bounded	63.34842	48.7804878	44.2	
#> morph=Use	67.67677	23.3449477	19.8	
#> Tech=Clay_P	0.00000	0.0000000	0.8	
#> morph=No_use	54.86284	76.6550523	80.2	
#> Format=Headless	43.93939	10.1045296	13.2	
#> Bound=No_bounded	52.68817	51.2195122	55.8	
#> Tech=Black_P&_Clay_P	0.00000	0.0000000	1.0	
#> Tech=Red_P	38.09524	5.5749129	8.4	
#> Theme=Unknown	40.00000	7.6655052	11.0	
#> Theme=Arrow	0.00000	0.0000000	1.2	
#> Theme=Paired_strokes	0.00000	0.0000000	1.4	
#> Surface.texture=Very_Soft	11.11111	0.6968641	3.6	
#> Theme=Sign	0.00000	0.0000000	2.4	
#> Theme=Ibex	27.45098	4.8780488	10.2	
#> Tech=Finger_Engr	0.00000	0.0000000	2.8	
#> Surface=Clay	0.00000	0.0000000	4.0	
#> Theme=Points	0.00000	0.0000000	4.6	
#> Tech=Simple_Engr	21.11111	6.6202091	18.0	
#> Incl=NF_I	0.00000	0.0000000	9.6	
#> Orient=NF_O	0.00000	0.0000000	9.6	
#> Finish=NF_Fi	0.00000	0.0000000	9.6	
#> Format=NF_F	0.00000	0.0000000	9.6	
#>		p.value	v.test	
#> Tech=Black_P	7.774847e-18	8.602868		
#> Theme=Bison	2.060066e-12	7.030356		
#> Format=Complete	4.088293e-08	5.486995		
#> Incl=Vertical	5.005320e-07	5.026109		
#> Finish=Very_Detailed	1.486355e-06	4.813062		
#> Incl=Inclined	1.025703e-05	4.411683		
#> Tech=Black_P&_Simple_Engr	1.156028e-04	3.855268		
#> Finish=Detailed	1.459448e-04	3.797870		
#> Orient=Left	1.447912e-03	3.184926		
#> Tech=Black_P&_Simple_Engr&_Multiple_Engr	1.679641e-03	3.141710		
#> Tech=Black_P&_Scraping	2.050596e-03	3.082805		
#> Tech=Black_P&_Multiple_Engr	1.129780e-02	2.533350		
#> Format=Protome	1.622443e-02	2.403827		
#> Bound=Bounded	1.690772e-02	2.388708		
#> morph=Use	2.063020e-02	2.314685		
#> Tech=Clay_P	3.240119e-02	-2.139426		
#> morph=No_use	2.063020e-02	-2.314685		
#> Format=Headless	1.920352e-02	-2.341557		
#> Bound=No_bounded	1.690772e-02	-2.388708		
#> Tech=Black_P&_Clay_P	1.365292e-02	-2.466268		
#> Tech=Red_P	9.416311e-03	-2.596558		
#> Theme=Unknown	6.450958e-03	-2.723933		
#> Theme=Arrow	5.736985e-03	-2.762447		
#> Theme=Paired_strokes	2.403959e-03	-3.035175		
#> Surface.texture=Very_Soft	5.281012e-05	-4.042829		
#> Theme=Sign	2.975961e-05	-4.175298		
#> Theme=Ibex	6.186889e-06	-4.519900		
#> Tech=Finger_Engr	5.033900e-06	-4.563370		
#> Surface=Clay	2.267874e-08	-5.590216		
#> Theme=Points	1.460515e-09	-6.048664		
#> Tech=Simple_Engr	1.217651e-14	-7.714177		
#> Incl=NF_I	5.383509e-20	-9.156043		

```

#> Orient=NF_O          5.383509e-20 -9.156043
#> Finish=NF_Fi        5.383509e-20 -9.156043
#> Format=NF_F          5.383509e-20 -9.156043
#>
#> $`2`                  Cla/Mod   Mod/Cla Global
#> Tech=Simple_Engr    64.444444 39.7260274 18.0
#> Incl=Horizontal      38.368580 86.9863014 66.2
#> Theme=Ibex           70.588235 24.6575342 10.2
#> Finish=Simple         43.877551 58.9041096 39.2
#> Theme=Unknown         60.000000 22.6027397 11.0
#> Format=Headless       56.060606 25.3424658 13.2
#> Tech=Simple_Engr&_Multiple_Engr 45.918367 30.8219178 19.6
#> Tech=Black_P&_Clay_P 100.000000 3.4246575 1.0
#> Surface.texture=Hard 32.865169 80.1369863 71.2
#> Format=Isolated_Part 56.521739 8.9041096 4.6
#> Tech=Clay_P          100.000000 2.7397260 0.8
#> Bound=No_bounded      33.333333 63.6986301 55.8
#> Tech=Black_P&_Simple_Engr&_Multiple_Engr 6.250000 0.6849315 3.2
#> Theme=Reindeer        0.000000 0.0000000 2.0
#> Bound=Bounded         23.981900 36.3013699 44.2
#> Tech=Black_P&_Scraping 0.000000 0.0000000 2.2
#> Theme=Sign             0.000000 0.0000000 2.4
#> Surface.texture=Soft 20.634921 17.8082192 25.2
#> Tech=Finger_Engr     0.000000 0.0000000 2.8
#> Tech=Black_P&_Simple_Engr 0.000000 0.0000000 3.2
#> Theme=Bison            21.393035 29.4520548 40.2
#> Incl=Vertical          9.090909 2.7397260 8.8
#> Surface=Clay           0.000000 0.0000000 4.0
#> Theme=Points            0.000000 0.0000000 4.6
#> Finish=Very_Detailed   11.428571 5.4794521 14.0
#> Tech=Red_P              4.761905 1.3698630 8.4
#> Incl=NF_I                0.000000 0.0000000 9.6
#> Orient=NF_O              0.000000 0.0000000 9.6
#> Finish=NF_Fi              0.000000 0.0000000 9.6
#> Format=NF_F              0.000000 0.0000000 9.6
#> Tech=Black_P              9.923664 8.9041096 26.2
#>                         p.value   v.test
#> Tech=Simple_Engr        1.124045e-14 7.724374
#> Incl=Horizontal          3.938067e-11 6.606389
#> Theme=Ibex                1.228311e-10 6.435792
#> Finish=Simple             9.958744e-09 5.731430
#> Theme=Unknown              5.129504e-07 5.021404
#> Format=Headless            1.022731e-06 4.887214
#> Tech=Simple_Engr&_Multiple_Engr 8.839829e-05 3.920410
#> Tech=Black_P&_Clay_P      2.021016e-03 3.087126
#> Surface.texture=Hard       4.054222e-03 2.873912
#> Format=Isolated_Part       5.873494e-03 2.754761
#> Tech=Clay_P                7.059324e-03 2.694033
#> Bound=No_bounded            2.245798e-02 2.282531
#> Tech=Black_P&_Simple_Engr&_Multiple_Engr 3.201732e-02 -2.144194
#> Theme=Reindeer               3.047625e-02 -2.163845
#> Bound=Bounded                 2.245798e-02 -2.282531
#> Tech=Black_P&_Scraping       2.139557e-02 -2.300930
#> Theme=Sign                     1.500753e-02 -2.432197
#> Surface.texture=Soft          1.327328e-02 -2.476351
#> Tech=Finger_Engr                7.364459e-03 -2.679898
#> Tech=Black_P&_Simple_Engr      3.601152e-03 -2.911138
#> Theme=Bison                     1.542338e-03 -3.166597

```

#> Incl=Vertical	1.014461e-03	-3.286485
#> Surface=Clay	8.518979e-04	-3.335358
#> Theme=Points	2.862277e-04	-3.627456
#> Finish=Very_Detailed	1.888195e-04	-3.733524
#> Tech=Red_P	5.321248e-05	-4.041050
#> Incl=NF_I	2.310391e-08	-5.586990
#> Orient=NF_O	2.310391e-08	-5.586990
#> Finish=NF_Fi	2.310391e-08	-5.586990
#> Format=NF_F	2.310391e-08	-5.586990
#> Tech=Black_P	1.912972e-09	-6.005029
#>		
#> \$`3`		Cla/Mod
#>		100.000000
#> Surface=Clay		100.000000
#> Tech=Finger_Engr		72.222222
#> Surface.texture=Very_Soft		100.000000
#> Tech=Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled		100.000000
#> Theme=Vulva		100.000000
#> Theme=Horse		10.000000
#> Incl=Horizontal		5.740181
#> Tech=Simple_Engr&_Modelled&_Scraping		100.000000
#> Tech=Finger_Engr&_Simple_Engr		100.000000
#> Tech=Finger_Engr&_Modelled		100.000000
#> Tech=Clay_P&Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled		100.000000
#> Format=Headless		0.000000
#> Incl=Inclined		0.000000
#> Surface=Speleothem		0.000000
#> Tech=Simple_Engr&_Multiple_Engr		0.000000
#> Tech=Black_P		0.000000
#> Surface.texture=Hard		0.000000
#> Surface=Limestone		0.255102
#>		Mod/Cla
Global		
#> Surface=Clay		95.238095
4.0		
#> Tech=Finger_Engr		66.666667
2.8		
#> Surface.texture=Very_Soft		61.904762
3.6		
#> Tech=Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled		9.523810
0.4		
#> Theme=Vulva		9.523810
0.4		
#> Theme=Horse		42.857143
18.0		
#> Incl=Horizontal		90.476190
66.2		
#> Tech=Simple_Engr&_Modelled&_Scraping		4.761905
0.2		
#> Tech=Finger_Engr&_Simple_Engr		4.761905
0.2		
#> Tech=Finger_Engr&_Modelled		4.761905
0.2		
#> Tech=Clay_P&Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled		4.761905
0.2		
#> Format=Headless		0.000000
13.2		
#> Incl=Inclined		0.000000
15.0		

#> Surface=Speleothem	0.000000
17.6	
#> Tech=Simple_Engr&_Multiple_Engr	0.000000
19.6	
#> Tech=Black_P	0.000000
26.2	
#> Surface.texture=Hard	0.000000
71.2	
#> Surface=Limestone	4.761905
78.4	
#>	p.value
#> Surface=Clay	7.873430e-35
#> Tech=Finger_Engr	1.995704e-22
#> Surface.texture=Very_Soft	9.694180e-17
#> Tech=Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled	1.683367e-03
#> Theme=Vulva	1.683367e-03
#> Theme=Horse	7.435829e-03
#> Incl=Horizontal	1.195148e-02
#> Tech=Simple_Engr&_Modelled&_Scraping	4.200000e-02
#> Tech=Finger_Engr&_Simple_Engr	4.200000e-02
#> Tech=Finger_Engr&_Modelled	4.200000e-02
#> Tech=Clay_P&Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled	4.200000e-02
#> Format=Headless	4.789956e-02
#> Incl=Inclined	3.052234e-02
#> Surface=Speleothem	1.564196e-02
#> Tech=Simple_Engr&_Multiple_Engr	9.215054e-03
#> Tech=Black_P	1.452996e-03
#> Surface.texture=Hard	1.467069e-12
#> Surface=Limestone	1.927821e-13
#>	v.test
#> Surface=Clay	12.311310
#> Tech=Finger_Engr	9.742008
#> Surface.texture=Very_Soft	8.308473
#> Tech=Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled	3.141062
#> Theme=Vulva	3.141062
#> Theme=Horse	2.676668
#> Incl=Horizontal	2.513574
#> Tech=Simple_Engr&_Modelled&_Scraping	2.033520
#> Tech=Finger_Engr&_Simple_Engr	2.033520
#> Tech=Finger_Engr&_Modelled	2.033520
#> Tech=Clay_P&Simple_Engr&_Multiple_Engr&_Finger_Engr&_Modelled	2.033520
#> Format=Headless	-1.978258
#> Incl=Inclined	-2.163245
#> Surface=Speleothem	-2.417164
#> Tech=Simple_Engr&_Multiple_Engr	-2.603971
#> Tech=Black_P	-3.183911
#> Surface.texture=Hard	-7.077567
#> Surface=Limestone	-7.353708
#>	
#> \$`4`	
#>	Cla/Mod Mod/Cla Global p.value
#> Incl=NF_I	95.833333 100.000000 9.6 3.696837e-63
#> Orient=NF_O	95.833333 100.000000 9.6 3.696837e-63
#> Finish=NF_Fi	95.833333 100.000000 9.6 3.696837e-63
#> Format=NF_F	95.833333 100.000000 9.6 3.696837e-63
#> Theme=Points	95.652174 47.826087 4.6 1.304533e-24
#> Tech=Red_P	57.142857 52.173913 8.4 2.297271e-17
#> Theme=Sign	100.000000 26.086957 2.4 8.720402e-14
#> Theme=Arrow	100.000000 13.043478 1.2 4.448171e-07

```

#> Theme=Paired_strokes          85.714286 13.043478 1.4 2.933632e-06
#> morph=No_use                 10.473815 91.304348 80.2 3.874680e-02
#> Tech=Simple_Engr&_Multiple_Engr 4.081633 8.695652 19.6 4.185157e-02
#> morph=Use                     4.040404 8.695652 19.8 3.874680e-02
#> Incl=Vertical                0.000000 0.000000 8.8 1.167008e-02
#> Theme=Ibex                   0.000000 0.000000 10.2 5.514933e-03
#> Theme=Unknown                 0.000000 0.000000 11.0 3.573625e-03
#> Format=Headless              0.000000 0.000000 13.2 1.060614e-03
#> Finish=Very_Detailed         0.000000 0.000000 14.0 6.764093e-04
#> Tech=Black_P                 2.290076 6.521739 26.2 5.193788e-04
#> Incl=Inclined                0.000000 0.000000 15.0 3.830933e-04
#> Finish=Detailed              0.000000 0.000000 16.6 1.519813e-04
#> Theme=Horse                  0.000000 0.000000 18.0 6.663662e-05
#> Format=Protome               0.000000 0.000000 20.0 1.998774e-05
#> Finish=Finished              0.000000 0.000000 20.6 1.384103e-05
#> Finish=Simple                0.000000 0.000000 39.2 2.683467e-11
#> Theme=Bison                  0.000000 0.000000 40.2 1.174497e-11
#> Orient=Right                 0.000000 0.000000 40.8 7.102364e-12
#> Format=Complete              0.000000 0.000000 48.0 1.057251e-14
#> Orient=Left                  0.000000 0.000000 49.6 2.174847e-15
#> Incl=Horizontal              0.000000 0.000000 66.2 2.093343e-24
#> v.test
#> Incl=NF_I                    16.775349
#> Orient=NF_O                  16.775349
#> Finish=NF_Fi                 16.775349
#> Format=NF_F                  16.775349
#> Theme=Points                 10.240579
#> Tech=Red_P                   8.477681
#> Theme=Sign                   7.458966
#> Theme=Arrow                  5.048704
#> Theme=Paired_strokes        4.675413
#> morph=No_use                 2.066866
#> Tech=Simple_Engr&_Multiple_Engr -2.034993
#> morph=Use                     -2.066866
#> Incl=Vertical                -2.521967
#> Theme=Ibex                   -2.775309
#> Theme=Unknown                 -2.913534
#> Format=Headless              -3.273934
#> Finish=Very_Detailed         -3.398967
#> Tech=Black_P                 -3.470558
#> Incl=Inclined                -3.551465
#> Finish=Detailed              -3.787810
#> Theme=Horse                  -3.987986
#> Format=Protome               -4.265028
#> Finish=Finished              -4.346368
#> Finish=Simple                -6.662971
#> Theme=Bison                  -6.783314
#> Orient=Right                 -6.855580
#> Format=Complete              -7.732174
#> Orient=Left                  -7.930945
#> Incl=Horizontal              -10.194726
c$desc.var$quanti
#> $`1`                         v.test Mean in category Overall mean sd in category Overall sd
#> DistGr   6.293442           1.347108      1.22448      0.5069857  0.505246
#> View     3.337367           7.400697      6.75000      5.4006452  5.055640
#> DifVal   -11.050138          96.567317     209.84110     117.6178975 265.804999
#> ETA      -15.059691          4.509094      11.61076      3.1049019  12.227723
#> LCP      -15.084539          98.864042     157.76004     49.7930861 101.240703

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#>           p.value
#> DistGr 3.105029e-10
#> View   8.457622e-04
#> DifVal 2.188791e-28
#> ETA    2.981765e-51
#> LCP    2.046979e-51
#>
#> $`2`
#>           v.test Mean in category Overall mean sd in category Overall sd
#> LCP    17.390489    280.4875342   157.76004    75.8026183 101.240703
#> ETA    16.801709    25.9317808   11.61076    11.8712820 12.227723
#> DifVal 9.321880    382.5606918   209.84110   299.3239338 265.804999
#> View   -2.711254    5.7945205    6.75000    3.7249948  5.055640
#> DistGr -6.694708    0.9886986    1.22448    0.4130131  0.505246
#>           p.value
#> LCP    9.740024e-68
#> ETA    2.371131e-63
#> DifVal 1.142965e-20
#> View   6.702921e-03
#> DistGr 2.161021e-11
#>
#> $`3`
#>           v.test Mean in category Overall mean sd in category Overall sd
#> Dim    3.837534    2946.9524    1379.8931   2708.7490  1909.965
#> DifVal 3.786562    425.0281    209.8411    347.0999  265.805
#>           p.value
#> Dim    0.0001242761
#> DifVal 0.0001527462
#>
#> $`4`
#>           v.test Mean in category Overall mean sd in category Overall sd
#> Dim   -3.421047    460.9615    1379.893    2133.225  1909.965
#>           p.value
#> Dim  0.000623805

```

***S1: Aukeratutako lekuaren deskribapena*****10. SANTIMAMIÑE****Kokapena**

**ETRS89 / UTM ZONE 30N      X: 529452      Y: 4799371      Z: 160**

Santimamiñeko haitzuloa Kortezubiko (Bizkaia) udalerrian dago, Ereñozar mendiko arrezipa-limoa masiboen Aptiar-Albiar garaiko arrezipa-kareharri masiboen eremuan, hegoaldeko isurialdean, egungo itsas mailatik 160 metrora. Oka ibaiaren ibarrean dago, Urdaibaioko estuarioan, egungo kostaldetik 6 km-ra.

**Deskribapen topografiko laburra**

365 m luze den galeria nagusi bat duen diaklaza batean zehar eratzen da, 45° buzamenduarekin (sarreran duen itxuraren antzekoa), batez beste 3,5 eta 4 metro arteko zabalera duena (nahiz eta puntu batzuetan 10 metro arteko neurriak ere hartzen dituen) eta 6-7 metroko batez besteko altuera duena (nahiz eta uneren batean 40 metro inguruko altuera lortu) (Maeztu eta Aranzabal, 2011).

Antzinako gizakiek erabili zuten kobazuloaren eremuak (gune arkeologikoa) kobazuloaren lehen 120 metroak hartzen ditu. Eremu honetan, lehenik, haitzuloaren sarrera aurkituko dugu, Behe Madeleine alditimotaren garairako habitataren kokalekuarekin (Aranzadi et al., 1931; López-Quintana, 2011), nahiz eta okupazio zaharragoen ebidentziak dauden (Aranzadi eta Barandiaran, 1935; Ruiz Idarraga, 1987). Atariaren ondoren, eremu apaindua dago (Madeleine garaiko pintura eta grabatuekin, ikus beherago).

Apaindutako eremua hainbat sektoretan banatuta dago: ataria bera, “Aretoa” izenekoa (galeria nagusiaren barruko lehen aretoa), “Pinturen Areto Zaharraren” multzoa (“Ganberaurre” batekin eta “Ganbera” nagusiarekin) eta “Pinturen Areto Berria” (galeria nagusiaren azken atal apaindua). Metro gutxiko luzera duen arren, topografia oso malkartsua du, eta horrek asko areagotzen du bertatik ibiltzeko zailtasuna. Nahiz eta lehen pinturak sarrerako gelan bertan aurkitu (puntu gorriak eta orbanak), gune garrantzitsuenak haitzuloaren alde sakonetan daude (gela ilunetan). Batez ere, sarreratik hirurogei bat metrotara dagoen alboko galeria batean (geologikoki Galeria Nagusiaren zati bat izan arren, formazioek bereizten zutena, ikus daitekeenez), leize-irudi multzo nagusia aurkituko dugu (“Pinturen Areto Zaharra”). Galeria Nagusian zehar ere badira bakanago diren arte ebidentzia batzuk (“Aretoa” izeneko “Pinturen Areto Zaharra”-ren aurreko gelan). Azken irudiak “Pinturen Areto Berrian” daude, gaur egun eskailera eta pasabideei esker lor daitekeen bide malkartsu eta arriskutsu baten ondoren.

“Pinturen Areto Berritik”, 6,5 metroko igoera bertikal baten ondoren, galeria 240 metro barrurago dago. Inguru hauetan ez da aztarna arkeologikorik aurkitu. Hala ere, haitzuloaren eremu sakon hauetan zehar, Santimamiñeko liburukirik handienak (“Gela Handia” eta “Gela Zuria”) eta formazio geologiko ikusgarriak aurkituko ditugu, “Arraultza Frijitua” bezalakoak.

## **Labar artea**

Santimamiñen egindako labar-arte paleolitikoaren azken inventarioetan oinarrituta (Aranzadi et al., 1925; González Sainz & Ruiz Idarraga, 2010; González Sainz, 2016/17; Garate, 2017b; Intxauburbe & Garate, 2022), elementu grafikoen datu-base bat garatu dugu (gure proiektuan identifikatutako irudi berri batzuk gehitu ditugu, berrinterpretazio batzuez gain).

Haitzuloko labar-arteak 75 unitate grafiko individualizatuk (UG-k) osatzen dute, horietatik 30ek bisontea irudikatzen dute, identifikatzen zailak diren 8 animaliekin batera, 8 zaldi, 4 ahuntz, hartz 1, orein 1, zenbait zeinu simple (puntuak, marka parekatuak, etab.) eta nahi gabeko aztarnak (orbanak, markak, etab.). Bost sektoretan kokatzen dira: A edo “Ataria”, B edo “Aretoa”, C edo “Aurreganbera”, D edo “Ganbera” eta E edo “Pinturen Areto Berria”. Pinturak, batez ere, egur-ikatzarekin egindako pigmentu beltzarekin sortu ziren, nahiz eta azaleko grabatuak ere erabili ziren (batzuetan margoekin konbinatuta), baita burdin oxidoan oinarritutako pigmentu gorria ere (González Sainz eta Ruiz Idarraga, 2010). Grabatuak, gehienetan, finak eta azalekoak dira, nahiz eta kasu batzuk sakonagoak izan. Ildoa bakarra edo errepikatua da.

Margolanak datatzen saiatu ziren, data modernoegia lortuz (907-671 cal. BP) (Moure & González, 2000), ziur aski karbonoaren kutsadura modernoa ezabatzen dela bermatzeko aurretiazko tratamendu eskasak sortua. Izan ere, lagina txikiengiaren datazioa lehenetsi zen, bermeen gainetik (H. Valladas, Komunikazio Pertsonala). Hala ere, beste arte higigarri eta labar-arte batzuekiko antzekotasuna dela eta, Erdi Madeleine eta Goi Madeleine aldiaren tartean koka ditzakegu ebidentzia grafiko hauek (duela 17, 5, 14,5 ka). Bestalde, 2022an, M. Medina-Alcaidek eta I. Intxaurbek ikatz-zati batzuk aurkitu zituzten panel nagusiaren inguruan, ziur aski aretoan izandako antzinako giza presentziak eragingo zituenak, agian labar-artearen ekoizpenari lotuta.

### **1. LUMENTXA**

#### **Kokapena**

**ETRS89 / UTM ZONE 30N      X: 540408      Y: 4800919      Z: 88**

Lumentxa haitzuloa Ispasterren dago (Bizkaia), Lekeitiotik gertu, izen bereko muinoaren hegoaldean, Lea haranaren mendebaldeko ertzean, egungo kostaldetik oso hurbil (kilometro bat baino gutxiago). Kareharri mikritiko Aptiar-Albiar organogenikoetan irekitzen da, itsas mailatik 88 metrora.

#### **Deskribapen topografiko laburra**

Kobazuloak bi sarrera ditu, bata hegoaldera eta bestea ipar-ekialdera begira. Sarrerako areto nagusiko habitatak okupazio-geruzak ditu, Behe Madeleine garaitik erromatarren garaira bitarteko materialekin (Aranzadi eta Barandiaran, 1935; Arribas Pastor eta Berganza Gochi, 2018). 50 m inguruko garapena du eta galeria nagusi batek osatzen du. Galeria honen amaieran, sabai-erorketa zahar batzuk daude, alboko pasabide batzuk eta sasi-leize-maila sortuz. Haitzuloko labar-artearen zati nagusia haitzuloaren azken sektore

horietan dago. Zoritzarrez, haitzuloa oso erabilia izan da garai historikoetatik (XVIII. mendetik gutxienez), eta graffitiz, kedar markaz eta espeleotema hautsiez beteta dago.

### **Labar artea**

Lumentxan egindako labar-arte paleolitikoaren azken inventarioetan oinarrituta (Garate et al., 2013b), elementu grafikoen datu-base bat garatu dugu (gure proiektuan identifikatutako irudi berri batzuk gehitu ditugu). Haitzuloko harkaitz-arteak 31 unitate grafiko individualizatuk (UG'k) osatzen dute, eta horietatik bi bisonteak dira, zaldi bat, 3 zeinu simple (puntuak) eta borondatzkoak ez diruditen edo oso simpleak diren aztarnak (orbanak, hatz-hegalak, eta abar) (S1-1 irudia). Hiru sektoretan kokatzen dira: B, C eta D. Batez ere, burdina oxidoz (hematitez) egindako pigmentu gorriarekin sortu ziren pinturak (C. Chanteraud, Komunikazio Pertsonala), nahiz eta kobazuloaren zatirik sakonenean grabatu anizkoitzaren teknika ere erabili zen, gainazal bigunetako hatz-grabatu batzuekin batera (kareharrizko gainazal higatu batean). Zentzu honetan, okre orban handi bat dago harkaitz handi bat estaltzen duen luraren gainean, panel nagusitik eta beste UG soil batzuetatik gertu (orbanak, puntuak, eta abar). Sarrerako pitxadura batean sukarrizko xafla bat ere aurkitu zuten. Aztarna horiek (eta batez ere okre orbana) haitzuloaren jarduera grafikoarekin lotuta daudela dirudi. Badira egur ikatz batzuk ere, sarbide zaila duten lekuetan luraren gainean, baita estalagmita batez estalitako harkaitzez egindako horma bat ere. Nolanahi ere, zaila da beste aztarna horiek jarduera grafikoarekin lotzea, haitzuloa historian zehar asko erabili delako (Libano & Vega, 2019/20).

Multzoak beste arte higigarri eta labar adibide batzuekin duen antzekotasunagatik, zuzenean eta testuinguru bidez datatua, Erdi Madeleine eta Goi Madeleine aldiaren koka daitezke (duela 17,5 eta 14,5 mila urte). Bizitokiaren kokalekuan, okre gorrizko piezak aurkitu ziren Goi Madeleine aldko mailetan, horietako bat hiru zaldi grabaturekin (Aranzadi eta Barandiaran, 1934), horietako bat piezaren muga erabiliz animalien atzealdea irudikatzeko, bi bisonteak haitzuloko panel nagusian egiten duten bezala.

## **2. ATXURRA**

### **Kokapena**

**ETRS89 / UTM ZONE 30N      X: 541048      Y: 4797129      Z: 55**

“Gazteluko Atxa” edo “Gerika” mendiaren hegoaldeko maldan, Berriatuan (Bizkaia), Aptiar-Albiar arrezife-kareharrian (Behe Kretazeoa) eratutako haitzulo-sistema da, gaur egungo itsas mailatik 55 metrora, Zulueta errekkak osatzen duen haranean, Lea ibaiaren ibaiadarrean, egungo kostaldetik 3 kilometrora.

### **Deskribapen topografiko laburra**

Bi pasabide sub-horizontal ditu altuera ezberdinatan (koba-mailak), behekoa Armiña izenekoa eta goikoa Atxurra izenekoa. Haitzuloak bi sarrera ditu, bi maila horizontaletara sarbide egiten dutenak; behekoak Armiña izena du (1882an ireki zuten artifizialki errepidearen egileek), eta goikoak Atxurra du izena. Biak sistema endokarstiko beraren parte dira; haitzulo-sistemaren garapen topografiko osoa 1085 metrokoa da (A.D.E.S.,

Komunikazio Pertsonala). Goi mailako sarreraren ondoren, garai bateko haitzulora sartzeko gune bakarra, atal txiki bat dago, gutxienez 2 metroko metaketa sedimentarioa duena, gutxienez azken Pleistozenotik (Gravette aldia, Behe eta Goi Madeleine aldia) Holozenoraino (Neolito/Kalkolitikoa) garatua (Barandiaran Ayerbe, 1961a; Rios-Garaizar et al, 2019; Aranbarri et al, 2024). Espazio hori zeharkatu eta leihox txiki batetik igaro ondoren, haitzuloaren barnealdeko sektoreetara iritsiko gara. Puntu honetan, sarreratik 17 metroko sakoneran, arrapala handi bat dago, 15,03 metroko luzera duena eta batez beste metro bateko zabalera duena, eta bertikalki jaisten dena 10 metro, kobazuloaren beheko mailarekin bat egin arte. Bidea gurutzatzen badugu, sabai baxuko eremu batean sartuko gara, eta berau hainbat katazulotan amaituko da. Puntu honen ondoren, galeriaren tamainak handitu egiten dira, leizeetako hartzaren zuloez betetako zoruak dituzten hainbat espazio handi zeharkatuz. Kareharri estratifikatuetan irekitako pasabide batzuk igaro ondoren, maila hori beheko mailarekin lotzen den puntura iritsiko gara. Barrurantz jarraituz gero, gune apainduak hasten diren puntua litzateke.

Gaur egun, sistemara sartzeko, beheko mailako sarrera artifiziala (Armiña) erabiltzen da. Bertan, gutxienez, matrizean oinarritutako bi kono kolubial daude, pasabidea kanpotik betetzen dutenak. Puntu honetatik gertu, Goi Madeleine aldiko giza okupazio labur baten testigantzak daude, sarrera hau kanpoaldetik isolatuta zegoela iradokitzen dutenak, eta gizakiak goiko mailako sarreratik heldu zirela hona iradokitzen dutenak (Rios-Garaizar et al., 2020). Leize-maila hau 4 bider 4 metroko neurri erregularreko pasabide handi batek eta zoru horizontal samar batek osatzen dute (azken zatia izan ezik, non leizeetako hartzaren hobiekin estalitako zoruak aurki ditzakegun), 200 metro inguruko hedadura egonkorraekin. Azken zatian, goiko mailarekin (Atxurra) lotzen da, sabaiaren erorketek eragindako arrapala malkartsu baten bidez (sarreretatik 203 metrora).

Labar-arterea eta aztarna arkeologikoak dituzten eremuak ere hemen hasten dira (goiko mailan), Armiña eta Atxurra lotu baino 10 metro lehenago, lehen irudikapen batekin, eskuineko hormaren behealdean dagoen tunel freatiko batean (A sektorea). Puntu honen eta sarreratik 365 metrorainoko sakoneraren artean, apaindutako sektoreak bata bestearen atzetik joango dira. 15 sektoretan aztarna arkeologikoak daude (labar-arterea edo zoru gaineko aztarnak, hala nola silevezko piezak edo egur ikatzak) eskuineko horman, eta 10 ezkerrekoan. Normalean, galeriaren azpiko aldetik dihoan pasabide errazenaren gaineko erlaitz garaietan aurkitzen dira. Horietako batzuk, oso sarbide zaileko eremuak dira (C sektorea, H sektorea, F' eta G sektorea), nahiz eta pasabide errazena dihoan galeria nagusiaren alde banatan kokaturiko zenbait eremu ere badauden (G floor, I floor edo J floor sektoreak). Sektore batzuek, hala nola D sektoreak (“Bisonteen aretoa”) edo J sektoreak (“Zaldien erlaitza”-k), aldi berean jende dezente hartzeko gaitasuna dute.

Azken sektore arkeologikoetatik (K' eta J') hogeita hamar metrora, ia pasabide osoa hartzen duen formazio eraketa bertikal bat dago. Hau 3 metroko altueran dagoen leihox bat irekiz hautsi da, haitzuloa sakonago arakatu ahal izateko asmoarekin, pasabide estu batetik. Estugune honen osteko 600 metroko pasabideak lehengo morfologia bera du, baina noiz behinka betetzen den aintzira bat ere badago. Labar artearen ebidentziarik (edo

bestelako aztarna arkeologikorik) ez da aurkitu grabitatez eratutako espeleotema honetatik harantzago.

### **Labar artea**

Kobako labar-artea 2015ean aurkitu zen (Garate et al., 2020e), eta oraindik ez da inventario osorik argitaratu. Hala ere, badira inventario partzial batzuk (Intxaурbe et al., 2020; Garate et al., 2023). Kobazuloko UGak 18 sektoretan aurkitu ziren, eta horien artean, 7k aztarna arkeologikoak ere bazituzten (ikatz sakabanatuak, su finkoak, balizko koipe-lanpara eta/edo silex-zatiak), eta beste 5 sektore gehiago ere badaude, aztarna arkeologikoak baino ez dituztenak (batez ere, ikatz sakabanatuak). Labar-artea duten sektoreak hauek dira: A, C zorua, C edo “Hartzen hatzapar marken ganbara”, D zorua, D edo “Bisonteen gela”, D’, F, G, E’, H, F’, G’, G’ zorua, I’ zorua, J edo “Zaldien erlaitza”, J zorua, J’ zorua eta K’.

Haitzuloko labar artea 256 unitate grafiko (UG) individualizatuk osatzen dute, horietatik 48 bisonteak, 34 ahuntz, identifikatzen zailak diren 25 irudi zoomorfiko, 11 zaldi, 4 orein eme, 3 emakume irudi estilizatu probable (FFS), tentuz animalia zehaztugabe gisa interpretatuak, 2 orein ar, 2 hartz eta 2 uro. Lau gezi isolatu eta hiru zeinu konplexu ere badaude (meandro formako grabatuak eta klabiforme probable bat) eta nahi gabeko arrastoak edo oso simpleak (113 lerro isolatu edo ez-figuratiboak eta 5 pigmentu gorriko orban). Pinturak, batez ere, ikatzez egindako pigmentu beltzarekin sortu ziren, nahiz eta azaleko grabatuak ere erabili ziren (batzuetan margoekin konbinatuta), baita pigmentu gorria ere, ziurrenik burdin oxidoz egina. Grabatuak, gehienetan, finak eta azalekoak dira, nahiz eta kasu batzuk sakonagoak izan. Hatz-grabatua UGetako batean ikus zitekeen, eta karrakatzea ere erabili zen, batzuetan beste teknika batzuekin konbinatuz (grabatu fina, pintura beltza, eta abar).

Multzoak beste arte higigarri eta parietal batzuekin duen antzekotasunagatik, zuzenean eta testuinguruaren arabera datatuak, batez ere aurrez aurreko ikuspegian dauden ahuntzak eta oreinak daudelako, irmoki iradoki dakiode Goi Madeleine aldiari (duela ggb. 15-13,5 mila urte). Proposamen kronologiko hori bat dator kobaren erabilera-faseetako baterako lortutako testuinguru-datekin (14,7-13,9 ka), hainbat egur ikatz sakabanatutik eta panelen azpian aurkitutako su finko batean lortutakoak. Leginik adierazgarrienetako bat haitzuloko panel nagusiaren azpian (J sektorea) aurkitu zen sukarrizko lanabes bati (xafla bat) itsatsita aurkitu zen, eta haren erabilera-aztarnek baieztagatzen dute ziurrenik panel bereko irudi batzuk egiteko erabili zela (Garate et al., 2023).

### **3. EKAIN**

#### **Kokapena**

**ETRS89 / UTM ZONE 30N      X: 558775      Y: 4787273      Z: 90**

Ekaingo haitzuloa Aptiar-Albiar arrezife-kareharrietan dago, errudista eta koralekin, Ekaingo muinoaren ekialdeko maldan, Debako (Gipuzkoa) udalerriaren barruan, itsas mailatik 90 metrora, Sastarrain eta Goltzibar errekek (Urolaren ibaiadarrak) osatzen duten haranen loturan, egungo kostaldetik 6,6 km-ra.

## Deskribapen topografiko laburra

Galeria horizontalen sare bat da (nahiz eta ohikoa den bat-bateko aldaketak aurkitzea zenbait putzu eta erlaitz sortuz, edo lurreko depresioak), 420 metroko garapena duena, eta goranzko joera orokor bat, sarrerarekiko 17 metroko desnibela lortzeko aukera ematen duena (Galán, 1992). Galerien norabidea nahiko aldakorra da, eta gradienteen aldaketengatik, baita higadura eta paragenesi forma ugariengatik ere (sabai-kanalak, *pendant*-ak, eta abar), kobazuloa pasabide-labirinto handia dela dirudi. Nolanahi ere, haitzuloa topografikoki bereiz genezake, erdiko gela handi bat bezala deskribatzu (“Erdialde” izenekoa), nondik adar ugari irteten diren hainbat norabidetan. Horietako batek atalondora eta sarrera nagusira iristeko aukera ematen du, non historiaurreko bizitoki kokaleku bat zegoen, Paleolito ertain eta garaiaren arteko trantsizio mailekin (Châtelperroniarra), Aurignac, Erdi eta Goi Madeleine aldiekin (azken bi horiek arte higigarriko elementuekin), Azil aldi, Mesolito eta Neolitikoko (Altuna, 1984; 2019; Rios-Garaizar, 2011) mailekin.

Aztarna arkeologikoak dituzten kobazuloko eremu sakonei dagokienez, Madeleine aldiko gizarteek erabiltzen zuten sarbidea atari beretik abiatzen zen segur aski, beheragoko maila batean zegoen pasabide batetik (gaur egun lubaki bat duena). Horrek 10 bat metrotara arrastaka ibiltza eskatzen zuen (guk A sektorea deitua), non berriki pigmentu gorrizko orban txiki bat aurkitu dugun hegoaldean. Behin pasatuta, haitzuloak goranzko hodi freatiko batetik jarraitzen du, “Erdibide” edo B Sektorea izenekoa, zeinaren zorua kolada estalagmitiko batek osatzen duen, eta non lehen irudikapen figuratiboak dauden, tartean nabarmentzen den gorri margotutako bisonte bat. Aurreraxeago, sartzen ari garen hodiak, zeharka, beheranzko galeria handiago batekin bat egingo luke. “Erdialde” barruan, bere iparraldeko horman, hodi estu bat dago, eta jarraitzen badugu, zeharka ebakitzen duen galeriarekin konektatzeko aukera emango digu. Azken galeria horretatik igotzen jarraitzen badugu, C Sektorea izeneko galeria-bidegurutze batean aurkituko gara berriro, sabai baxu lau samar bat duena, non zaldi buru baten irudia, bisonte beltz baten atzeko lerroa eta gorri margotutako bisonte handi argitaragabe bat dituen panel bat dagoen. Handik ortogonalki abiatzen den galeria “Ahuntzei” edo D sektorea da, orein ar eta eme baten irudi grabatuekin, ahuntz eta izokin baten marrazki beltzkin, eta puntu eta orban gorriekin. Sarrerako hodiarekiko edo “Erdibide”-arekiko paraleloan doan “Ahuntzei”-n sartu ordez, aurrera jarraituz gero “Erdialde” edo E Sektorean sartuko ginateke. Hemen, mendebaldeko aldea nabarmentzen da lurreko buztinean hartz batzuen hobiak daudelako, bai eta zuzien igurtziak, lurrean egur ikatzak, beltzez margotutako zaldi baten pinturak eta pintura gorrizko zenbait orban itxuragabe ere, zeinuen artean zeinu simple bat (puntu) dagoen, baita irudi zehaztugabe bat ere. Gela hau gurutzatzen badugu, galeriaren norabideari eutsiz, F sektorea deritzan hegoalderantz doan ardatz batean sartuko gara, zeinaren teilatua pixkanaka beherantz doan, herrestan joan behar zaren bide batera heldu arte, sabaia pigmentu gorri eta zuzi markaz beterik duena. Hala ere, F sektorera aurreratu beharrean, aurreko sektoreen zorua (B, C eta D) osatzen zuen kolada estalagmitiko batek marraztutako “bide” bati jarraitzen badiogu, 90° biratuko ditugu goranzko galeria berri batean sartzeko, zeinaren lehen atala, oraindik ere “Erdialde” areto handiaren barruan, baina alboetako erlaitzek eta blokeek bereizten

dutena, helduko gara. Zona hau “Zaldei” deitzen da, eta hainbat panel ikusgarri ditu, polikromia, monokromia (gorriz eta beltzez) eta grabatu bidez egindako zaldien, bisonteen, ahuntzen, oreinen eta arrainak irudiak dituena. Zenbait adar abiatzen dira handik, eta horietako batzuek aztarna arkeologikoak dituzte: G sektorea (buztinean hatz-markak dituena, grabatu eta pintatutako bisonte bat, eta ikatz batzuk), H (edo “Hartzei”, beltzez margotutako bi hartzekin), I (pigmentu gorriko zenbait orban dituena), J (edo “Azkenzaldei”, zenbait zaldi-irudi eta bisonte probableekin), K (edo “La Fontana”, buztinezko grabatuekin). Galeria hori L sektorea izeneko bihurgune batean amaitzen da, buztinean egindako zenbait irudi grabaturekin, eta pare bat orban gorriz eta beltzekin. Zona honetan sarrera buxatu bat egongo litzateke, han hondakinak eta material organikoa pilatzen dituzten hainbat animalia txikik erabiltzen dutena.

Material arkeologikoa duten sektoreetatik kanpo, haitzuloak interes geologiko eta paleontologikoko beste eremu batzuk ditu. Guztietatik, beheragoko mailak osatzen dituzten galeria-labirintoak nabamentzen dira, “Erdibide” izeneko pasabidea ortogonalki ebakitzetan zuen galeriatik jaitsita iristen dena<sup>56</sup>. Ekaingo kobazuloaren barrualdeko beste sarrera batek, gaur egun artifizialki betetzen denak, kanpoko kobazulo batekin lotzen zuen pasabide estu batez, “Ahuntzei” ko hartz hobia baten ostetik abiatzen zena.

### Labar artea

Gaur egun Ekainen ezagutzen den labar arte taldea aurkikuntza berriak gehitu dituzten berrikuspen eta bisita zehatz ugariren emaitza da (Altuna & Apellaniz, 1978; González Sainz et al., 1999; Altuna & Mariezkurrena, 2008; Fano et al., 2012; Garate et al., 2015c; Ochoa et al., 2018; 2019). M. Arriolabengoa zuzendutako proiektuaren esparruan egindako bisitetan, inoiz ikusi gabeko ebidentzia ugari aurkitu ditugu, horietako batzuk figuratiboak (C sektorean gorriz margotutako bisonte handi bat, adibidez, edo Ek.E.VI. panel nagusian bertikalean jarritako animali motibo zehaztugabe bat. Horregatik egin dugun inventarioa behin-behinekotzat hartu behar da. Kobazuloko UGak 12 sektoretan aurkitu ziren, horien artean 3 lurrazaleko aztarna arkeologikoak ere bazituzten (egur ikatzak, hatz-markak, sukarri xafla bat eta okre orban handi bat): A, B, C, D, E, F, G, H, I, J, K eta L. Haitzuloko labar-artea 180 unitate grafiko individualizatuk osatzen dute, eta horietatik 44 zaldiak, 18 bisonte, 6 ahuntz, zehazteko zailak diren 4 irudi, 3 orein eme, 2 hartz, orein 1 ar bat, izokin 1, eta zehazteko zaila den arrain 1. Gainera, 9 puntu daude, eta hatz marken multzo bat. Nahi gabeko arrastoei edo arrasto oso simpleei dagokienez, 57 orban gorri edo beltz eta 32 lerro isolatu edo ez-figuratibo daude. Pinturak, batez ere, ikatzarekin egindako pigmentu beltzarekin sortu ziren, nahiz eta kasu batzuetan manganesoaren pigmentua erabili zen (Chalmin et al., 2002). Grabatu finak ere erabiltzen

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<sup>56</sup> 2024ko otsailaren 8an, sare hori arakatzen ari ginela, kolmataturiko sarrerak bilatzeko asmoarekin, S. Salazarrek eta I. Intxaurbek galeria mehe estu-estu batzuk aurkitu zituzten, orban gorri itxuragabez beteak (behin-behinean S.E.S.B. galeria ezizena jarri zioten koloreagatik), historiaurreko bisitariek esploratu zituztela frogatzen zutenak. Eremu honen eta azken gune arkeologikoen (B sektorea) artean aztarna arkeologikorik gabeko sekzio luze bat dagoenez, eta handik gertu sarrerak kolapsatuta edo blokeatuta daudela dirudienez, azterlan gehiagoren zain gaude sare berri honen Paleolito garaiko funtzionamendua ulertzeko.

ziren (batzuetan margoekin konbinatuta), baita hatzen grabatuak ere gainazal leunetan, edo gainazal higatu batzuetan karrakatuak. Grabatuak, batez ere, finak eta azalekoak dira.

Kronologiari dagokionez, haitzuloa apaintzeko bi une ezberdin egon zirela proposa dezakegu. Ekaingo labar-artearen zati handi bat oso ongi egokitzen da Kantauriko eta Pirinioetako labar edo arte higigarriarekin, eta Erdi Madeleine alditik Goi Madeleine aldiaren hasierara (17,5-14,5 ka) igaroko litzatekeen fase bati egozten baitiote. Bestalde, “Ahuntzei” galeriaren surrealdeko ahuntzak hobeto egokitzen dira Madeleine aldko azken uneetara (15-13,5 ka). Koban datazio zuzenak egiteko saiakera batzuk egin ziren. Kutsadura modernoa ezabatzeko tratamendu eskasagatik baztergarriak direnak alde batera utzita (H. Valladas, Komunikazio Pertsonala), lagina edozelan datatzeko erabakia lehenetsi zelako, zaldietako bat (Ek. 26) Goi Madeleine aldian datatu zen (15.161-14.275 ka), beste zaldi batek emandako frakzio humikoak, berriz, Erdi Madeleine aldko kronologia eman zuen bitartean (18.202-17.071 ka) (González Sainz, 2005b). Azken datu hau lortu zen panel bereko beste zaldi bati (Ek.E.VI.20) egindako laginketa berriaren emaitzak jakiteko zain gaude (Ochoa et al., 2021a), ikusteko ea informazio gehiago eman dezakeen kontu honi buruz. M. Arriolabengoak zuzendutako proiektuaren esparruan egindako bisitetan, E sektorearen gainazalean zenbait egur-ikatz sakabanatu aurkitu genituen, haietako batzuk bertan zegoen zuzi-marka bati lotuak. Gela hartan, bere erdialdean, okre orban handi bat zegoen gainazalean (Lumentxan zegoenaren antzehoa), eta han zeuden baita ere egur-ikatz hondar sakabanatu batzuk, zoritzarrez oso gaizki kontserbatuak, bisitarien etengabeko zapalketaren ondorioz, buztinez estali baitute. Bestalde, G sektorean, M. Medina-Alcaidek hormari itsatsitako ikatza aurkitu zuen, eta buztinezko betegarri batean, gizakiek atzamarra sartzean utzitako markak daude, estalagmita-jario batek estaliak. Aztarna horiek B sektorean (Altuna, 1997) dagoen erlaitz baten gainean aurkitu zen silex xafla bati gehitzen zaizkio, zeinaren usadio-aztarnak bateragarriak baitziren harrizko gainazalak grabatzeko tresna gisa erabiltzearekin (J. Rios-Garaizar, Komunikazio pertsonala). Kobazuloan Paleolito osteko beste erabilerarik edo bisitarik ezagutzen ez denez (adibidez, hileta-erabilerak Holozenoan), oso litekeena da aztarna hauek jarduera grafikoaren garaikideak izatea, eta, beraz, euren datazioak, labar-artearen kronologia argitzen ere lagun lezake.

#### **4. ALTXERRI**

##### **Kokapena**

**ETRS89 / UTM ZONE 30N      X: 570214      Y: 4791021      Z: 25**

Altxerriko haitzuloa (Aia, Gipuzkoa) Beobetagaña mendiaren ekialdeko maldan dago, Altxerri ibaiaren haranaren gainean, Oriaren ibaiadarra. Haitzuloa Ebaki kalkareoak eta kareharri mikritikoak txandakatzen dituen bretxa batean garatzen da, Maastrichtian-daniar garaikoak, Marga/kareharri eta margak, marga gorrixka eta grisaxka-dun bandekin txandakatuz, egungo kostaldetik 2,5 km-ra eta itsas mailatik 25 metrotara.

## Deskribapen topografiko laburra

Altxerriko haitzuloa 2,5 km-ko luzera duen sare espeleologikoa da, gutxienez hiru mailatan garatua (Galán, 2011). Pasabideak oso baldintzatuta daude kaxa-harkaitzezko estratu estuen estratifikazioarekin (kalkarenitak, margak eta hareharriak). Horrek itxura “karratua” ematen die galeria askori. Beste sektore batzuetan, estratuak tolestek egiturazko ahuleziak sortu ditu, noizbehinkako erorketak eragin dituztenak. Izan ere, bitxia da nola erdiko solairuaren morfologiak (sistemara sartzeko erabiltzen direnak) 16 metro gorago errepikatzen diren (goiko solairuan), baina beheko ardatzetik 20 metro ingurura mugituta, 45°-ko buzamendu baten ondorioz. Badirudi estratifikazioan zegoen antiklinalak mesede egiten ziola espazioen zabalerari (kolapsoen bidez) eta solairuen arteko lotura eratzeari. Haitzuloa irekitzen den mendigunearen egitura-ezaugarri berezia dela eta, ura nahiko erraz isurtzen da sistemako hainbat puntutatik, material finak garbitu eta uztea faboratuz. Hauek, normalean, maila ezberdinaren arteko hodi (erdi) bertikal irekiekin lotzen dira, non, eremu horizontal eta baxuenetan, buztin eta lupetz metaketak dauden. Beste eremu batzuek infiltrazio-jarduera txikiagoa dute, espeleotema aktibo esporadikoagoekin. Badira espeleotema-belaunaldi zaharrak ere, batez ere kupula formako formazioak, eta zuruko koladak.

1956an irekitako zulo artifizialetik hurbilen dauden eremuetan, sistemara sartzeko sarrera bakarra dena gaur egun, gune arkeologikoa egongo litzateke, kobazuloaren lehen 120 metroak hartuko lituzkeena. Eremu horretan, galeriak gutxienez 3 maila nagusitan antolatuta daude, eta azpi-maila batzuk dituzte, elkarren artean lotuta putzu bertikalen eta/edo arrapala oso malkartsuen bidez, haitzuloaren oinarri den egitura geologikoak (batez ere, harrizko euskarri estratifikatuek eta tolesturek). Tarteka, barrunbeetan metatutako betekin detritikoek ere sasi solairuak eratzen dituzte. Oraingo sarreratik haitzuloaren tarteko maila fosil batera iritsiko gara. Eremu honetan kobaren ataria aurki dezakegu, baina aurkitutako ebidentzien kopurua eta tipologian oinarritzen bagara, ez dirudi habitat gisa erabilia izan zenik. Aurreraxeago galeria tarte bat dago, bi zulo/arrapalarekin mugatzen dena. Behin bigarrena igarota, dekorazio klasikoko sektorea hasten da, hainbat grabatu eta margolanez osatua, 6 metroko putzu baten behealdean kokaturiko bi bisonteez gain (“Leizeko taldea” izenekoa). Lehen sektore horietan dauden konbentzio estilikoko Madeleine aldiaren azken faseetakoak dira. Haitzuloaren hasierako gela igaro eta berehala, tximinia bat garatzen da litologiaren estratifikazioaren eta tolestura antiklinalaren alde. 12 metroko hasierako igoera honek aukera ematen digu egungo sarrera artifizialarekiko +22 metroko altueran kokaturiko maila handiago batera iristeko. Goiko sektore honetan, bizpahiru azpi-solairu gainjarriez osatua eta eskailera bertikalen bidez elkarloturik, beste multzo arkeologiko bat dago, zoru gainean dauden aztarna arkeologiko ugarirekin (hezur erreak, hezurrak, ikatza, okrea, silexa) eta pinturekin (pigmentu gorrixka edo morez eginak). Erradiokarbono datazioak eta irudien paralelismo estilikoko Aurignac garaiari egozten diote talde hau (González Sainz et al., 2013). Nolanahi ere, bistakoa dirudi deskribatutako bi multzoek (behekoak eta goikoak) bi haitzulo independente bezala jokatu zutela, bakoitza bere sarrerekin, gaur egun kolapsatuta egongo zirenak. Horregatik, goiko sektoreari Altxerri B izena jartzea erabaki

zen (Aurignac garaiko bisitekin), Altzterri A izeneko beheko mailatik independentea (Madeleine aldiko bisitekin).

“Leizeko taldetik” abiatuta, pasabide baxu batek bi galeriaren buruan uzten gaitu. Sarrerarantz jarraituz, baina beheraxeago, haitzuloaren sekzio aktiboaren zati batera irits gitezke, zeina gaur egungo sarreratik hurbil (baina 21 metro beherago) dagoen sifo batan amaitzen den, hareharri gorri disolbaezinekin kontaktuan. Kontrako norabidean jarraitzen badugu, pasabide baxu batek arrapala baten buruan uzten gaitu berriro eremu aktibora garamatza (baina ibaian gorako tarte batan). Hemendik haitzuloaren garapen sakon batera igo gaitezke, altuera ezberdinan dauden galeria aktibo eta fosilez osatutako labirintoz osatua. Nahiz eta sektore horiek interes geologiko eta biologikoa izan, horietan ez da ezagutzen historiaurreko jatorri antropikoko elementurik, eta, beraz, ez dirudi iraganean gizakiak hemendik sarritan ibili zirenik.

### Labar artea

Altxerrin egindako Paleolitoko labar-artearen azken inventariotik abiatuz (Ruiz-Redondo, 2014), eta “Altzterri A” izeneko Madeleine aldiko artea duen sektorera mugatuz, elementu grafikoen datu-base bat prestatu dugu, non haitzuloan egindako azken proiektuetan identifikatutako motibo berriren bat gehitu dugun (D. Garate buru duen ikerketa geomorfologikoa eta M. Medina-Alcaide buru duen testuinguru arkeologikoaren azterketa). Aurkikuntzen artean bi irudi femenino egongo lirateke, estilizatuak, eta pintura gorriko zenbait orban, orain arte Madeleine aldiko labar artearen atalean argitaratu gabeak. Kobazuloko UG-ak 5 sektoretan aurkitu ziren, horien artean 4k, azaleko aztarna arkeologikoak ere bazituztelarik (egur-ikatz sakabanatuak, bi silex-zati, hezurrak eta okre zati probable batzuk): B, C, D, E eta F. Haitzuloko labar-arterea 166 unitate grafiko individualizatuk osatzen dute (UG-ak), eta horietatik 70ek bisonteak lirateke, 8 irudi zoomorfo zehaztugabe, 7 elur-orein, 5 ahuntz, 3 sarrio, 2 antropomorfo (ar bat eta zehaztu gabe bat), 2 emakume irudi estilizatu (FFS), 2 uro, 2 orein eme, 2 saiga antelope, 2 platuza, izokin 1, zehaztugabeko arrain 1, txori 1, hartz 1, suge 1, azeri 1 and orein ar 1. Badira 12 zeinu konplexu ere: 4 marra pare, 2 gezi, 2 gurutze formadun zeinu, 2 zeinu oboide, 2 zeinu zirkular edo azpizirkular (horietako baten interpretazio alternatibo batek gizonezko irudi antropomorfo baten uzkia bezala interpreta daitekeela uste dugun arren). Nahi gabeko arrastoei edo oso bakunak diren ebidentziei dagokienez, 21 lerro isolatu edo ez-figurativo eta 15 orban gorri edo beltz daude. Pinturak, batez ere, ikatzez egindako pigmentu beltzarekin sortu ziren, nahiz eta azaleko grabatuak ere erabili ziren (batzueta margoekin konbinatuta), baita pigmentu gorria ere, ziurrenik burdin oxidoz egina. Grabatuak, gehienetan, finak eta azalekoak dira, nahiz eta kasu batzuk sakonagoak izan. Hatzen grabatua ikus daiteke UG batzuetan, eta karrakatzea ere erabiltzen zen, batzuetan beste teknika batzuekin konbinatuz (grabatu fina, pintura beltza, eta abar). Bi grabatuk ere urradura batzuk dituzte ildoan, bolumena emateko.

Multzoak beste arte higigarri eta parietal batzuekin duen antzekotasunagatik, zuzenean eta testuinguru bidez datatuak, Erdi Madeleine aldiaren eta Goi Madeleine aldiaren arteko garaiari irmoki iradoki dakioka (duela 16,5 eta 13,5 ka tartean). Ez dago gida-fosilik, aurrez aurre dauden ahuntzak bezala, fase zehatz bateko kide izatea erabakitzet duenik.

Hala ere, animalia batzuek marraztean dituzten eskematizazio erradikalak, ia “espresionista” (adibidez, bisonte bat, ilearen ugaritasuna irudikatzen duten lerroen multzo batera murrizten dena), Madeleine aldiaren azken faseetan tipikoagoa dirudi, Atxurako kobazuloan, Azken Madeleine aldian (duela 14,7 eta 13,9 ka artean), dauden ale batzuetatik oso hurbila dirudi estilistikoki. Aitzitik, Altzerrik Atxurran ezagutzen ez diren fauna hotzaren irudiak ditu, hala nola elur-oreinak, kobako bigarren gairik garrantzitsuena direnak irudikapen kopuruari dagokionez. Horregatik, ezin da baztertu garai batean (agian Erdi Madeleine aldiaren amaieran) egindako artea daukala. M. Á. Medina-Alcaide buru duen proiektuaren barruan zenbait egur ikatz sakabanatu aurkitzeak, batzuk kolada estalagmitiko higatu baten azpian, artearen exekuzioarekin lotuta egon litekeen giza bisitaren fase bat datatzeko aukera ematen du. Hondakin horiek J.M. Barandiaranek (1964a) aurkitutakoei gehituko litzaizkieke, atondoan -30 eta -80 sakoneran kokaturiko okupazio-geruza iragankorrap barne, egur ikatz batzuk eta bi silex zati zeuzkatenak maila bakoitzean (xafla bat lehenengoan eta puska txiki bat bestean).

## 5. AITZBITARTE IV

### Kokapena

**ETRS89 / UTM ZONE 30N      X: 589641      Y: 4790572      Z: 223**

Aitzbitarte IV.aren haitzuloa izen bereko muinoaren mendebaldeko maldan dago (Errenerria, Gipuzkoa), Urumea ibaiaren adarra den Landarbaso ibaiaren haranaren gainean. Haitzuloa kalkarenita bioklastikoetan garatzen da, kareharri mikritiko masiboak eremu txikiagoekin, silidifikazioak dituzten kareharriekin eta kareharri eskistosoekin batera, Goi Albiar garaikoak, egungo kostaldetik 8,3 km-ra eta itsas mailatik 223 metrotara.

### Deskribapen topografiko laburra

Aitzbitarte IV haitzuloak 280 metroko garapena du, eta haitzulo-sistema bat osatzen du hurbileko Aitzbitarte V-rekin, gutxienez bi mailatan garatua, azpi-maila batzuekin batera 54 metroko desnibela osatuz. Haitzuloak hainbat adar ditu sistemaren beste solairu batzuetarako norabidearekin. Sarrerako pasilloaren ezkerraldetik, beheko gelaxka batera sar daiteke, non galeria labur batzuk hasten diren, Aitzbitarte III-ren sarreraren ezkerretik ere abiatzen den adar batetik metro gutxira amaitzen direnak. Gauza bera gertatzen da haitzuloaren hondoan, non pitzadura eta zulo bertikal batzuek Aitzbitarte III-ren galeria nagusia irekitzen den mailan kokatutako galeria erdi-aktiboetara sartzeko aukera ematen duten (Manteca et al., 1997). Beste adar batzuk, ordea, galeria nagusiaren tarteetan hasten dira, eta sistemako beste haitzulo batzuetara iristen dira, non buztinez modelatutako animalien sektorea eta Aitzbitarte V-rekin lotzen duen tximinia dauden.

Mendiguneko kobazulorik handiena da, 19 metro zabal eta 9 metro altu den sarrera nagusi batekin, beherantz doan atalondo bati bide ematen diona (A sektorea), blokez betetako zorua duena eta antzinako edo kontrolik gabeko indusketen ondorioz sedimentua hustu zitzaina, baita helburu militar edo industrialetarako (perretxikoak landatzeko) espazioa egokitu ere. Eremu horretan, gutxienez honako hauei egotz dakizkiekeen habitat-mailak

zeuden: Aurignac aldia (zalantzekin), Solutre aldia, Badegouliarra, Madeleine aldia, Azil aldia, Kalkolito/Brontze Aroa eta Burdin Aroa (Barandiarán Ayerbe, 1961b; 1963a; 1963b; 1964b; 1965; Barandiarán Maestu, 1967; Utrilla, 1981; Straus, 1983).

Barrurantz, galeria handi batera iristen gara, zorua noizean behin bloke handiz estalia duena, eta puntu batean galeria partzialki ixten duen horma bat ikus dezakegu, agian barrunbe horretan gertatu zen ustiapen mikologiko batekin zerikusia duena (Manteca et al., 1997). Hortik aurrera, lurzoruko sedimentua buztinezko geruza uniforme eta trinko bihurtzen da, XX. mendearren hasieran perretxikoak landatzeko egokitzapenari lotua.

Galeria horretatik abiatuta, pasabidea bata bestearen atzetik zeharkatzen duten pitzadura ortogonalak zeharkatuta (haitzuloko lanetan bete ziren onddoak lantzko lurra lautzeko asmoarekin), posible da bi tximinia bertikaletara iristea. Hauek bi solairutara garamatzate, 20 eta 25 metroko altueran. B sektorea edo “buztinezko animalia modelatuen tximinia” horietako batean dago. Bestetik, Aitzbitarte V-era iristen da, azken haitzulo honetako sarrera eta apaindutako sektoreen arteko eremura.

Barrurago, geologikoki zehar-junturetako batean induskatutako galeria estu eta labur batek haitzuloaren azken gelara sartzeko aukera ematen digu, non harkaitzean zizelkatutako eskailerek haitzuloaren azken beheko aretora jaisteko aukera ematen diguten (C eta D sektoreak). Gure bisitetan ikusi genuen infiltrazio-urak Aitzbitarte IV-ren galeria horretara nola iristen ziren, ur-korronte nabarmenak sortuz, leize-maila baxuagotara jaisten zirenak. Gela honetan, beren estutasuna dela eta, sarrera zaila duten bazter-eremuetan, pintura gorriz egindako labar-artedun hainbat panel daude.

## Labar artea

Labar artearen lehen ebidentzia 2012an aurkitu zen, eta geroago, 2017an, buztinez grabatutako eta modelatutako animalia irudi multzo garrantzitsu bat aurkitu zen tximinia batean, galeriako egungo solairutik 20 metro baino gehiagora. Ikerketa projektuek iraun duten bitartean, aurkikuntza puntualak gehitu dira, batez ere haitzuloaren azken gela batean, eta oraindik ez da inventario osorik argitaratu. Hala ere, badira inventario partzial batzuk (Garate et al., 2013d; 2020d). Kobazuloko UGak 4 sektoretan aurkitu ziren (horietako batean 4 azpisektore ere bereizi ditugu). Labar artea duten sektoreak A (ataria), B (“Buztinezko animalia modelatuen tximinia”), B.A; B.B; B.C eta B.D azpisektoreekin), C eta D (haitzuloko azken aretoan dauden azken biak) dira.

Haitzuloko labar-artea 59 unitate grafikok (UG-k) osatzen dute. Horietatik 11k bisontea irudikatzen dute, 3 zaldi, identifikatzeko zailak diren 2 irudi zoomorfo, 2 alu, elur-orein 1 eta ibex 1 irudikatzen dituzte. Lau zeinu ere badaude (laukizuzen formako zeinu bat eta 3 puntu), hiru hatz-pasada sail eta nahi gabeko edo oso simpleak diren arrasto batzuk (13 lerro isolatu edo ez-figuratibo eta 19 pigmentu gorrizko orban). Margoak burdin oxidoz eginak izango ziren. Hormak deskaltzifikazio-buztina sortzen duen eraldaketa-geruza bat zuen leku batuetan, non hatz-grabatuak erabili ziren, baita erauzketak eta modelatzeak ere, eskuak erabiliz bolumena sortzeko. Horma gogorragoetan badira grabatu batzuk, gehienak finak eta azalekoak, nahiz eta kasu batzuk sakonagoak diren, batez ere euskarria

bigunagoa denean. Karrakatzea ere erabiltzen zen kasu batzuetan, eta irudi batzuk egiten ziren batzuetan teknika batzuk konbinatuz.

B Sektoreko grabatuak (“Buztinean modelaturiko animalien tximinia”) testuinguruaren bitartez datatzeko saiakera bat egin zen, tximinia hasten den lekuan dauden pitzaduretan sartutako hezur eta animali hortz bat datatu nahian, arrakastarik gabe. Hala ere, beste arte higigarri eta zuzenki dataturiko labar arte batzuekiko antzekotasuna dela eta, Erdi Madeleine eta Goi Madeleine aldiaren (duela 17,5 eta 14,5 ka) artean datatu daitezke behin-behinean. Adibidez, begi itxia edo bisontearen surrealdea irudikatzeko modua, Erdi Madeleine aldko beste irudikapen datatu batzuetan aurki liteke (adibidez, Covaciella, 17.3-16.9 mila urte arteko datazioarekin). Buztinarekin egindako irudikapenak maiz agertzen dira Pirinioetan nagusiki dauden beste kobazulo batzuetan (Tuc d’Audoubert, Montespan, Bedeilhac, Erberua, Oxocelhaya, Fontanet, Labouïche eta Etxeberri), nahiz eta Kantauri itsasoan (La Garma eta El Castillo) eta Dordoinan (Les Combarelles eta La Calèvie) ere ezagunak diren. Multzo hauek testuinguru bidez datatuak izan diren kasuetan (Tuc d’Audoubert, Etxeberri, Fontanet eta La Garma), lortutako datak Erdi Madeleine aldkoak izan ohi dira.

Azken aretoan gorriz margotutako labar arteari dagokionez, zalantza asko sortu ditu 2012an aurkitu zirenetik, batez ere bere kronologiari zegokienean. Kantauri itsasoan ohikoak dira pintura gorriz apaindutako haitzuloak, eta Madeleine aurreko kronologia izan ohi dute (batez ere Aurignac eta Gravette aldiak, eta agian Solutre aldia). Horregatik, hasieran, irudiak garai horretakoak zirela zirudien. Hala ere, badira Madaleine aldian ia soilik kolore gorri honetan apaindutako kobazulo ezagunak ere, Lumentxa kasu. 2020an hiru animaliaz osatutako talde bat (zaldia, bisonte bat eta zehaztea zaila den animalia bat, ahuntz bat agian) aurkitu izanak galdera hau nolabait argitu zuen: Bisontea irudikatzeko moduak, “S” formako adar bihurri bat eta bi hanka perspektiban dituela, Paleolitoko kronologia berantiarren (Madeleine aldian) tipikoagoa zirudien. Uste dugu hasierako zalantzak pintura gorrien multzoaren kontserbazio latzagatik ulertu behar direla, irudien interpretazio zuzena eragozten dutelarik, Morgotako haitzuloan gertatu zen bezala (Garate et al., 2015a).

## **6. AITZBITARTE V**

### **Kokapena**

**ETRS89 / UTM ZONE 30N      X: 589666      Y: 4790584      Z: 251**

Aitzbitarte V haitzuloa izen bereko muinoaren mendebaldeko maldan dago (Erreenteria, Gipuzkoa), Urumea ibaiaren adarra den Landarbaso ibaiaren haranaren gainean. Haitzuloa kalkarenita bioklastikoetan garatzen da, kareharri mikritiko masiboak eremu txikiagoekin, silidifikazioak dituzten kareharriekin eta kareharri eskistosoekin batera, Goi Albiar garaikoak, egungo kostaldetik 8,3 km-ra eta itsas mailatik 251 metrotara

### **Deskribapen topografiko laburra**

Aitzbitarte V haitzuloak 95 metroko garapena du, eta haitzulo-sistema bat osatzen du hurbileko Aitzbitarte IV-rekin, gutxienez bi mailatan garatua, eta azpi-maila batzuekin

batera 54 metroko desnibelarekin. Hasiera batean, 25 metro inguruko garapena, 3 metro inguruko zabalera eta 2,20 metroko altuera zuen (Manteca et al., 1997) meandro itxurako hodi bakar gisa deskribatu zen. Barren-barrenean, estugune oztopatu batzuk ikusten ziren. Sistema karstikoaren barruan egindako azterketek erakutsi zutenez, blokeatutako pasabide horiek “Hartzen Galeria” deritzenaren amaieratik oso gertu zeuden, Aitzbitarte IV-etik 25 bat metrora zegoen tximinia bertikal batetik sar zitekeen bertara. Haitzulo honen sarreran industria litikoaren, zeramikaren, makrofaunaren, moluskuen eta giza burezur zati baten aztarnak aurkitu ziren (Altuna et al., 1995). Geroago, 2015ean Felix Ugarte Elkarteko talde espeleologikoak pasabide blokeatua ireki zuen, eta ekintza honen esparruan, historiaurreko zeramika zati ugari aurkitu ziren, horietako batzuk ziurrenik Brontze Arokoak, baita presio bidez lortutako sukarri xafla handi bat ere. Zeramika-hondarrak ere aurkitu dira katazuloaren beste aldean, baita Aitzbitarte IV-rekin lotzen duen tximiniaren oinean ere.

Ikusi ahal izan denez, hasiera batean blokeatuta zegoen katazulo estu horrek bi modutara banatzen zituen sarrera eta sektore sakonen arteko lotura: alde batetik, ezkerrerantz zihohan adar batek Aitzbitarte IV eta V. lotzen dituen tximinia bertikalaren goialdearekin lotzen zuen. Bestetik, eskuineko adarrak zuzenean lotzen zuen “Hartzen Galeria”-rekin, eta horrek errazago eta zuzenago ahalbidetzen zuen bertako eremu apaindua. Espeleologoek, halaber, bakarrik ireki zuten ezkerraldeko bidea.

Galeria horren izena (“Hartzen Galeria”), zoruaren ikusi daitezkeen haitzulo-hartzen hobu ugariengatik eta bertako hormetan ikus daitezkeen atzapar-marka ugariengatik datorkio. Galeriaren lehen zatiak, putzuaren ondoren, gutxienez 2 metro zabal eta 3 metro garai izaten jarraitzen du, eta 60 metro inguruko garapena.

Azken zatian, igoera txiki batek erlaitzen eta hodi freatikoen bidez elkar loturiko pasabidek osatutako sektore batera sartzeko aukera ematen du. Lehen sektorea (A sektorea) “Hartzen Galeria” eta eremu sakonenak lotuko lituzkeen erlaitza da. B sektorea korridore estu bat da, A sektorearen azpiko hodi freatiko baten bidez sartzen dena. Azken igoera batek C sektorera iristeko aukera ematen du. Pasabide estu hori haitzuloaren azken atalarekin lotzen da, D sektorearekin.

## Labar artea

Haitzulo honetako labar-artea 2015ean aurkitu zen, B sektorera mugatuta. Sektore horrek 4 bisonte zituen, Madeleine aldko estiloan grabatuak, eta interpretatzen zailak ziren lerro batzuk (Garate et al., 2016c). 2017an, ebidentzia berriak aurkitu ziren A eta D sektoreetan, Gravette aldko paraleloekin, Aitzbitarte V-a konplexu diakroniko edo tradizio luzekoa bihurtu zelarik. Azkenik, 2020an, C eta D sektoreetan grabatu gehiago aurkitu dira, guztiak haitzuloaren lehen ziklo grafikoari eslei dakizkiokeenak, nahiz eta azken sektoreko irudietako baten paralelismo teknikoak (antzoko tresna bat erabiltzea) eta estilistikoak (“S” formako adar bihuriak eta perspektiba zuzenekoak) dituen B sektoreko Madeleine aldko bisonteekin (Garate et al., 2020).

Haitzuloko labar-artea 18 unitate grafiko individualizatuk (UG’k) osatzen dute, eta horietatik 11k bisontea eta identifikatzen zaila den irudi zoomorfiko bat irudikatzen

dutelarik. Bi zeinu ere badaude (konopial formako zeinua), hatz sorta bat eta nahi gabeko arrastoak edo oso sinpleak (3 lerro isolatu edo ez-figuratibo eta orban gorri bat). Margoak burdin oxidoz eginak izango ziren. Grabatuak, gehienetan, finak eta azalekoak dira, nahiz eta kasu batzuk sakonagoak izan. Hatz-grabatua UG batean ikus daiteke.

Lehen esan dugun bezala, A, C eta D sektoreetako grafikoetako batzuek paralelismoak dituzte gaiari dagokionez (bisonte, batez ere) eta estiloari dagokionez (perspektibarik eza), kronologia Gravette aldiko arte higikor eta labar artearekin (duela 30-23 mila urtekoak), Frantziako hego/mendebaldeko partean aurkitu direnekin, gehienbat (Isturitz, Gargas, Cussac, eta abar), edo perspektibarik gabeko estiloekin, Mediterraneoa ere (Cosquer, El Parpalló, eta abar) hartzen duen lurralte handiago batean aurkitutakoekin (Garate et al., 2020a). B sektore osoak, eta agian D sektoreko irudi batek, Madeleine aldiko estiloarekin ahaidetasuna dute. Gainera, bisontearren aurrealdeko lerroaren ilajea lerro txikien bidez irudikatzeko xehetasuna Erdi Madeleine aldian baino ez da aurkitzen (Rivero, 2010).

## 7. ALKERDI 1

### Kokapena

**ETRS89 / UTM ZONE 30N      X: 619828      Y: 4792224      Z: 155**

Alkerdi 1 haitzuloa muino txiki baten mendebaldeko maldan dago (Urdazubi-Urdax, Nafarroa/Nafarroa), Urtxume erreka sartzen den urzulo baten gainean, Urdazuri edo La Nivelle ibaiaren haranean. Leizea errudistik dituen Albion/Turoniar garaiko kareharri gorriaren garatzen da, egungo kostaldetik 17,1 km-tara eta itsas mailatik 155 metrotara.

### Deskribapen topografiko laburra

Alkerdi 1 haitzuloa sare espeleologiko konplexu baten zati da, 5 km-tik gorako garapena duena 5 haitzulo maila ezberdinetan eta 80 metroko desnibelarekin. Kobazuloa 4. leize-mailan dago eta gutxi gora behera 160 metroko garapena du, 5 metroko desnibelarekin.

Sarrerako atari zabalak (11 x 5 metro) atarira sartzeko aukera ematen du. Egia esan, nahiko espazio deserosoa da, sabai baxuekin, eta bertan egindako indusketeek okupazio labur batzuk dituen maila bat baino ez dute dokumentatu, Gravette aldikoa (Barandiaran Maestu et al., 2010).

D. Garate eta O. Rivero (2015a) atariaren atzealdean dagoen sektore batean, C sektorea deritzonean, I. Barandiarán Maestu (1974) bi grabatu zeudela adierazi zuen, morfologiari zegokionean nahikoa arraroak zirenak, eta berriro aurkitu ez direnak.

Atariko hondoko horman, ezkerraldean, galeria bat hasten da, sedimentu-kolubioiak eragindako malda batekin, erdian subsidentziak eragindako depresio baterantz doana, B sektorea izenekoa, ezkerreko horman grabatu bat duclarik. Galeria honen amaieran, bihurgune batean, formazio estalagmitiko bat dago (kolada bat) kupula baten forman (A sektorea edo “Mogote estalagmitikoa” deritzo), animali grabatu multzo batekin.

Ezkerreko galeriatik aurrera egin beharrean, atariaren eskuinerantz jarraitzen badugu, tarte irregular samar bat zeharkatuko dugu sabaitik abiatzen diren meandroekin. Hodi paragenetiko hauetan (sabaiko kanalak), belarjale hortz bat aurkitu zen (agian zaldi edo ekido batenak). Arrasto honek 38,615 – 37,020 mila urte kalibratuko Aurignac aldiko kronologia eman zuen ( $33,600 \pm 270$  BP uncal, Beta-431389). Gizakiek ekarria izan daiteke, baina froga gehiagoren esperoan, ikerketatik kanko uztea erabaki da.

Ondoren, sabai baxuko gela bat irekitzen da, eta, bere hormetako batean, galeria bat dago, tamaina txikitzen duena meandro itxurako hodi estu bihurtu arte, “Bisontearen galeria” edo D sektorea izenekoa, grabatu-multzo handiena duena. Galeria hau haitzuloko bigarren gelara zabaltzen da berriz pasabide oso estu baten ondoren.

The Alkerdi 1 cave is part of a complex speleological network, which is characterized by the development of more than 5 km in 5 different cave-levels and 80 metres of elevation gain. The cave is situated on the 4th cave-level and has a known development of ca. 160 m and 5 m vertically.

### Labar artea

Haitzulo honetako labar-arteak bi sektore nagusik osatzen dute batez ere, ez bakarrik espazioan elkarren artetik urrun daudenak, baizik eta estiloa (eta agian egite-une kronologikoa) ere ezberdinak izan daitezke: A sektorea edo “Mogote estalagmitikoa” eta D sektorea edo “Bisontearen galeria”.

Haitzuloko labar-artearen azken azterketan oinarrituta egin zen inventarioaren arabera (Garate & Rivero, 2015b), kobazuloak 31 unitate grafiko ditu. Horietatik 14 bisonteak lirateke, identifikatzen zailak diren 4 irudi zoomorfo, 3 zaldi, orein ar 1 eta uro 1. Badira, halaber, zeinu bat (bi puntuko serie bat) eta nahi gabeko aztarnak edo oso simpleak (6 lerro isolatu edo ez-figuratibo eta pigmentu beltzeko orban bat). Margoak burdin oxidoz eta ikatzez eginak izango ziren. Grabatuak, gehienetan, finak eta azalekoak dira, nahiz eta kasu batzuk sakonagoak izan. Irudi batzuk teknika batzuen konbinazioarekin egin ziren.

Bere kronologiari dagokionez, “Bisontearen Galeria”-ren aurkikuntzak eta bere ikerketak, jada, A eta D sektoreen arteko estilo ezberdintasunak adierazten zituen. Lehen sektoreko bisonteak ilerik gabeko konkor jarraitua du, Kantauri itsasoaren erdialdean ohikoagoa dena, Hornos de la Peñan bezala (Garate & Rivero, 2015a). Aitzitik, D sektoreko bisonteek asko markatzen dute ilajea, Pirinioetako ezaugarri tipikoagoa dena, adibideekin Trois Frères, Niaux edo Marsoulas-en. Halaber, azken haitzulo honek badu beste antzekotasun bat Alkerdi 1eko bisonte batzuekin: hauen adarrak perspektiban irudikatzeko modua da, lehen planoan dagoen adarraren atzean egindako bigarren planoko adarrarekin, justu kontrakoa ikustea denean ohikoa (urrekaldetik egotea atzeko adarra). Ezaugarri hori ez da Marsoulasena bakarrik, Dordoina aldean (Rouffignac edo Font-de-Gaume) eta Kantaurialdean (Altamira) ere ikusten da. Irudikapen horiek guztiak (batez ere Altamira, Font-de-Gaume eta Marsoulas) Behe Madeleine aldiaren edo Erdi Madeleine goiziarraren garaietakoak dira. Ebaluazio hau baieztago egin da hezur luze baten, ziurrenik bobidoa, 18,425-18,12 mila urteko datazioarekin, D sektoreko irudien azpian aurkitu zena, sarbide konplikatua eta espazio-harreman estua duen leku batean.

Bigarren multzoari dagokionez (A sektorea), Behe Madeleine aldian tradizionalki egokitutako kronologia (adibidez, Barandiarán Maestu et al., 2010), buru “ildaskatua” zuen orein ar baten presentzian oinarritu zen. Nahiz eta ezaugarri hori, tradizionalki Kantauriko Behe Madeleine aldiari egotzi dakioken, kronologia horiei bakarrik ez dagokiela esan da berriki (Rivero et al., 2019a), Atxurrako edo Altzerriko bezalako adibide berantiarragoekin, ezta eskualdeko konkretu bati ere (adibidez, Marsoulas, Fritz et al., 2016a). Bisontea irudikatzeko modua, lehen esan dugun bezala, Kantauriko eskualdean tipikoagoa da. Hornos de la Peña kobazuloan lortutako testuinguru-dataazioak ere, estilo horretako irudiekin (bisontea konkor biribilduarekin, ilajea irudikatu gabe), D sektorearen (18.646-18.036 ka) antzeko aldi kronologikoa hartzen du (Medina-Alcaide, 2020).

Laburbilduz, eta Alkerdi 1 artea Madeleine aldiaren fase berriagoetan ere egiteko aukera alde batera utzi gabe, uste dugu nahikoa froga badagoela gure azterketan sartu dugun talde artistiko zaharrena barne hartzen duela proposatzeko.

## **8. ETXEBERRIKO KARBIA**

### **Kokapena**

**ETRS89 / UTM ZONE 30N      X: 669350      Y: 4776457      Z: 448**

Etxeberriko Karbia “Ascune” serieko (Vanara, 2000) Goi Aptiar aldko Urgoniar kareharrietañ irekitzen da, Gamere-Zihigako (Zuberoa) udalerrian dagoen Hardegainxardeka (edo "Axkoargibela") 852 metrotako mendiaren ekialdeko maldan irekitzen da, itsas mailatik 448 metrora eta egungo kostaldetik 66 kilometrora.

### **Deskribapen topografiko laburra**

Etxeberriko karbiak kanoi zuzen handi baten forma du, gutxi gorabehera 240 metroko luzerakoa, batzuetan 30 metroko altuera duena, eta 10 metroko zabalera, salbuespen gutxi batzuetan izan ezik. Galeria hau zenbait puntutan kolapsoz eta sedimentazio detritiko eta litokimikoz beteta dago, malda handi eta malkartsuak eta hainbat tokitan infiltrazio-urez betetzen diren arroak eratzen dituztenak, noizbehinkako lakuak eratuz. 541 metroko garapen topografiko ezaguna du, eta 63,5 metroko desnibela, +12 metroko eta -51,5 metroko metatutako aldea sarrerako mailarekiko. Galeriaren bi aldeetan, terraza horizontalak ikus daitezke, baita zintzilikatutako zoru horizontalak ere.

Lehenik eta behin, haitzuloaren sarrerako aretoa legoke (A sektorea), zeinaren zorua bloke erori handiz estalita dagoen, laster hasten delarik igoera malkartsu bat “Gours-en galeriara” (B sektorea) iritsi arte. Galeria horren goialdean, han jarritako babes-hesi baten ondoren, hodia jaisten hasten da “Lakuen Galeria” (D sektorea) aldera. Lehen bi aintzirak urez beteta egon ziren joan den mendearen zati handi batean behintzat. Haiek elikatzen dituen behin-behineko ur-korrontea hesia dagoen lekuaren bertan hasten da, eta bat egiten du Neolitikotik errromatarren garairako okupazio-geruzak zeudela baieztagatzen zuen indusketa egin zen leku batekin (Ebrard, 2013a). Gaur egun, ur-ibilgua desbideratu egin da, eta “Gours-en galeriarantz” doa lehenik, atarira iritsi arte aurrerago, eta han errekatxoa arroken artean desagertzen delarik. Hirugarren lakua, bertan dagoen kolada handi batetik erortzen diren infiltrazio-urek elikatzen dute (beraz, udan bakarrik aurki daiteke erdi

hutsik), eta hauek, handik gutxira kokatutako 7 eta 10 metro arteko zulo bertikalen bidez iristen den beheko sare batean amaitzen dute. Jauzi bertikal horien gaineko hondorik gabeko pasabide arriskutsu batetik jarraituz gero, baina oposizio-teknika erabiliz gaindi daitekeena (bi hormetan presioa eginez) eta soka batez ziurtatua, kolada estalagmitiko baten oinera iritsiko gara. Oztopo horretara igoz gero (6 metro), erlaitz batetara iritsiko gara, eta handik herrestan igaro behar den estugune larri bat abiatzen da. Hau bat-batean amaitzen da bi metro bertikaleko jauzi batean, eta horrek “Margoen Gela” (E sektorea) izeneko sektorean uzten gaitu, haitzuloaren sektore nagusian, labar-arteari eta aztarna arkeologikoei dagokienez. Zazpi metroko arrapala malkartsu eta ia bertikalean behera joanez gero, “Putzuaren areto” (F sektorea) iritsiko gara. Izena oso gertu dagoen “Aingeruaren Putzu”-tik dagokio, 16 metro bertikaleko eta kanpai itxurako amildegi bat. Istripu topografiko honen inguruan daude Paleolito garaian apaindu ziren azken lau sektoreak: “Estutasuna” (G sektorea), “Arrakala apaindua” (H sektorea), “Buztinean grabatutako zaldiaren erlaitza” (I sektorea) eta “Aingeruaren Putzua” bera (J sektorea).

Amildegi honen hondoan, euriteen arabera beteago edo hustuago dagoen aintzira bat aurkituko dugu, “Niphargusen itsasoa” deiturikoa. Aurreraxeago kokaturiko erlaitz batzuetatik, leho estu batera irits gaitezke, 20 metroko sakonera duten putzu bertikal jarraitu bitara igarotzen uzten diguna, haitzuloaren azken gelara iristen uzteko, “Margoen Gela” azpian garatzen dena, baina 70 metro beherago. “Diskoen Aretoa” deitu zaio sektore honi, formazio geologiko bitxiengatik eman zaiolarik izen hori.

### Labar artea

Haitzuloko labar-artea 77 unitate grafiko indibidualizatuk (UG) osatua dago. Horietatik 15ek zaldiak irudikatzen dituzte, identifikatzen zailak diren 4 animaliekin batera, 3 bisonte, ahuntz bat, hainbat zeinu (laukizuzen formako bat, angelu-formako zeinu bat, klabiforme posible bat, bi marra bikoitz eta 4 puntu) eta borondatzkoak ez diren edo oso simpleak diren aztarnak (38 orban eta 8 lerro isolatu edo ez-figuratiboak). 6 sektoretan kokatzen dira: “Margoen gela” (E sektorea), haitzuloko sektore apaindu nagusia, “Putzuaren gela” (F sektorea), “Estutasuna” (G sektorea), “Arrakala apaindua” (H sektorea), “Buztinean grabatutako zaldiaren erlaitza” (I sektorea) eta “Aingeruaren putzua” (J sektorea). Pintura beltzak, batez ere, egur-ikatzarekin egindako pigmentu beltzarekin sortu ziren, kasu batzuetan koniferoa zela ikusi zena, burdin oxidoekin egindako pintura gorriekin batera, batzuetan alumino-silikatoekin (buztina) nahastuta, eta marroi kolorea haitzuloko buztinarekin egiten zen, batzuetan hezur erreakin ere nahastuta (Laval et al., 2017). Grabatuen kasuan, azaleko grabatu fina erabili zen (kasu batean pintura beltzarekin konbinatua). Gehienak finak eta azalekoak dira, nahiz eta kasu batzuetan sakonagoak izan, euskarria biguna denean. Ildo simpleak erabili ziren (ez anizkoitzak). Buztinezko gainazal bigunetan behatzarekin grabatu zen.

Beste arte higigarri eta zuzenki dataturiko labar artearekin duen antzekotasuna dela eta, Erdi eta Goi Madeleine artean apaindu zela esan genezake (ggb. duela 17,5 - 14,5 mila urte). Adibidez, begi itxia edo bisontearen surrealdea irudikatzeko modua, Madeleineko erdialdeko aroko beste irudikapen datatu batzuetan aurki liteke (adibidez, Covaciella, 17,3-16,9 ka artean datatua). Pintura-gelako bisonte handiaren kasuan (Etx.E.II.08), Tito

Bustilloko kobazuloan haren oso antzeko irudikapen bat dago, 16,454 – 15,275 mila urte artean datatu zena C14az (Forte, 2007). Gainera, buztinarekin egindako irudikapenak maiz agertzen dira batez ere Pirinioetan dauden beste koba batzuetan (Tuc d'Audoubert, Montespan, Bedeilhac, Erberua, Oxocelhaya, Fontanet edo Labouïche), nahiz eta Kantauri itsasoan (La Garma eta El Castillo) eta Dordoinan (Les Combarelles eta La Calèvie) ere ezagunak diren. Testuinguruarekin datatuak izan diren kasuetan (Tuc d'Audoubert, Etxeberri, Fontanet eta La Garma), datak Erdi Madeleine aldikoak izan dira. Azkenik, Etxeberriko testuinguru arkeologikoaren azterketak erradiokarbono-datazioak egitea ahalbidetu zituen, labar artearen kronologia estimatuarekin bat zetozenak, arestian aipatu ditugun ezaugarri tekniko eta estilistikoetan oinarrituta (Garate & Bourrillon, 2012). “Margoen Gelako” indusketako I. mailako hezur zati zehaztugabe batek 16,284 eta 15,729 kalibraturiko mila urteko (Beta-284730) arteko data itzuli zuen. Indusketa bereko II. mailak erretako beste hezur zati zehaztugabe batzuek kalibraturiko 16,958 eta 16,425 mila urteko data eman zuten (Beta-284733), eta lehen aipatutako *Littorina obtusata* oskol zatiak, 20.212 eta 19.625 kcal arteko data (Beta-284731). Laburbilduz, pentsa dezakegu Etxeberri labar arte konplexua Erdi Madeleine aldiari esleituta dakiokeela, kronokultura horren barruan hainbat fase salbuetsi gabe.

**S2: Aztertutako Unitate Grafikoen (UG) taula**

**1. SANTIMAMIÑE**

Kobazuloko 55 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (1. Taula, S2).

**2. LUMENTXA**

Kobazuloko 6 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (2. Taula, S2).

**3. ATXURRA**

Kobazuloko 136 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (3. Taula, S2).

**4. EKAIN**

Kobazuloko 91 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (4. Taula, S2).

**5. ALTXERRI**

Kobazuloko 130 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (5. Taula, S2).

**6. AITZBITARTE IV**

Kobazuloko 24 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (6. Taula, S2).

**7. AITZBITARTE V**

Kobazuloko 136 irudi sartu ditugu gure analisian, elementurik simpleenak (grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab.) eta beste kronologia bateko UGak baztertu ostean (7. Taula, S2).

**8. ALKERDI 1**

Kobazuloko 23 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (8. Taula, S2).

**9. ETXEBERRIKO KARBIA**

Kobazuloko 32 irudi sartu ditugu gure analisian, elementurik simpleenak baztertu ostean: grabatu edo marraztutako lerro simpleak, pigmentuzko orbanak, etab. (9. Taula, S2).

### **S3: 3D eskaneatzeko prozesua kobazulo bakoitzean**

#### **1. SANTIMAMIÑE**

2007an, Tokiko agintarieki Santimamiñe leizea laser eskaner bidez dokumentatzea eskatu zuten. Lan hau Virtualware enpresak egina. 2016an GIM Geomatics-ek egindako bigarren eskaneatze bat Aurreganbera eta Ganberara mugatu zen eta fotogrametria z osatu zuten. GIM Geomatics-eko espezialistek (Bayarri et al., 2021) aldez aurretik zehaztutako lan-fluxua grosso modo jarraitu zuen lan hark. Horrela, kobaren hiru dimentsioko erreplika bat sortu zen puntu-hodei gisa, FARO® LS 880 3D laser eskaner bat erabiliz (2007an), segundoko 120.000 neurketa egiteko gai zena eta FARO® X-130 bat (2016an) segundoko 960.000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen (2007an 3mm 10m bakoitzeko), % 85eko islapenarekin. Guztira 185 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentzia zko esferak eta helburuak erabiliz eredu orientatzeko. Modeloa Redmi Note 11 telefono mugikorreko GPS batekin geoerreferentziatu zen. Eskaneatze horiek erabiliz, datu gordinak CloudCompare erabiliz prozesatu ziren, puntu-hodeien lehen edizioa egin ondoren. Prozesua bizkorragoa izan zedin, koba hainbat segmentutan banatu zen, etengabeko estazioekin. Hauek softwarean kargatu eta gero fusionatu ziren. Behin hodei guztiak multzo bakar batean elkartuta, puntuak triangulazioaren bidez normalizatzen ziren (sentsoredun ‘scan grids’ bidez, orientaziorako metodo bera erabiliz, eta ‘minimum spanning tree’-ko sei baloredun ‘k nearest neighbour’ balio batekin). Puntu-hodei normalizatua sare bihurtu zen geroago ‘Poisson surface reconstruction’ prozesuarekin (8 metroko ‘octree depth’, eta 0,05 metroko batez besteko erresoluzioarekin). Azkenik, segmentu ezberdinak Meshlab® programan kargatu eta batu egin ziren; ondoren, geometria komunak garbitu eta edozein akats ezabatu zen. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

#### **2. LUMENTXA**

2012an labar-arteak aurkitu ondoren, ikerlari berberekin haitzuloa eskaneatu zuten (Garate et al., 2013b). 2016an, haitzuloa berriro eskaneatu zuen GIM Geomatics enpresak, FARO® Focus3D X-130 laser eskaner bat erabiliz, segundoko 960.000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 85eko islapenarekin. Guztira 111 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentzia zko esferak eta helburuak erabiliz eredu orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

Behaketa-metodoa diferentziala izan da, bai RTK behaketa estatikoen bidez, bai denbora errealean, erreferentzia-estazioetatik abiatuta, WGS84 sistema globaleko oinarrizko

elementuak lortuz eta gehikuntzak koordinatuz erreferentzia-ekipoetatik behatutako punturaino.

Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiquotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. GIM Geomatics-ek 3D eredu bat sortu zuen, 0,05 metroko doitasun geometrikoarekin. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

### **3. ATXURRA**

2015an labar-arteak aurkitu ondoren, haitzuloa berriro eskaneatu zuen GIM Geomatics enpresak, FARO® Photon 20/120 laser eskaner bat erabiliz, segundoko 976,000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 90eko islapenarekin. Guztira 538 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta helburuak erabiliz eredua orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

Behaketa-metodoa diferentziala izan da, bai RTK behaketa estatikoen bidez, bai denbora errealean, erreferentzia-estazioetatik abiatuta, WGS84 sistema globaleko oinarrizko elementuak lortuz eta gehikuntzak koordinatuz erreferentzia-ekipoetatik behatutako punturaino.

Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiquotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. GIM Geomatics-ek 3D eredu bat sortu zuen, 0,05 metroko doitasun geometrikoarekin. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

### **4. EKAIN**

Ekaingo kobazuloaren zati bati laser eskaner bidez eskaneatu zuten ALFA arte eta ZK Producciones enpresek 1998tik 2005era bitartean bere erreplika eraikitzea asmoarekin (“Ekainberri” izenekoa), Minolta™ markako VIVID 910/VI-910 bat erabiliz (koba partzialki erregistratu zen intereseko gune batuetan). 2021ean, haitzuloa berriro eskaneatu zuen GIM Geomatics enpresak, FARO® Focus3D X-330 laser eskaner bat erabiliz, segundoko 976,000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 90eko islapenarekin. Guztira 245 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta

helburuak erabiliz eredu orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

Behaketa-metodoa diferentziala izan da, bai RTK behaketa estatikoen bidez, bai denbora errealean, erreferentzia-estazioetatik abiatuta, WGS84 sistema globaleko oinarrizko elementuak lortuz eta gehikuntzak koordinatuz erreferentzia-ekipoetatik behatutako punturaino.

Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiguotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. GIM Geomatics-ek 3D eredu bat sortu zuen, 0,05 metroko doitasun geometrikoarekin. Gainera, kobazuloaren zati batzuk (batez ere B sektorea) I. Intxurbek prozesatu zituen zehaztasuna lortzeko, CloudCompare softwarea erabiliz, puntu-hodeien lehen edizioa egin ondoren. Prozesua bizkorragoa izan zedin, koba hainbat segmentutan banatu zen, etengabeko estazioekin. Hauek softwareean kargatu eta gero fusionatu ziren. Behin hodei guztiak multzo bakar batean elkartuta, puntuak triangulazioaren bidez normalizatzen ziren (sentsoredun ‘scan grids’ bidez, orientaziorako metodo bera erabiliz, eta ‘minimum spanning tree’-ko sei baloredun ‘k nearest neighbour’ balio batekin). Puntu-hodei normalizatua sare bihurtu zen geroago ‘Poisson surface reconstruction’ prozesuarekin (8 metroko ‘octree depth’, eta 0,05 metroko batez besteko erresoluzioarekin). Azkenik, segmentu ezberdinak Meshlab® programan kargatu eta batu egin ziren; ondoren, geometria komunak garbitu eta edozein akats ezabatu zen. Eedu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

## **5. ALTXERRI**

Altxerriko kobazuloaren zati bat CONSULTORES INDEPENDIENTES EN GESTIÓN DE RESURSOS NATURALES, S.A. (CRN) enpresakoek eskaneatu zuten Matpek™-en i-site 4400 laser eskaner bat erabiliz, eta GIM Geomatics enpresakoek, aurreko enpresak egindako dokumentazioa osatzeko asmoarekin. 2021ean, GIM Geomatics enpresakoak berriz kontratatu zituzten kobazuloaren eskaneatze berri bat egiteko asmoarekin. 2011n FARO® LS 880 laser eskaner bat erabili zuten, segundoko 120,000 neurketa egiteko gai zena, eta FARO® Focus3D X-330 2021ean, 960,000 neurketa egiteko gai dena segundoko. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen (2007an 3mm 10m bakoitzeko), % 85eko islapenarekin. Guztira 260 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta helburuak erabiliz eredu orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

Behaketa-metodoa diferenziala izan da, bai RTK behaketa estatikoen bidez, bai denbora errealean, erreferentzia-estazioetatik abiatuta, WGS84 sistema globaleko oinarrizko elementuak lortuz eta gehikuntzak koordinatuz erreferentzia-ekipoetatik behatutako punturaino.

Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiguotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. GIM Geomatics-ek 3D eredu bat sortu zuen, 0,05 metroko doitasun geometrikoarekin. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

## **6. AITZBITARTE IV**

2017an “Buztinean Modelaturiko Animalien Tximinia”-ko labar-arteak aurkitu ondoren, haitzuloa GIM Geomatics enpresak eskaneatu zuen, FARO® Focus3D X-330 laser eskaner bat erabiliz, segundoko 960.000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 85eko islapenarekin. Guztira 251 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta helburuak erabiliz eredua orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

Behaketa-metodoa diferenziala izan da, bai RTK behaketa estatikoen bidez, bai denbora errealean, erreferentzia-estazioetatik abiatuta, WGS84 sistema globaleko oinarrizko elementuak lortuz eta gehikuntzak koordinatuz erreferentzia-ekipoetatik behatutako punturaino.

Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiguotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. GIM Geomatics-ek 3D eredu bat sortu zuen, 0,05 metroko doitasun geometrikoarekin. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

## **7. AITZBITARTE V**

2015ean labar-arteak aurkitu ondoren, haitzuloa GIM Geomatics enpresak eskaneatu zuen, FARO® Focus3D X-130 laser eskaner bat erabiliz, segundoko 960.000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 85eko islapenarekin. Guztira 118 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta helburuak erabiliz eredua orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako

poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

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Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiguotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. GIM Geomatics-ek 3D eredu bat sortu zuen, 0,05 metroko doitasun geometrikoarekin. Eredua hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

## **8. ALKERDI 1**

2014an Bisonteen Galeria-ko labar-artea aurkitu ondoren, haitzuloa GIM Geomatics enpresak eskaneatu zuen, FARO® Photon 20/120 laser eskaner bat erabiliz, segundoko 976.000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 90eko islapenarekin. Guztira 74 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta helburuak erabiliz eredua orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

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‘Poisson surface reconstruction’ prozesuarekin (8 metroko ‘octree depth’, eta 0,05 metroko batez besteko erresoluzioarekin). Azkenik, segmentu ezberdinak Meshlab® programan kargatu eta batu egin ziren; ondoren, geometria komunak garbitu eta edozein akats ezabatu zen. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

## **9. ETXEBERRIKO KARBIA**

Haitzuloa 2022ko irailean eskaneatu zen, I. Intxaurbek zuzendutako “Ilunpeko Sekretuak Argiztatzen” proiektuaren barruan, GIM Geomatics enpresak eskaneatu zuen, FARO® Focus3D X-330 laser eskaner bat erabiliz, segundoko 976.000 neurketa egiteko gai zena. Zehaztasun operatiboari dagokionez, bere akatsa 25m bakoitzeko 2mm zen, % 90eko islapenarekin. Guztira 172 estazio erabili ziren lurpeko espazioaren forma neurtzeko, erreferentziazko esferak eta helburuak erabiliz eredu orientatzeko. Modeloa geokokatzeko, zenbait base ezarri ziren kobazuloaren kanpoaldean, egindako poligonalaren irteera eta helmuga gisa jardun zutenak. Base horiek frekuentzia L1+L2 bikoitzeko TOPCON markako HIPER SR modeloko GPS-GNSS bat erabili zen, GPS+GLONASS barneratuta zuena, bai REAL TIME (RTK) eta zehaztasun zentimetrikoa (2 zmtik beherako errorea).

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Behaketa-denborak satelite operatiboen kopuruak eta geometriak (GDOP), ionosferaren perturbazioek eta oinarrien luzerak zehaztu dituzte. Baseak kalkulatzeko eta anbiguotasunak ebazteko datuen tratamendua ekipoen softwarea erabiliz egin da, GPS behaketetatik ETRS89 sistemako puntu guztien koordenatuak lortuz. Eskaneatu horiek erabiliz, kobazuloaren modeloa eratu genuen, CloudCompare softwarea erabiliz, puntu-hodeien lehen edizioa egin ondoren. Prozesua bizkorragoa izan zedin, koba hainbat segmentutan banatu zen, etengabeko estazioekin. Hauek softwarean kargatu eta gero fusionatu ziren. Behin hodei guztiak multzo bakar batean elkartuta, puntuak triangulazioaren bidez normalizatzen ziren (sentsoredun ‘scan grids’ bidez, orientaziorako metodo bera erabiliz, eta ‘minimum spanning tree’-ko sei baloredun ‘k nearest neighbour’ balio batekin). Puntu-hodei normalizatua sare bihurtu zen geroago ‘Poisson surface reconstruction’ prozesuarekin (8 metroko ‘octree depth’, eta 0,05 metroko batez besteko erresoluzioarekin). Azkenik, segmentu ezberdinak Meshlab® programan kargatu eta batu egin ziren; ondoren, geometria komunak garbitu eta edozein akats ezabatu zen. Eredu hau lurzoruen plano bat sortzeko erabili da, sabaiak moztuz eta fitxategia .wrl motako fitxategi bihurtuz, ArcGIS® bidez ireki daitekeena.

**S4: Paisaia berreraikitzea duela 13,5 - 18,5 mila urte****1. SANTIMAMIÑE**

Santimamiñeko haitzuloa, oro har, jatorrizko haitza eta higadurak eta paragenesiak sortutako morfologiak leku askotan ezkutatu dituzten espeleotema ugariek bereizten dute. Sedimentu detritikoen depositu batzuk eta hareharri aloktonozko errekarrien terrazen lekuko batzuk ere badaude galerian zehar. Horrek guztiak hodiaren jatorrizko topografia aldatu du, buxadurak eta handitzeak tartekatuz (zenbait puntutan hogei metrorainokoak), jauzi bertikalak eta arrapala nabarmenak sortuz, baita alboetako pasabide ugari ere. Ebidentzia hauetako gehienak Madeleine aldian jada existitzen ziren, eta ondorengo aldaketa batzuk baino ezin ditugu adierazi, hala nola Holozénoko formazioen hazkundea galeria batzuetako solairuetan (goursak, koladak, etab.), baita berreraikuntza litokimiko espezifikoak ere. Ez da baztertzen Antzinako Pintura Aretoaren sarrera ixten zuten formazioen zati batek Holozénoko hazkunde geruzak izatea, baina pasabidearen itxura orokorra egungoaren oso antzekoa litzateke (Intxaubur et al., 2023b).

Gaur egun, bidea nahiko erraza da eskailera, baranda, pasabide eta zoru artifizialei esker, baina jatorrizko itxurari eutsiko balio, segurtasun eta progresio bertikaleko instalazio espeleologikoak (sokak, ainguratzeak, eskalak, etab.) beharko lirateke haitzuloa bisitatzeko. Bistan denez, aldaketa moderno horiek guztiak ez ziren existitzen Madeleine aldian, eta haitzuloaren 3D eredutik atera behar izan ziren Paleolitoko haitzulotik ahalik eta hurbilen zegoen eredu bat lortzeko.

*Ikerketa geomorfologikoari eta kobazulo honen berreraikuntzari buruzko informazioa hurrengo estekan aurki daiteke:*



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## 2. LUMENTXA

Lumentxa zahartzaroan dagoen leize-maila bat da, eta espeleotema oso zaharren belaunaldiak ditu. Ia ez dira ikusten espeleotema aktibo garrantzitsuen belaunaldi berriak. Gainera, haitzuloan forma korrosiboak ugari dira, beharbada pasabidearen mutur bakoitzean bi sarrera daudelako, eta leize-sabaiaren eta kanpoaldearen artean lodiera mehe bat dagoelako, galerian biofilm eta onddo ugari sartzen dituztenak. Lehen esan bezala, galeriaren azken zatian bloke batzuk daude. Kolapsoen antzinatasuna nolabait frogatu egin daiteke, izan ere lehen fase uberratsu baten ondoren, blokeak erori egin ziren eta berriro zeharkatu zituen beranduago ur korronte batek (paragenesia eratz). Fase honetan, eroritako bloke hauek freatikoki higatu ziren, formazio batzuekin batera. Laburbilduz, zaila da haitzuloak iraganean (eta batez ere Madeleine aldian) izango lukeen forma zehazki ziurtatzea, baina aldaketa nagusiak bi sarreratik hurbil egongo lirateke (kolubioi erako sedimentazioa eta giza okupazioaren aztarnak). Leizearen beste aldeetan, galeriako zenbait lekutan lurrazen maila baxuagoa zela suposa dezakegu (batez ere, infiltrazioak eragindako laminar motako ur-korroneek sartutako kolada aktiboengatik eta sedimentu finen metaketatik bakarrik aipatu ditzakegu), baina ez lukete gizakien igarobidean eragin handirik izango. Era berean, ezin dugu baztertu zenbait subsidentzia prozesuak gertatu izana galeriaren zenbait puntutan, beheragoko mailetara garraiatus goiko sedimentuak eta haietan batera dauden materialak, atariko zonaldean ziurtasun osoz geratu zirenak (Castaños, 2022; Gómez-Olivencia et al., 2022; 2023). Indusketa arkeologikoek eragindako aldaketa nagusiak berregin egin dira, kobazuloaren itxura paleolitikotik ahalik eta hurbilen dagoen eredua lortzeko.

Lagin.	$^{238}\text{U}$	$^{232}\text{Th}$	$^{230}\text{Th} / ^{232}\text{Th}$	$d^{234}\text{U}^*$	$^{230}\text{Th} / ^{238}\text{U}$	$^{230}\text{Th}$ Age (yr)	$^{230}\text{Th}$ Age (yr)	$d^{234}\text{U}_{\text{Initial}}^{**}$	$^{230}\text{Th}$ Age (yr BP)***
Zkia.	(pb)	(pt)	(atomikoa $\times 10^{-6}$ )	(neurtua)	(aktibitatea)	(zuzendu gabe)	(zuzendua)	(zuzendua)	(zuzendua)
<b>LUM-1</b>	16,5 $\pm 0,0$	31374 $\pm 631$	10 $\pm 0$	364,1 $\pm 6,3$	1,1027 $\pm 0,0136$	159312 $\pm 4435$	<b>115574</b> $\pm 34411$	505 $\pm 49$	<b>115503</b> $\pm 34411$
<b>LUM-2</b>	48,6 $\pm 0,2$	27939 $\pm 564$	38 $\pm 1$	172,0 $\pm 5,2$	1,3217 $\pm 0,0112$				>600ka
<b>LUM-3</b>	43,7 $\pm 0,2$	61781 $\pm 1261$	15 $\pm 0$	178,2 $\pm 7,2$	1,2802 $\pm 0,0131$				>600ka
<b>LUM-4</b>	40,5 $\pm 0,1$	677 $\pm 14$	1213 $\pm 24$	492,8 $\pm 2,8$	1,2293 $\pm 0,0031$	161544 $\pm 1093$	<b>161270</b> $\pm 1107$	777 $\pm 5$	<b>161199</b> $\pm 1107$
<b>LUM-6</b>	15,1 $\pm 0,0$	7171 $\pm 144$	42 $\pm 1$	171,3 $\pm 4,0$	1,2127 $\pm 0,0125$	432806 $\pm 51772$	<b>423650</b> $\pm 48218$	566 $\pm 80$	<b>423579</b> $\pm 48218$

**Table S4-1.** Santimamiñeko kobaren  $^{230}\text{Th}$  dataazioaren emaitzak (laginketa-puntuak 2, taulan ikus daitezke). Akatsa 2s errorea da. Laborategia: Xi'an Jiaotong Unibertsitatea. U dekadentzia-konstanteak:  $I_{238} = 1.55125 \times 10^{-10}$  (Jaffey et al., 1971) eta  $I_{234} = 2.82206 \times 10^{-6}$  (Cheng et al., 2013). Th decay constante:  $I_{230} = 9.1705 \times 10^{-6}$  (Cheng et al., 2013).  $*d^{234}\text{U} = ([^{234}\text{U}/^{238}\text{U}]_{\text{aktibitatea}} - 1) \times 1000$ .  $** \delta^{234}\text{U}_{\text{hasierakoa}}$  kalkulua  $^{230}\text{Th}$  (T) adinaren arabera egin zen, hau da,  $\delta^{234}\text{U}_{\text{hasierakoa}} = \delta^{234}\text{U}_{\text{neurtua}} \times e^{I^{234}\text{U} \times T}$ . Zuzendutako  $^{230}\text{Th}$  adinak, hasierako  $^{230}\text{Th}/^{232}\text{Th}$  erlazio atomikoa  $4,4 \pm 2,2 \times 10^{-6}$  dela gain hartzen du. Horiek dira oreka sekularrean dagoen material baten balioak. Lurreko  $^{232}\text{Th}/^{238}\text{U}$  kumulu balioa 3,8 izanda. Akatsek % 50 suposatzen dute arbitrarioki.\*\*\* B.P.-k “Oraina baino lehen” esan nahi du, non “Oraina” 1950 A.D. bezala definitzen den.

## 3. ATXURRA

Haitzuloan egindako azterketa geomorfologikoak (Arriolabengoa et al., 2020) hainbat sedimentazio-fase identifikatu zituen, kobaren Madeleine aldiko bisiten osteko garaietan gertatu zirenak. Horiek bat etorriko lirateke hainbat puntutan identifikatutako formazio litikimikoekin (batez ere zoladura motakoak, hala nola lurrazaleko gours-ak eta koladak), baita jatorri karstikoko betegarriekin ere, potentzia txikiko infiltrazio-urek sortuak.

Bestalde, endokarsterako sarbideek kolubioi motako sedimentu metaketak sorrarazi zituen, giza okupazioek haitzuloan sortutakoei gehituko zitzainak (lehen aipatu ditugun Holozeno betegarriekin batera).

Horrek guztiak aukera ematen digu haitzuloaren glaziazio berantiarrean egindako giza erabileraren osteko eraldaketak mugatzeko, batez ere haitzuloko bi solairuetako (Atxurra eta Armiña) kanpo-sektoreetan. Hau da, lurraren maila egungoa baino baxuagoa izango litzateke, eta horri esker, egun dauden sabai baxuko pasabideak gaur egun baino modu errazagoan zeharkatu ahal izango lirateke puntu askotan. Bestalde, eremu apainduan, galeriako punturik baxuenetan gertatuko lirateke aldaketarik handienak, eta, beraz, labar-arteak zuten sektoreek ia ez zuketen aldaketarik sumatuko Madeleine alditik gaur egunera arte. Identifikatutako aldaketa guztiak berregin egin ziren digitalki antzinako giza taldeek ezagutu zuten kobazuloaren ahalik eta leialena izango zen eredu bat lortzeko asmoarekin.

*Kobazulo honetan egindako ikerketa geomorfologikoari buruzko informazioa hurrengo estekan aurki daiteke:*



<https://onlinelibrary.wiley.com/doi/10.1002/jqs.3225>

#### 4. EKAIN

Ekaingo haitzuloak sedimentu aloktonoen era jatorri flubialeko zenbait metaketa ditu (detritikoak, errekarriak, etab.), espeleotemen belaunaldi ezberdinekin batera. Ekainen prozesu aktibo ugari dago, horien artean aipatzekoak direlarik infiltrazio-uren sarrerak, Madeleine garaian baxuago zeuden gainazal batzuk ezkutatzen dituzten hainbat eraketa aktiborekin batera (gours-ak, koladak, etab.).

Gainera, kobazuloan ez da inoiz esku hartu bisitak errazteko, eta, beraz, 1969an aurkitu zutenean bezala dagoela esan daiteke, lehendabiziko zatian zegoen katazuloa izan ezik, lubaki bat zulatuz handitu baitzen. Hala ere, indusketa honek pasabide honen estratigrafia ezagutzeko aukera eman zigun, eta, beraz, badakigu *Ursus Spelaeus*-en hezurrekin tartekatutako arkeologikoki antzuak ziren maila batzuez osatua zegoela gehienbat, lehen 10 zentimetroetan izan ezik, non ekarpen berriagoak egon zitezkeen, agian kobazuloan sartu ziren animaliek eragindako erauzteen emaitza (Altuna, 2019). Hori kontuan hartuta, indusketa arkeologiko horiek eragindako aldaketa nagusiak aldatu egin dira, haitzuloaren itxura paleolitikotik ahalik eta hurbilen dagoen eredu lortzeko.

## 5. ALTXERRI

Haitzuloa dagoen litologia berezia dela eta, oso zaila da zehatz-mehatz jakitea historiaurreko garaian kobazuloa nolakoa izango zen. Erorketa eta sakonune ugari daude, estratigrafia erlatiboan datatzea ia ezinezko diren egiturazko ahulezien ondorioz sortuak. Nolanahi ere, aurki dezakegun beste informazio batzuei esker, Altxerriko galeriak dekoratuak izan ziren garaian zuten itxura nolakoa zen jakin dezakegu.

Adibidez, eta Altxerri A-ra bakarrik mugatuz (Madeleine aldian bisitatu zuten haitzulo zatia), badakigu lehen irudi multzoan grabatuak zituen zati bat, hauek egin ostean hormatik askatu zela eta lurrera erori, harraskagailu baten gainean zehatz mehatz, ziur asko grabatu batzuk egiteko erabili zena (J. M. Barandiaranek bere egunkari pertsonalean adierazi zuen bezala). Gainera, sarreratik hurbilen dagoen eremuan material finen sedimentazio-prozesuak daude (buztinak eta limoak), infiltrazio-urek sortuak, kaltzio karbonatozko geruza laminatu meheek txandakatuak, historiaurreko bisita puntual batzuen aztarnak zituzten bi maila ezberdin (ziurrenik Paleolito garaikoak) gutxienez zibilatutako zituztenak. Bestalde, apaindutako sektoreen aurretik zegoen harri erorketak Madeleine aldian existitu behar zuen, haren gainazalean egurrikatz aztarnak baitzeuden, estaltzen zuen koladaren azaleko geruzaren azpian. Madeleine aldiko taldeek barrura sartzeko erabili zuten sarrerari dagokionez, zaila da haren itxura ezagutzea, berau ixten duten kolubioi geruzak arkeologikoki antzuak baitira (salbu eta goreneko koladatik -20 centimetroko kotara dagoen maila batek dituen egurrikatz bakan batzuk, zeinak J.M. Barandiaranen agindupean zeuden langileek 1962an ireki zuten lubakiaren estratigrafian ikus daitezkeen). Bi hipotesi proposa ditzakegu: sarrera handia zela, edo, aitzitik, oso tamaina txikia eta diskretua zuela. Altxerriko Madeleine aldiko grabatuak dituen zonaldean historiaurreko bizitokien aztarnen arrastorik ez dagoela ikusita, eta Madeleine garaiaz geroztiko beste giza erabilera batzuk egiaztatzen dituzten ebidentzia gutxi daudenez (Neolitoan datatutako zuzi kolpe bat izan ezik, M. A. Medina-Alcaide, Komunikazio Pertsonala), eta haitzuloa Oria ibaiaren gaineko leku estrategiko batean dagoela kontuan hartuta, bigarren hipotesia probableagoa dela uste dugu. Hori kontuan hartuta, haitzuloaren eredu aldatu egin zen, Paleolitoan izango zukeen etik itxuratik ahalik eta hurbilen agertzeko.

$^{230}\text{Th}$  dating results. The error is  $2\sigma$  error.

Lagin	$^{238}\text{U}$	$^{232}\text{Th}$	$^{230}\text{Th} / ^{232}\text{Th}$	$\delta^{234}\text{U}^*$	$^{230}\text{Th} / ^{238}\text{U}$	$^{230}\text{Th}$ Age (yr)	$^{230}\text{Th}$ Age (yr)	$\delta^{234}\text{U}_{\text{Initial}}^{**}$	$^{230}\text{Th}$ Age (yr BP)***
Zkia.	(pb)	(pt)	(atomikoa $\times 10^{-6}$ )	(neurtua)	(aktibitatea)	(zuzendu gabea)	(zuzendua)	(zuzendua)	(zuzendua)
ALT-4	148,5 $\pm 0,2$	20630 $\pm 414$	155 $\pm 3$	1103,9 $\pm 2,5$	1,3089 $\pm 0,0039$	95546 $\pm 452$	<b>93878 <math>\pm 1262</math></b>	1439 $\pm 6$	93807 $\pm 1262$
ALT-5	42,5 $\pm 0,2$	166400 $\pm 3382$	4 $\pm 0$	246,8 $\pm 6,1$	0,9124 $\pm 0,0106$	134218 $\pm 3232$	<b>-60411 <math>\pm 254901</math></b>	208 $\pm 120$	-60482 $\pm 254901$
ALT-6	43,6 $\pm 0,2$	74271 $\pm 1507$	4 $\pm 0$	280,0 ####	0,3981 $\pm 0,0056$	40033 $\pm 798$	<b>-7192 <math>\pm 36903</math></b>	274 $\pm 30$	-7263 $\pm 36903$

**Table S4-2.** Altxerriko kobaren  $^{230}\text{Th}$  dataazioaren emaitzak (laginketa-puntuak 2. taulan ikus daitezke). Akatsa 2s errorea da. Laborategia: Xi'an Jiaotong Unibertsitatea. U dekadentzia-konstanteak:  $I_{238} = 1.55125 \times 10^{-10}$  (Jaffey et al., 1971) eta  $I_{234} = 2.82206 \times 10^{-6}$  (Cheng et al., 2013). Th decay constante:  $I_{230} = 9.1705 \times 10^{-6}$  (Cheng et al., 2013). \* $\delta^{234}\text{U} = ([^{234}\text{U}/^{238}\text{U}]_{\text{aktibitatea}} - 1) \times 1000$ . \*\*  $\delta^{234}\text{U}_{\text{hasierakoa}}$  kalkulua  $^{230}\text{Th}$  (T) adinaren arabera egin zen, hau da,  $\delta^{234}\text{U}_{\text{hasierakoa}} = \delta^{234}\text{U}_{\text{neurtua}} \times e^{I_{234} \times T}$ . Zuzendutako  $^{230}\text{Th}$  adinak, hasierako  $^{230}\text{Th}/^{232}\text{Th}$  erlazio atomikoa  $4,4 \pm 2,2 \times 10^{-6}$  dela gain hartzen du. Horiek dira oreka sekularrean dagoen material baten balioak. Lurreko  $^{232}\text{Th}/^{238}\text{U}$  kumulu balioa 3,8 izanda. Akatsek % 50 suposatzen dute arbitrarioki. \*\*\* B.P.-k “Oraina baino lehen” esan nahi du, non “Oraina” 1950 A.D. bezala definitzen den.

## **6. AITZBITARTE IV**

Aitzbitarte IV-ko haitzuloak aldaketa ugari jasan ditu historian zehar, Goi Paleolitoan izan zezakeen jatorrizko morfologia erabat aldatu dutenak. Prozesu horietako batzuk, neurri batean, arrazoi naturalen ondorio izan daitezke, baina, batez ere, jatorri antropikokoak direnak aurki daitezke (haitzuloaren erabilera militarra edo industriala, bandalismoa, arpilatze arkeologikoa, zaintza arkeologikorik gabeko garbiketa, eta abar).

Haitzuloaren gaur egungo zoru-maila, galeria nagusiaren garapenaren gehieneko zatian, XX. mende hasierakoa da. Garai hartan, jatorrizko sedimentuaren zati handi bat hustu egin zen, lehergailuen bidez haitzulotik bertatik ateratako beste klasto eta harkaitz zati batzuekin batera, galeria nagusia ortogonalki zeharkatzen zituzten pitzadura sakonak estaltzeko asmoarekin (bertatik ibiltzea asko arriskatzen baitzuten), eta industriarako espazio erabilgarria zabaltzeko asmoarekin. Gainera, lurra detritu organikoz bete egin zen bertan perretxikoak landatzeko. Hormen eta zoruaren ertzak karea erabiliz desinfektatu zituzten, eta horrek arrasto zurixka nabarmenak utzi zituen galerian zehar. Gaur egun, sartutako lur guztiak trinkotu egin dira kobazuloak jasan dituen etengabeko bisitekin.

Altuera aldakor batean, gaur egungo zoru mailatik 1,50 metro eta 2 metro artean, testigu estalagmitiko batzuko ikusi daitezke, azpian sedimentu eseki aurki daitekeelarik noizbehinka (*Ursus Sp.*-ren hezurrekin). Testigu hauek, haitzuloaren antzinako lurzoru maila irudikatuko lukete. Gainera, lekuo haren gaineko sabaietan, K.o. XI. eta XIII. mendeen artean datatuak izan ziren zenbait marka beltz eta ikatz-metaketa ikusten dira, Erdi Aroko bisitek antzinako zoru maila hori erabiltzen zutela frogatzen dutenak (Garate et al. 2013d). Ez dago zalantzak handirik Goi Paleolitoko zorua maila honetan zegoelaren inguruan (edo hemendik oso gertu), testiguen azpian hartzen hezurrak aurkitzen baitira. Datu hau M. Arriolabengoa eta I. Intxaurbek egindako azterketa geomorfologikotik ateratako datazio erradiometrikoaren bidez baiezttatu zen. Berriro adierazi nahi dugu galeria nagusiko jatorrizko bidea zulo arriskutsu askok zeharkatu egiten zutela. Gainera, sabaiak altuera txikiagoan zeuden leku askotan, eta, beraz, zaila izango zen Aitzbitarte IV-ren paleotopografian zehar ibiltzea.

Gainera, ezin da baztertu Holozeno garaian biokorrosio-prozesuak ere ugaritu izana (galerian bizi den kiroptero-koloniek sortuak), eta horiek, Kärcher bidez (presio-uren garbitzailea) haitzuloak XX. mendearren azken hamarkadan jasan zituen garbiketa-prozesu antropikoekin batera, aztarna arkeologiko ugari suntsitu ahal izan zituzzela pentsa daiteke (tartean, labar-artea). Izan ere, apaindutako sektore nagusien itxura, apaindutako haitzulo handiago bateko sektore terminalena da (O. Rivero, Komunikazio Pertsonala). Hori guztia kontuan izanik, eta V. Bayarrik eta J. Herrerrak (GIM Geomatics) haitzuloa zeharkatzen zuten zuloen sakonera ezartzeko egindako ikerketa geofisiko batetik ateratako datuak erabiliz, haitzuloaren eredua aldatu dugu, Madeleine aldean, bisitatu eta apaindu zenean, izango zukeenek hurbilago dagoen itxura erakusten duen eredu bat lortzeko asmoarekin.

Lagin	$^{238}\text{U}$	$^{232}\text{Th}$	$^{230}\text{Th} / ^{232}\text{Th}$	$d^{234}\text{U}^*$	$^{230}\text{Th} / ^{238}\text{U}$	$^{230}\text{Th}$ Age (yr)	$^{230}\text{Th}$ Age (yr)	$d^{234}\text{U}_{\text{Initial}}^{**}$	$^{230}\text{Th}$ Age (yr BP)***
Zkia.	(pb)	(pt)	(atomikoa x10 <sup>-6</sup> )	(neurtua)	(aktibitateay)	(zuzendu gabea)	(zuzendua)	(zuzendua)	(zuzendua)
IV-1	1412,2	$\pm 31,2$	1808260	$\pm 56503$	4 $\pm 0$	200,5 $\pm 12,0$	0,3273 $\pm 0,0085$	34386 $\pm 1120$	-1820 $\pm 27066$
IV-2	35,7	$\pm 0,3$	119986	$\pm 2516$	7 $\pm 0$	408,8 $\pm 7,6$	1,4200 $\pm 0,0144$	284537 #####	210197 $\pm 81093$
IV-3	31,0	$\pm 0,2$	12156	$\pm 249$	40 $\pm 1$	344,4 $\pm 6,5$	0,9527 $\pm 0,0076$	124554 $\pm 2113$	116582 $\pm 5990$
IV-4	28,0	$\pm 0,2$	18226	$\pm 377$	27 $\pm 1$	525,6 $\pm 9,1$	1,0840 $\pm 0,0077$	122264 $\pm 2013$	110744 $\pm 8428$
IV-5	977,8	$\pm 9,9$	1244490	$\pm 37839$	9 $\pm 0$	1642,5 $\pm 11,8$	0,7077 $\pm 0,0173$	32900 $\pm 924$	18611 $\pm 10356$
IV-6a	47,6	$\pm 0,3$	233019	$\pm 4787$	4 $\pm 0$	552,8 $\pm 8,9$	1,1594 $\pm 0,0139$	132892 $\pm 3208$	-60047 $\pm 204463$
IV-6b	50,4	$\pm 0,5$	275312	$\pm 5815$	4 $\pm 0$	543,4 $\pm 12,8$	1,2833 $\pm 0,0178$	163404 $\pm 5628$	-60535 $\pm 254241$
								458 $\pm 285$	-60606 $\pm 254241$

**Table S4-3.** Aitzbitarte IV eta V-eko kobaren  $^{230}\text{Th}$  dataazioaren emaitzak (laginketa-puntuak 2. taulan ikus daitezke). Akatsa 2s errorea da. Laborategia: Xi'an Jiaotong Unibertsitatea. U dekadentzia-konstantea:  $I_{238} = 1.55125 \times 10^{-10}$  (Jaffey et al., 1971) eta  $I_{234} = 2.82206 \times 10^{-6}$  (Cheng et al., 2013). Th decay konstante:  $I_{230} = 9.1705 \times 10^{-6}$  (Cheng et al., 2013). \* $d^{234}\text{U} = (I^{234}\text{U}/I^{238}\text{U})_{\text{aktivitatea}} - 1 \times 1000$ . \*\*  $\delta^{234}\text{U}_{\text{hasierakoa}}$  kalkulua  $^{230}\text{Th}$  (T) adinaren arabera egin zen, hau da,  $\delta^{234}\text{U}_{\text{hasierakoa}} = \delta^{234}\text{U}_{\text{neurtua}} \times e^{I^{234}\text{X}T}$ . Zuzendutako  $^{230}\text{Th}$  adinak, hasierako  $^{232}\text{Th}/^{232}\text{Th}$  erlazio atomikoa  $4,4 \pm 2,2 \times 10^{-6}$  dela gain hartzen du. Horiek dira oreka sekularrean dagoen material baten balioak. Lurreko  $^{232}\text{Th}/^{238}\text{U}$  kumulu balioa 3,8 izanda. Akatsek % 50 suposatzen dute arbitrarioki. \*\*\* B.P.-k “Oraina baino lehen” esan nahi du, non “Oraina” 1950 A.D. bezala definitzen den.

## 7. AITZBITARTE V

Haitzuloak bi sektore oso desberdin ditu Historiaurrean erabili zenetik gertatu diren aldaketei dagokienez. Alde batetik, sarrerako sektoreek paleolito osteko erabilera izan dute, eta horrek sedimentazioa sartu du haitzuloan. Gainera, “Felix Ugarte Elkarte”-ko kideek 2015ean ireki zuten katazuloa Holozénoko materialez itxia zegoen (ziurrenik Brontze Arokoak diren zeramika puskekin, presioz landutako silex xafla bat barne). Pasabide honek bifurkazio bat du bere lehen zatian, eta eskuinaldeko adarrak (gaur egun oraindik kolubioi bidezko materialek estalia jarraitzen duena) haitzuloko sektorerik sakonenetara zuzenean (eta era infinituki errazago batean) iristeko aukera emango luke. Gaur egun, ezkerreko adarra baino ez dago irekita. Beraz, gaur egun beharrezkoa da 25 metroko zulo baten gainetik zeharkatzea “Hartzen Galeriara” iristeko. Zulo hau, beheko mailarekin bat egiten duena izango litzateke (Aitzbitarte IV kobarekin).

Bestalde, leizeetako hortzek zoruan egindako hobit ugariek eta “Hartzen Galeria”-ko hormetan aurki ditzakegun atzapar markek adierazten dutenez, haitzuloko sektore sakon horiek ia ez dute ekarpen sedimentariorik jaso duela 25.000 bat urtetik hona. Jakina, bandalismoak eragindako aldaketa handiak azpimarratu behar dira (graffitiak, sute handien sorrera, zabor-pilaketa, eta abar), nahiko harrigarriak direnak sektore horretara iristeko zailtasuna kontuan hartuta (25 metroko tximinia bertikala igo behar da). Zorionez, prozesu horiek ez dute galeriaren morfologia aldatu.

Azkenik, haitzuloaren azken sektorera sartu baino lehen (bertan daude Gravette aldiko eta erdi Madeleine aldiko kronologiadun labar-artez apainduriko panelak), adar bat dago galeriaren ezkerraldetik abiatzen dena, eta azken puntu estu batera iristeko aukera ematen duena, non betekin detritiko (flubiokarstiko) dagoen, zeina koladez tartekatzen den. Betegarri horren ostean, 7 metroko distantzia duen tarte ezezagun bat legoke, eta honen ostean Aitzbitarte IV-an buztinean modelatutako animalien sektoreko azken gela apaindua egongo litzateke. Betekin hori ez zen datatu (paragenesi fase zaharrei dagokiela

dirudien arren), ikusi baitzen hau kendu arren pasabide horrek izango zituen dimentsio guztiz estuek (eraketa estalagmitikoaren azken faseetako batzuk ezabatuta ere) ezinezkoa egingo zutela pertsona batek bi haitzuloen artean igarotzea. Beraz, horrek baieztago luke Magdalenako taldeak Aitzbitarte IV-ko galeria nagusitik sartu zirela apainduriko leku honetara, gaur egun egiten duten bezala.

## **8. ALKERDI 1**

Alkerdi 1eko galerietan ezaugarri geomorfologiko eta sedimentario ezberdinak ikusten dira, hala nola sabai lauak, sabai-kanalak (batzuetan meandro itxurako pasabideak eratzen dituztenak), zintzilikatutako sedimentuak eta formazio estalagmitikoak (zorukoak edo hormako koladak, batzuk aktiboak). Alkerdi 1 apaindu zuten gizartea igaro ondoren (Madeleine aldikoak), bigarren unitate aloestratigrafikoa osatuko litzateke, eta batez ere hainbat koladaz osatua egongo litzateke, horietako batzuk gaur egun aktibo daudelarik (Aranzadi Zientzia Elkartea, 2016).

Ataria nahiko espazio deserosoa da, sabai baxukoa, eta puntu horretan egindako indusketeak Aurignac eta Gravette aldiko okupazio-mailak baino ez dituzte dokumentatu hemen; beraz, badakigu espazio hori Madeleine garaian jada sedimentuz josita zegoela.

“Mogote estalagmitikora” (A sektorea) sartzeko aukera ematen duen ezkerreko adarrari dagokionez, lurra bigarren belaunaldiko sedimentu detritiko eta estalagmitikoz osatuta dago, baina, edonola ere, uste dugu Madeleine aldia baino lehenagokoak direla, galeriaren amaieran dagoen koladak adierazten duen bezala, zeina gizarte paleolitikoek erabili baitzuten gainean labar artedun irudiak egiteko.

Haitzuloaren erdialdeko zonaldeari dagokionez, Madeleine garaian existituko ez ziren espeleotema aktiboz estalia dago, espazioa txikiagotzen dutenak eta, beraz, eremu honetatik igarotzea gaur egun baino zertxobait errazagoa litzateke. Berdina gertatuko litzateke kobazuloaren bigarren areto nagusian, eta D sektorearen edo “Bisontearen Galeria”-ren hasieran. Hala ere, galeria honen azken eremua lur detritiko batek osatzen du, klastoekin, bigarren unitate aloestratigrafikoari legokiokeena. Hala ere, Paleolitoko fasiei (ikatza, okrea, hezurrak, etab.) egotz dakizkiekeen material arkeologikoak daudenez, horietako batzuk grabatuei eta pinturei egotz dakizkiekeen garaikoak, badakigu hango morfologia oso gutxi aldatu dela. Hori kontuan hartuta, kobazuloaren 3D eredua aldatu egin da giza taldeek Madeleine aldian ezagutu zuten kobazulotik ahalik eta gertuen dagoen eredu bat lortzeko asmoarekin.

## **9. ETXEBERRIKO KARBIA**

Ikerketa geomorfologiko baten bidez haitzuloaren sedimentazio eta higadura prozesuak identifikatzen saiatu ginan eta kronologia erlatibo bat ezartzen estratigrafiaren bidez.

Kobazuloaren ezaugarri berezi gisa, biokorrosioak aldatutako eremu handiak daudela aipatu dezakegu, baina, nahiz eta ikusi dugun saguzar metaketa berriak daudela, uste dugu

orokorrean antzinako prozesuak direla, Paleolito garaiko gizartean iraganaldiaren aurrekoak. Ondorio honetara iritsi gara ikusi dugulako estratigrafikoki, biokorrosioak gehien eragindako formazioak antzinako espeleotema-belaunaldiak direla. Gainera, kasu batzuetan (Etx.E.I.01 zeinuaren kasuan), labar artea egin zutenean, aurretik saguzarrengatik herdoilduta zegoen azalerak erabili izanaren ebidentziak aurkitu ditugu.

Bestalde, sakonune eta lur-jausiak batez ere sarreran bertan dauden eremuetan aurki ditzakegu. Zona honetan zaila da ziurtatzea zein garaitakoak diren. Hala ere, eremu sakonenetan ere lur-jausien aztarnak aurkitu ditugun arren (adibidez, “Putzuaren Gelan”), hauek espeleotemaz estalita daudela ikusi daiteke, eta, beraz, haitzuloa eratzeko gertaeren kronologia erlatiboan koka daitezke, prozesuen estratigrafia orokorrari esker. Honi esker uste dugu erori hauek Madeleine garaiko artistak pasatu baino aurretikoak direla. Horregatik erabaki dugu gure analisi espaziala gaur egungo atariaren atzeko alde batetik hastea, ezinezkoa baitzaigu atariak Madeleine aldian zuen itxura ziurtasunez jakitea.

Leizearen barruko zonetan ikus ditzakegun Madeleine garai osteko aldaketen artean, “Gours-en galeriatik” jaisten den maldaren zorua estaltzen duen kolada handia legoke, izena ematen dioten gours aktiboekin batera. Galeria horren goialdean, han dagoen burdin hesitik gertu, zonaldearen sedimentazioa ezagutzeko aukera ematen zuen indusketa bat egin zen, Holozenoari egotz zitekeen metro bateko gutxiengoko detritu bidezko sedimentazioa dagoela egiaztatuz, zeinen artean Gours-itxurako eraketa litokimikoen faseak tartekatuko liratekeen, noizbehinkako giza presentzien arrastoekin, itxuraz Kalkolito eta Erromatar Garaien (Ebrard, 2013a) artean datatutako hileta-jarduerei lotuak.

Hiru laku intermitenteen sektorean, zaila da zehatz-mehatz jakitea espazio horiek zer forma izango zuketen Paleolitoan; izan ere, uholdeek material detritiko fina, lupatz eta buztin formakoa, metatu dute arro horietan, eta bertara isuritako koladek kaltzio karbonatozko azaleko geruzak utzi dituzte. Nolanahi ere, ez dugu uste Madeleine garaitik hona espazio horietan gertatu diren aldaketek gehiegi aldatu dituztenik dekoratutako sektoreen irisgarritasun-ezaugarriak. Gainera, barneko arkeologia-testuinguruaren bi elementu posibleren existentziak (II eta III lakuen arteko balizko sute baten aztarnak eta Etx.D.I.01-03 panel apaindua hirugarren lakuaren inguruan) ziurtatzen du espazio zehatz horiek ez dutela aldaketa handirik jasan.

Beste gai interesgarri bat “*Salle des Peintures*”-era sartzeko igaro beharreko bidea ixten zuen eraketa estalagmitikoa da. Uste dugu estratigrafikoki formazio hau Magdalenakoa baino zaharragoa den belaunaldi bati dagokiola, baina zalantzak sortzen ditu. Leizearen azken zatia, oztopo horretatik haratago, 1934an aurkitu zuten. Aurkitu zuten esploratzaleek adierazi zuten estugunearen bigarren atala “*Coup de marteau*” (mailu kolpe bidez) erabiliz ireki zutela (J. Labeyrie, Komunikazio pertsonala). Orain, katazuloaren amaieran, itxi zuen estalagmitaren/zutabearen orbaina ikus dezakegu. Hipotesi gisa, esan dezakegu Madeleine garaiko gizakiak iritsi zirenean, pasabidea itxitia aurkitu zutela antzinako belaunaldi bati zegokion zutabe/estalagmita honengatik. Baino geratzen zen zirrikituak garbi erakusten zuen kobazuloak aurrera jarraitzen zuela, eta horregatik ireki zuten pasabidea. Alde horretatik, haitzuloaren barne-testuinguru arkeologikoan aurkitutako silexezko piezen erabilera-aztarnen azterketak ziurtasun

handiz baiezatzen du pieza horiek estalagmitak zulatzeko/lantzeko erabili zirela (Rios-Garaizar et al., 2017).

Geroago, Holozenoaren etorrerarekin, espeleotema berri batzuk sortu ziren kobazulo osoan, eta beste batzuk berraktibatu egin ziren, geruza eta formazio berriak sortuz. Litekeena da Glaziar ondorengo ur tantek (Holozeno garaian?) Madeleine garaiko gizakiek hautsitako espeleotemaren orbaina erabili izana bertatik errazago ibiltzeko, eta leku berean zutabe estalagmitiko berri bat sortu izana. Formazio berri hau 1930eko hamarkadan hautsi zen.

Azkenik, garai modernoetan kobazuloan gizakiek eragindako aldaketak azpimarratu behar ditugu. 1950eko maiatzean, Etxeberriko Karbiako labar-arteak aurkitu zen, eta haitzulo honen ondare historikoa hein handi batean hondatu zuten eraldaketa-prozesuak hasi ziren (kobazuloa itxita egon arren eta labar-artearen existentzia kobazuloa bisitatzen zuten espeleologoengatik ezaguna zen arren). “*Salle des Peintures*” (E sektorea) eta “*Salle du Gouffre*” (F sektorea)-en oso ugariak diren inskripzio eta grafitez gain, “*Fissure Ornée*” (H sektorea) delakoan, batez ere, eta J (“*Puits de l' Ange*”) sektoreetako gainazal apainduen kontra igurtziek sortutako kalteak azpimarratu behar ditugu. Sektore horietan katalogatutako unitate grafikoen ia % 100ek nolabaiteko kalteak jasan dituzte aurkitu zituztenetik. Kalte horietako batzuk ia saihestezinak dira, irudien egoera dela eta. H sektorekoak 50 zentimetroko zabalera duen arrakala oso estu batean eginak daude, 16 metroko zulo baten gainean; beraz, arnesak eta zintzilik dauden mosketoia (oztopo bertikalaren presentziagatik ezinbestekoak) harkaitzaren kontra igurzten dira eta labar irudiak kaltetu dituzte urteetan zehar. J sektoreko irudiak I. sektorerako ibilbide bakarrean daude, eta, beraz, oso zaila da haien marruskadura saihestea.

Hori kontuan hartuta, kobazuloaren 3D eredu eraldatu egin da giza taldeek Madeleine aldian ezagutu zuten kobazulotik ahalik eta gertuen dagoen eredu bat eratzeko.

## **S5: Parametro espazialen analisia**

ArcMap 10.5 softwarearen bidez Pythonen gidoi bat erabiliz, irudien ezaugarri espazial hauek aztertu ziren. Azterketa guztia jasotzen duen piton gidoia hemen eskura daiteke: <https://github.com/inakiintxaurbe/espacial-detencion-comunicacion-related-to-magdalenian-cave-art>.

Scripta instalatzeko sistema gidoian bertan, irakurketa-fitxategian eta aurreko lanetan adierazi da (Intxaubre et al., 2021; 2022).

Koba bakoitzeko UG bakoitzaren azterketa espazialaren emaitzak jasotzen dituen taula bat egin dugu<sup>57</sup>, baita datu hauek dituzten lau mapa ere: sartzeko zailtasunen mapa metatua, baita koba bakoitzaren sarbide zailtasun nagusiak ere, urrunen dagoen labar irudiraino, eta irisgarritasun kosturik handienera (iristeko zailtasunei dagokienez).

### **1. SANTIMAMIÑE**

Haitzuloaren 55 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (1. Taula, S5).

### **2. LUMENTXA**

Haitzuloaren 6 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (2. Taula, S5).

### **3. ATXURRA**

Haitzuloaren 136 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (3. Taula, S5).

### **4. EKAIN**

Haitzuloaren 91 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (4. Taula, S5).

### **5. ALTXERRI**

Haitzuloaren 130 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (5. Taula, S5).

### **6. AITZBITARTE IV**

Haitzuloaren 24 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (6. Taula, S5).

### **7. AITZBITARTE V**

Haitzuloaren 5 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. Eta beste kronologia bateko UGak alde batera utzita (7. Taula, S5).

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<sup>57</sup> Taulak ingelesezko bertsioan daude eskuragarri.

**8. ALKERDI 1**

Haitzuloaren 23 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (8. Taula, S5).

**9. ETXEBERRIKO KARBIA**

Haitzuloaren 32 irudi aztertu ditugu elementu simpleenak alde batera utzita: lerro grabatu edo pintatu simpleak, pigmentu-orbanak, etab. (9. Taula, S5).

### *S6: Analisi estatistikoa. Emaitzen deskribapena*

Hurrengo QR kodean R estudio programaren kodea gehituko dugu “Reprex hautaketa” funtzioarekin, hemen eskuragarri: <https://github.com/inakiintxaurebe/espektial-detekzionismoa-relacionad-magdalenian-cave-art>.



Zenbait iruzkin sartu ditugu analisiak azaltzen dituen informazioarekin.

Hurrengo atalak banako eta aldagai guztien laburpena egiten du, bai kategorikoak, bai kuantitatiboak<sup>58</sup>.

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<sup>58</sup> Estatistikak ingelesezko bertsioan daude eskuragarri.