

## Early Neolithic human remains from Galería del Sílex in Sierra de Atapuerca, Burgos, Spain

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### ABSTRACT

We present new datings and a new anthropological study of Early Neolithic human remains found in Galería del Sílex in 1979. This gallery is part of the Cueva Mayor system in the Sierra de Atapuerca. The human fossils attributed to the Neolithic period correspond to a minimum number of three individuals that have been radiocarbon dated to the last third of the 6th millennium cal BCE. Thus, the fossils from Galería del Sílex are among the oldest Neolithic human remains in the interior of the Iberian Peninsula. The human remains from Galería del Sílex were not found within a domestic context of human occupation of the cave, but rather within two pits (simas) located more than three hundred meters from the ancient entrance. This suggests that Galería del Sílex could have been an area reserved for depositing deceased humans during the Early Neolithic. Given the scarcity of this kind of funerary cave in the Spanish northern plateau during the Early Neolithic, the data from the Galería del Sílex add to our knowledge of human mortuary behavior during this period. In addition to the Galería del Sílex, there are two other well-known Neolithic sites in Sierra de Atapuerca: El Portalón in Cueva Mayor, which was a human occupation site, and Cueva del Mirador, which was used for livestock stabling and exploitation. Considered altogether, the emerging evidence provided by these three sites makes Sierra de Atapuerca increasingly relevant as a source of information about Early Neolithic people from the interior of the Iberian Peninsula.

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## 1. Introduction

The available evidence shows that the Neolithic reached the Iberian Peninsula in the middle of the VI millennium BCE (Fig. 1, Table 1). Most of the sites of this period with human remains are located on the Mediterranean coast, although the three oldest well-dated sites are located inland on the peninsula (Fig. 1, Table 1). The current consensus is that the arrival of the first Neolithic populations to the Iberian Peninsula took place by sea (Zilhão, 2001; Isern et al., 2017; De Vareilles et al., 2020), and previous DNA studies placed the origin of the Peninsula's first Neolithic settlers in Anatolia (Hofmanová et al., 2016). After the first Mediterranean settlements, Neolithic populations expanded along the coast, occupying the southern half of the Atlantic coast (Isern et al., 2017). Almost at the same time, the interior of the peninsula was colonized following the paths of the main river valleys (Rojo Guerra, 2014), mainly that of the Ebro River (Fig. 1, Table 1). The arrival of the Neolithic to the Iberian Peninsula influenced local Mesolithic populations, who assimilated Neolithic customs and technology (Alday, 2012; Alday et al., 2012).

Human remains discovered at Early Neolithic sites on the Iberian Peninsula are not abundant and are found in different contexts: caves, rock shelters and open-air sites (Table 1). Early Neolithic human remains from the Mediterranean and Atlantic coasts have mainly been found in caves, whereas in the inland regions of the Iberian Peninsula, Early Neolithic human remains have largely been discovered in open-air burials (Jiménez, 2019). These open-air burials are also prevalent in the Ebro River basin, even though this region includes numerous caves

where cadavers could have easily been deposited. Indeed, there were only two known caves in this area with Early Neolithic human remains: Els Trocs and Chaves (Utrilla et al., 2008; Alt et al., 2020). In both caves, human remains appeared in domestic contexts (Rojo et al., 2020; Utrilla et al., 2008), suggesting there was no special place reserved for the burial of their dead.

Besides the important Pleistocene sites, the Sierra de Atapuerca also contains Holocene sites of great interest, such as Cueva del Mirador (Fig. S1), El Portalón, and Galería del Sílex (Fig. 2). The first systematic interventions in these Holocene sites were made by the team of J.M. Apellániz in El Portalón deposits and took place between 1972 and 1983 (Clark, 1979; Apellániz and Domingo, 1987; Mínguez, 2005; Carretero et al., 2008). New excavations were started again in El Portalón in 2000 (Carretero et al., 2008), and have documented a complete sequence from the Early Neolithic to the Iron Age with sporadic occupations during the Roman period and the Middle Ages (Carretero et al., 2008). Human remains have been recovered from the Early Neolithic, the Chalcolithic (Pérez-Romero et al., 2017) and Bronze Age (Günther et al., 2015; Valdiosera et al., 2018), and, at present, the Neolithic levels are under excavation and study. In addition to El Portalón, another important Holocene site in the Sierra de Atapuerca, called El Mirador, is also being excavated since 2000. This site contains archaeological levels from the Early Neolithic to Bronze Age (Vergès et al., 2016) and has yielded human remains from the final Neolithic, Chalcolithic and Bronze Age levels (Vergès, 2022).

The Galería del Sílex (GS) was discovered in 1972 and stands out for a series of paintings and rock engravings on the walls of some areas

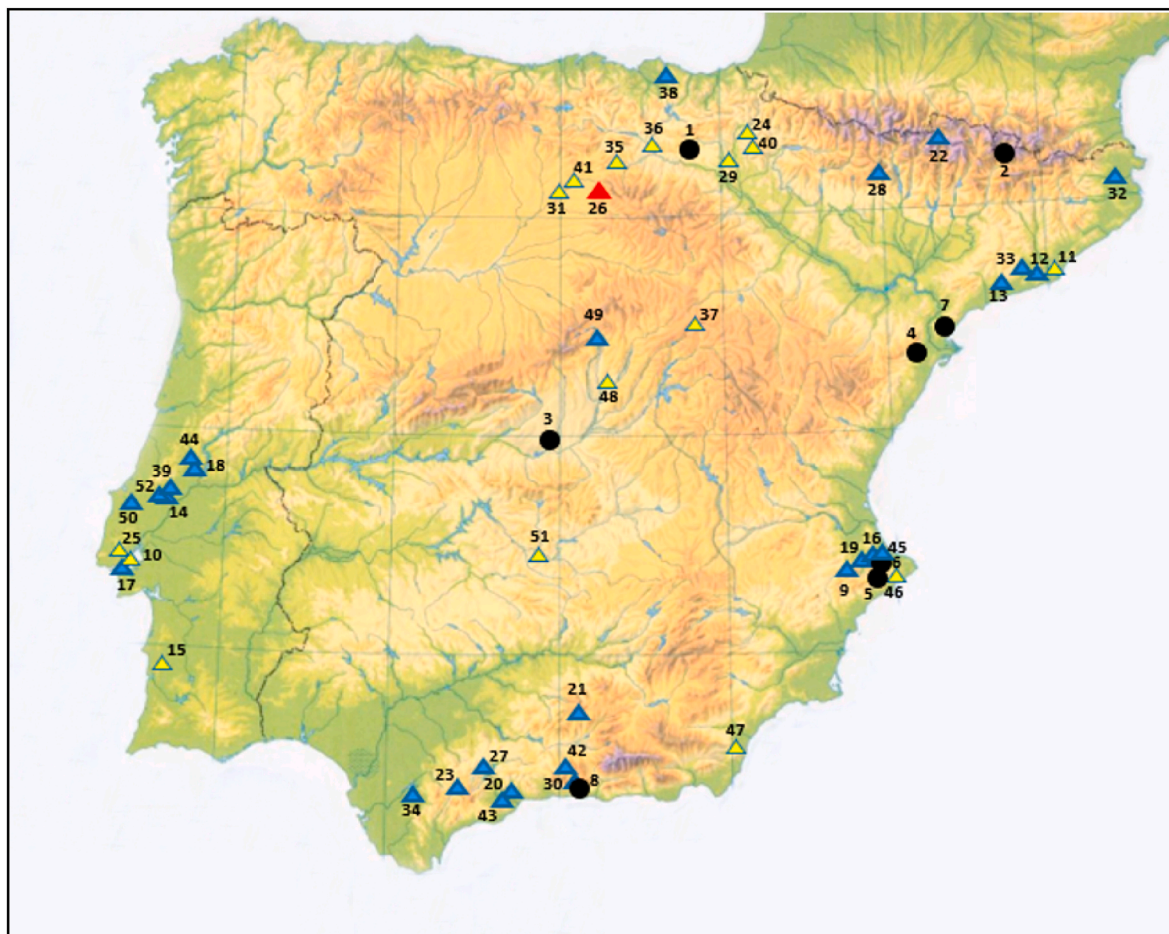


Fig. 1. Geographic distribution of Early Neolithic sites (before 4800 cal BCE) in the Iberian Peninsula. Only sites with dating results from bones (human or domestic fauna), seeds and grains are shown. Black circles: sites without human remains. Triangles: sites with human remains. Blue triangles: cave burials. Yellow triangles: open-air burials. Red triangle: Galería del Sílex. Sites are in numerical order from oldest to most recent, following Table 1.

(Apellániz and Uribarri, 1976). In addition to these panels, numerous human remains, ceramic fragments and faunal remains were also discovered scattered on the surface in different areas of the gallery. In the campaigns carried out between 1974 and 1983, an important collection of human remains, ceramic fragments and faunal remains were collected (Apellániz and Domingo, 1987). Among the human remains, two sets stand out because they were isolated and deposited at the foot of two pits (called Sima A and Sima B) (Fig. 3), located more than 300 m from the entrance. Although all human remains from GS were initially assigned to the Bronze Age (Galera, 1986), ceramics attributed to the Early Neolithic have also been reported, associated with the human remains found at Sima A and Sima B (Apellániz and Domingo, 1987). This situation suggests that these human remains could also correspond to Early Neolithic people, leading us to conduct further in-depth research to determine their actual age.

In this context, the present study provides the results of the dating

carried out on four human bones, likely representing three different individuals, coming from Sima A and Sima B. We also provide a description of the taphonomic context in which these human remains appear, as well as a review of the Minimum Number of Individuals and sex and age diagnosis provided by Galera (1987).

## 2. Materials and methods

### 2.1. History of discoveries at Galería del Sílex

Galería del Sílex is part of the upper level of galleries of the Cueva Mayor-Cueva del Silo karstic system (Fig. 2). Cueva Mayor is located in Sierra de Atapuerca, placed about 15 km east of the city of Burgos (Ortega and Martín, 2012; 2013, 2018). This gallery was discovered in 1972 by members of the Edelweiss Speleology Group from Burgos (Martín et al., 1981), who opened an access point from the adjacent El

**Table 1**

Main sites from the Early Neolithic (before 4800 cal BCE) with human remains in the Iberian Peninsula. The oldest sites (prior to 5500 BCE) have also been included even if they do not contain human remains. Only sites with dating results from bones (human or domestic fauna), seeds and grains are shown. Only the oldest dating of each site is presented.

Site	Human remains	Type of site	Date BP	Cal 2σ BCE	Reference
1. Peña Larga IV	No	Rock shelter	6720 ± 40	5715–5561	Fernández Eraso, 2011
2. Balma Margineda	No	Rock shelter	6690 ± 30	5662–5556	Manen et al. (2019)
3. La Paleta	No	Open air	6660 ± 60	5650–5450	Jiménez-Guijarro et al. (2008)
4. Guixeres Vilobí	No	Open air	6655 ± 45	5660–5500	Oms et al. (2014)
5. Mas d'Is	No	Open air	6627 ± 38	5624–5507	Bernabeu Auban and Pardo-Gordó, 2020
6. Cova d'En Pardo	No	Cave	6610 ± 40	5620–5480	Soler Díaz et al., 2011
7. Caserna Sant Pau del Camp	No	Open air	6590 ± 30	5615–5585	Gómez Bach and Molist, 2017
8. Cueva Nerja	No	Cave	6590 ± 40	5630–5470	Aura et al. (1998)
9. Cova de la Sarsa	Yes	Cave	6532 ± 24	5536–5472	García Borja et al. (2016)
10. Gruta do Caldeirão	Yes	Cave	6452 ± 29	5477–5364	Carvalho (2018)
11. Praça Vila de Madrid	Yes	Open air	6440 ± 40	5535–5460	Pou et al. (2010)
12. Cova Bonica	Yes	Cave	6410 ± 30	5469–5327	Oms et al. (2017)
13. Can Sadurní	Yes	Cave	6400 ± 30	5470–5315	Edo et al. (2019)
14. Galería da Cisterna	Yes	Cave	6380 ± 21	5468–5232	Zilhão (2021)
15. Samouqueira I	Yes	Open air	6370 ± 70	5480–5210	Soares (1995)
16. Cova de l'Or	Yes	Cave	6356 ± 23	5470–5320	Olalde et al. (2015)
17. Gruta do Correio-Mor	Yes	Cave	6330 ± 60	5422–5090	Cardoso et al., 2003
18. Antigos Armazéns Sommer	Yes	Open air	6315 ± 24	5356–5215	Cardoso et al. (2018)
19. Cova Negra de Gaianes	Yes	Cave	6309 ± 36	5359–5214	García Borja et al. (2016)
20. Cueva Hostal Guadalupe	Yes	Cave	6298 ± 30	5324–5216	Cortés et al. (2012)
21. Cueva Malalmuerzo	Yes	Cave	6295 ± 45	5373–5079	Carrasco Rus and Martínez-Sevilla, 2014
22. Cueva Els Trocs	Yes	Cave	6285 ± 25	5312–5219	Rojo Guerra et al., 2013
23. Cueva Hundidero-Gato	Yes	Cave	6270 ± 50	5356–5069	Carrasco Rus and Martínez-Sevilla, 2014
24. Paternambidea	Yes	Open air	6267 ± 33	5321–5062	Fernández-Crespo et al. (2019)
25. Lapiás das Lameiras	Yes	Open air	6256 ± 35	5316–5077	López-Dóriga and Simões (2015)
26. Galería del Sílex	Yes	Cave	6252 ± 23	5307–5120	This study
27. Cueva de Ardales	Yes	Cave	6326 ± 24	5303–5068	Ramos-Muñoz et al. (2022)
28. Cueva Chaves	Yes	Cave	6230 ± 45	5308–5057	Baldellou (2011)
29. Los Cascajos	Yes	Open air	6230 ± 50	5311–5054	García Gazólaz and Sesma Sesma. (2007)
30. Cueva del Agua/Mujer	Yes	Cave	6220 ± 35	5330–5061	Carrasco Rus and Martínez-Sevilla, 2014
31. Molino de Arriba	Yes	Open air	6210 ± 30	5293–5057	Rojo Guerra et al., 2016
32. Cova de l'Avellaner	Yes	Cave	6204 ± 34	5290–5055	Gibaja et al. (2018)
33. Cova Foradada	Yes	Cave	6200 ± 40	5295–5045	Cebrià et al. (2011)
34. Cueva de la Dehesilla	Yes	Cave	6180 ± 30	5222–5036	García-Rivero et al. (2021)
35. Alto de Rodilla	Yes	Open air	6171 ± 55	5296–4987	Alonso Fernández and Jiménez Echevarría (2015)
36. El Prado	Yes	Open air	6170 ± 30	5215–5030	Alonso-Fernández (2017)
37. La Lámpara	Yes	Open air	6144 ± 46	5217–4962	Rojo Guerra et al., 2008
38. Cueva Santimamiñe	Yes	Cave	6130 ± 40	5210–4950	López Quintana et al. (2015)
39. Lapa da Bugalheira	Yes	Cave	6128 ± 26	5209–4992	Rodríguez et al. (2020)
40. El Llano de Montico	Yes	Open air	6125 ± 30	5209–4983	Rojo Guerra et al., 2016
41. Fuente Celada	Yes	Open air	6120 ± 30	5208–4961	Alameda et al. (2011)
42. Sima LJ 11	Yes	Cave	6120 ± 35	5208–4957	Carrasco Rus and Martínez-Sevilla, 2014
43. Cueva del Toro	Yes	Cave	6100 ± 30	5080–4935	Santana et al. (2019)
44. Nossa Senhora das Lapas	Yes	Cave	6100 ± 70	5230–4847	Oosterbeek (1993)
45. Cova del Randero	Yes	Cave	6090 ± 30	5205–4852	Roca de Togores Muñoz et al., 2021
46. Tossal de les Basses	Yes	Open air	6030 ± 40	5030–4830	Rosser Limiñana and Soler Ortiz, 2016
47. Cerro Virtud	Yes	Open air	6030 ± 55	5070–4790	Ruiz and Montero et al., 1999
48. El Congosto	Yes	Open air	6015 ± 55	5041–4788	Martín Bañón, 2007
49. Cueva de la Ventana	Yes	Cave	6010 ± 40	5000–4794	Jiménez-Guijarro (2008)
50. Casa da Moura	Yes	Cave	5990 ± 60	5020–4720	Straus et al. (1988)
51. Villamayor	Yes	Open air	5945 ± 40	4932–4725	Rojo Guerra et al., 2016
52. Algar do Picoto	Yes	Cave	5904 ± 36	4880–4700	Carvalho and Petchey, 2013

Portalón site. Nevertheless, GS was largely an independent space with its own entrance until the end of the Bronze Age when this ancient entrance was closed by a massive fall of blocks from the roof (Apellániz and Uribarri, 1976; Ortega and Martín, 2012). Once sealed, the ambient conditions remained unaltered until its discovery in 1972, and thus, it was not subjected to any tampering or looting. These conditions facilitated the excellent conservation of the archaeological remains, such as cave paintings, ceramics, human bones, as well as faunal remains found inside. The undeniable interest in the discovery led to several archaeological campaigns in GS between 1974 and 1983 (Apellániz and Uribarri, 1976; Apellániz and Domingo, 1987; Carretero et al., 2008; Ortega and Martín, 2012).

Although the main conduit of GS is approximately 500 m in length, its total surveyed development, including all lateral passages and small nooks, is 920 m (Apellániz and Domingo, 1987; Ortega et al., 2013). In their study of the site, these authors subdivided GS into five zones: First Room (or Sepulchral Room) and Sectors A, B, C and D, respectively (Fig. 3). Sima A and Sima B, the two pits where the human remains under study were found, are located in Sector D (Apellániz and Domingo, 1987).

## 2.2. Archaeological context of human remains

Some human remains from the First Room were recovered in the 1974 field season, while the others were collected between 1978 and 1983 on the surface of the floor of the gallery (Fig. 3). In total, 2700 human remains from the different areas of GS were collected. In addition, numerous hearths and remains of torches, more than 6000 ceramic fragments (belonging to a minimum of 336 vessels), 6 worked tools, 18 tools of flint, 10 pebbles, 80 flint nodules, a polished axe, and 341 faunal remains were collected (Apellániz and Domingo, 1987).

In addition to these archaeological remains, 53 panels of engravings and red and black cave paintings have been also catalogued (Apellániz and Uribarri, 1976). Based on radiometric dating (García-Díez et al., 2003, 2005), two of the black paintings have been attributed at the end of the III millennium cal BCE ( $3670 \pm 40$  BP and  $3530 \pm 110$  BP, respectively). On the other hand, a charcoal fragment recovered at the end of GS, has been dated (Ortega and Martín, 2012) to the middle of the III millennium cal BCE ( $4030 \pm 40$  BP).

The location of hearth and torch remains provides insight into how the spaces of GS were used, although not at what specific moment. The remains of the 12 torches were found in strategic locations throughout Sector D: at the bottom of Sima A, and in the anterior and posterior

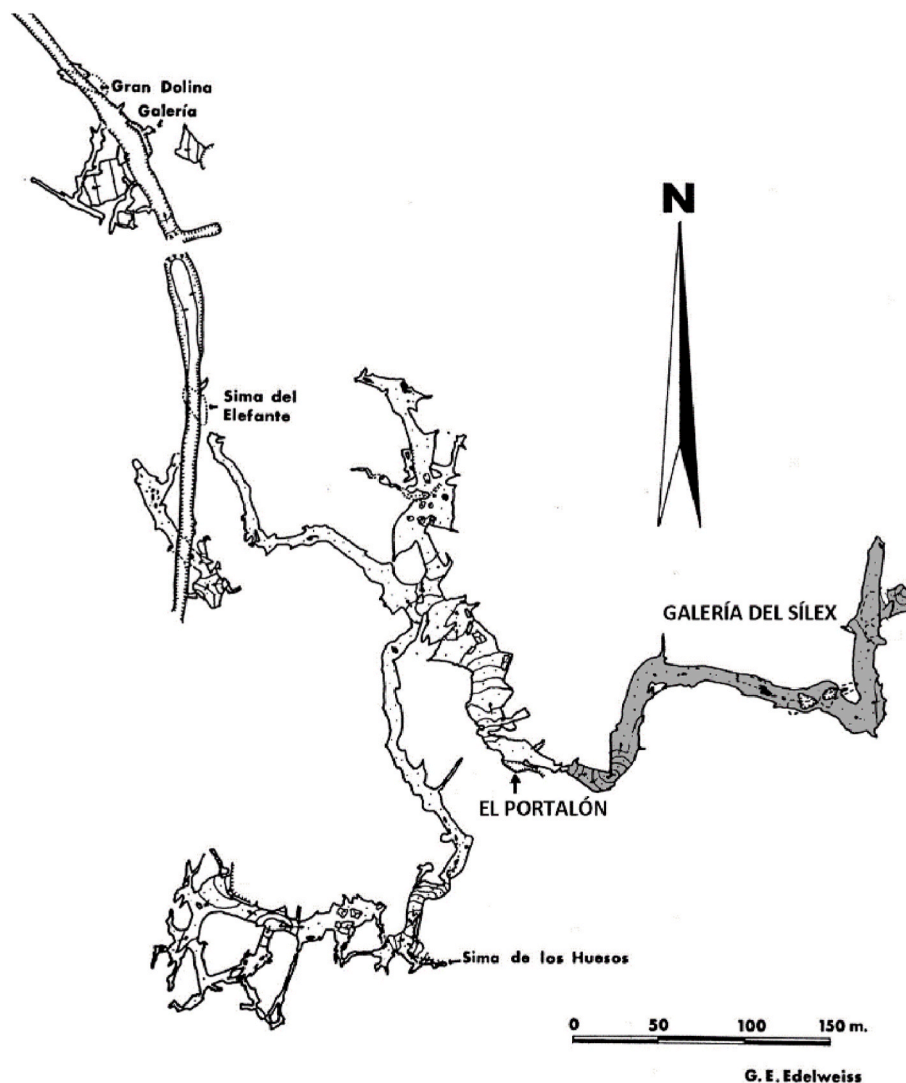


Fig. 2. Map of Cueva Mayor in the Sierra de Atapuerca showing the location of the Galería del Sílex (in gray) and its relationship with the site of El Portalón. The map also shows the spatial relationship of Cueva Mayor with the main Pleistocene sites in the Sierra de Atapuerca located in the sector known as the Trinchera del Ferrocarril: Gran Dolina, Galería and Sima del Elefante.

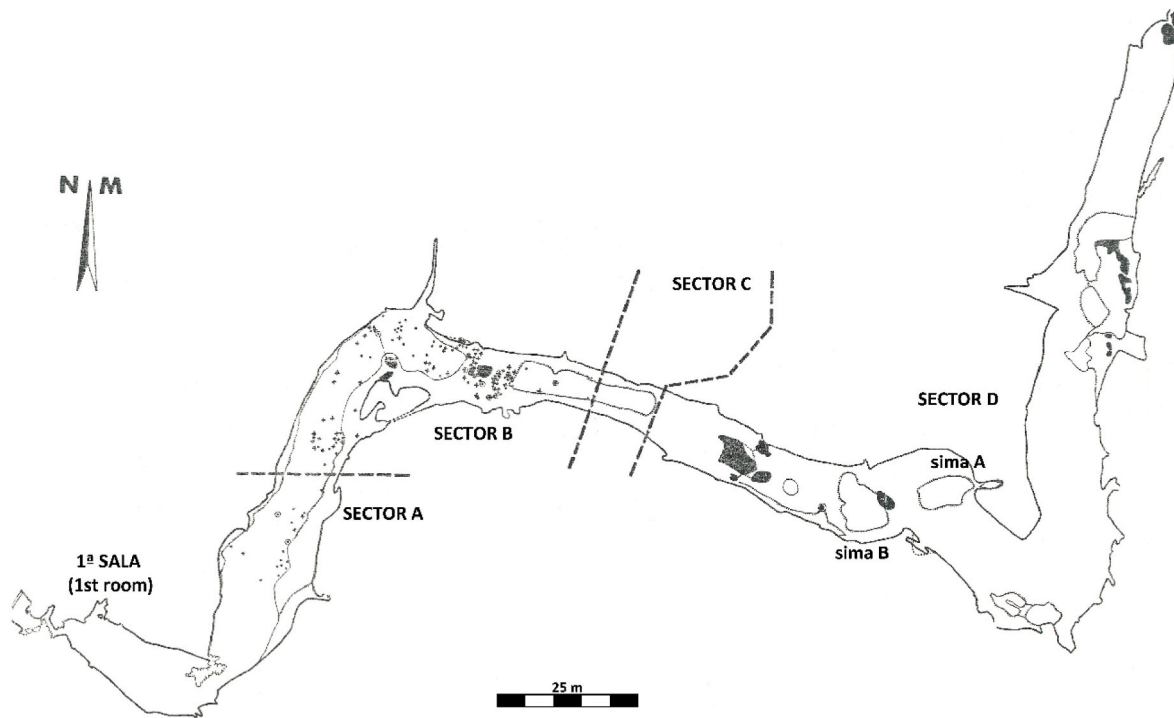


Fig. 3. Map of Galería del Sílex showing the locations of the First Room, Sectors A-D, Sima A and Sima B. The small dots in sectors A and B show the spatial position of the human remains recovered on the surface. Note the large spatial separation between these human remains and those recovered in Sima A and Sima B. Modified from Apellániz and Domingo (1987).

pathways of Sima A and Sima B. The remains of the 38 hearths are especially concentrated in the curve of Sector B, where they would have provided light to both sides of the cave, as well as in the area of Sector D where Sima A and Sima B are located (Apellániz and Domingo, 1987, 233).

The typological analysis of ceramic remains indicates the presence of characteristic elements of the Neolithic, Chalcolithic and early Bronze Age (Apellániz and Domingo, 1987). It is worth mentioning the presence of pieces with Boquique style decorations, belonging to the Early Neolithic (Apellániz and Domingo, 1987; Alday et al., 2009). According to Castaños (1987), the 341 faunal remains that were recovered represent a minimum of 31 different individuals. The most represented species are largely ovicaprids, which comprise 55.71% of the total remains, followed by the hare (*Lepus capensis*) and the rabbit (*Oryctolagus cuniculus*), which together make up 33.25% of the total.

The human remains presented here, recovered from Sima A and Sima B, were attributed to five individuals by Galera (1987). The remains of two of these five individuals were found at the bottom of Sima A, meanwhile the human remains belonging to the other three individuals were discovered on a ledge at the beginning of Sima B (Fig. 4). It is interesting that fragments of pottery clearly attributable to the Early Neolithic were found almost exclusively in Sector D, including at the bottom of Sima A (Apellániz and Domingo, 1987; Jiménez Guijarro, 2008). The spatial association between the Early Neolithic pottery and human fossils from Sima A and Sima B suggests that these human remains could also correspond to Early Neolithic people. In order to confirm this idea, we have carried out datings on several human remains from Sima A and Sima B. In addition, it also seems necessary to carry out a new anthropological study of the human remains from both pits in order to update the assignment of the remains to different individuals and to refine the sexual diagnosis and the age of death assigned to the identified individuals.

### 3. Results

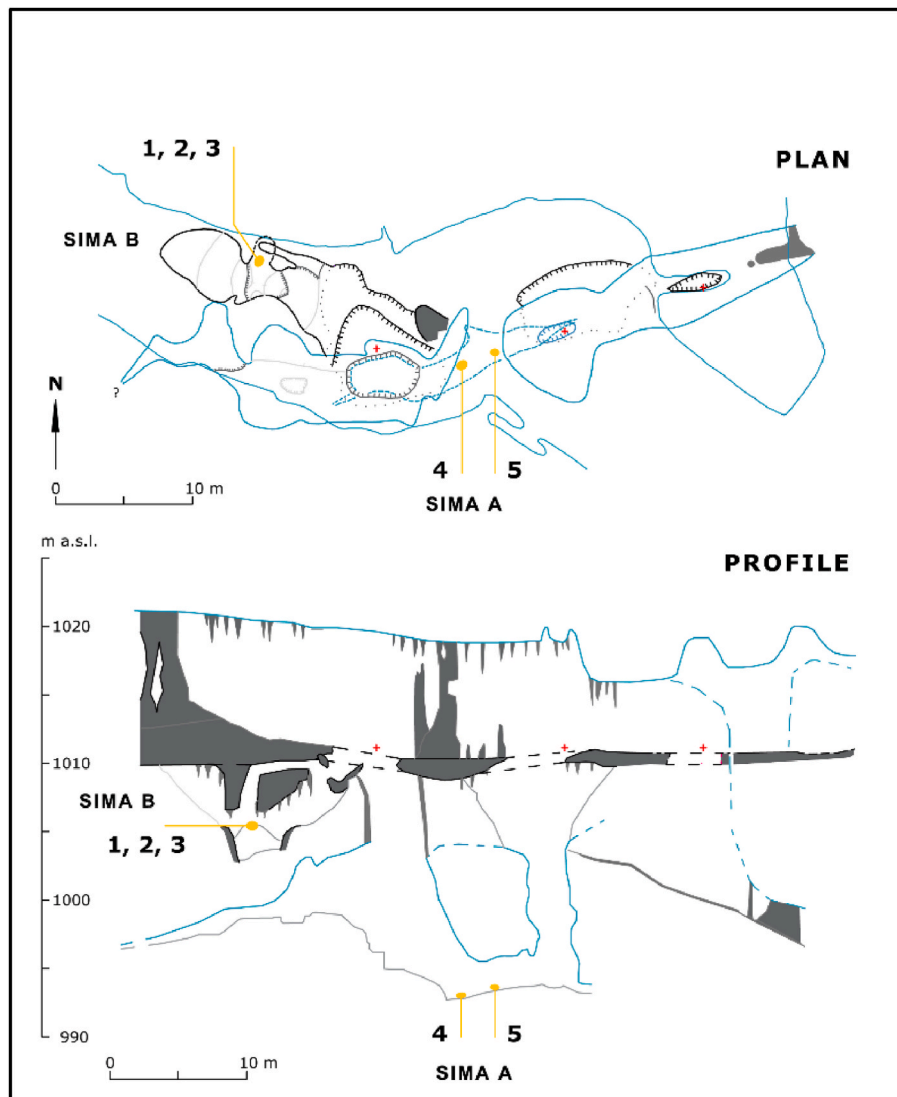
#### 3.1. Human remains from Sima B. Individuals 1, 2 and 3

Human remains from Sima B were recovered in 1983 (Galera, 1987; Ortega and Martín, 2012) and were found grouped together on a ledge at the upper part of the shaft (Fig. 4), which, in Galera's (1987) opinion, indicates that they were deliberately placed there. Unfortunately, there is no photographic documentation of their position. In the first study on human remains from Sima B, Galera (1987) distinguished three different individuals: an adult female (Individual 1), an adult male (Individual 2) and a juvenile individual (Individual 3).

##### 3.1.1. Sima B individual 1 (I-1)

Remains attributed to this individual include several cranial fragments, as well as other remains corresponding to all regions of the postcranial skeleton, including numerous hand and foot bones (Table S1 and Fig. S2). The right maxillary teeth have tartar, displaying a certain loss of alveolar support, and the second premolar has a significant interdental cavity. The calcaneus presents osteophytes in the base of, where toe flexors and the small toe abductor are inserted, indicating the existence of an enthesal change the Achilles tendon. This is a frequent injury in people who travel great distances on irregular surfaces (Al-Oumaoui et al., 2004). In the right humerus, the right femur and the left patella, slight traumatic injuries are observed which do not display signs of bone healing.

Although our study concurs with Galera (1987) in attributing most of these remains to an adult female, we disagree with her assignment of some human remains attributed to this individual. Galera (1987) distinguished two zygomatic bone fragments (known in this study as CMS-1001.2 and CMS-1002.6), which she attributed to both sides of I1. However, there is also a third malar bone fragment (known as CMS-1003.1) among the human remains attributed by Galera to the I1.



**Fig. 4.** Plan (above) and Profile (below) of Sector D where Sima A and Sima B are located showing the location of the human remains recovered. 1: Individual 1 (I-1); 2: Individual 2 (I-2); 3: Individual 3 (I-3); 4: Individual 4 (I-4); 5: Individual 5 (I-5). Note the position of the remains of individuals I-1, I-2 and I-3 in Sima B on a small promontory.

Based on the appreciable differences in size between these three malars we have assigned each of them to a different individual. We thought that it would be most reasonable to assign the biggest malar (CMS-1002.6) to the individual assigned by Galera as an adult male (I-2), the intermediate sized one (CMS-1001.2) to the individual assigned as an adult female (I-1), and the smallest one (CMS-1003.1) to the juvenile individual (I-3). On the other hand, the iliac fragment CMS-1001.40 (Table S1) was initially assigned to individual I-3 by Galera (1987) as she considered that the iliac crest was not completely fused to the rest of the bone and, thus, attributed this remain to a juvenile individual who was not yet fully grown. Nevertheless, in our opinion, the iliac crest is completely fused to the rest of the bone (Fig. 5), indicating that the individual had already reached adulthood and making it compatible both with both I-1 and I-2. Taking into account the numerous preserved postcranial remains from I-1, which include some isolated coccyx remains, we think that it is reasonable to assign to I-1 the iliac fragment CMS-1001.40.

### 3.1.2. Sima B individual 2 (I-2)

Galera (1987) assigned to this individual a small set of bone fragments: a partial right hemimandible (preserved from the  $M_3$  to the  $I_1$ ), a small fragment of a left mandibular body, and several fragments from

both mandibular rami (Table S2, Fig. S3). As previously mentioned, we have also attributed the left malar CMS-1002.6 to this individual. The mandible teeth display multiple cervical cavities, dental calculi, and significant alveolar reabsorption. The presence of the right  $M_3$ , fully functional, indicates that it corresponded to an adult individual. On the other hand, we have used the bucco-lingual measurements of the permanent teeth (Table S3) to assign I-2 to a male using the method of Viciano et al. (2013). This result agrees with the sex diagnosis made by Galera (1987).

### 3.1.3. Sima B individual 3 (I-3)

The collection of human remains recovered from Sima B also includes three human remains that Galera (1987) did not attribute to any of the individuals: the left malar CMS-1003.1 (see above), the distal end of a left humeral diaphysis (CMS-1003.2), and the lateral condyle of the distal epiphysis of a right humerus (CMS-1003.5). However, we think that the reduced dimensions of these remains suggest that they belonged to a juvenile individual and they could be assigned to I-3 (Table S4, Fig. S4), whose age at death would be a bit younger than Galera (1987) initially believed (see below).



Fig. 5. Iliac fragment (CMS-1001.40) attributed to Individual 1. Iliac crest completely fused is shown. Scale bar = 5 cm.

### 3.2. Human remains from Sima A. Individuals 4 and 5

Human remains from Sima A were collected during the 1979 excavation at the bottom of this chasm (Fig. 4) and correspond to two differentiated sets (Galera, 1985). One of them belongs to a large part of an upper skeleton, in anatomical connection, lacking the pelvis and lower extremities. Galera (1985) attributed these remains to an adult male specimen (Individual 4). The second set of bones was found gathered, but not in anatomical connection, next to one of the chasm walls. Galera (1985) attributed these remains to a juvenile, possibly male, individual (Individual 5).

#### 3.2.1. Sima A individual 4 (I-4)

There is a practically complete cranium, as well as a large part of the postcranial skeleton, with the exception of the pelvis and bones of lower extremities (Table S5, Fig. S5). It is remarkable that the remains assigned to this individual were found in anatomical connection and face down. The teeth display abundant dental calculi, occlusal and interdental cavities, a slight loss of alveolar support, and hypoplasia in the right mandibular canine. All the third molars are functional, indicating the individual was an adult. Basing on bucco-lingual measurements of the permanent teeth (Table S3) we assign I-4 to a male using the method of Viciano et al. (2013).

#### 3.2.2. Sima A individual 5 (I-5)

The remains Galera (1985) attributed to this individual were found in a set next to one of the pit walls and at some distance from the remains assigned to individual I-4 (Fig. 4). The remains attributed to I-5 include a rather complete cranium, including the teeth from the right  $M^2$  to the left  $I^2$ , and the presence of the upper right deciduous canine is notable (Table S6, Fig. S6). A bone fracture facilitates observation of the right  $M^3$  which is still included in its crypt. The mandibular body is very complete, displaying an almost complete right dental series (the right inferior canine and the  $M_3$  are absent). There are also numerous bones from the postcranial skeleton, including several hand and foot bones. The epiphyses of long bones, metacarpals, metatarsals and phalanges were not yet fused with their corresponding diaphysis. Both upper and lower teeth of I-5 display dental calculus. Cervical cavities are also observed in the left  $M_2$ .

Galera (1985) came to the conclusion that this individual was a

juvenile, between 12 and 15 years of age at death. The presence of the permanent  $M^2$  and the deciduous canine indicates an age at death close to 12–14 years (Ubelaker, 1989), which is compatible with the lack of fusion between the diaphysis and the epiphyses of hand and foot bones of this individual. Moreover, the lengths of the preserved diaphysis of the humerus (234 mm), ulna (203 mm), and tibia (272 mm) also indicate a likely age at death of around 13–14 years old, according to the regression formulas for female subadults older than 2 years from Cardoso et al. (2014). Following the method of Viciano et al. (2013), and based on bucco-lingual measurements of the permanent teeth (Table S3), we have attributed I-5 to a female.

### 3.3. Chronology of the human remains

Radiocarbon dating has been carried out in three different laboratories on four human remains corresponding to four of the five individuals recovered from the two chasms (Table 2, Fig. 6 and Fig. S7). We have decided not to date I-3 due to the small fragments preserved from this individual. The results show that I-1, I-2 and I-5 date from the Early Neolithic, whereas I-4 is more than three millennia later, and dates from the beginning of the Bronze Age (Table 2). Interestingly, these results are compatible with the presence in Sector D of ceramic remains with a characteristic typology of the Early Neolithic (Apellániz and Domingo, 1987).

## 4. Discussion and Conclusions

The origin of the human remains in Sima A and Sima B was debated by researchers who initially made the discovery, and they proposed different explanations for each case (Apellániz and Domingo, 1987; Galera, 1987). They suggested that human remains found in Sima B (I-1, I-2 and I-3) were intentionally placed there, mainly due to the fact that these remains were found on a protrusion of the vertical shaft and not at the bottom of it. On the other hand, they suggested that the origin of human remains from Sima A (I-4 and I-5) was accidental and, in their opinion, the remains would correspond to individuals who got lost in the cave and accidentally fell into this pit.

The accidental explanation seems reasonable for I-4, whose upper skeleton appeared face down on the ground and whose bones were in anatomical connection, although an explanation would still be necessary to account for the absence of the pelvis and lower limbs of this individual. However, the accidental origin of remains for I-5 is less clear, as their remains were not found in anatomical connection. Additionally, the six ceramic vessels that were recovered from the depths of Sima A, attributed to the Early Neolithic (Apellániz and Domingo, 1987), are compatible with the date we obtain for I-5. Thus, it is reasonable to believe that the aforementioned fragments of vessels were deliberately deposited in Sima A, together with the partial remains of I-5. In fact, ceramic vessels are often found left as funerary offerings in Neolithic burials, such as some Spanish cases that are geographically and temporally close to GS: El Molino de Arriba, in Burgos, Los Cascajos, in Navarra (Rojo Guerra et al., 2016), or La Lámpara, in Soria (Rojo Guerra et al., 2008).

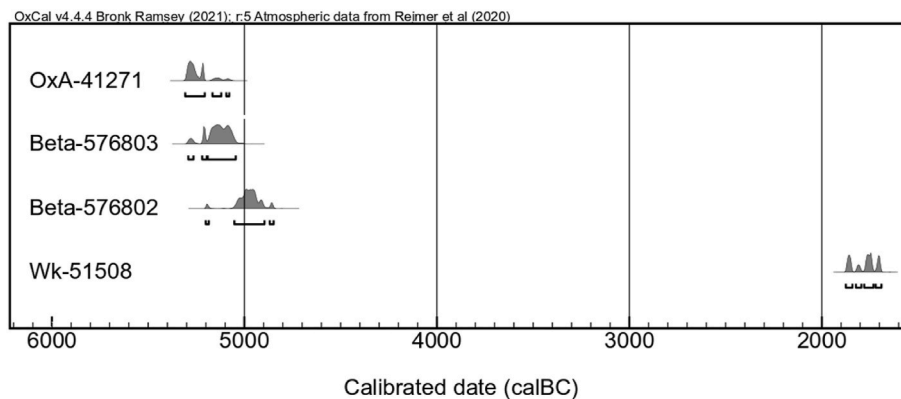
In summary, while the remains of I-4 may have arrived inside GS accidentally, this explanation does not seem adequate for the remains of individuals I-1, I-2, I-3 and I-5, whose origin is better explained by an intentional act, possibly of funerary origin, related to the presence of ceramic pieces. It is of significance that whereas I-1 and I-5 are represented by several bone remains corresponding to all skeletal regions, I-2 is only represented by a small set of mandibular remains, part of a malar bone, and two radius fragments. This fact suggests that I-1 and I-5 could correspond to a primary deposit, while I-2 could be a secondary deposit, all of them carried out during the Early Neolithic times. However, the absence of original photographs of the original position of the bones does not allow us to be completely sure of the nature of the deposits.

On the other hand, dating results (Table 2, Fig. 6) can help us to

**Table 2**

Radiocarbon dating of human remains from the GS with chronologies corresponding to the Early Neolithic and the Bronze Age. OxA: Research Laboratory for Archaeology and the History of Art at the University of Oxford; Beta: Analytic Beta; Wk: Radiocarbon Dating Laboratory at the University of Waikato.

Laboratory ID	Material	Individual	Place	Date BP.	Cal. 2 $\sigma$ BCE.	Period
OxA-41271	Phalange	Individual 1	Sima B	6252 $\pm$ 23	5307–5120	Early Neolithic
Beta-576802	Tooth	Individual 2	Sima B	6070 $\pm$ 30	5058–4897	Early Neolithic
		Individual 3	Sima B			NOT DATED
Wk-51508	Petrous bone	Individual 4	Sima A	3452 $\pm$ 17	1880–1690	Initial Bronze Age
Beta-576803	Tooth	Individual 5	Sima A	6200 $\pm$ 30	5288–5051	Early Neolithic



**Fig. 6.** Available radiocarbon dates for Galería del Sílex. Calibrated date (software OxCal v4.4.4) Bronk Ramos-Muñoz et al. (2022); r.5 Atmospheric data from Reimer et al. (2020).

establish the order of arrival of human remains corresponding to the Early Neolithic. The arrival of the remains of I-1 and I-5 could have taken place during the same generation, whereas the arrival of I-2 occurred several generations later. Interestingly, I-1 and I-5, who are practically contemporaries, could be considered a primary deposit, while I-2, dated to almost two hundred years later, seems to correspond to a secondary deposit. These data suggest two different funerary practices over time: the first with primary deposits and a subsequent one with secondary deposits of human remains. In this context, it is possible that I-3's remains, found in Sima B, and not directly dated, could be more or less contemporary with those of I-2 and I-5, since all three consisted of a secondary deposit.

It is also important to note that the dates obtained for Individuals I-1, I-2 and I-5 suggest that they are among the oldest human remains from the Early Neolithic found in the interior of the Peninsula (Table 1, Fig. 1). The oldest Neolithic sites from the inland region of the peninsula do not include any human remains and constitute, what Alday et al. (2012) or García-Martínez de Lagrán (2014) have called, Neolithic pioneers. Later, in the period spanning 5300–5000 BCE, the Early Neolithic funerary tradition began in the interior of the peninsula (Rojo Guerra et al., 2016). According to García Borja et al. (2011) and Valdósera et al. (2018), the first Neolithic groups were made up of few individuals, normally comprising no more than five families. They were not very sedentary, whereas later groups were more numerous and became more sedentary. For Guilaine and Manen (2007), the low population density of the first Neolithic settlers, in addition to their continuously changing settlements, could explain the lack of visibility of death from that period. Besides, while most of the sites containing human remains from the south of France, Portugal and Andalusia are found in caves, outdoor burials are predominant in the interior of the Iberian Peninsula (Fig. 1; Jiménez, 2019), which makes the funerary nature of the cave in GS even more atypical. On the other hand, primary burials, as those of Individuals I-1 and I-5 in GS, cannot be considered as atypical for this period, because most of the Early Neolithic burials on the Iberian Peninsula are considered primary, even with successive primary burials in many cases (Jiménez, 2019).

There is a great diversity of burial contexts in caves from the Early

Neolithic on the peninsula (Table 1). Some of the burials took place in pits, such as in Chaves (Utrilla et al., 2008), La Dehesilla (Acosta Martínez, 1987), El Agua (Carrasco Rus and Martínez-Sevilla, 2014), and Nerja (García Sánchez and Jiménez Brobeil, 1995). In other cases, human remains were deposited in cracks, such as in La Sarsa (García Borja et al., 2011), La Gruta das Salemas (Castro and Ferreira, 1972), and Los Molinos cave (Jiménez Brobeil, 1990). There are also examples in which the remains were deposited on the surface, like in Els Trocs (Alt et al., 2020), Chaves (Utrilla et al., 2008), La Sarsa (García Borja et al., 2011), LJ 11 (Carrasco Rus and Martínez-Sevilla, 2014), and Cova Negra de Gaianes (García Borja et al., 2016). Against this backdrop, the case of human remains in GS, deposited more than 300 m from the entrance, is truly rare and can only be compared with the case of the three individuals from El Gato cave, which were located in a hearth in the gallery, close to 200 m from the entrance (Carrasco Rus and Martínez-Sevilla, 2014).

With respect to the age at death and sex attributed to Early Neolithic individuals found in GS, it is noteworthy that both sexes are represented: there is one adult female individual and one adult male. This is remarkable because out of all Early Neolithic individuals from the Iberian Peninsula and the south of France, just 16% are women (Jiménez, 2019). The presence of a juvenile individual, female, in the GS sample is noteworthy as well, since Early Neolithic juveniles are also rarely represented on the Iberian Peninsula and in the south of France, making up just 21% of the total (Jiménez, 2019).

A great number of authors consider that most of the caves with Early Neolithic occupations, such as Els Trocs (Rojo Guerra et al., 2016), Chaves (Utrilla et al., 2008), La Sarsa (García Borja et al., 2011), Cova de l'Or (García Borja et al., 2016), Can Sadurní (Edo et al., 2019) and La Dehesilla (García-Rivero et al., 2022), were used as living spaces, in addition to their burial function. On the other hand, Carrasco Rus and Martínez-Sevilla (2014) thought that some caves were fundamentally funerary, as is the case of LJ 11 and Agua/Mujer caves. With respect to GS, there is no doubt that it was used for funerary purposes, given the great distance between the location where human remains were deposited and the ancient cave entrance (Fig. 3).

This funerary nature of GS is especially relevant when taken in

context with the other two Early Neolithic sites in Sierra de Atapuerca. On the one hand, El Portalón site, which is attached to GS and today is connected to GS by a small opening (Figs. 2 and 3), has provided a wealth of evidence, suggesting its exclusive use as living quarters around  $6270 \pm 40$  BP (Ortega et al., 2008; Carretero et al., 2008), although a human bone fragment has been dated to  $6170 \pm 30$  BP (Valdiosera et al., 2018). On the other hand, excavations carried out on the nearby site of Cueva de El Mirador have shown that it was solely dedicated to livestock stabling, around  $6300 \pm 50$  BP (Vergès et al., 2016). The new evidence provided here, by dating human remains from GS Sima A and Sima B, highlights a unique set of occupations in Sierra de Atapuerca during the Early Neolithic, in which the use of different caves was specialized for different purposes: occupational in El Portalón, livestock exploitation in El Mirador, and funerary in GS.

This suggests that caves in the Sierra de Atapuerca played an important role for the first Neolithic groups occupying the Arlanzón valley, and can be considered representative of an *ex-novo* Neolithic settlement. Therefore, we believe that the group of Neolithic occupations in Atapuerca can be considered a focal point for neolithization of the Duero valley, just as the Chaves cave is considered for the Ebro valley (Rojo Guerra et al., 2008).

In summary, GS is an extraordinary site due to the fact that it was sealed at the end of the Bronze Age and has remained intact to the present day. The new evidence provided by dating human remains found in Sima A and Sima B, along with the dating of some of the panels with cave paintings (García-Díez et al., 2003; 2005), illustrates that it could have been used as a funeral gallery whose use extended from the Early Neolithic, throughout the Chalcolithic, and lasted until the beginning of the Bronze Age. Human remains recovered during the first excavations from the other three sectors of this cave (First Room, Sector A and Sector B) have yet to be dated and studied anthropologically. We expect the results of these studies to be invaluable in gaining better insight into the use of GS as a funerary space over four millennia.

#### Author contribution

**Antonio Molina-Almansa:** Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing - Revision. **Mercedes Conde-Valverde:** Writing – original draft, Visualization, Validation, Writing - Revision. **Ana Isabel Ortega:** Investigation, Writing – review & editing, Visualization. **Rebeca García-González:** Validation, Writing – review & editing. **Laura Rodríguez:** Validation, Writing – review & editing. **Alfonso Alday:** Writing – review & editing. **Eneko Iriarte:** Writing – review & editing. **Salvador Domingo:** Investigation. **Juan Luis Arsuaga:** Funding acquisition. **José María Bermúdez de Castro:** Funding acquisition. **Eudald Carbonell:** Funding acquisition. **José Miguel Carretero:** Validation, Writing – review & editing. **Ignacio Martínez:** Conceptualization, Writing – original draft, Writing - Revision, Supervision, Funding acquisition.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Data availability

No data was used for the research described in the article.

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#### Appendix A. Supplementary data

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