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The tempo of the Iberian megalithic rituals in the European context: The cemetery of Panoría

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ABSTRACT

Our ability to build precise narratives regarding megalithic societies largely depends on the chronology of the multi-ritual events that usually shaped these complex sites. The cemetery of Panoría offers an excellent opportunity for exploring ritual complexity in Iberia through radiocarbon chronology, as four of the nine recently excavated dolmens are remarkably well preserved. For this purpose, seventy-three radiocarbon dates were obtained and analysed within a Bayesian framework. The resulting refined chronology has led us to three main conclusions: i) in all tombs, the second half of the 4th millennium cal BC was an intensive but brief period of funerary depositions, probably over three to six generations; ii) after a long hiatus, most of the dolmens were reused in the 25th and 21st centuries cal BC during even shorter periods, spanning just a few decades and approximately one to four generations; and (iii) long after the funerary rituals had ended in the 21st century, the memory of the cemetery was revived in Late Antiquity. These short, punctuated periods of use are highly consistent with those seen in a growing number of European megalithic monuments. From Britain to Iberia, a pattern of short spans of use is dramatically changing our perception of the social and political roles of these complex monuments.

1. Introduction

In recent decades, chronologies derived from scientific dating have emerged as a key aspect for a better understanding of past societies. This is especially true for the study of megalithic monuments that in many cases comprise multi-depositional ritual and funerary events that produced complex palimpsests. The frequent use and reuse of these monuments have produced ritual deposits characterised by masses of stratified, fragmented and mixed human bones and grave goods that are found piled on top of each other. Since megalithic palimpsests are created by overlapping depositional events over variable periods of time (Lucas, 2005; Bailey, 2007), our ability to build precise narratives for these societies largely depends on the chronology of the multi-ritual events that occurred at each megalithic site.

Fortunately, methodological advances in radiocarbon dating and their statistical interpretation have led to a profound change in our perception of prehistoric societies (e.g. Buck et al., 1991; Bronk Ramsey, 1995, 2013; Bayliss, 2009; Scarre, 2010; Whittle et al., 2011). The Iberian Peninsula has recently become part of this ground-breaking change. In the last decade, a series of radiocarbon programmes has substantially improved our understanding of the megalithic phenomenon in different Iberian regions (Fernández-Eraso and Mujica-Alustiza, 2013; Robles Henriques et al., 2013; Aranda Jiménez and Lozano Medina, 2014; Valera et al., 2014, 2019; Aranda Jiménez et al., 2017; 2018a, 2018b, 2020a, 2020b, 2021a, 2021b; García Sanjuán et al., 2018; Valera, 2020; Santa Cruz Del Barrio et al., 2020; Linares Catela and Vera Rodríguez, 2021). These new radiocarbon programmes have dramatically increased the number of available dates but also brought

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with them a shift in the sampling strategy. Radiocarbon dating efforts are now focusing on improving our understanding of the complex temporality of each monument. This is a remarkable development if we consider that until very recently megalithic chronology in Iberia had been based on a limited number of dates per tomb, usually between one and three.

In this new scenario, the megalithic cemetery of Panoría stands out as a unique case-study for exploring ritual variability through radiocarbon chronology. Thanks to recent fieldwork in 2015 and 2019, nine tombs were excavated, of which four were remarkably well preserved without major post-ritual disturbance. The meticulous recording techniques, including the assistance of trained bioarchaeologist excavators, have produced detailed information on bone assemblage formation. The radiocarbon dating of the funerary events identified in each tomb offers an excellent opportunity for exploring the similarities and differences between tombs in the same cemetery. For this purpose, we produced 40 new radiocarbon dates from Tombs 3, 11 and 15 that, when combined with the previous 33 dates, 26 from Tomb 10 and seven from Tombs 6, 7, 8 and 18 (Aranda Jiménez et al., 2018b; 2021b), creates one of the largest radiocarbon series on megalithic burials in Europe. This paper is specifically aimed at discussing the social and ritual implications that can be inferred from this radiocarbon series. In the following sections, the general background of the cemetery, especially of Tombs 3, 10, 11 and 15, will be analysed before examining the new chronological series in a Bayesian framework. The resulting refined chronology is then discussed with respect to the chronological features of Iberian and European megalithic societies.

2. Archaeological background: The Panoría cemetery

The megalithic cemetery of Panoría is located in the southeast of the Iberian Peninsula. Discovered in 2012, it occupies a strategic position at the easternmost end of the Sierra Harana Mountains, overlooking most of the Guadix Basin in the present-day province of Granada. At least 19 tombs have been preserved, although the original number must have been higher if we take into account the damage caused by farming, especially in the last few decades. The cemetery consists of dolmens with rectangular and trapezoidal-shaped funerary chambers that range from 1.10 to 2 m in length with short passages. Five of these megalithic tombs were excavated in 2015 (Benavides López et al., 2016; Aranda Jiménez et al., 2018b, 2018c, 2020b; Díaz-Zorita Bonilla et al., 2017, 2019) and four in 2019 (Fig. 1). Of the nine tombs, only four preserve the ritual deposits in good condition without major post-depositional disturbances. In order to understand the funerary and ritual variability, we focus our attention on these four dolmens.

Tomb 3 consists of a passage dolmen with a trapezoidal chamber and a short corridor (Fig. 2). Two different phases of mortuary and ritual deposition separated by a paved floor with horizontally-placed slabs were identified. In the most recent (Phase A), skeletal remains were concentrated in the western half of the funerary chamber next to the headstones. These remains were recovered in an articulated position, although some minor displacement could be identified. All the individuals were placed on their left side (left lateral decubitus) with the arms and legs flexed. Bodies were arranged parallel to one another with the skulls next to the headstones, orientated from west to east and aligned with the main axis of the chamber. There were five articulated individuals, all adults: two men, one woman and two undetermined. Below the paved floor, in the earlier phase of mortuary depositions (Phase B), there was a very different picture. In this case, all the skeletal remains were found disarticulated, commingled, usually fragmented, and piled on top of each other. The MNI was 17, calculated on the basis of tooth 42 for adults and teeth 38 and 75 and a perinatal bone for subadults. Unlike Phase A, in which all individuals were adults, in Phase B the 30% of the MNI are subadults ranging from perinatal to juveniles.

Tomb 11 is also a passage dolmen with trapezoidal-shaped funerary chamber and a short corridor (Fig. 3). Post-depositional activity consisting of a pit affected the right-hand side of the chamber. One of the three orthostats on this side was missing and another two partially broken. The pit also affected the mortuary deposits, albeit only partially. As in Tomb 3, two different phases of mortuary activity were identified. The most recent (Phase A) consisted of a compact layer of articulated individuals who were found together with other skeletal remains that had lost their anatomical connections. Nine individuals were identified in articulated or semi-articulated positions. They ranged from largely complete bodies, such as Individuals 1 and 4, to specific anatomical parts, for instance, the lower limbs of Individuals 5 and 6. All the anatomical connections were found in a flexed and left lateral decubitus position, except for Individual 4 who was placed on his right side. The

Fig. 1. Orthophotography with the location of the 9 excavated tombs at Panoría cemetery.

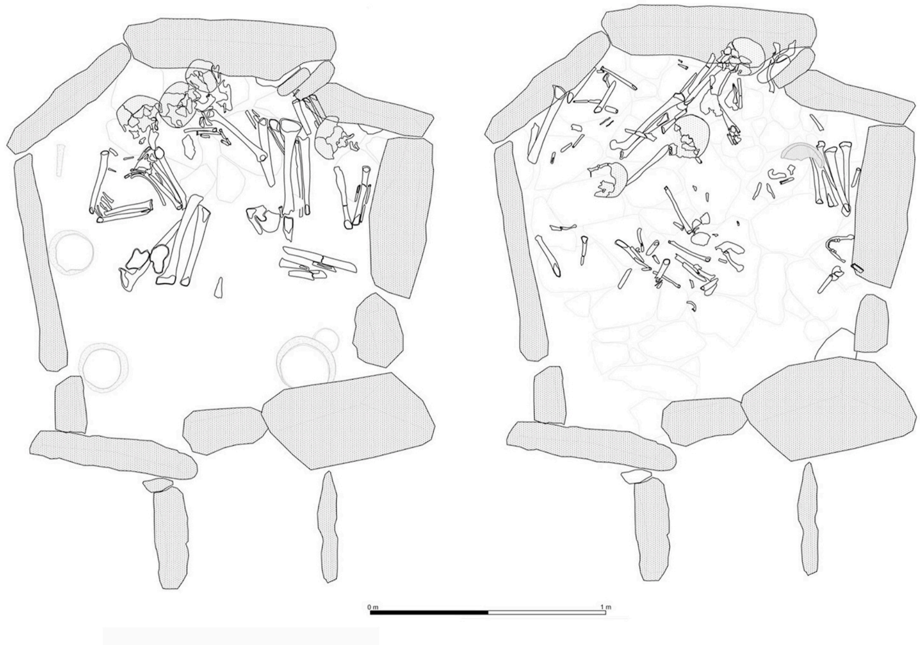

Fig. 2. Anthropological remains of Phases A (left) and B (right) from Tomb 3.

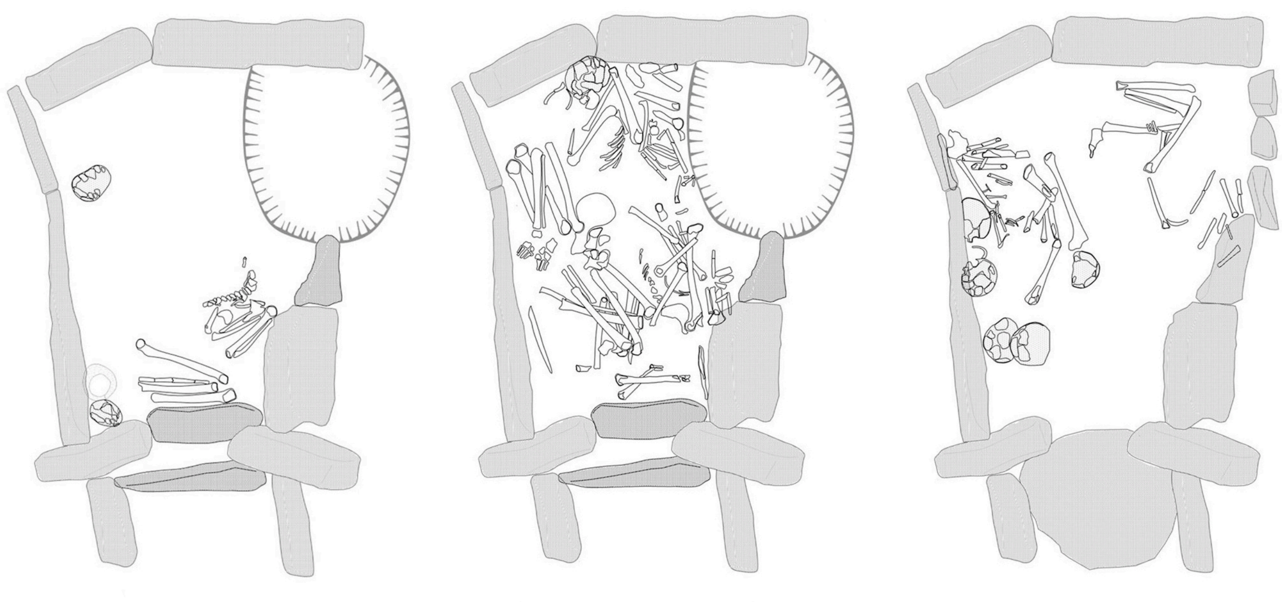

Fig. 3. Anthropological remains from Tomb 11 (left: top of the Phase A; centre: Phase A; right: Phase B).

MNI was 13, based on the temporal bone for adults and on tooth 17 and a left humerus for subadults. Men, women and children of all ages are well represented, which means that sex or age differences do not appear to have been a determining factor in mortuary practices.

The earliest phase of interments (Phase B) also consists of a layer of skeletal remains located mainly in the southern and western part of the funerary chamber. They were found scattered, mostly fragmented and disarticulated, except for two cases: the left upper limb of a subadult (7–9 years old; Individual 10) placed in left lateral decubitus position, and the upper and lower limbs of an adult, probably female (Individual 11), found in the right lateral decubitus position. Especially remarkable is the concentration of four skulls next to the orthostat that formed the southern side of the mortuary chamber. The MNI for Phase B in Tomb 11 was estimated as 9 individuals, a figure calculated from tooth 42 for adults and teeth 36 and 47 for subadults. Regarding sex and age, particularly remarkable was the large number of subadults who amounted to 44% of the MNI, in contrast to only 13% in Phase A.

Tomb 15 is also a passage dolmen characterised by a trapezoidal mortuary chamber and a short corridor (Fig. 4). This is the only tomb with skeletal remains outside the chamber and the passage. An adult female skull (18–25 years old) and two long bones –a humerus and a tibia– placed above the skull were recovered from a pit located next to the right-hand orthostat that defines the chamber entrance. In the funerary chamber, human remains were found as a layer of highly fragmented and mixed bones, concentrated principally in the western part. Only the remains of an adult male (41–60 years old) laid on the

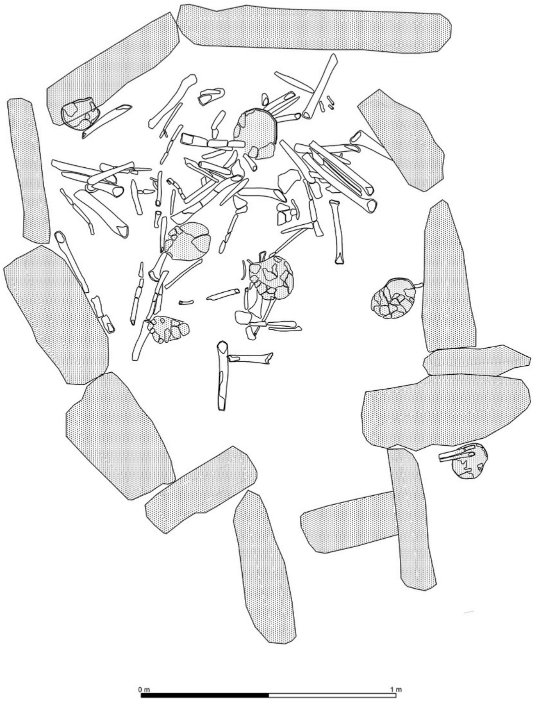

Fig. 4. Anthropological remains from Tomb 15.

right lateral decubitus were found in an articulated and flexed position. The MNI of 14 was calculated from the right femur for adults and on teeth 28 and 37 and a clavicle for subadults. In the pit outside the chamber, the MNI was one. The skeletal remains belonged to males, females and subadults of all ages, although most fit into the adult range.

Tomb 10 is the only well-preserved dolmen excavated in 2015 and published elsewhere (Aranda Jiménez et al., 2018b; 2018c, 2021b; Díaz-Zorita Bonilla et al., 2017). Like the previous tombs, it can be included among the passage-type dolmens with a trapezoidal-shaped burial chamber and a short corridor (Fig. 5). As in Tomb 15, different occupation phases were not distinguishable as the skeletal remains were in single compact layer of mixed bones that were found scattered not only in the mortuary chamber but also in the corridor. Although most of the bone remains had lost their anatomical connections, five individuals appeared in articulated or semi-articulated positions that ranged from almost complete bodies to only the upper or lower limbs. In all these cases, the bodies appeared in flexed and in left lateral decubitus position. As had been seen in Tomb 3, articulated individuals were found in the funerary chamber orientated from west to east and aligned with the major axis of the tomb. The MNI was 24, calculated on the basis of the permanent tooth 45 for adults and on the deciduous tooth 63 for subadults. Individuals of both sexes and all ages were also well represented in the bone assemblage.

3. Materials and methods

Judging from our previous experience (Aranda Jiménez et al., 2021a, 2020a, 2020b, 2018a; Lozano Medina and Aranda Jiménez, 2018), the dating strategy based on the minimum number of individuals is the best way of ensuring that no individual is dated twice. Bearing this criterion in mind, the sampling was adapted to the specific features of each tomb (Table 1). For Tomb 3, the five articulated individuals from Phase A and the 17 from Phase B were selected. For Tomb 11, instead of the MNI of 22 individuals, we selected for dating only those in an articulated position, i.e. seven individuals for Phase A and two for Phase B. Articulated bone samples are particularly suitable for dating, as they are reflective of being in their primary contexts, meaning that contemporaneity between the date obtained and the act of deposition can be guaranteed. In the case of Tomb 15, we used the MNI based on skulls in order to concentrate the radiocarbon measurements on the same individuals undergoing

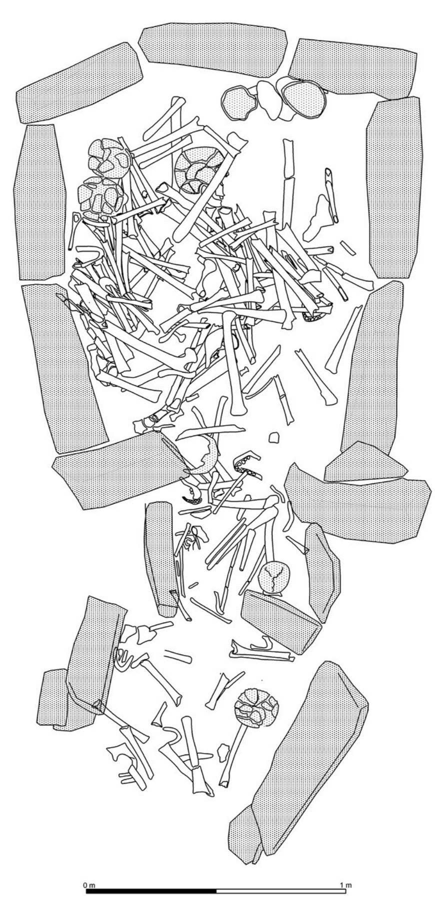

Fig. 5. Anthropological remains from Tomb 10.

Table 1
The NMI identified at the Panoría cemetery and the number of individuals sampled and dated.

Tomb	Context	NMI	Samples selected	Samples dated
Tomb 3	Funerary Chamber (Phase A)	5	5	5
	Funerary Chamber (Phase B)	17	17	17
Tomb 6	Funerary Chamber	1	1	1
Tomb 7	Funerary Chamber	3	3	3
Tomb 8	Funerary Chamber (Phase A)	2	1	0
	Funerary Chamber (Phase B)	2	2	2
Tomb 10	Funerary Chamber	12 (bones)	12	12
		24 (teeth)	15	14
Tomb 11	Funerary Chamber (Phase A)	13	7	7
	Funerary Chamber (Phase B)	9	2	1
Tomb 15	Pit outside of Funerary Chamber	1	1	1
	Funerary Chamber	14	12	9
Tomb 18	Funerary Chamber	1	1	1
TOTAL		96	79	73

other intended studies such as mobility isotopes and DNA analysis. For this reason, we sampled specifically the occipital bone for adults and two mandibles, a clavicle and an occipital bone for subadults, which meant a total of 13 samples instead of the 15 MNI calculated mainly on right femurs.

Tomb 10 was dated in two main rounds. Firstly, we focused on bone samples that included several articulated individuals in order to gain accuracy in the relationship between the time of death and the act of body deposition. As a result, 12 individuals were sampled and successfully dated (Aranda Jiménez et al., 2018b). In a second round, we focused on the differential skeletal representation found between bone (n = 12) and teeth (n = 24) with the aim of better understanding bone assemblage formation. For this purpose, we dated 14 teeth samples to explore through comparative chronology not only the deposition but also the removal of bone remains from the tomb (Aranda Jiménez et al., 2020b). As result, the current radiocarbon series from Tomb 10 totals 26 dates.

As mentioned above, the new radiocarbon series produced for this paper comes from Tombs 3, 11 and 15. As previously described, we selected 44 samples of which six failed due to poorly preserved collagen. Two samples from Tomb 15 were replaced and successfully dated in a second attempt, which led to a final radiocarbon series of 40 new dates (Table 2).

All samples were dated using Accelerator Mass Spectrometry (AMS) at the Scottish Universities Environmental Research Centre (SUERC).[1] The radiocarbon measurements were calibrated using the IntCal20 atmospheric curve (Reimer et al., 2020) and the OxCal v4.4.4 program (Bronk Ramsey, 2001, 2009, 2017). Calibrated ranges were obtained using the probability method (Stuiver and Reimer, 1993) and the end-points were rounded out by 10 years when the error was equal to or greater than 25 years and by 5 years when the error was less than 25 years (Stuiver and Polach, 1977; Millard, 2014). The new chronological series was modelled in a Bayesian framework using the OxCal program v4.4.4 (Bronk Ramsey, 2001, 2009). For comparative purposes, when large numbers of radiocarbon dates had to be considered, we used a statistical method based on Kernel Density Estimation (KDE) (Bronk Ramsey, 2017).

When planning a radiocarbon dating programme based on human samples, establishing the diet of the studied population is always a principal issue. If marine and freshwater resources were regularly consumed, the radiocarbon measurement will be affected by the so-called "reservoir effect", producing an earlier date than other contemporaneous terrestrial organisms (Stuiver and Braziunas, 1993; Lanting and Van Der Plicht, 1998; Cook et al., 2001). The distance of the Panoría cemetery from the sea, the absence of wetlands in the region and the highly seasonal watercourses preclude the consumption of significant amounts of marine and freshwater resources. In fact, the previous studies of the Panoría population show that the diet was based on C_3 plants and terrestrial animals, with no evidence of any relevant marine or freshwater food consumption (Díaz-Zorita Bonilla et al., 2019). Nevertheless, to explore the potential dietary reservoir effect, all the new samples selected to be dated were also subjected to δ^{13}C and δ^{15}N stable isotope analysis.

4. Results

The δ^{13}C values for the newly dated individuals from Tombs 3, 11 and 15 ranged from −20.1 to −18.7‰ and the mean was −19.2‰ ± 0.3‰. The δ^{15}N ratios ranged from 7.6 to 11.5‰ and the mean was 9.2‰ ± 0.9‰.[2] These values matched the previous results from Panoría discussed in-depth elsewhere (Díaz-Zorita Bonilla et al., 2019), which means there was no "reservoir effect" in the sampled populations. Therefore, the new radiocarbon dates can be considered accurate estimations in equilibrium with the atmosphere. Furthermore, the isotopic values from Panoría are consistent with the palaeodiet studies from other megalithic cemeteries, such as Los Millares (Waterman et al., 2017; Aranda Jiménez et al., 2020a), Mojácar (Aranda Jiménez et al., 2021a) and El Barranquete (Díaz-Zorita Bonilla et al., 2019). According to those studies, the consumption of marine and freshwater resources did not play any relevant role in the diet of south-eastern megalithic populations.

The chronological models were built based on the stratigraphic relationships between the different phases of mortuary activity and the sequence of depositional events that preserved individuals in their articulated positions. In accordance with this prior information, a Bayesian model was built for each of the four tombs discussed previously. For Tomb 3, two phases of mortuary activity were identified. In the earliest phase (Phase B), all 17 individuals dated were initially clustered in a simple bounded phase, as described in Hamilton and Kenney (2015), which assumes no stratigraphic relationships between any of the samples. However, two radiocarbon dates (SUERC-96550 and -96551) were approximately half a millennium later than the other 15 and were therefore separated out as representing a later period of reuse. In the most recent phase (Phase A), the five articulated individuals were found in the following archaeological sequence: Individuals 2 and 4 were the earliest depositions, although there is no stratigraphic relationship between them. Individuals 1 and 5 were deposited in subsequent funerary events, the first overlaying Individual 2 and the second above Individual 4. The four radiocarbon dates pass the test for statistical consistency (T' = 2.6; df = 3; T'(5%) = 7.8) (Ward and Wilson 1978), which means that all the individuals could have died at the same time or, what seems more likely, in a short series of closely connected events. The last funerary deposition was Individual 3, who was placed above Individuals 2 and 4. His radiocarbon date shows the most recent deposition, at least several decades after the previous interments.

The Bayesian model has a good index of agreement (A_{model} = 157), which indicates that the radiocarbon dates conform to the prior archaeological information incorporated in the analysis (Fig. 6 and Table 3). According to this model, the first bodies deposited in the earliest primary phase of mortuary activity were placed between *3530*–3395 cal BC *(95% probability; First burial Phase B primary)*, probably between *3465*–3410 cal BC *(68% probability)*. This primary Phase B of burial activity is estimated to have ended in *3355*–3275 cal BC *(95% probability; Last burial Phase B primary)* and probably in *3345*–3315 cal BC *(68% probability)*. This period of use was *55–225 years (95% probability; Span Phase B primary)*, and probably for *75–145 years (68% probability),* which means between three and six generations.[3] After an intense primary period of interments, there was a brief reuse between *2910*–2780 cal BC *(95% probability; First burial Phase B reuse)*, probably between *2900*–2880 cal BC *(68% probability),* and *2900*–2705 cal BC *(95% probability; Last burial Phase B reuse)*, possibly in *2895–2785 (68% probability)*. The difference between these distributions implies a period of use of *1–135 years (95% probability; Span Phase B reuse)*, and probably for *1–25 years (68% probability*).

There was a long hiatus between the primary and reuse activity of Phase B and the later Phase A. After this hiatus, which lasted for *210–430 years (95% probability; Difference Phase A and B)* and probably for *300–420 years (68% probability)*, the tomb was reused for a very short period. Ritual activity began again between *2570*–2460 cal BC *(95% probability; First burial Phase A)*, probably between *2560*–2465 cal BC *(68% probability)* and ended between *2560*–2405 cal BC *(95% probability; Last burial Phase A),* and probably in *2555*–2450 cal BC *(68%*

[1] The methods used by the SUERC are described by Dunbar et al. (2016).

[2] The individual classified as Infant was not included in these estimates because their isotopic values could be associated with the breastfeeding signal rather than the consumption of marine resources.

[3] We assume that a generation represents 25 years (for further discussion see Whittle et al., 2007a).

Table 2
Radiocarbon dates from the Panoría cemetery.

Laboratory Code	Type of material (Age)	Context	Radiocarbon age (BP)	δ13 IRMS ‰	δ15N ‰	C:N	%C	%N	Calibrate date (68% confidence) cal BC/AD	Calibrate date (95% confidence) cal BC/AD
TOMB 3										
SUERC-96531	Femur (Adult) Individual 1	Funerary Chamber (Phase A)	3940 ± 23	−19.5	8.7	3.3	39.0	13.7	2475–2350 BC	2565–2345 BC
SUERC-96532	Left Femur (Adult) Individual 2	Funerary Chamber (Phase A)	3985 ± 24	−19.1	9.5	3.4	40.7	14.0	2565–2470 BC	2570–2465 BC
SUERC-96533	Left Femur (Adult) Individual 3	Funerary Chamber (Phase A)	3838 ± 24	−19.4	8.6	3.5	39.3	13.2	2340–2205 BC	2450–2200 BC
SUERC-96537	Left Femur (Adult) Individual 4	Funerary Chamber (Phase A)	3969 ± 25	−19.4	8.3	3.4	40.4	13.9	2560–2460 BC	2570–2350 BC
SUERC-96538	Right Humerus (Adult) Individual 5	Funerary Chamber (Phase A)	3948 ± 24	−19.4	9.0	3.4	39.7	13.7	2560–2350 BC	2570–2345 BC
SUERC-96540	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4524 ± 25	−19.1	8.5	3.3	38.2	13.5	3350–3110 BC	3360–3100 BC
SUERC-96541	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4597 ± 23	−19.4	9.9	3.0	33.8	13.2	3485–3355 BC	3495–3195 BC
SUERC-96542	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4686 ± 23	−18.8	11.5	3.3	37.8	13.4	3515–3380 BC	3525–3380 BC
SUERC-96543	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4689 ± 23	−19.1	7.8	3.2	33.8	12.3	3515–3380 BC	3525–3370 BC
SUERC-96547	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4513 ± 25	−19.2	9.0	3.0	37.0	14.2	3350–3110 BC	3355–3100 BC
SUERC-96548	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4700 ± 23	−18.7	9.7	3.0	36.5	14.1	3520–3380 BC	3605–3375 BC
SUERC-96549	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4717 ± 25	−19.2	10.3	3.3	33.3	11.8	3600–3380 BC	3630–3380 BC
SUERC-96550	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4224 ± 25	−19.0	9.4	3.1	37.6	14.0	2900–2780 BC	2900–2700 BC
SUERC-96551	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4245 ± 24	−19.4	9.2	3.2	37.5	13.7	2900–2875 BC	2910–2710 BC
SUERC-96552	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4500 ± 23	−19.2	9.0	3.3	38.0	13.5	3335–3105 BC	3345–3260 BC
SUERC-96553	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4661 ± 23	−18.9	8.1	3.3	36.8	13.2	3510–3370 BC	3515–3370 BC
SUERC-96557	Tooth 42 (Adult)	Funerary Chamber (Phase B)	4688 ± 25	−18.8	8.0	3.3	36.6	12.9	3520–3380 BC	3530–3370 BC
SUERC-96558	Tooth 38 (Juvenile)	Funerary Chamber (Phase B)	4719 ± 25	−19.2	9.6	3.3	32.7	11.7	3600–3380 BC	3630–3380 BC
SUERC-96559	Tooth 75 (Infant II)	Funerary Chamber (Phase B)	4674 ± 23	−18.2	11.9	3.4	38.5	13.3	3510–3375 BC	3520–3370 BC
SUERC-96560	Tooth 75 (Infant II)	Funerary Chamber (Phase B)	4705 ± 23	−18.6	11.2	3.4	39.3	13.6	3525–3380 BC	3620–3375 BC
SUERC-96561	Tooth 75 (Infant I)	Funerary Chamber (Phase B)	4719 ± 23	−18.7	11.1	3.4	37.6	13.0	3600–3380 BC	3625–3375 BC
SUERC-96562	Phalange (Perinatal-Infant I)	Funerary Chamber (Phase B)	4528 ± 25	−18.7	9.4	3.2	34.9	12.9	3360–3110 BC	3360–3100 BC

(continued on next page)

Table 2 (*continued*)

Laboratory Code	Type of material (Age)	Context	Radiocarbon age (BP)	δ13 IRMS ‰	δ15N ‰	C:N	%C	%N	Calibrate date (68% confidence) cal BC/AD	Calibrate date (95% confidence) cal BC/AD
TOMB 6										
ETH-69960	Femur (Adult)	Funerary Chamber	4353 ± 25	−19.5	9.7	3.4	32.9	11.3	3020–2910 BC	3030–2900 BC
TOMB 7										
ETH-69961	Right Humerus (Adult)	Funerary Chamber	4608 ± 25	−19.2	9.3	3.4	35.3	12.3	3500–3350 BC	3500–3340 BC
Beta-448208	Left Radius (Adult)	Funerary Chamber	4550 ± 30	−19.3	10.2	3.4	39.72	13.81	3370–3120 BC	3370–3100 BC
Beta-448209	Left Radius (Adult)	Funerary Chamber	3910 ± 30	−19.8	9.9	3.7	39.18	12.51	2470–2340 BC	2480–2290 BC
TOMB 8										
ETH-71513	Right Femur (Adult)	Funerary Chamber (Phase A)	3959 ± 26	−20.0	9.7	3.6	23.3	7.5	3020–2920 BC	3090–2900 BC
SUERC-72323	Left Femur (Adult)	Funerary Chamber (Phase A)	4365 ± 30	−19.7	9.4	3.3	19.8	6.5	2570–2460 BC	2570–2340 BC
TOMB 10										
ETH-69962	Left Femur (Adult) Articulated skeleton	Passage (2nd section)	3945 ± 24	−19.3	8.5	3.3	40.5	14.4	2550–2350 BC	2565–2345 BC
ETH-69963	Left Femur (Adult)	Passage (2nd section)	3993 ± 24	−19.4	8.2	3.3	40.7	14.5	2565–2475 BC	2575–2470 BC
ETH-69964	Left Femur (Adult) Articulated skeleton	Funerary Chamber	3899 ± 24	−19.5	8.8	3.3	37.6	13.3	2460–2350 BC	2470–2300 BC
ETH-69965	Left Femur (Adult)	Passage (1st section)	3718 ± 17	−19.8	9.2	3.4	36.8	12.7	2190–2045 BC	2195–2035 BC
ETH-69966	Left Femur (Adult)	Funerary Chamber	3942 ± 24	−19.7	8.0	3.3	31.6	11.1	2490–2350 BC	2565–2345 BC
ETH-71515	Left Femur (Adult)	Funerary Chamber	3886 ± 23	−19.6	9.0	3.3	36.3	12.9	2460–2345 BC	2465–2300 BC
ETH-69967	Left Femur (Adult)	Funerary Chamber	3941 ± 24	−19.4	8.3	3.3	40.7	14.3	2490–2350 BC	2560–2345 BC
ETH-69968	Left Femur (Adult) Articulated skeleton	Funerary Chamber	3980 ± 24	−19.3	9.0	3.3	40.2	14.3	2560–2470 BC	2570–2465 BC
ETH-69969	Left Femur (Adult)	Funerary Chamber	3959 ± 24	−19.7	9.0	3.3	38.1	13.6	2560–2465 BC	2560–2465 BC
ETH-69970	Left Femur (Adult)	Funerary Chamber	3954 ± 24	−19.4	8.4	3.3	40.0	14.2	2560–2450 BC	2570–2350 BC
Beta-448207	Left Femur (Adult)	Funerary Chamber	3700 ± 30	−19.4	9.3	3.3	40.94	14.31	2140–2040 BC	2200–1980 BC
SUERC-72324	Left Femur (Adult)	Passage (1st section)	3898 ± 30	−20.1	8.0	3.3	33.8	11.9	2460–2350 BC	2470–2300 BC
SUERC-84314	Tooth 63 (Infantile I)	Funerary Chamber	4533 ± 24	−18.8	11.2	3..3	40	14	3355–3120 BC	3360–3105 BC
SUERC-86899	Tooth 45 (Adult)	Funerary Chamber	4218 ± 34	−19.3	8.7	3.5	44.5	15	2900–2760 BC	2910–2680 BC
SUERC-86889	Tooth 45 (Adult)	Funerary Chamber	4083 ± 32	−19.3	10.3	3.4	43.8	15	2840–2570 BC	2860–2500 BC
SUERC-84312	Tooth 45 (Adult)	Funerary Chamber	4077 ± 24	−19.8	7.8	3.2	41	15	2835–2575 BC	2850–2500 BC
SUERC-84313	Tooth 45 (adult)	Funerary Chamber	4074 ± 21	−19.8	10.1	3.2	42	15	2830–2575 BC	2840–2500 BC
SUERC-84311	Tooth 45 (adult)	Funerary Chamber	4074 ± 24	−19.8	7.8	3.3	43	16	2830–2575 BC	2850–2495 BC
SUERC-86898	Tooth 45 (adult)	Funerary Chamber	4072 ± 34	−19.5	8.7	3.4	43.5	15	2830–2500 BC	2860–2490 BC
SUERC-84310	Tooth 45 (adult)	Funerary Chamber	4059 ± 24	−19.8	8.4	3.3	43	15	2620–2500 BC	2835–2490 BC
SUERC-86892	Tooth 45 (adult)	Funerary Chamber	4026 ± 34	−19.2	10	3.4	42.8	14.7	2580–2490 BC	2830–2470 BC
SUERC-86893	Tooth 45 (adult)	Funerary Chamber	4025 ± 32	−19.6	9	3.3	43	15.1	2580–2490 BC	2620–2470 BC
SUERC-86891	Tooth 45 (adult)	Funerary Chamber	4019 ± 34	−19.1	8.5	3.4	44.3	15	2570–2490 BC	2620–2470 BC
SUERC-86897	Tooth 45 (adult)	Funerary Chamber	4013 ± 34	−19.5	8.5	3.4	43.4	14.9	2570–2490 BC	2620–2470 BC
SUERC-86900	Tooth 45 (adult)	Funerary Chamber	3958 ± 34	−19,2	9.1	3.4	43.2	14.8	2570–2410 BC	2570–2350 BC
SUERC-86890	Tooth 45 (adult)	Funerary Chamber	3954 ± 34	−19,4	9.8	3.4	44.5	15.2	2570–2350 BC	2570–2340 BC

(*continued on next page*)

Table 2 (*continued*)

Laboratory Code	Type of material (Age)	Context	Radiocarbon age (BP)	δ13 IRMS ‰	δ15N ‰	C:N	%C	%N	Calibrate date (68% confidence) cal BC/AD	Calibrate date (95% confidence) cal BC/AD
TOMB 11										
SUERC-99085	Left Femur (Adult) Individual 1	Funerary Chamber (Phase A)	3689 ± 29	−20.1	7.6	3,3	26,9	9,5	2140–2030 BC	2200–1970 BC
SUERC-99086	Left Femur (Adult) Individual 2	Funerary Chamber (Phase A)	3907 ± 29	−19.3	8.8	3,4	34,4	11,9	2460–2350 BC	2470–2300 BC
SUERC-99087	Left Femur (Adult) Individual 3	Funerary Chamber (Phase A)	3744 ± 29	−19.6	8.6	3,3	24,6	8,6	2200–2060 BC	2280–2040 BC
SUERC-99088	Left Femur (Adult) Individual 4	Funerary Chamber (Phase A)	3775 ± 29	−19.8	8.8	3,4	25,9	8,8	2280–2140 BC	2290–2050 BC
SUERC-99089	Left Femur (Adult) Individual 5	Funerary Chamber (Phase A)	3973 ± 29	−19.9	8	3,4	31,8	11,1	2570–2460 BC	2575–2350 BC
SUERC-99090	Left Femur (Adult) Individual 6	Funerary Chamber (Phase A)	3951 ± 29	−19.5	8.4	3,4	31,2	10,8	2560–2350 BC	2570–2340 BC
SUERC-99094	Left Femur (Adult) Individual 7	Funerary Chamber (Phase A)	3929 ± 29	−19.7	8.9	3,4	34	11,7	2470–2350 BC	2560–2300 BC
SUERC-99095	Left Femur (Adult) Individual 11	Funerary Chamber (Phase B)	4448 ± 29	−19.3	9	3,3	31	10,9	3320–3025 BC	3335–2935 BC
TOMB 15										
SUERC-98105	Skull (Adult)	Pit	1634 ± 28	−19	10.5	3,4	36	12,5	410–530 AD	380–540 AD
SUERC-98109	Skull (Adult) Articulated skeleton	Funerary Chamber	4589 ± 28	−19.4	9.9	3,3	30,7	10,9	3490–3345 BC	3500–3120 BC
SUERC-98110	Skull (Adult)	Funerary Chamber	4247 ± 28	−19.3	9.9	3,4	28,3	9,7	2905–2875 BC	2910–2710 BC
SUERC-98111	Skull (Adult)	Funerary Chamber	4548 ± 28	−19.2	9	3,2	18,3	6,6	3365–3120 BC	3370–3100 BC
SUERC-98112	Skull (Adult)	Funerary Chamber	4570 ± 28	−19.3	9.5	3,3	30,1	10,7	3370–3140 BC	3490–3105 BC
SUERC-98113	Skull (Adult)	Funerary Chamber	4567 ± 28	−19.1	10.3	3,3	36,8	12,9	3370–3140 BC	3490–3105 BC
SUERC-99096	Skull (Adult)	Funerary Chamber	4651 ± 29	−19.1	11.1	3,2	23,4	8,5	3500–3370 BC	3520–3365 BC
SUERC-98114	Mandible (Infant II)	Funerary Chamber	4554 ± 28	−19	9.7	3,3	26,9	10,5	3370–3130 BC	3480–3100 BC
SUERC-98115	Mandible (Juvenile)	Funerary Chamber	4519 ± 28	−19.6	11.2	3,4	32	11,1	3350–3110 BC	3360–3100 BC
SUERC-99097	Skull (Juvenile)	Funerary Chamber	4407 ± 29	−19.3	10.6	3,2	24,8	8,9	3090–2930 BC	3310–2920 BC
TOMB 18										
ETH-71514	Right Humerus (Adult)	Funerary Chamber	4123 ± 23	−19.6	9.1	3.4	33.8	11.5	2855–2625 BC	2865–2580 BC

probability). In this case, the period of use spans *1–120 years (95% probability; Span Phase A)*, but probably only *1–30 years (68% probability)*, which is approximately one generation.

There are important differences between the two phases of burial activity. The earliest phase was a very intense period of funerary rituals that spanned between *75 and 145 years (68% probability)*, with a short period of reuse, probably in the 29th century cal BC. The sequence of frequent mortuary events would have produced continuous disturbances that commingled and fragmented the bone assemblage, which has not preserved any skeletal articulation. Conversely, between the last decades of 26th and the first decades of the 25th centuries cal BC, after a long hiatus, the funerary chamber was reused for a very brief period, between *1 and 30 years (68% probability)*, and for a few adult individuals that have preserved their anatomical connections. At that time Tomb 3 would have housed two very different ritual practices separated by a period of mortuary inactivity dated to the first half of the 3rd millennium cal BC.

Tomb 11 also has two phases of mortuary deposits. As mentioned above, only individuals in articulated or semi-articulated positions were chosen for radiocarbon dating, i.e. two individuals for the earliest phase (Phase B) (although only Individual 11 produced good quality collagen for radiocarbon dating) and seven individuals for the most recent layer of interments (Phase A). In this later phase, the seven individuals presented different stratigraphic relationships that were incorporated into the chronological model as prior information. Individual 1 was the most recent deposition superimposed on two different sequences of funerary events stratigraphically unrelated to each other. In the first sequence, Individual 4 was placed partially over Individual 2 and that body in turn over Individual 7. Individual 5 consisted of a skull and partially articulated lower limbs that had been displaced from their original position and placed over Individuals 4 and 7, probably at the time Individual 4 was interred. For these reasons, this individual is considered to have been deposited earlier than the sequence of largely complete bodies of Individuals 2, 4 and 7. In the second sequence of stratigraphic relationships, Individual 3 appeared to overlay the skeletal remains of Individual 6.

The Bayesian model shows a good index of agreement ($A_{model} = 110$) (Fig. 7 and Table 3), as the radiocarbon dates are consistent with the

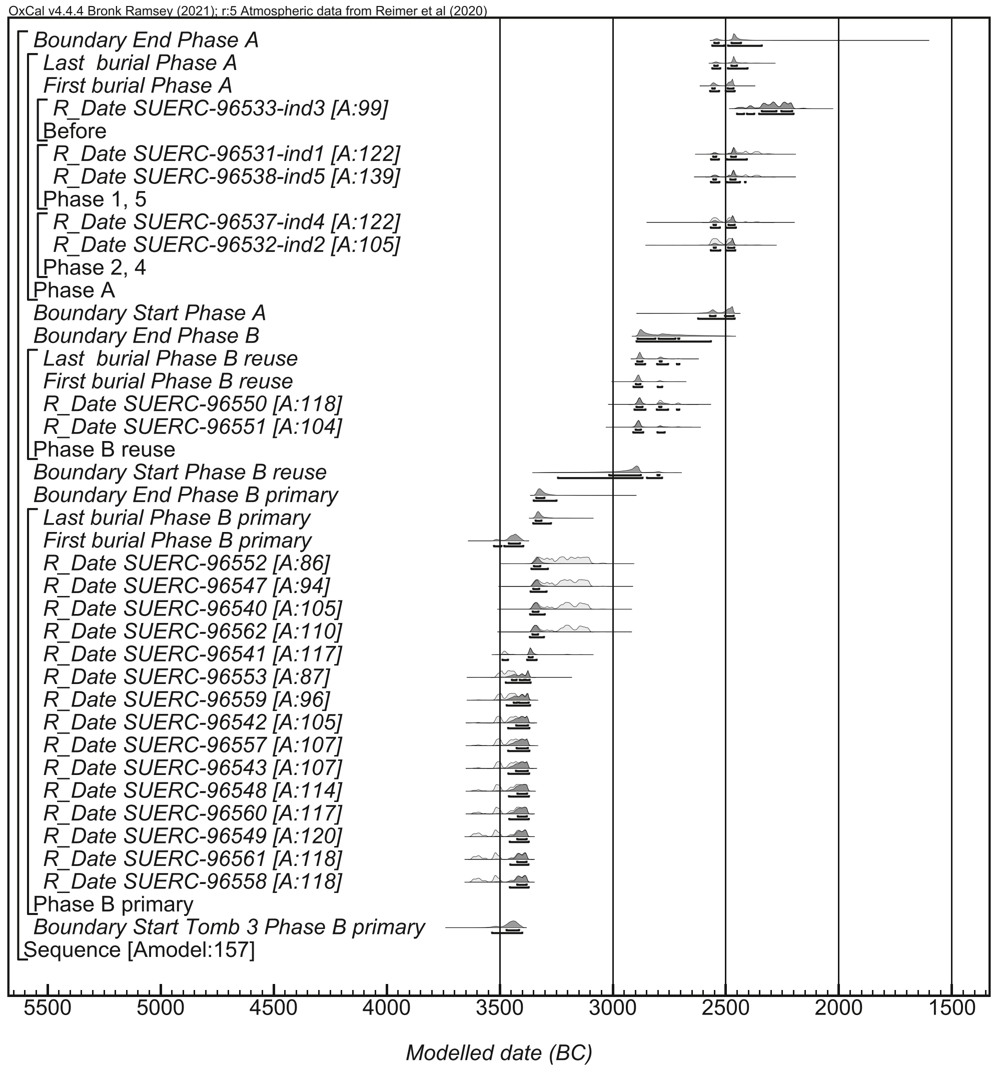

Fig. 6. Probability distribution of dates from the Tomb 3 at the Panoría cemetery. Each date shows two distributions: light grey represents the radiocarbon calibration and dark grey indicates the result of the Bayesian model (posterior density estimates). Distributions other than those relating to particular dates correspond to aspects of the model. The square brackets down the left-hand side and the OxCal keywords define the overall model exactly.

archaeological interpretation of the stratigraphic relationships. The deposition of human remains during the first phase of interments occurred chronologically in the last centuries of the 4th millennium (SUERC-99095 4448 ± 29; 3335-2935 cal BC at 95% probability). The dating strategy based on articulated individuals reduced the number of samples from a minimum number of 9 individuals estimated from teeth to two individuals in anatomical connection. Furthermore, one of these two samples failed due to poor collagen preservation. Therefore, the only dated sample prevents us from drawing any conclusions about the use-life of this phase, although it is plausible that it would have been during the second half of the 4th millennium, as occurs in the earliest phases of other tombs in the cemetery.

Once the mortuary depositions in Phase B had finished, there was a hiatus before the secondary accumulation of interments began (Phase A). This gap between the deposition of Individual 11 and the start of Phase A lasted several centuries, between *300 and 840 years (95% probability; Difference Phase B burial and Start Phase A)*, and probably for *455–765 years (68% probability)*. The most recent phase of mortuary activity (Phase A) began in *2800*–2420 cal BC *(95% probability; Start Phase A)*, probably between *2610*–2470 cal BC *(68% probability)* and ended in *2190*–1810 cal BC *(95% probability; End Tomb 11 Phase A)*, probably in *2130*–1980 cal BC *(68% probability)*. The difference between these two distributions suggests that this period of mortuary activity spanned *280–530 years* (*95% probability; Span A*), probably *335–460 years (68% probability)*.

Nevertheless, a more accurate analysis of the dates reveals that Individuals 2, 5, 6 and 7 pass the test of contemporaneity (T' = 2.9; df = 3; T'(5%) = 7.8), as well as Individuals 1, 3 and 4 (T' = 4.5; df = 2; T'(5%) = 6.0), which means that funerary depositions seem to be chronologically concentrated in two brief main events. We have modelled the radiocarbon dates of Phase A according to this criterion, which is also supported by the stratigraphic location of Individuals 1, 3 and 4 as they are the most recent mortuary depositions. The model shows a good index of agreement (A_{model} = 133) (Table 3 and supplementary materials). Individuals 2, 5, 6 and 7 were concentrated in *c.* 25th century cal BC (*between 2560–2460 and 2465*–2340 cal BC *Start and End respectively, 68% probability*) and Individuals 1, 3 and 4 around the 22nd century cal BC (*between 2300–2140 and 2140*–1985 cal BC *start and end respectively, 68% probability*). In both cases, the period of use was short, between 1-120 years and 1–95 years *(68% probability)* respectively for each cluster of burials. Tomb 11 followed a general dynamic of use similar to Tomb 3. In both cases, the earliest phases were dated in the second half of 4th millennium and, after a long period of mortuary inactivity, both tombs were reused briefly in the second half of the 3rd millennium cal BC.

Tomb 15 had a single compact layer of skeletal remains in the funerary chamber and a skull and two long bones deposited in an outside

Table 3
Posterior density estimates of Bayesian models discussed in the text.

Cluster criteria	Parameter	Posterior density estimate (68% of probability cal BC)	Posterior density estimate (95% of probability cal BC)
Tomb 3 (Fig. 6)			
Phase A	*First*	*2560–2465*	*2570–2460*
	Boundary Start	*2570–2465*	*2625–2460*
	Last	*2555–2450*	*2560–2405*
	Boundary End	*2550–2435*	*2560–2340*
	Span	*1–30 years*	*1–120 years*
Chronological hiatus	*Difference between Phase A and B*	*300–420 years*	*210–430 years*
Phase B Primary reuse	*First*	*2900–2880*	*2910–2780*
	Boundary Start	*3015–2795*	*3245–2785*
	Last	*2895–2785*	*2900–2705*
	Boundary End	*2890–2710*	*2895–2565*
	Span	*1-25 years*	*1-135 years*
Phase B Primary use	*First*	*3465–3410*	*3530–3395*
	Boundary Start	*3470–3415*	*3535–3400*
	Last	*3345–3315*	*3355–3275*
	Boundary End	*3340–3305*	*3350–3250*
	Span	*70–145 years*	*55–225 years*
Tomb 10 (Fig. 10)			
Phase A (bone samples)	*Boundary Start*	*2225–2070*	*2375–2045*
	Boundary End	*2135–2010*	*2190–1925*
	Span	*1–40 years*	*1–100 years*
Chronological hiatus	*Difference between Phase A and B*	*220–380 years*	*70–410 years*
Phase B (bone samples)	*Boundary Start*	*2480–2470*	*2500–2460*
	Boundary End	*2465–2445*	*2470–2400*
	Span	*1–25 years*	*1–70 years*
Phase C (teeth samples)	*Boundary Start*	*3200–3110*	*3310–3050*
	Boundary End	*2500–2470*	*2525–2465*
	Span	*595–665 years*	*550–730 years*
Difference between phases	*Difference Start Teeth & Start Bones*	*640–730 years*	*575–830 years*
Tomb 11 (Fig. 7)			
Phase A	*Boundary Start*	*2610–2470*	*2800–2420*
	Boundary End	*2130–1980*	*2190–1810*
	Span	*335–460 years*	*280–530 years*
Chronological hiatus	*Difference between Phase A and B*	*460 and 765*	*300 and 840*
Phase B	*Individual 11*	*3320–3025*	*3335–2935*
Tomb 11 (Phase A)			
Individuals 1, 3 and 4 (Phase A1)	*Boundary Start*	*2300–2140*	*2625–2050*
	Boundary End	*2140–1985*	*2200–1650*
	Span	*1–95 years*	*1–190 years*
Individuals 2, 5, 6 and 7 (Phase A2)	*Boundary Start*	*2560–2460*	*2740–2360*
	Boundary End	*2465–2340*	*2470–2152*
	Span	*1–120 years*	*1–190 years*
Tomb 15 (Fig. 9)			
Funerary chamber	*Boundary Start*	*3535–3375*	*3690–3365*
	Boundary End	*2900–2800*	*2910–2620*
	Span	*470–610 years*	*460–635 years*
All tombs (Supplementary material)			
Whole Radiocarbon Series	*Boundary Start*	*3550–3495*	*3595–3450*
	Boundary End	*2130–2045*	*2180–2010*
	Span	*1360–1450 years*	*1305–1490 years*

pit. Of the 13 samples selected for radiocarbon dating, 10 were successfully dated, one from the pit and 9 from the chamber. Surprisingly, the skull found in the pit belonged to a Late Antiquity reuse event dated in the *ca.* 5th century cal AD (SUERC-98105 1634 ± 28, 380–540 cal AD at 95% probability). Although finds of Roman and Late Antiquity burials associated with megalithic monuments are not unusual in Iberia (Lorrio Alvarado and Montero Ruíz, 2004; García-Sanjuán et al., 2008; Aranda Jiménez et al., 2015) and other European and North African regions (Holtorf, 1998; Bradley, 2002; Díaz-Guardamino et al., 2015; Sanmartí et al., 2015), they generally follow the funerary rituals distinctive of those times. However, this was not the case of the pit found at Tomb 15, where any evidence, such as grave goods or the use of distinctive materials, e.g. *tegulae*, anticipated a Late Antiquity chronology. Moreover, the skeletal remains found should not be considered as a proper mortuary practice as they were deposited already skeletonised. The ritual consisted of a deliberate act of careful deposition of three bones next to the funerary chamber: a skull and two long bones –a humerus and a tibia– placed over the skull (Fig. 8). Despite the singularity of the find, it should be considered in a broader context of megalithic monument reuse in Late Antiquity, probably as part of ritual practices associated with the memory of communities in the distant past and the legitimisation of specific social roles.

In the funerary chamber of Tomb 15, except for one individual found articulated, the skeletal remains appeared fragmented and commingled in the single layer of depositions. The lack of a clear sequence of mortuary events prevented the use of any informative prior information (i.e. stratigraphic sequencing), which means that the radiocarbon series was clustered in a simple phase of ritual activity that assumes no stratigraphic relationship between the dated individuals. The Bayesian model has a good index of agreement (A_{model} = 104) (Fig. 9 and Table 3). Funerary activity began in *3690*–3365 cal BC *(95% probability; Start Tomb 15)*, probably between *3535*–3375 cal BC *(68% probability)* and ended in *2910*–2620 cal BC *(95% probability; End Tomb 15)*, possibly in *2900*–2800 cal BC *(68% probability)*. According to this model, the period of use of the funerary chamber would have spanned several centuries, between 470 and 610 years *(68% probability; Span Tomb 15)*. Nevertheless, six of the nine dates pass the test for statistical consistency ($T' = 2.57$; df = 5; $T'(5\%) = 11.07$) (Ward and Wilson 1978), which means that most the individuals would have died in closely connected events in the second half of the 4th millennium, with a brief reuse in the first century of the 3rd millennium cal BC. The chronology of this tomb matches Phase B of Tomb 3. The use of both tombs would have occurred mainly between the 35th and 34th centuries cal BC, with a later reuse in the 29th cal BC century. However, unlike Tombs 3 and 11, the funerary chamber of this tomb does not show any evidence of a more recent phase of funerary activity.

Tomb 10 also had one compact layer of funerary and ritual remains that, in this case, was scattered not only in the chamber but also along the corridor. The radiocarbon series of this tomb was obtained in two dating rounds that are discussed in depth elsewhere (Aranda Jiménez et al., 2018b; 2020b). In 2016, although the MNI was calculated on teeth, we focused our attention on the MNI based on the bones, with the aim of including articulated and partially articulated individuals in the radiocarbon series. As a result, twelve samples were selected, a figure calculated on the basis of 11 left femurs from adults and a fibula from a juvenile. Of the 12 samples, four were from skeletons still in anatomical connection. According to the stratigraphic relationship between the samples, two phases of mortuary activity were identified and used as prior information (Phases A and B) (see for further details Aranda Jiménez et al., 2018b). The Bayesian analysis had a good index of agreement (A_{model} = 144) (Fig. 10 and Table 3). In Phase B, in which most of the interments were concentrated, mortuary activity began in *2500*–2460 cal BC *(95% of probability; Start Phase B)*, probably between *2480*–2470 cal BC *(68% probability)* and ended in *2470*–2400 cal BC *(95% of probability; End Phase B)*, possibly in *2465*-2445 cal BC *(68% probability)*. The difference between these two distributions suggests a very short period of use, between 1 and 70 years *(95% probability; Span Phase B)*, or more likely between 1 and 25 years *(68% probability)*, which means that approximately one generation would have been buried during this phase. After a hiatus of at least a couple of centuries (*220–380 years at 68% probability; Difference Phase A and B)*, the tomb was reused during a short period and only for a few interments. Mortuary rituals restarted in *2375*-2045 cal BC *(95% of probability; Start Phase A)*, probably between *2225*-2070 cal BC *(68% probability)* and ended between *2190*-1925 cal BC *(95% of probability; End Phase A)*, possibly in *2135*-2010 cal BC *(68% probability)*. This period of mortuary activity spanned 1–100 *years* (*95% probability; Span Phase A*), probably

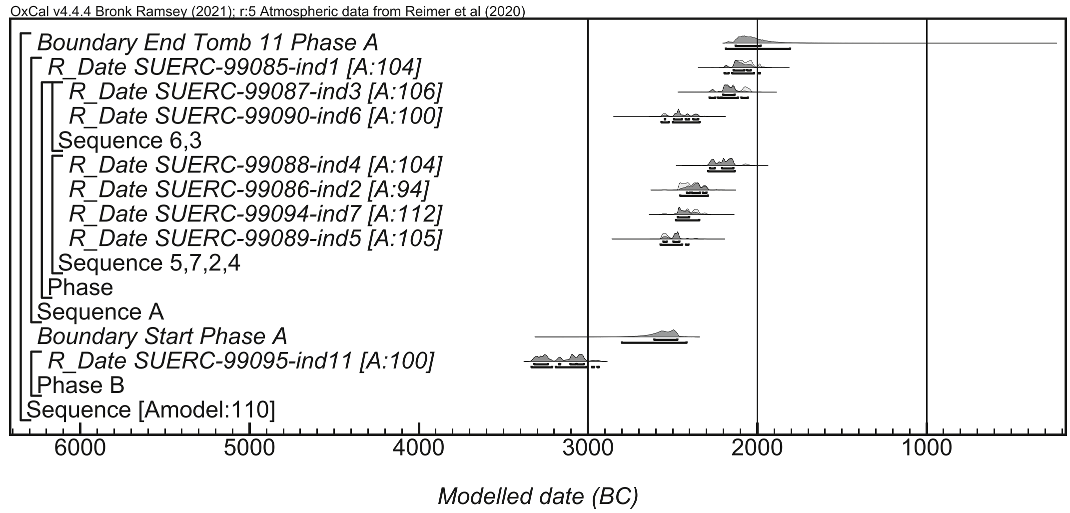

Fig. 7. Probability distribution of dates from the Tomb 11 at the Panoría cemetery. The format is identical to that in Fig. 6.

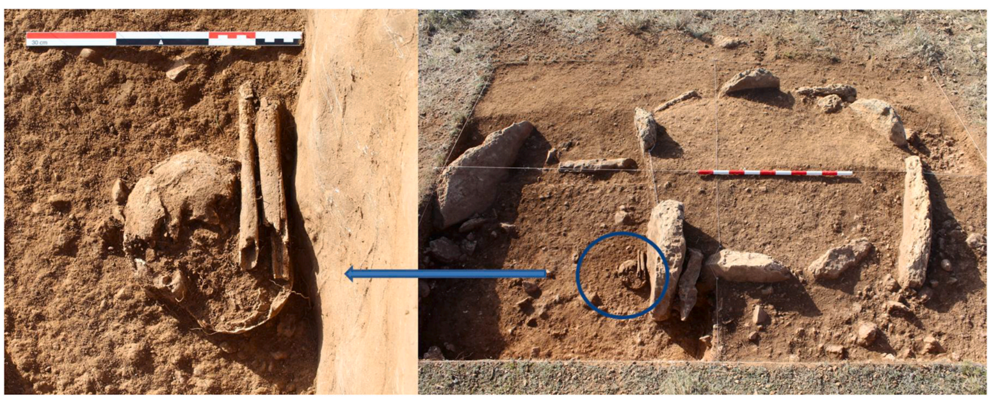

Fig. 8. Pit burial at Tomb 15 of the Panoría cemetery. Right: pit location. Left: detail of the human bone remains.

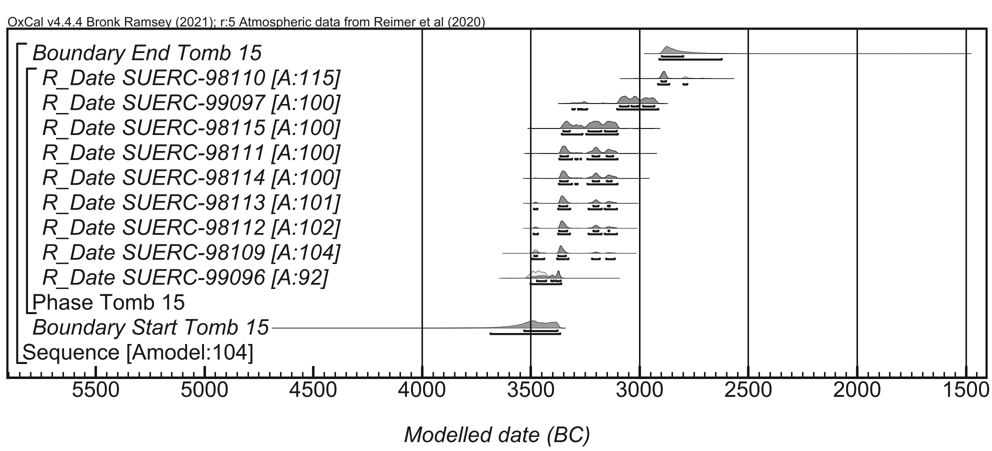

Fig. 9. Probability distribution of dates from the Tomb 15 at the Panoría cemetery. The format is identical to that in Fig. 6.

1–40 years (68% probability), again approximately one generation. According to this model, the tomb was in use over a few decades with a later brief reuse event coinciding chronologically with the appearance of the Early Bronze Age societies (Aranda Jiménez et al., 2018b).

In 2019, we progressed in our understanding of the bone assemblage formation of Tomb 10 through an innovative methodology based on comparative radiocarbon chronology. The main goal was to explore whether the depositional events of human remains were concentrated in short periods of time, as the previous model suggests, or if the bone assemblage formation could have been influenced by social actions that may have involved not only the deposition but also the removal of skeletal remains. To address this hypothesis, for various reasons we focused our attention on the teeth found in the tomb. Firstly, the MNI was largely calculated on teeth, which suggested twice as many interments as the number of people calculated according to the bones (24 versus 12). Furthermore, teeth have different properties that make them

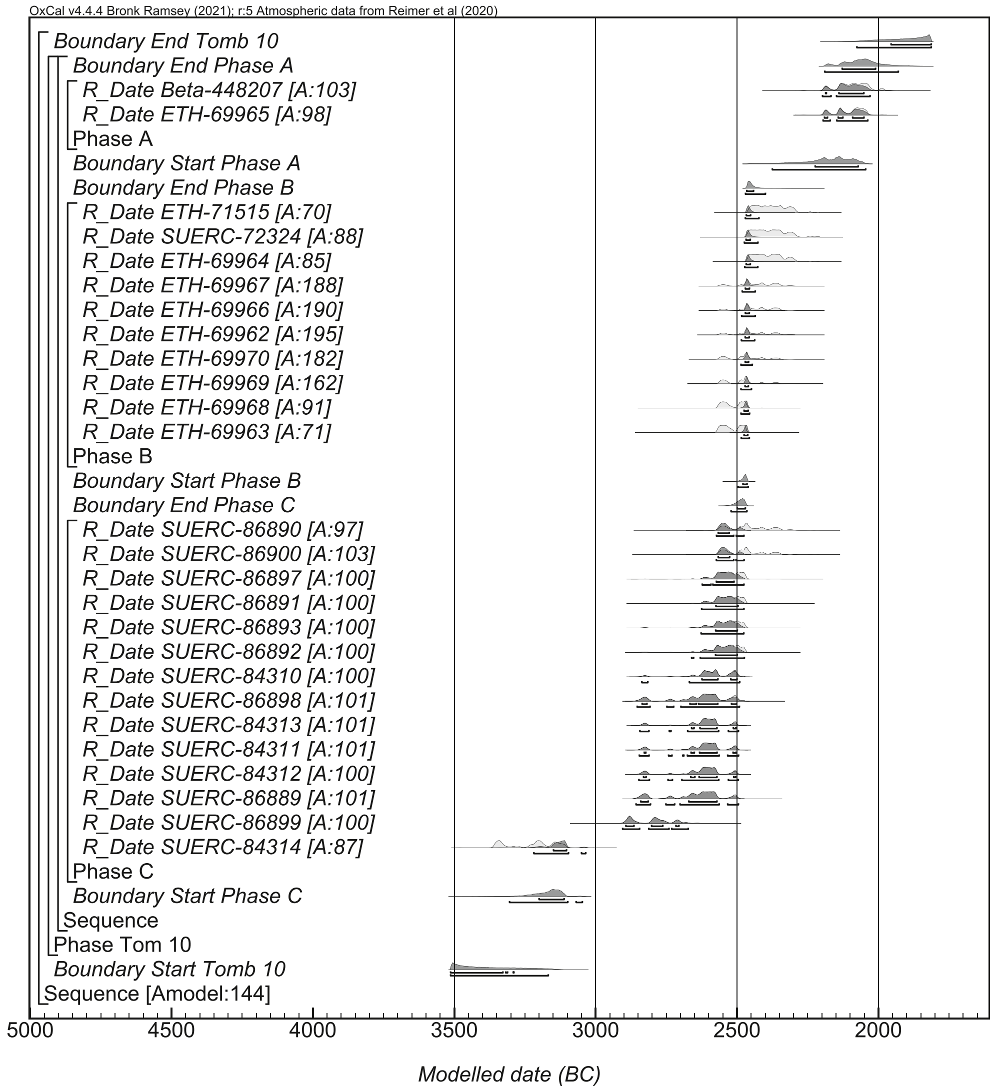

Fig. 10. Probability distribution of dates from the Tomb 10 at the Panoría cemetery. The format is identical to that in Fig. 6.

very suitable for addressing the possible removal of skeletal remains: small size, good preservation in different taphonomic conditions due to their high mineral content and the fact they easily detach from mandibles and maxillae after the skeletal decomposition begins.

Of the 24 potential samples, we selected only loose teeth, avoiding those that remained *in situ* in a mandible or the maxillae. After several dating rounds, 14 dates were successfully obtained (Phase C). As a result, the earliest human remains were placed in the tomb in *3310*–3050 cal BC *(95% probability; Start Phase C*), probably in *3200*–3110 cal BC *(68% probability)*, which contrasts with the beginning of the mortuary activity according to the bone remains. The difference between these two distributions moves the beginning of the funerary depositions to an earlier date between 640 and 730 years (*68% probability; Difference between Start Teeth and Start Bone*). It is remarkable that most of the teeth belong to funerary activities earlier than those identified from the bone samples. It seems clear that the radiocarbon series of teeth samples dramatically changes our chronological understanding of Tomb 10, with a long phase of ritual events previously having gone unnoticed. The radiocarbon series based on teeth not only pushes back the beginning of mortuary activity to the last centuries of the 4th millennium, but also suggests that teeth provide the evidentiary link to skeletal depositions subsequently removed from the tomb (Aranda Jiménez et al., 2020b).

Finally, a Bayesian model was built taking into account all 73 radiocarbon dates from the Panoría cemetery (Supplementary Material and Table 3). In addition to the previously discussed Tombs 3, 10, 11 and 15, four more dolmens have provided radiocarbon dating, Tombs 6, 7, 8 and 18 (Table 2). Nevertheless, the poor preservation of their funerary depositions has prevented obtaining a large radiocarbon series. The MNI for these four tombs was nine, although only seven individuals were finally successfully dated (Table 1) (for further details see Aranda Jiménez et al., 2018b). The Bayesian model has a good index of agreement (A_{model} = 95) and estimates that the burial activity began in *3595*–3450 cal BC *(95% probability; Start Cemetery),* probably between *3550*–3495 cal BC *(68% probability),* and ended in *2180*–2010 cal BC *(95% probability; End Cemetery),* possibly around *2130*–2045 cal BC *(68% probability)*. The difference between these two distributions suggests a very long period of use, between 1360–1450 calendar years (*68% probability Span*). Nevertheless, if all the dates are added up in a KDE model (Fig. 11), this long period of use shows a punctuated pattern with four pulses of ritual intensity: two stronger peaks in the 34th and 25th centuries cal BC and two milder pulses in the 29th and 21st centuries cal BC respectively. The two main pulses in particular are very consistent with the specific models of the four tombs discussed previously. Tombs 3 and 15 have a peak of ritual intensity around the 34th century and Tombs 3, 10 and 11 in the 25th century.

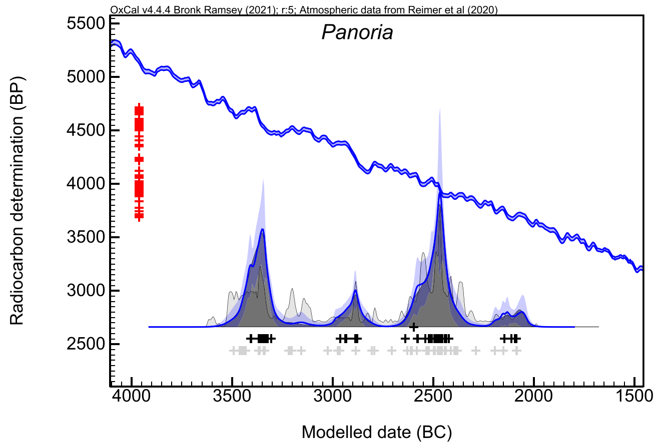

Fig. 11. KDE-modelled distribution of all radiocarbon dates from Panoría cemetery (blue line). Radiocarbon measurements appear in red, the IntCal20 calibration curve in blue and the summed distribution in grey. Calibrated and modelled ages appear as grey and black crosses respectively. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

5. Discussion and conclusions

Our knowledge of Iberian megalithic monuments has substantially improved in recent decades, although only in a very few cases have the new insights been based on recent fieldwork (Bueno Ramírez et al., 2005; Rojo Guerra et al., 2010; Alt et al., 2016; Fernández Flores et al., 2016; Valera et al., 2019; Valera, 2020). In this context, Panoría stands out as the unique cemetery in Iberia with a large number of recently excavated dolmens. The remarkable state of preservation of four of the nine tombs has offered an excellent opportunity for exploring their ritual variability. According to the previous discussion, the general dynamics of the use of these dolmens shared many of the same ritual and mortuary practices.

All these tombs presented an initial phase of funerary depositions dated in the second half of the 4th millennium cal BC. In Tombs 3 and 15, ritual activity began around the 36th or 35th centuries cal BC, probably when most of the tombs were built. The mortuary activity was concentrated principally in the 35th and 34th centuries cal BC with a brief reuse event in the 29th century cal BC. Less clear is the use-life of Tombs 10 and 11 because of the limited number of dates in the case of Tomb 11 and the removal of skeletal remains from Tomb 10. However, in all four tombs the second half of the 4th millennium cal BC was a period of intensive funerary depositions that reached their peak in the 34th century cal BC. This primary use, probably over three to six generations, would have produced a bone assemblage formation characterised by fragmented and commingled skeletal remains that appeared piled on top of each other as compact burial layers. Anatomical connexions were only preserved partially in three cases, one in Tomb 15 and two in Tomb 11. Ritual activities at that time were a very complex matter that included different social actions such as the primary depositions of articulated bodies that were disturbed by subsequent burials; the selective removal of skeletal remains; and the concentration of skulls in specific areas inside the funerary chambers.

Around the 29th century cal BC ritual activities ceased in most of the Panoría dolmens. After a hiatus of several centuries, most of the tombs were reused, although in a different way to the previous funerary tradition. In the first decades of the 25th century, mortuary activity restarted in Tombs 3, 10 and 11. Funerary rituals were concentrated principally in the 25th and 21st centuries cal BC in a few events spanning very few decades, approximately over one to four generations. In several cases the possibility that all the interments were deposited at the same time cannot be ruled out. These short periods of use are also consistent with the features of the bone assemblage formation. In many cases, the bone remains were found in articulated positions ranging from largely complete bodies to specific anatomical parts, usually lower and upper limbs. In total, 19 individuals preserved their anatomical connections, in contrast to only three partially articulated bodies found in the earliest phases of mortuary activity. Furthermore, except for Individuals 1 and 4 in Tomb 11, all these interments were placed flexed in the left lateral decubitus position, with a west-east orientation and aligned with the major axis of the chambers.

Thanks to recent radiocarbon series analysed in a Bayesian framework of several Iberian megalithic monuments, including Montelirio (García Sanjuán et al., 2018), Alto Reinoso (Alt et al., 2016) and Los Zumacales (Santa Cruz Del Barrio et al., 2020) in Spain and Perdigões 4 (Valera et al., 2014; Valera, 2020), and Cardim 6 (Valera et al., 2019) in Portugal, a regional pattern of funerary use has emerged. As at Panoría, funerary activity in all these tombs was concentrated in short periods spanning not more than several decades or even years. According to the chronological models, the mortuary use of these tombs would normally have ranged from one to five generations, although single events of simultaneous interments cannot be ruled out (Alt et al., 2016; García Sanjuán et al., 2018; Valera 2020; Santa Cruz Del Barrio et al., 2020; Aranda Jiménez et al., 2021b). The short period of use of these monuments was characterised in several cases by the deposition of only a few interments that have preserved their anatomical connections. This is especially noticeable in Montelirio where the 20 individuals were found in the main funerary chamber in an articulated position (Pecero Espín, 2016).

This pattern of short periods of mortuary use can also be found at other well-known European megalithic monuments (Whittle et al., 2008, 2011; Schulting, 2014; Bourgeois, 2015; Quinn, 2015; Bradley, 2020; Whittle, 2020). This is certainly the case of British cairns and long barrows, including those of Ascott-under-Wychwood, which was in use over three to five generations (Bayliss et al., 2007a); Hazleton North, with only two or three generations (Meadows et al., 2007); West Kennet with little more than a single generation (Bayliss et al., 2007b); and Wayland's Smithy I with an even a shorter period, probably less than one generation, which is also consistent with a single deposition event (Whittle et al., 2007b). All these tombs would have been in use for approximately one century or less.

Short periods of use have also been suggested in other European regions. This is the case of megalithic monuments such as the Irish passage tomb cemetery at Knowth (Schulting et al., 2017), the Dutch barrows of Garderen-Bergsham and Apeldoorn–Wieselse Weg (Bourgeois, 2015), and very especially the Irish Mound of the Hostages that, like Panoría, shows two main phases of short-lived mortuary rituals separated by a long hiatus. At the end of the 4th millennium cal BC, the primary use of this monument was very intense but short, spanning less than a century. After the hiatus, during the first centuries of the 2nd millennium cal BC, the Mound of the Hostages was reused by a few people in two main events lasting 150 and 50 years respectively (Bayliss and O'Sullivan, 2013; Quinn and Kuijt, 2013; Quinn, 2015).

The chronological models of different European megalithic monuments agree in suggesting a surprisingly short span of use for whole monuments or for specific periods of funerary activity. As has been suggested elsewhere (Whittle et al., 2007b; Whittle, 2020), these social practices could indicate that people were not dealing with anonymous ancestors and, consequently, megalithic monuments did not typically survive beyond the remembrance of their builders. Even in those monuments with a time-span of three or less generations, the last individuals buried could have witnessed their construction during childhood. Although this scenario seems very plausible for many megalithic monuments, in other cases, for example in Panoría and in the Mound of the Hostages, it is not unusual to find short reuse events after hiatuses of several centuries. In these cases, the builders and first users had probably been forgotten or were just a vague memory. Megalithic tombs became the house of unknown people probably considered as ancestors who could be used to legitimise specific social roles and create or modify social identities. However, the powerful meaning of these monuments was further enhanced until they became principally sacred places possibly linked to the past history of the local communities. Again, Panoría offers an excellent example. Not just centuries but also millennia later, the memory of the cemetery was recovered during Late Antiquity. Megalithic monuments may have played different social roles throughout their long and punctuated biographies, from places in which to remember known people to resting places for unknown ancestors and even just sacred places that embody histories from the distant past.

The fine-grained chronology achieved at different European megalithic tombs in the last two decades has dramatically changed our perception of the social role of these monuments. Instead of long, uniform chronological units, megalithic monuments were in many cases characterised by brief, usually intense periods of funerary and ritual activity followed by long hiatuses. Their use by a few generations raises fresh questions and shakes up traditional assumptions. The Panoría cemetery joins to this European trend, producing a unique fine-grained chronology in Iberia that breaks down the traditional long chronological phases into shorter periods. It seems clear that a better understanding of the social dynamics and the political strategies performed by different social groups at these monuments can only be accessed through fine-grained chronologies together with the application of formal modelling.

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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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jas.2022.105579.

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