Radiocarbon, Vol 60, Nr 1, 2018, p 1–19 DOI:10.1017/RDC.2017.96

CHRONOLOGY OF MEGALITHIC FUNERARY PRACTICES IN SOUTHEASTERN IBERIA: THE NECROPOLIS OF PANORIA (GRANADA, SPAIN)

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ABSTRACT. An excavation carried out at the megalithic necropolis of Panoria in 2015 offered an excellent opportunity for dating a widespread variety of polygonal, rectangular, and trapezoidal-shaped tombs with short passages for which, surprisingly, there were previously no known radiocarbon (^{14}C) measurements available. Based on the anthropological remains, a series of 19 ^{14}C dates was obtained and modeled in a Bayesian statistical framework. The results stress a long period of use that began in the Late Neolithic (3525–3195 cal BC), reaching the most intensive ritual activity during the Copper Age and ending in the Early Bronze Age (2125–1980 cal BC). Throughout this period, tombs were built at different times and used at different temporal scales and intensities, ranging from a few decades to centuries.

KEYWORDS: Bayesian modeling, funerary ritual, Iberian Peninsula, Late Prehistory, megalithic phenomenon, radiocarbon dating.

INTRODUCTION

In recent decades, methodological advances in radiocarbon (^{14}C) measurements and their statistical interpretation have led to a profound change in our perception of the chronology of past societies (e.g. Buck et al. 1991; Bronk Ramsey 1995, 2013; Bayliss 2009; Scarre 2010; Whittle et al. 2011). These developments have provided a great opportunity to create a refined chronological framework that could be considered a critical issue, particularly in the study of the megalithic phenomenon, which is characterized by long periods of use in many cases (Whittle et al. 2008, 2011; Scarre 2010).

The Iberian Peninsula has not benefited from these improvements, at least not in the same way as other European regions. Only a few graves have been dated with the aim of confirming a broad cultural framework for this phenomenon. Radiocarbon chronology was not an important concern until very recently. This is the case of southeastern Iberia, where the lack of ^{14}C dates—only 10 by 2012—has been one of the main factors hindering a better understanding of this phenomenon (Aranda Jiménez 2013). Our current research is aimed at contributing to changing this situation with new insights into the chronology and temporality of these megalithic monuments (Aranda Jiménez and Lozano Medina 2014, 2017; Aranda Jiménez et al. 2017a; Lozano Medina and Aranda Jiménez 2017).

This paper is specifically aimed at discussing the ^{14}C dates obtained for the necropolis of Panoria (Darro, Granada) (Benavides et al. 2016; Aranda Jiménez et al. 2017b). In the following pages, a new chronological series will be analyzed in a Bayesian framework and the social and cultural implications of these results will be discussed in the context of the megalithic societies of the region.

ARCHAEOLOGICAL BACKGROUND: THE PANORIA NECROPOLIS

This megalithic necropolis is located in the foothills of the mountain of the same name, at the easternmost end of the Sierra Harana in the present-day province of Granada. Discovered in 2012,

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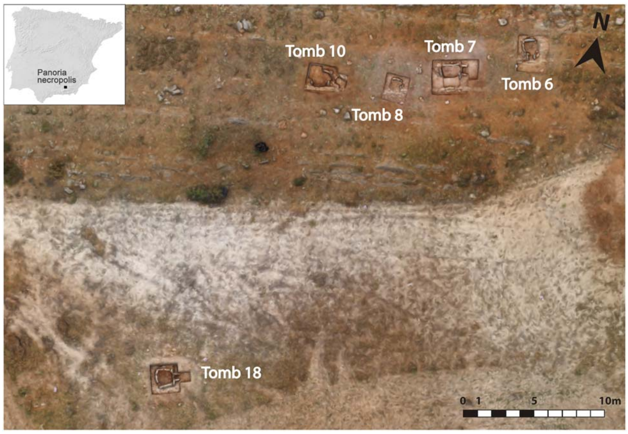

Figure 1 Orthophotography with the location of the 5 excavated tombs at Panoria necropolis.

it is the latest addition to the known megalithic cemeteries spread across the Guadix Basin. This region stands out as one of the most important megalithic concentrations in Western Europe (Leisner and Leisner 1943). Archaeological fieldwork since the end of the 19th century has led to the discovery of more than 400 megalithic tombs in several dozen necropolises. Despite a long research tradition (Siret 1891 [2001], 1908; Leisner and Leisner 1943; García Sánchez and Spahni 1959; Ferrer 1976; Ferrer et al. 1988), chrono-typological concerns have been the main avenue for exploring this phenomenon. Little attention has been paid to other cultural aspects, which have been poorly investigated or completely unnoticed. This is the case of the ^{14}C chronology. It is very surprising that the ^{14}C dates of this paper are the first reported measurements known in the region.

The Panoria necropolis occupies a strategic position overlooking most of the Guadix Basin. Intensive surveys have found 19 dolmens that consist of small tombs with polygonal, rectangular and trapezoidal chambers—normally between 1.10 and 1.60 m in length—and short passages (Figure 1). Four of these megalithic tombs (Figure 2), plus a stone cist, were excavated between February and June 2015 (Tombs 6, 7, 8, 10, and 18)[1]. The excavation process confirmed that all the tombs were at least partially affected by human activities of uncertain origin; for instance, only Tomb 18 retained all its uprights. As expected, only small and fragmented human bones, mixed with the sedimentary deposits that filled the funerary chambers, were documented. In two cases, Tombs 7 and 18, a few anthropological remains—mainly large bones—were found in primary position above well-preserved paved floors.

Unexpectedly, in Tomb 10 an anthropological deposit was found in a remarkable state of conservation that does not seem to have been affected by post-depositional disturbances (Figure 3). The mortuary remains found in the chamber and passage consisted of a mass of stratified, mixed human bones that were found piled on top of each other, overlapping in many cases. Although most of the skeletal remains were scattered, in a few cases complete individuals or specific anatomical parts appeared in an articulated or semi-articulated position (Figure 4). Therefore, it seems that the ritual behavior consisted of primary depositions that were disturbed by later activities. These were mainly subsequent burials, but there were also horizontal and vertical displacements as a result of factors such as gravity and voids created by the decomposition of soft tissue.

[1]A detailed description of the architectural features of each tomb can be found in Benavides et al. (2016).

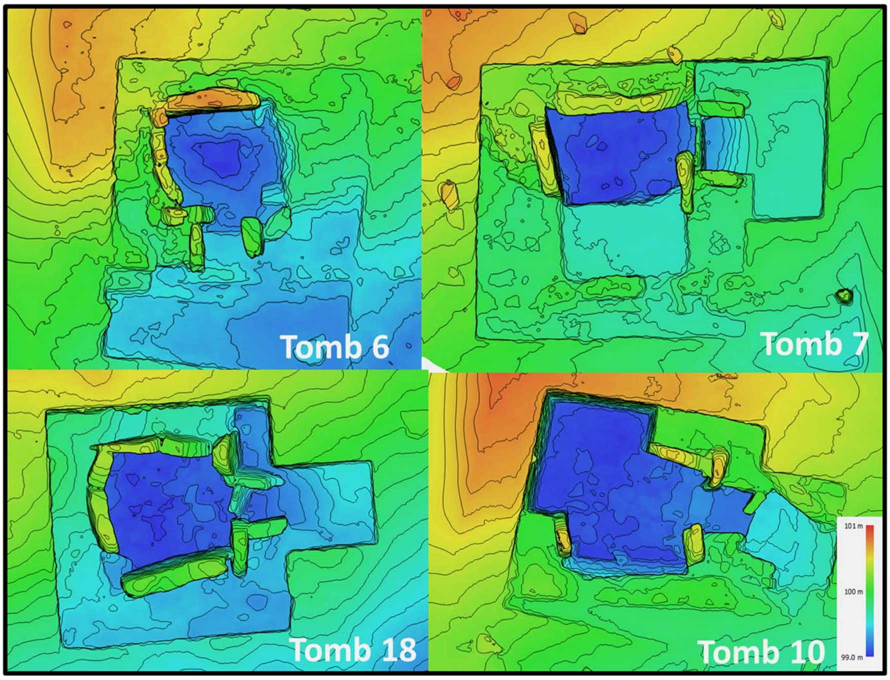

Figure 2 Digital elevation model with contour lines at 5-cm intervals of megalithic Tombs 6, 7, 18, and 10.

According to the anthropological study, the minimum number of individuals (MNI) identified in the five excavated tombs was 37 (Table 1). All the anatomical parts are represented in the skeletal collection, and the main taphonomic processes identified include weathering, bone fracturing and, roots, and rodent marks. The bone remains belong to men, women, and children of all ages, although most fit into the adult range. Sex or age differences do not appear to have been a determining factor in these funerary practices.

MATERIAL AND METHODS

The ^{14}C dating plan was based on two main criteria: (1) we focused on anthropological remains, as they are short-lived samples and the most representative finds of the different ritual practices and depositional events that took place in each tomb; and (2) we decided to date the minimum number of individuals as the best way of ensuring that no individual was dated twice[2].

As stated above, the MNI in the five excavated tombs was 37, although they were not uniformly distributed (Table 1). Tomb 10 concentrates an MNI of 28, which was calculated on the basis of the teeth. In this case, the samples to be dated were selected according to two more specific criteria. Firstly, a new MNI based on bones and not teeth was established to include the articulated individuals in the ^{14}C series. This kind of sample is especially suitable for dating, as they are primary contexts in which the contemporaneity between the date obtained and the act

[2]This pre-condition is very important if the intention is to take a Bayesian approach to the interpretation of the chronological data. The algorithm used in this analysis assumes that every date is statistically independent of the others (Bronk Ramsey 2001).

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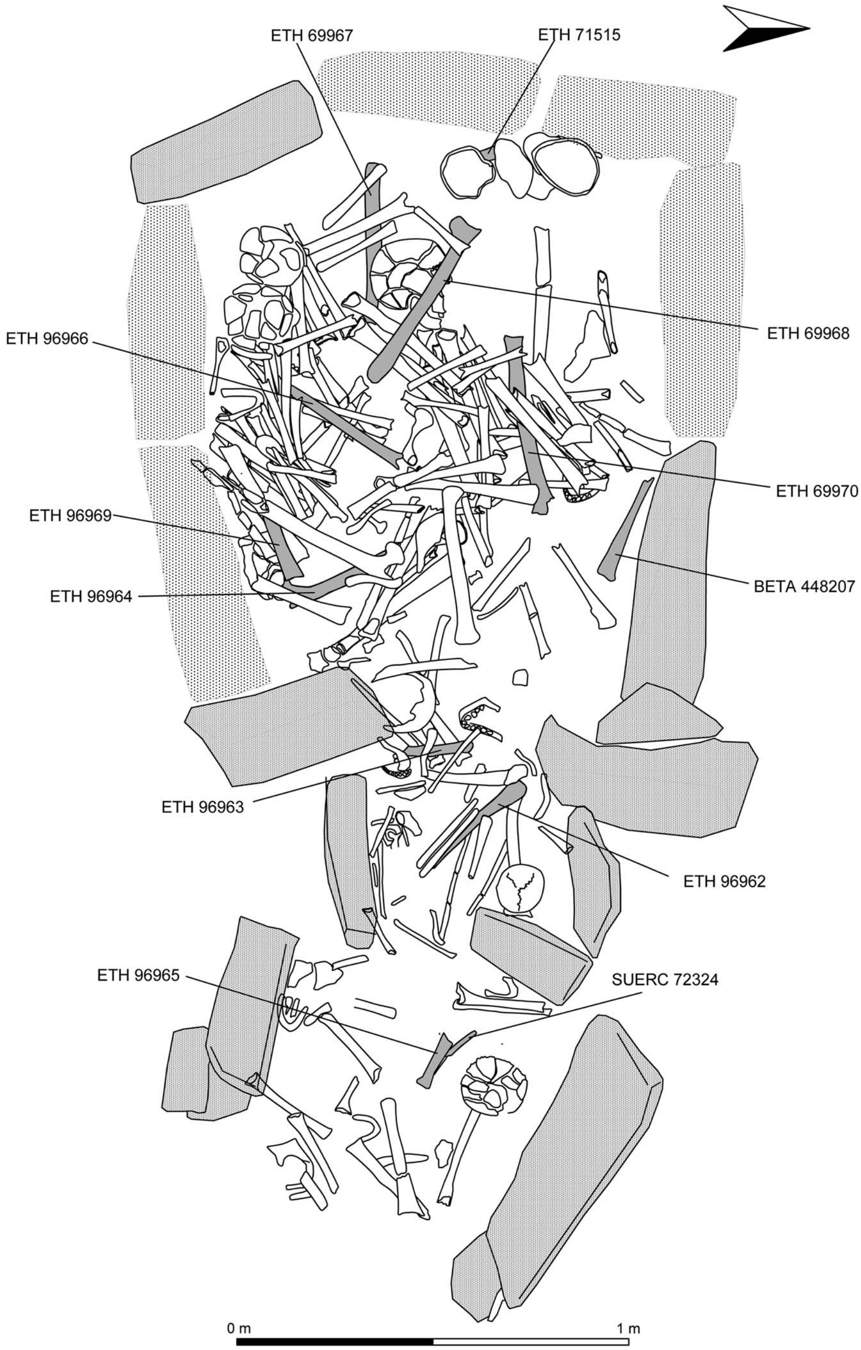

Figure 3 Anthropological remains from Tomb 10 with the identification of the dated bones.

of deposition can be guaranteed. Secondly, to recalculate the MNI, all the skeletal remains were considered as a single group because the mass of bone remains was spread out as a compact deposit through the chamber and passage. This option seemed to be the most appropriate to

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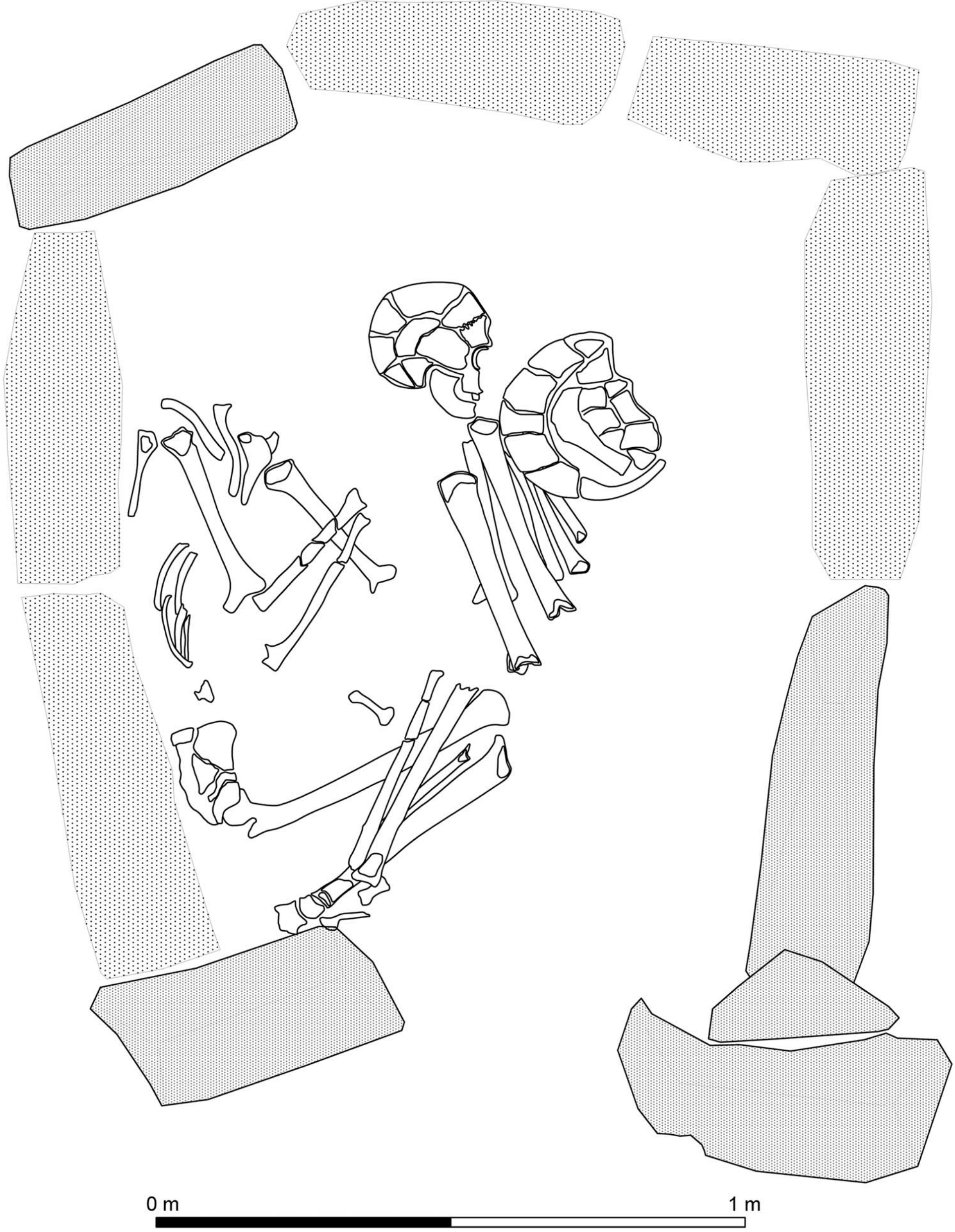

Figure 4 Two partially articulated bodies found in Tomb 10.

avoid potential duplicate dates. According to these criteria, the MNI calculated and selected for dating was 12.

In the other tombs, the remains of the funerary activities were affected by later human disturbance to a greater or lesser extent. Tomb 6 was completely plundered and only very few fragments of human bone were preserved. The MNI identified by the anthropological study was one for this tomb. Tombs 7 and 18 give a slightly different picture as they had not been

Table 1 The NMI identified at the Panoria necropolis and the number of individuals sampled and dated.

Tomb	Context	NMI	Samples selected	Samples dated
Tomb 6	Funerary chamber	1	1	1
Tomb 7	Funerary chamber	3	5	3
Tomb 8	Funerary chamber (Phase 2)	2	1	0
	Funerary chamber (Phase 1)	2	2	2
Tomb 10	First section of the passage	6	12	12
	Second section of the passage	4		
	Funerary chamber	18		
Tomb 18	Funerary chamber	1	1	1

completely looted. In these cases, the samples for ^{14}C measurement were selected from those bone remains located in primary position to ensure that the dates were clearly from their funerary use. The MNI for these tombs was three and one, respectively.

Finally, Tomb 8 preserved two depositional phases of anthropological remains. The earliest or Phase 1 consisted of a few fragments of large bone preserved below different stone slabs that had fallen onto the paved floor of the funerary chamber. The second phase comprises a small pit filled with bone remains that was dug into the sedimentary deposits inside the cist. From an MNI of four, only three samples were selected for ^{14}C dating, as one sample from Phase 2 presented unsuitable properties that anticipated few possibilities of dating.

As a result, 22 samples were selected at different stages and 19 were successfully dated (Table 2). Unfortunately, the only sample from the second phase of Tomb 8 could not be dated due to poorly preserved collagen. In the case of Tomb 7, the first sampling based on three right humeri only provided one ^{14}C date. In a second attempt, the best option was to sample two left radii, accepting the risk that one of the radii could belong to the same individual already dated. After the measurements were obtained, this possibility appeared unlikely, as the calibrated ranges at 95% of probability only overlap by a very few years. The ^{14}C measurements were carried out in three different labs: Beta Analytic Ltd. (Beta) (USA)[3], the Swiss Federal Institute of Technology (ETH) (Switzerland)[4] and the Scottish Universities Environmental Research Centre (SUERC)[5] (Scotland). All samples were measured using accelerator mass spectrometry (AMS). ^{14}C dates were calibrated using the internationally agreed atmospheric curve, IntCal13 (Reimer et al. 2013), and the OxCal v4.2 computer program (Bronk Ramsey 2001, 2009). Calibrated ranges were obtained using the probability method (Stuiver and Reimer 1993) and the end-points were rounded out by 10 yr when the error was greater than or equal to 25 yr and by 5 yr when the error was less than 25 yr (Stuiver and Polach 1977; Millard 2014).

The quality of the bone collagen can be checked in Table 3. The $\delta^{13}C$ values and C:N ratios of all samples are adequate according to Van Klinken (1999) ($\delta^{13}C$ –19 to –22‰) and DeNiro (1985) (C:N 2.9-3.6). Only Beta-448209 displays a C:N ratio slightly out of this range (3.7). However, its %C, %N and $\delta^{13}C$ values suggest that this measurement can be considered as accurate. ETH-71513 and SUERC-72323 also present low values of %C and %N, although

[3]The protocols followed by the Beta laboratory can be found at www.radiocarbon.com.
[4]The methods used by the ETH are provided by Bonani et al. (1987), Synal et al. (2007), and Hajdas (2008).
[5]The methods used by the SUERC are described by Dunbar et al. (2016).

Table 2 Radiocarbon dates from the Panoria necropolis.

Laboratory code	Type of material	Context	^{14}C age (BP)	Calibrated date (95% confidence) cal BC	Modeled dates (95% confidence) cal BC
		Tomb 6			
ETH-69960	Femur from an adult	Funerary chamber	4353 ± 25	3030-2900	*3025-2900*
		Tomb 7			
ETH-69961	Right humerus from an adult	Funerary chamber	4608 ± 25	3500-3340	*3500-3120*
Beta-448208	Left radius from an adult	Funerary chamber	4550 ± 30	3370-3100	*3370-3100*
Beta-448209	Left radius from an adult	Funerary chamber	3910 ± 30	2480-2290	*2475-2295*
		Tomb 8			
ETH-71513	Left femur from an adult	Funerary chamber (Phase I)	3959 ± 26	2570-2340	*2570-2345*
SUERC-72323	Right femur from an adult	Funerary chamber (Phase I)	4365 ± 30	3090-2900	*3090-2905*
		Tomb 10			
ETH-69963	Left femur	Second section of the passage	3993 ± 24	2575-2465	*2575-2465*
ETH-69968	Left femur	Chamber Partially articulated skeleton	3980 ± 24	2570-2460	*2570-2460*
ETH-69969	Left femur	Funerary chamber	3959 ± 24	2570-2345	*2570-2345*
ETH-69970	Left femur	Funerary chamber	3954 ± 24	2570-2345	*2570-2345*
ETH-69962	Left femur	Second section of the passage Partially articulated skeleton	3945 ± 24	2565-2345	*2565-2345*
EHT-69966	Left femur	Funerary chamber	3942 ± 24	2565-2345	*2565-2345*
ETH-69967	Left femur	Funerary chamber	3941 ± 24	2565-2345	*2560-2345*
ETH-69964	Left femur	Funerary chamber Articulated body	3899 ± 24	2470-2300	*2470-2300*
ETH-71515	Left femur	Funerary chamber	3886 ± 23	2465-2295	*2465-2295*
ETH-69965	Left femur	First section of the passage	3718 ± 17	2200-2035	*2200-2035*
SUERC-72324	Fibula from a juvenile	First section of the passage	3898 ± 30	2470-2290	*2470-2295*
Beta-448207	Left femur	Funerary chamber	3700 ± 30	2200-1980	*2200-2030*
		Tomb 18			
ETH-71514	Right humerus from an adult	Funerary chamber	4123 ± 23	2865-2580	*2855-2625*

Table 3 Quality markers of the bone collagen and δ^{13}C and δ^{15}N isotope values from the ^{14}C dating series.

Tomb	Laboratory code	^{14}C age (BP)	δ^{13}C (AMS) (‰)	δ^{13}C (IRMS) (‰)	δ^{15}N (‰)	C:N	%C	%N
6	ETH-69960	4353 ± 25	−19.8	−19.5	9.7	3.4	32.9	11.3
7	ETH-69961	4608 ± 25	−18.2	−19.2	9.3	3.4	35.3	12.3
	Beta-448208	4550 ± 30	—	−19.3	10.2	3.4	39.72	13.81
	Beta-448209	3910 ± 30	—	−19.8	9.9	3.7	39.18	12.51
8	ETH-71513	3959 ± 26	−20.6	−20.0	9.7	3.6	23.3	7.5
	SUERC-72323	4365 ± 30	—	−19.7	9.4	3.3	19.8	6.5
10	ETH-69962	3945 ± 24	−19.2	−19.3	8.5	3.3	40.5	14.4
	ETH-69963	3993 ± 24	−19.6	−19.4	8.2	3.3	40.7	14.5
	ETH-69964	3899 ± 24	−20.1	−19.5	8.8	3.3	37.6	13.3
	ETH-69965	3718 ± 17	−20.2	−19.8	9.2	3.4	36.8	12.7
	ETH-69966	3942 ± 24	−21.2	−19.7	8.0	3.3	31.6	11.1
	ETH-71515	3886 ± 23	−19.4	−19.6	9.0	3.3	36.3	12.9
	ETH-69967	3941 ± 24	−19.0	−19.4	8.3	3.3	40.7	14.3
	ETH-69968	3980 ± 24	−20.1	−19.3	9.0	3.3	40.2	14.3
	ETH-69969	3959 ± 24	−20.6	−19.7	9.0	3.3	38.1	13.6
	ETH-69970	3954 ± 24	−19.8	−19.4	8.4	3.3	40.0	14.2
	Beta-448207	3700 ± 30	—	−19.4	9.3	3.3	40.94	14.31
	SUERC-72324	3898 ± 30	—	−20.1	8.0	3.3	33.8	11.9
18	ETH-71514	4123 ± 23	−20.4	−19.6	9.1	3.4	33.8	11.5

they are well within the limits considered acceptable (17–53% at 2 σ) by Van Klinken (1999). The new ^{14}C series provided a coherent sequence of accurate dates in which the results from the different labs were very well integrated. To analyze this chronological data, different Bayesian models were built using the OxCal program v4.2 (Bronk Ramsey 2001, 2009).

Handling anthropological remains for dating entails a very important concern if we really want to base our assessments on solid foundations. It is crucial to ensure that the carbon in the sampled bones was in equilibrium with the atmosphere. Bone collagen from omnivores such as humans may derive from a diet based on marine and freshwater resources, which means that ^{14}C measurements could be strongly influenced by the reservoir effect (Stuiver and Braziunas 1993; Lanting and van der Plicht 1998; Cook et al. 2001). In these cases, the carbon is not in equilibrium with the atmosphere, presenting an earlier date than any contemporaneous terrestrial organism. Although the distance of the Panoria necropolis from the sea (over 130 km) presumably precludes the consumption of significant amounts of marine resources, the appearance of seashells as grave goods suggests that seafood consumption cannot be ruled out. The consumption of appreciable quantities of freshwater fish and waterfowl also seems very unlikely, taking into account the absence of wetlands in the region and that most of the watercourses are highly seasonal. Nevertheless, to explore the potential dietary reservoir effect in the human bones, all the samples selected to be dated were also chosen for δ^{13}C and δ^{15}N stable isotope analysis.

RESULTS AND DISCUSSION

According to isotopic analysis, the δ^{13}C values obtained for the human samples ($n = 19$) range from –19.2‰ to –20.1‰, and for the δ^{15}N from 8‰ to 10.2‰ (Table 3 and Figure 5).

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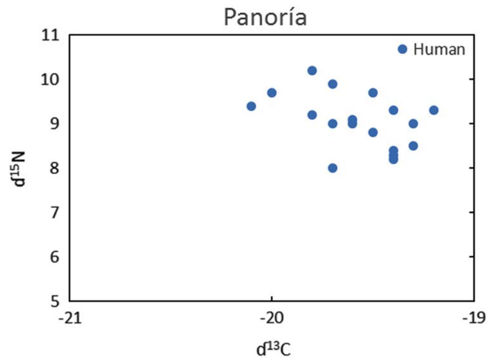

Figure 5 $\delta^{13}C$ and $\delta^{15}N$ results for the 19 individuals sampled for ^{14}C dating.

The mean for $\delta^{13}C$ is –19.6‰ ± 0.25 (1σ), while for $\delta^{15}N$ is 9.0‰ ± 0.6 (1σ). These figures reveal that the $\delta^{13}C$ values are quite homogeneous (>1‰ range) in comparison with the $\delta^{15}N$ that show a range of <2.5‰. According to the isotopic results for carbon ($\delta^{13}C$ lower than –19‰) and nitrogen ($\delta^{15}N$ between 8 and 10.5‰), all the human individuals consumed proteins originating from a C3 food web, essentially composed of herbivores[6]. Those values represent a terrestrial C3 ecosystem and are consistent with the expectations for late prehistoric societies in Iberia (Díaz-Zorita Bonilla 2017; Fontanals et al. 2017). As a result, the population buried in this necropolis has not been significantly influenced by any aquatic reservoir effect, and thus the ^{14}C dates from the human bone samples can be considered as accurate estimations. The absence of marine and freshwater resource consumption at Panoria is consistent with the available archaeological evidence and the few paleodiet studies that have been carried out for the megalithic societies of southern Iberia. This is the case of necropolises such as Los Millares (Waterman et al. 2017), El Barranquete (Díaz-Zorita Bonilla et al. forthcoming), and Montelirio (Bayliss et al. 2016).

The ^{14}C series for the Panoria necropolis consists of 19 dates that represent a significant improvement for a region with no previously known dates. Nevertheless, the conditions are far from ideal, with several limitations that affect the degree of resolution that can be achieved with a Bayesian modeling. As noted above, the MNI is the criterion used to select the datable samples. Because most of the tombs were affected by human actions of an undetermined nature, the MNI is very low, except for Tomb 10. The lack of available samples to date other important events, such as the construction, abandonment or total or partial rebuilding of the tombs, can be also considered a major drawback. Unlike in other megalithic tombs in south-eastern Iberia, no evidence of other kinds of ritual activity, such as the deposition of faunal remains or the use of fire inside the funerary chambers, has been found. Despite these limitations, Bayesian analysis is definitely still the best option for building a detailed and more precise chronological framework.

A first Bayesian model was built taking into consideration all the dates in just one phase of continuous activity that present a good index of agreement (A_{model} = 90%)[7]. According to this

[6]The lack of faunal remains in the excavated tombs makes it impossible to determine the terrestrial and marine endpoints. Therefore, in accordance with the $\delta^{15}N$ values and by following the increase of about 3–5‰ in the consumer over their diet (DeNiro and Epstein 1981; Schoeninger and DeNiro 1984; Bocherens and Drucker 2003), we can estimate the herbivore ecosystem.

[7]Bayesian modeling incorporates a statistic known as the index of agreement, which calculates the reliability of the model and provides useful information for identifying samples whose archaeological taphonomy has not been properly characterized. This index estimates a figure of how well any posterior probability distribution agrees with the relative

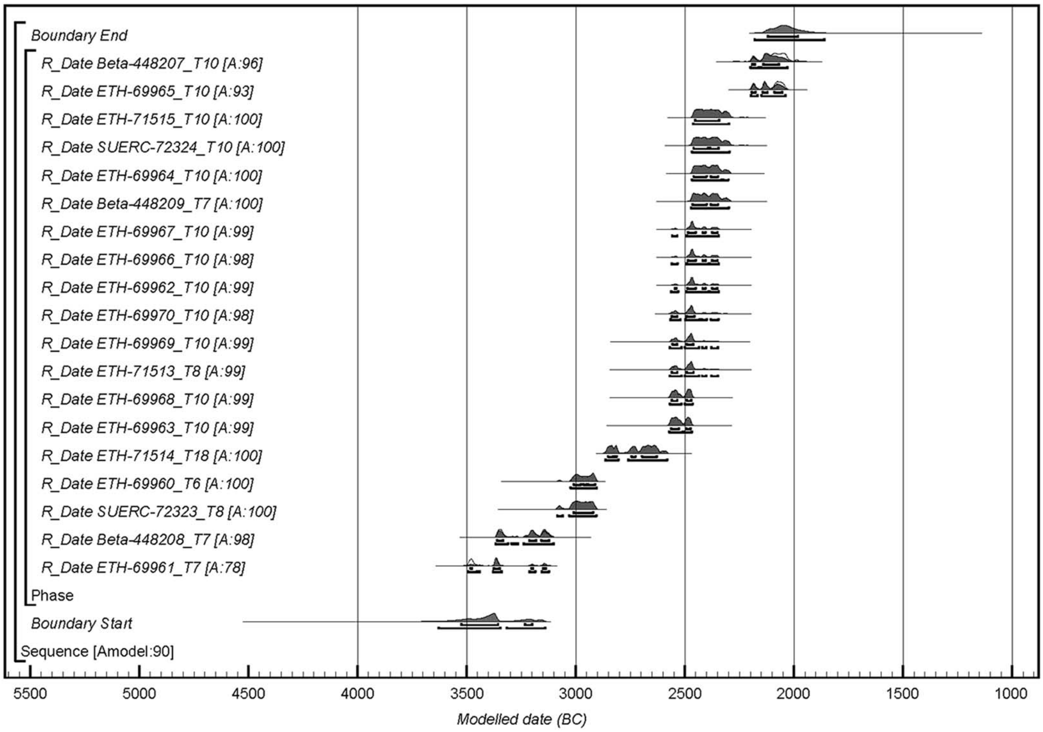

Figure 6 Probability distribution of dates from the Panoria necropolis. Each date shows two distributions: the one in light grey represents the ^{14}C calibration and the other in dark grey indicates the result of the Bayesian model (posterior density estimates). Distributions other than those relating 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.

model (Figure 6 and Table 2), the earliest bodies deposited in this necropolis were placed there between 3525 and 3195 cal BC (68% probability; boundary start) and the last between 2125 and 1980 cal BC (68% probability; boundary end), which implies a very long period of use, between 1055 and 1410 calendar years (68% probability span). Ritual activity, therefore, began in the Late Neolithic and ended in the transition between the Copper and Bronze Ages, at a time when major cultural changes were taking place in the Guadix Basin with the appearance of the so-called Argaric Culture (Aranda Jiménez et al. 2015). Nevertheless, most of the interments are concentrated in a short period during the Late Copper Age, although such intensity must be related to the specific biography of Tomb 10 and cannot be considered a general trend in the necropolis. In fact, other tombs, such as 7 and 8, present a different scenario with dates chronologically distanced from each other. This could suggest a long period of funerary activity or, alternatively, different periods of use separated by chronological hiatuses.

Different Bayesian models were built specifically for Tomb 10. Its ^{14}C series with 12 dates could be considered representative of funerary practices. In a first model (Figure 7 and Table 4), all dates were included in a single phase of continuous activity (A_{model} = 97%). The earliest mortuary depositions began in 2680–2475 cal BC (95% of probability), probably in 2605–2490 cal BC

(Footnote continued)
sequential information. If the index of agreement falls below 60%, the ^{14}C measurement should be considered somewhat problematic (Bronk Ramsey 1995:427–8).

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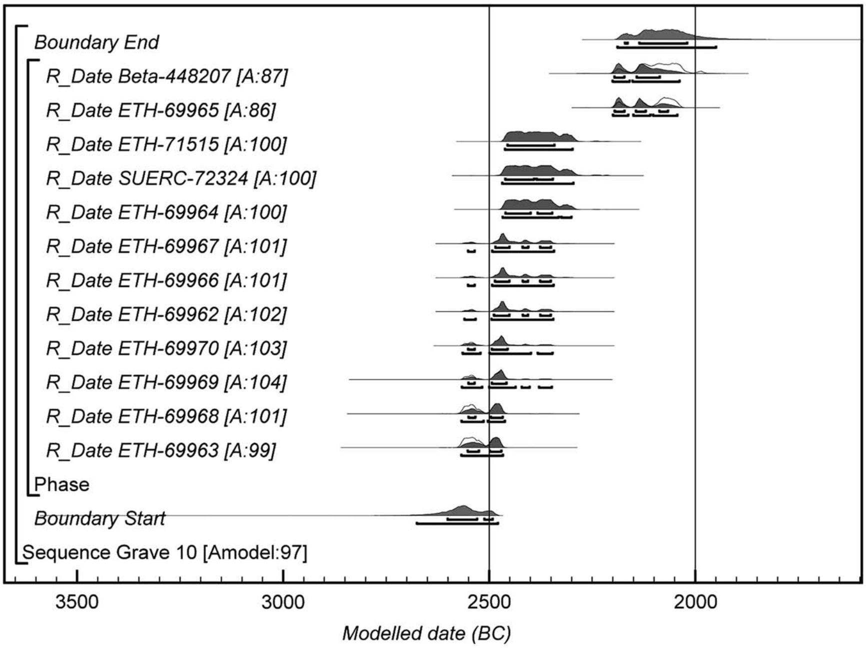

Figure 7 Probability distribution of dates from Tomb 10, first Bayesian modeling. The format is identical to that in Figure 6.

Table 4 Modeled dates from Tomb 10.

Laboratory code	^{14}C age (BP)	Calibrated date (95% confidence) cal BC	Model 1 (95% confidence) cal BC	Model 2 (95% confidence) cal BC	Model 3 (95% confidence) cal BC
ETH-69963	3993 ± 24	2575–2465	2570–2465	2570–2465	2500–2460
ETH-69968	3980 ± 24	2570–2460	2570–2460	2570–2460	2495–2460
ETH-69969	3959 ± 24	2570–2345	2570–2345	2470–2340	2495–2450
ETH-69970	3954 ± 24	2570–2345	2565–2345	2565–2345	2495–2450
ETH-69962	3945 ± 24	2565–2345	2560–2340	2560–2345	2495–2435
EHT-69966	3942 ± 24	2565–2345	2555–2340	2465–2335	2495–2435
ETH-69967	3941 ± 24	2565–2345	2555–2340	2560–2405	2490–2435
ETH-69964	3899 ± 24	2470–2300	2470–2300	2475–2370	2480–2415
ETH-71515	3886 ± 23	2465–2295	2465–2295	2465–2295	2475–2420
ETH-69965	3718 ± 17	2200–2035	2200–2040	2200–2045	2200–2035
SUERC-72324	3898 ± 30	2470–2290	2470–2295	2470–2295	2480–2415
Beta-448207	3700 ± 30	2200–1980	2205–2040	2205–2040	2200–2025

(68% of probability), and ended in 2190–1950 cal BC (95% of probability), possibly in 2175–2020 cal BC (68% of probability). The dates were concentrated in what appear to be two phases of activity separated by a chronological hiatus of 175–330 yr (68% of probability difference). The first group, in which most of the dates are clustered, is statistically consistent if the most recent date in the series is not considered ($T' = 12.7$; T' (5%) = 15.5) and the second set of dates clearly passes the contemporaneity test ($T' = 0.3$; T' (5%) = 3.8) (Ward and Wilson 1978). It appears that in this tomb there were two short periods of anthropological depositions.

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In a second model, the stratigraphic relationship between samples was used as helpful prior information. As stated above, the anthropological remains appear as a single deposit of bones piled on top of each other and spread out over the chamber and passage. Nevertheless, in four cases among the dated bones it was possible to establish relationships of anteriority and posteriority[8]. Sample ETH-69967 (2565–2345 cal BC; 95% probability) was found below the articulated body to which the date ETH-69964 belongs (2470–2300 cal BC; 95% probability). Above this individual, samples of two more people were dated (ETH-69969, 2570–2345 cal BC, 95% probability, and ETH-69966, 2565–2345 cal BC, 95% probability). All the dates are very similar, three have the same interval of probability and the fourth shares most of its probability distribution. Nevertheless, the Bayesian model that incorporates this stratigraphic information shows a poor overall agreement (A_{model} = 50%) and also fails in the individual agreement of different dates, mainly ETH-69969 and ETH-69966, which means the model does not conform to the relative sequence of information. It appears that the manipulation and displacement of bones during the ritual use of the tomb could explain this relationship between the articulated body ETH-69964 and the two dated samples (ETH-69969 and ETH-69966) found above it.

We further explored the chronology of this tomb by modeling the ^{14}C series according to the two phases of funerary activity identified in previous models. This option is also supported by the stratigraphic position of the two most recent dates. Beta-448207 belongs to a sample located on the top of the chamber funerary deposit and ETH-69965 was found in the first section of the passage, next to the entrance. Both samples are indeed consistent with the latest funerary depositions that occurred in the tomb. The new model shows good overall (A_{model} = 173%) and individual agreements (Figure 8). In the first phase, the mortuary activity began in 2510–2460 cal BC (95% of probability_boundary start) and ended in 2475–2385 cal BC (95% of probability_boundary end), which, in calendar years, represents a very short period of use, between 0 and 90 yr (95% probability span), or more likely between 0 and 40 yr (68% *probability*). If we assume a figure of 25 yr for each generation, this would indicate that only one or two generations would have been buried during this phase. Although all the people buried could have died at the same time, based on these intervals, this possibility seems to be unlikely as, together with articulated or partially articulated bodies, most of the bone remains were found scattered as a result of subsequent burials.

After a chronological hiatus (210–380 yr at 68% probability), the tomb was reused. During this second phase, the funerary activity began in 2225–2065 cal BC (68% probability boundary start) and ended between 2140 and 1985 cal BC (68% probability boundary end). Although this is also a short period of use, the limited number of measurements available prevents any conclusion being drawn. If we assume that mortuary activity began just after the construction of the tomb, we must conclude that it was built in the first years of the second half of the third millennium and was in use over a few decades. Two or three centuries later, the tomb was reused, coinciding chronologically with the appearance of the Early Bronze Age societies in the Guadix Basin.

The Panoria ^{14}C series has also been analyzed from a comparative perspective to explore how it fits into the regional sequence. All the dates from orthostatic tombs in southern Spain have been compiled, except those with a standard deviation ≥100 yr and those related to events preceding the construction and use of the megalithic tombs. As a result, 34 dates were available: 21 obtained from bone (18 of them from human bone) and 13 from charcoal (Table 5). This ^{14}C

[8]Due to the location and spatial relationships of the surviving articulations, it has not been possible to establish their precise depositional sequence. The anthropological study also failed to throw any light on this question.

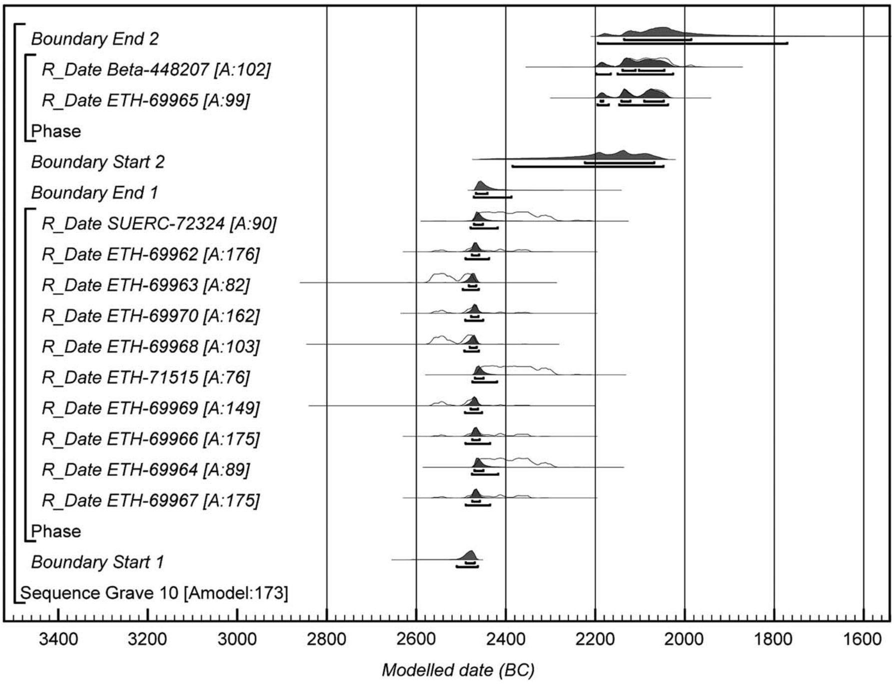

Figure 8 Probability distribution of dates from Tomb 10, third Bayesian modeling. The format is identical to that in Figure 6.

series has several drawbacks: (1) the so-called "old wood" effect on charcoal (Waterbolk 1971; Bowman 1990) and the reservoir effect on human bones (Stuiver and Braziunas 1993) have not been taken into account, which means that the ^{14}C measurements could be earlier than the death of the organism; (2) most of the samples come from uncertain contexts that make a proper critical analysis impossible; (3) 12 dates (35%) come from a single tomb; and (4) it is not known whether the same individual was dated more than once in those tombs with two or more dates. All these limitations and uncertainties mean that this ^{14}C series must be approached with caution.

The comparison with the Panoria series shows that in both cases funerary activity began in the Neolithic period, although a little earlier in the case of the general series (3884–3710 cal BC at 68% probability) than in that of Panoria (3525–3195 cal BC at 68% probability) (Figure 9). However, the intensification of mortuary activity coincides in both series, as most of the dates are concentrated in the Copper Age (ca. 3200–2100 cal BC). This intensification occurred in a context of increasing social complexity characterized by important cultural innovations in southern Iberia, such as a remarkable population growth and aggregation, the intensification of agriculture, the development of copper metallurgy, and the appearance of a new and more complex type of megalithic tombs known as a *tholos*.

The main difference between the two series is the importance attained by the continuity of ritual practices during the Bronze Age, which is missing in the Panoria necropolis. In fact, the general ^{14}C series ended between 1127 and 965 cal BC (68% probability), with many dates belonging to the Bronze Age. Conversely, the Panoria ^{14}C series ended between 2125 and 1980 cal BC (68% probability) at a time when the Bronze Age societies appeared in the Guadix Basin.

Table 5 ^{14}C dates from the orthostatic tombs in southern Spain.

Site	Laboratory code	Type of material	Context	^{14}C age (BP)	Calibrated date (95% confidence) cal BC	References
Alberite	Beta-80598	Charcoal	Burial chamber	5020 ± 70	3970–3660	Ramos Muñoz and Giles 1996
La Venta	Beta-150157	Charcoal	Passage grave	4200 ± 70	2920–2570	Nocete 2004
	Beta-150158	Charcoal	Tomb entrance	3820 ± 50	2460–2140	Nocete 2004
La Paloma	Beta-150154	Charcoal	Funerary deposit	4070 ± 70	2880–2470	Nocete 2004
Casullo	CNA-346	Charcoal	Funerary deposit located on the forecourt	4410 ± 50	3340–2900	Linares and García Sanjuán 2010
	CNA-345	Charcoal	Burial chamber	2890 ± 50	1220–920	Linares and García Sanjuán 2010
Puerto de los Huertos	CNA-341	Charcoal	Destruction of the tomb	3680 ± 50	2210–1930	Linares and García Sanjuán 2010
	CNA-344	Charcoal	Funerary deposit located on the forecourt	3940 ± 45	2570–2290	Linares and García Sanjuán 2010
	CNA-342	Charcoal	Burial chamber	4050 ± 50	2860–2460	Linares and García Sanjuán 2010
Los Gabrieles 4	Beta-185650	Charcoal	Burial chamber (layer 2)	3700 ± 50	2280–1940	Linares and García Sanjuán 2010
	Beta-185648	Charcoal	Burial chamber (layer 3)	3850 ± 40	2470–2200	Linares and García Sanjuán 2010
	Beta-185649	Charcoal	Burial chamber (layer 4)	3920 ± 50	2570–2210	Linares and García Sanjuán 2010
Soto	Ua-35665	Charcoal *Quercus ílex*	Burial chamber	3830 ± 35	2460–2150	Nocete et al. 2011
El Palomar	Beta-75067	Huma bone	Burial chamber	4930 ± 70	3950–3530	Cabrero et al. 1997
Viera	Beta-353822	Deer antler	Burial chamber	3580 ± 30	2030–1820	Aranda Jiménez et al. 2013
	Beta-353820	Animal bone	Burial chamber	4090 ± 30	2860–2490	Aranda Jiménez et al. 2013
Cuesta de los Almendrillos	GrN-25302	Human bone	Burial chamber	4450 ± 20	3330–3020	Fernández and Márquez 2001
Tesorillo de la Llaná	GrN-26488	Human bone	Burial chamber	3250 ± 40	1620–1430	Fernández and Márquez 2001
	GrN-26475	Human bone	Passage of the tomb	3250 ± 50	1640–1420	Fernández and Márquez 2001
	GrA-37339	Human bone	Passage of the tomb	4055 ± 35	2850–2470	Fernández and Márquez 2008
El Tardón A	UGRA-260	Bone	Burial chamber	3530 ± 60	2025–1690	Fernández Ruiz et al. 1997
El Tardón B	GrN-16066	Human bone	Burial chamber	3745 ± 25	2275–2035	Fernández et al. 1997
Los Bermejales 8	Beta-301937	Human bone (left ulna)	Burial chamber	3160 ± 30	1510–1320	Aranda Jiménez 2013

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Beta-301936	Human bone (right ulna)	Burial chamber	3300 ± 30	1650–1500	Aranda Jiménez 2013
Beta-301935	Human bone (right ulna)	Burial chamber	2910 ± 30	1210–1010	Aranda Jiménez 2013
Ua-39501	Human bone	Burial chamber	3018 ± 30	1390–1130	Cámara and Molina 2015
Ua-39503	Human bone	Burial chamber	3168 ± 32	1510–1320	Cámara and Molina 2015
Ua-39495	Human bone	Burial chamber	3183 ± 30	1510–1400	Cámara and Molina 2015
Ua-39499	Human bone	Burial chamber	3218 ± 30	1610–1420	Cámara and Molina 2015
Ua-39498	Human bone	Burial chamber	3543 ± 36	1980–1750	Cámara and Molina 2015
Ua-39497	Human bone	Burial chamber	3225 ± 36	1610–1420	Cámara and Molina 2015
Ua-39500	Human bone	Burial chamber	3246 ± 30	1620–1440	Cámara and Molina 2015
Ua-39502	Human bone	Burial chamber	3269 ± 31	1630–1450	Cámara and Molina 2015
Ua-39496	Human bone	Burial chamber	3286 ± 30	1630–1490	Cámara and Molina 2015

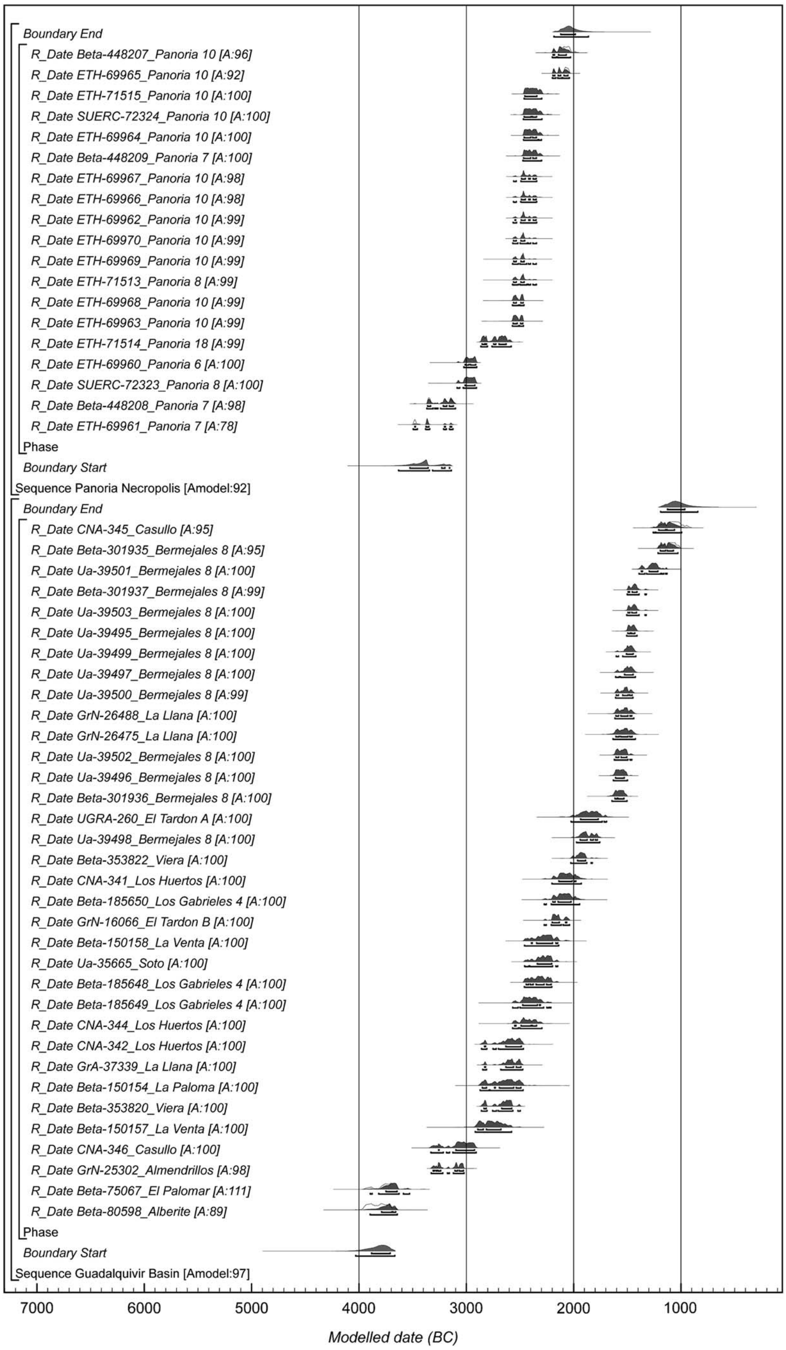

Figure 9 Relationship between the Bayesian models of the Panoria necropolis and the ^{14}C dates available for the orthostatic tombs in southern Spain.

Nevertheless, the absence of anthropological depositions during the Bronze Age must be considered an artifact of the Panoria necropolis series. In most of the Guadix Basin necropolises it is very usual to find grave goods that belong typologically to the Bronze Age

(Leisner and Leisner 1943; García Sánchez and Spahni 1959; Ferrer Palma et al. 1988; Lorrio Alvarado 2008).

CONCLUSIONS

The Panoria necropolis offered an excellent opportunity to explore the temporality of this kind of megalithic monument. For the first time in southeastern Iberia, this widespread type of megalithic burial has been dated with ^{14}C. Although the chronological series obtained can be considered a remarkable improvement, we are still far from fully understanding the chronological sequence of these ritual practices. Therefore, the following cultural assessments must be considered as a first approach.

The Panoria necropolis ^{14}C series shows a long period of use that began in the Late Neolithic, reached its most intensive ritual activity during the Copper Age, and ended at the same time as the Bronze Age societies appeared in the Guadix Basin. Nevertheless, throughout this period tombs seem to have been built at different times and used on different temporal scales and with different intensity. If we assume that mortuary activity began just after their construction, Tomb 10 was probably built in the first years of the 25th century cal BC (2490–2470 cal BC at 68% probability_boundary start Model 3), which means roughly one thousand years after the first interments in Tomb 7 (ETH-69961, 3500–3340 cal BC at 95% probability) and hundreds of years after the earliest burials in Tombs 6 (ETH-69960, 3030–2900 cal BC at 95% probability) and 8 (SUERC-72323, 3090–2900 cal BC at 95% probability). The sequence of construction at the Panoria necropolis appears to have lasted from the mid-4th to the mid-3rd millennium.

Tomb 10 also challenges the notion that the megalithic monuments remained in use over a span of centuries and contain long sequences of mortuary depositions. This tomb was only in use for a few decades, between 0 and 40 yr (68% of probability), which would have involved no more than two generations. After a chronological hiatus of two or three centuries, the tomb was reused for a very short period. Even the large gaps between the dates of Tombs 7 and 8 would suggest their reuse by unrelated people, rather than continual use over long periods. The Panoria cemetery was in use for more than a millennium, with the burials being made at different times during that period. Its configuration as a necropolis seems to be more the result of an aggregation of tombs than the ritual place of different social units that would have coexisted in the same settlement or region, as is normally assumed.

ACKNOWLEDGMENTS

This paper was written as part of the following research projects: "Everything Has Its Own Time. The Chronology and Temporality of the Megalithic Societies in South-Eastern Iberia" sponsored by the BBVA Foundation (Grants for Researchers and Cultural Creators 2015), and "Innovation, Continuity and Hybridisation. The Copper and Bronze Age Societies in the Southern Iberian Peninsula" (HAR2013-42865-P) funded by the Spanish Ministry of Economy and Competitiveness.

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