ARTÍCULO

Trabajos de Prehistoria, 81 (2)
Julio-Diciembre 2024, 995
ISSN-L: 0082-5638 – eISSN: 1988-3218
https://doi.org/10.3989/tp.2024.995

Prime time. The temporality of burial practices at the Valencina Copper Age mega-site (c. 2900-2650 BC)

Prime time. ***La temporalidad de las prácticas funerarias en el megasitio de la Edad del Cobre de Valencina (c. 2900-2650 a. C.)***

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Submitted: 08-03-2024; accepted: 11-12-2024; published online: 05-02-2025

Abstract: The quality of the radiometric data available for the study of the megalithic phenomenon in Iberia has improved markedly over the last fifteen years. As a result, relevant details are beginning to emerge in terms of the sequence, temporality and evolution of certain monument types, specific construction and clusters of them. In this paper we extend this line of research to the Valencina Copper Age mega-site, located in south-western Iberia. We present 46 fresh radiocarbon dates on human bone for the burial area located on the south-eastern quadrant of this site, which includes La Huera artificial cave, the PP4-Montelirio sector and the great Montelirio *tholos*. Through Bayesian and spatial modelling, these new dates are combined with eight already-published ones to provide a high-resolution image of the temporality of the complex sequence of burial and formal deposition that took place there during the 'peak' period of the site, between c. 2900 and 2650 BC. We examine the start date, sequence, spatial arrangement, duration and end date of 21 newly-dated burials and discuss the implications of the results in terms of the social practices that led to the formation of such a large site.

Keywords: radiocarbon; Bayesian modelling; spatial modelling; Copper Age; Archaeological zone Valencina de la Concepción-Castilleja de Guzmán.

Resumen: *La calidad de los datos radiométricos disponibles para el estudio del fenómeno megalítico en Iberia ha mejorado notablemente en los últimos quince años. Como resultado, comienzan a surgir detalles relevantes en cuanto a la secuencia, temporalidad y evolución de ciertos tipos de monumentos, construcciones específicas y agrupaciones de ellas. En este artículo ampliamos esta línea de investigación al mega-sitio de la Edad del Cobre de Valencina, situado en el suroeste de la península ibérica. Presentamos 46 dataciones de radiocarbono inéditas realizadas sobre hueso humano y procedentes del área de enterramiento ubicada en el cuadrante sureste de este yacimiento, que incluye la cueva artificial La Huera, el sector PP4-Montelirio y el gran* tholos *de Montelirio. A través de modelos bayesianos y espaciales, esas nuevas fechas se combinan con ocho ya publicadas para proporcionar una imagen de alta resolución de la temporalidad de la compleja secuencia de enterramientos y deposición formal que tuvo lugar allí durante el período de apogeo de uso del sitio entre c. 2900 y 2650 a. C. Examinamos las fechas de inicio, secuencia, disposición espacial, duración y fecha de finalización de 21 estructuras recientemente datadas, para discutir posteriormente las implicaciones de los resultados en términos de las prácticas sociales que llevaron a la formación de este mega-sitio.*

Palabras clave: *radiocarbono; modelado bayesiano; modelado espacial; Edad del Cobre; Zona Arqueológica Valencina de la Concepción-Castilleja de Guzmán.*

Citation / Cómo citar: García Sanjuán, L., Sánchez Díaz, F., Oms, F. X., Alcaina-Mateos, J. and Cintas-Peña, M. (2024). "Prime time. The temporality of burial practices at the Valencina Copper Age mega-site (c. 2900-2650 BC)". *Trabajos de Prehistoria*, 81 (2): 995. DOI: https://doi.org/10.3989/tp.2024.995

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1. INTRODUCTION

Barely ten years ago, the availability of radiometric data for the study of the megalithic phenomenon in southern Spain was quite dire. A review based on the dates published up to May 2011 (García Sanjuán *et al.*, 2011) revealed only 51 dates were available for the eight Andalusian provinces (Almería, Cádiz, Córdoba, Huelva, Granada, Jaén, Málaga and Seville) and the two provinces of Extremadura (Badajoz and Cáceres), a territory of 129.233 km^2 (the size of England, and bigger than Portugal). The limitations in the quality of many of those dates, largely obtained through the conventional radiocarbon method, based on samples of charred material, poorly contextualised and with large standard deviations, implied that not one megalithic monument had a large enough series to enable diachronic analysis looking at the use and evolution of individual monuments on the one hand, or burial complexes on the other (García Sanjuán *et al.*, 2011, p. 123). A little more than a decade on, the situation has changed quite significantly. Not only has the radiometric base for that same territory increased considerably, to well over 300 dates (specifically, the IDEArq database[1] returns 349 radiocarbon dates for megalithic burials in that region), but the newly published ones, now obtained through AMS (Accelerator Mass Spectrometry), are more precise and reliable, with standard deviations routinely below 30 years.

As a result, in recent years, several studies have looked in detail into the sequence, temporality and evolution of specific megalithic monuments and clusters of them. Some examples are quite revealing. A total of 79 dates (70 radiocarbon, 6 TL and 3 OSL) have been published for the Menga dolmen alone, 'flagship' of the Antequera megalithic site (García Sanjuán *et al.*, 2022a, 2023), compared to none existing in 2011, plus several others for closely connected monuments and sites (García Sanjuán *et al.*, 2020). Therefore, for Menga there are now more dates (79) than there were in 2011 for the whole megalithic phenomenon in southern Spain (51). For the megalithic tombs of Los Millares, 33 dates have now been published (Aranda Jiménez *et al.*, 2020; Molina González *et al.*, 2020), compared to one existing in 2011 –which was the first ever to be published for Iberian Prehistory (Almagro Basch, 1959), and which, for a staggering 60 years, had remained the only one available for the burials of the famed Almería site. For the Montelirio *tholos*, part of the Valencina de la Concepción-Castilleja de Guzmán Copper Age mega-site (henceforth Valencina), 22 dates on human bone have been published (Bayliss *et al.*, 2016; García Sanjuán *et al.*, 2018c, pp. 225-238) and 21 others, obtained on samples of marine shell from the beaded attires worn by some of the women buried in its Large Chamber, await publication (García Sanjuán *et al.*, 2025). The mega-site of Valencina itself bears witness to this trend: from a meagre 10 dates published in 2011, the number has increased to over 300 at the time of writing these lines (February 2024). Several other papers have contributed with fresh dates for individual megalithic monuments and burial complexes located in both western and eastern Andalusia, including La Orden-Seminario (Huelva) (Linares Catela and Vera-Rodríguez, 2021), El Barranquete (Níjar, Almería), Churuletas, Llano del Jautón and La Atalaya (the three of them located in Purchena, Almería) (Aranda Jiménez *et al.*, 2017; Aranda Jiménez and Lozano Medina, 2018), Mojácar (Almería) (Aranda Jiménez *et al.*, 2021), Panoría (Darro, Granada) (Aranda Jiménez *et al.*, 2022) and Los Eriales (Morelábor, Granada) (Milesi *et al.*, 2023).

The expansion of the chronometric database for the megalithic phenomenon in southern Spain has made possible higher-resolution approaches to themes such as the social history of specific monuments (García Sanjuán *et al.*, 2018c), the temporality of certain monument types, such as the *tholoi* (Aranda Jiménez *et al.*, 2021) or the supra-regional chrono-spatial spread of megalithic burials (García Sanjuán *et al.*, 2022b; Vijande-Vila *et al.*, 2022), to name just a few.

This paper aims to further expand this line of research. Its general goal is to push towards a high-resolution temporality of the megalithic phenomenon, which was so pervasive in southern Iberia in the 4th and 3rd millennia BC (and, in some cases, in the Bronze Age, Iron Age and subsequent historical periods). To this end, we present 46 unpublished dates for the "Plan Parcial 4 Montelirio" sector (PP4-Montelirio, for short) of the Valencina Copper Age mega-site, all based on human bone, and therefore associated with burial practices, in some cases in connection with megaliths. These new dates are combined with the eight dates that have already been published for this very sector (García Sanjuán *et al.*, 2018c). As is discussed below, spatially and statistically analysed, these 54 radiocarbon dates provide the basis for a completely new interpretation of the temporality of burial practices at this important site. In turn, this will serve as a high-quality basis for future social and cultural interpretations of the Valencina mega-site as a whole.

2. METHODOLOGY

The basic information for all 54 dates considered in this study is provided in Tab. 1. All dates were obtained

[1] http://www.idearqueologia.org/index.php?ln=es

LAB SIGNATURE	STRUCTURE AND STRATIGRAPHIC UNIT	STRUC-TURE TYPE	HUMAN BONE	DATE BP	DATE CAL 2σ	δ13C ‰	δ15N ‰	C:N	SOURCE
CNA-1303	10.042, UE 640	M	Ulna	4277 ± 31	3008-2778	NA	NA	NA	García Sanjuán *et al.*, 2018c
OxA-32370	10.071, UE 698 (Individual 6)	NS	Tooth (incisor)	4277 ± 30	3006-2781	-18.80	NA	3.3	García Sanjuán *et al.*, 2018c
CNA-4803	10.044, UE 632 (Individual 2)	NSSE	Unidentified	4240 ± 35	2916-2696	-16.11	NA	3.1	This paper
CNA-5421	10.023, UE 524 (Individual 10)	NSSE	Occipital	4240 ± 30	2912-2702	-12.27	NA	3.0	This paper
CNA-5406	10.023, UE 497 (Individual 1)	NSSE	Occipital	4230 ± 25	2906-2702	-15.69	NA	3.4	This paper
OxA-32299	10.071, UE 698 (Individual 1)	NS	Tooth (molar)	4222 ± 28	2905-2697	-19.10	NA	3.4	García Sanjuán *et al.*, 2018c
CNA-4800	10.060, UE 670 (Individual 2)	NS	Unidentified	4220 ± 35	2907-2674	-17.07	NA	3.2	This paper
CNA-5422	10.023, UE 524 (Individual 11)	NSSE	Occipital	4220 ± 30	2905-2678	-14.23	NA	3.5	This paper
CNA-4795	10.040, UE 564 (Individual 2)	NS	Unidentified	4200 ± 35	2898-2639	-10.51	NA	3.2	This paper
CNA-4802	10.044, UE 632 (Individual 2)	NSSE	Unidentified	4200 ± 35	2898-2639	-17.91	NA	3.2	This paper
CNA-4796	10.059, UE 730	NS	Unidentified	4200 ± 35	2898-2639	-17.10	NA	3.2	This paper
CNA-5412	10.023, UE 524 (Individual 1)	NSSE	Occipital	4200 ± 30	2895-2671	-16.67	NA	3.5	This paper
CNA-5416	10.023, UE 524 (Individual 5)	NSSE	Occipital	4200 ± 30	2895-2671	-18.46	NA	3.2	This paper
CNA-5419	10.023, UE 524 (Individual 8)	NSSE	Occipital	4200 ± 30	2895-2671	-18.00	NA	3.2	This paper
SUERC-107031	10.032, UE 505 (Individual 1)	M	Unidentified	4196 ± 25	2891-2674	-19.00	9.1	3.3	This paper
SUERC-60401	10.071, UE 698 (Individual 2)	NS	Tooth (molar)	4192 ± 27	2890-2671	NA	NA	3.2	García Sanjuán *et al.*, 2018c
CNA-4793	10.035, UE 503	NS	Unidentified	4190 ± 35	2893-2635	-12.32	NA	3.2	This paper
CNA-4801	10.044, UE 632 (Individual 3)	NSSE	Unidentified	4190 ± 35	2893-2635	-19.06	NA	3.3	This paper
CNA-4808	10.075-10.078, UE 938 (Individual 2)	NSSE	Unidentified	4190 ± 35	2893-2635	-19.33	NA	3.2	This paper
CNA-5426	10.023, UE 524 (Individual 15.1)	NSSE	Occipital	4190 ± 30	2891-2640	-17.42	NA	3.2	This paper
CNA-4789	10.002, UE 43	NS	Unidentified	4180 ± 35	2888-2632	-18.86	NA	3.8	This paper
CNA-4797	10.028, UE 189	NS	Unidentified	4180 ± 35	2888-2632	-12.69	NA	3.2	This paper
CNA-4791	10.055, UE 719	NSSE	Unidentified	4180 ± 35	2888-2632	-8.19	NA	3.1	This paper
CNA-4799	10.060, UE 670 (Individual 1)	NS	Unidentified	4180 ± 35	2888-2632	-17.06	NA	3.2	This paper
CNA-4798	10.077, UE 936	NS	Unidentified	4180 ± 35	2888-2632	-12.21	NA	3.2	This paper
CNA-5425	10.023, UE 524 (Individual 14)	NSSE	Occipital	4180 ± 30	2887-2636	-18.72	NA	3.2	This paper
CNA-5417	10.023, UE 524 (Individual 6)	NSSE	Occipital	4180 ± 30	2887-2636	-20.61	NA	3.2	This paper
CNA-5423	10.023, UE 524 (Individual 12)	NSSE	Occipital	4170 ± 30	2883-2632	-17.26	NA	3.4	This paper
CNA-5413	10.023, UE 524 (Individual 2)	NSSE	Occipital	4170 ± 30	2883-2632	-15.22	NA	NA	This paper
CNA-5414	10.023, UE 524 (Individual 3)	NSSE	Occipital	4170 ± 30	2883-2632	-14.35	NA	3.2	This paper
CNA-1291	10.042, UE 640	M	Ulna	4161 ± 34	2880-2629	NA	NA	NA	García Sanjuán *et al.*, 2018c
CNA-4804	10.073, UE 866 (Individual 1)	NSSE	Unidentified	4160 ± 35	2881-2627	-16.56	NA	3.2	This paper
CNA-4807	10.075-10.078, UE 875 (Individual 1)	NSSE	Unidentified	4150 ± 35	2879-2586	-22.44	NA	3.2	García Sanjuán *et al.*, 2018c
CNA-5407	10.023, UE 497 (Individual 2)	NSSE	Occipital	4150 ± 30	2876-2627	-18.27	NA	3.5	This paper
CNA-5408	10.023, UE 497 (Individual 3)	NSSE	Occipital	4150 ± 30	2876-2627	-18.30	NA	3.4	This paper
CNA-5418	10.023, UE 524 (Individual 7)	NSSE	Occipital	4150 ± 30	2876-2627	-17.85	NA	3.2	This paper
OxA-32300	10.071, UE 698 (Individual 4)	NS	Tooth (molar)	4147 ± 37	2879-2584	-19.20	NA	3.3	This paper
SUERC-104561	10.032, UE 446 (Individual 3)	M	Unidentified	4147 ± 23	2874-2628	-19.60	8.2	3.3	This paper
CNA-5424	10.023, UE 524 (Individual 13)	NSSE	Occipital	4140 ± 35	2875-2584	-16.58	NA	NA	This paper
CNA-4806	10.074, UE 923	NS	Unidentified	4140 ± 35	2875-2584	-18.03	NA	3.2	This paper

LAB SIGNATURE	STRUCTURE AND STRATIGRAPHIC UNIT	STRUCTURE TYPE	HUMAN BONE	DATE BP	DATE CAL 2σ	δ13C ‰	δ15N ‰	C:N	SOURCE
CNA-5427	10.023, UE 524 (Individual 15.2)	NSSE	Mandible	4140 ± 30	2875-2584	-18.21	NA	3.2	This paper
CNA-5415	10.023, UE 524 (Individual 4)	NSSE	Occipital	4140 ± 30	2875-2584	-17.39	NA	3.3	This paper
CNA-4792	10.013, UE 294	NSSE	Unidentified	4130 ± 35	2872-2580	-15.99	NA	3.2	This paper
CNA-4811	10.084, UE 868	NSSE	Unidentified	4130 ± 30	2871-2581	-14.99	NA	3.2	This paper
CNA-4805	10.073, UE 866 (Individual 2)	NSSE	Unidentified	4120 ± 35	2871-2576	-20.81	NA	3.2	This paper
SUERC-104555	10.028, UE 189 (Individual 1)	NS	Unidentified	4112 ± 22	2861-2576	-19.60	8.9	3.8	This paper
CNA-4790	10.005, UE 30 (Individual 1)	NS	Unidentified	4110 ± 35	2869-2505	-18.09	NA	3.2	This paper
SUERC-104559	10.028, UE 189 (Individual 2)	NS	Unidentified	4108 ± 22	2859-2575	-19.70	8.8	3.3	This paper
CNA-1301	10.031, UE 453 (Individual 2)	NS	Skull	4100 ± 68	2878-2488	NA	NA	NA	García Sanjuán *et al.*, 2018c
CNA-5420	10.023, UE 524 (Individual 9)	NSSE	Occipital	4100 ± 35	2867-2499	-18.32	NA	NA	This paper
CNA-1300	10.031, UE 453 (Individual 1)	NS	Skull	4094 ± 36	2866-2496	NA	NA	NA	García Sanjuán *et al.*, 2018c
CNA-4794	10.040, UE 564 (Individual 1)	NS	Unidentified	4090 ± 35	2865-2494	-16.97	NA	3.2	This paper
SUERC-104560	10.028, UE 189 (Individual 3)	NS	Unidentified	4077 ± 22	2846-2496	-19.40	9.1	3.4	This paper
SUERC-107032	10.038, UE 523 (Individual 2)	NS	Unidentified	4072 ± 25	2847-2493	-19.40	9.8	3.3	This paper

Tab. 1. Description of dates. Structure type: M (Megalith), NS (Negative Structure), NSSE (Negative Structure with Stone Elements). NA: Not available.

from samples of human bone, and therefore represent some kind of formalised funerary deposition. For exactly half of them, anatomical identification was not possible. This is largely due to the highly fragmented state of the remains and poor excavation procedures. The 27 dates based on anatomically-identifiable bones include mostly skull fragments (occipital) and teeth. In principle, each of the dates provides the chronology of a different individual.

The dates, obtained in all cases through AMS, come from three different laboratories. The large majority (44 of them) were processed at *Centro Nacional de Aceleradores* (CNA in its Spanish acronym), a facility belonging to the University of Seville and CSIC (Spain), while 3 come from the Oxford Radiocarbon Accelerator Unit (OxA, Oxford University, UK), and 7 from the Scottish Universities Environmental Research Centre (SUERC, University of Glasgow, UK). All dates were calibrated using OxCal 4.4 with the IntCal20 calibration curve (Northern Hemisphere) (Reimer *et al.*, 2020). The average standard deviation for the whole set of 54 dates is 32.1 years, with a maximum of 68 and a minimum of 22. By laboratory, the average standard deviations are as follows: CNA, 33.5 years, OxA, 31.6 years and SUERC, 23.7 years. On the other hand, δ13C data are available for 49 dates, while δ15N data are only available for 6 (all measured at SUERC). It must be noted, however, that the δ13C data provided in Tab. 1 for CNA dates do not come from sample collagen through IRMS (Isotope Ratio Mass Spectrometry) but from the graphite produced as part of the AMS sample processing. That means that the δ13C data provided for CNA dates must be used with caution when assessing the results in dietary terms as they may incorporate minor offsets of up to two points with regards to IRSM-measured collagen δ13C. Offsets caused by marine diet were ruled out, as the results obtained for this set of dates are fully compatible with those of an earlier study, which revealed that freshwater and marine fish were an insignificant part of the diet (García Sanjuán *et al.*, 2018c, p. 267).

All dates have been modelled according to Bayesian statistics. In the last ten years, Bayesian modelling has rapidly become standard in the analysis of radiocarbon dates within Iberian Late Prehistory (see for example Lull *et al.*, 2013; Jover *et al.*, 2014; Aranda Jiménez and Lozano Medina, 2014; Bayliss *et al.*, 2016; Pardo-Gordó *et al.*, 2017; García-Puchol *et al.*, 2018, 2023; García Sanjuán *et al.*, 2018c, 2023; Gironés Rofes *et al.*, 2020; etc.). Bayesian models are greatly helpful in order to improve chronological accuracy when additional information on the relative chronology of the dated contexts is available. This 'prior' information is combined with radiocarbon dates to provide 'posterior' probability distributions. In the absence of prior information regarding relative chronology, a suitable option is to build models that impose specific distributions on the data, thus taking advantage of their mathematical properties.

That is the case of the so-called 'uniform models', which assume that the dated events are uniformly distributed between two exterior events, which constitute the start and end of a phase. Uniform models have specific mathematical implications, which have been widely discussed in the literature (see for example Bronk Ramsey, 2009; Bayliss, 2009; Lanos and Philippe, 2018). Generally, the larger the amount of evidence within a phase, the smaller the uncertainty on the start and end boundaries, causing what some authors have called a 'concentration' effect in the probability distributions of individual radiocarbon dates (Lanos and Philippe, 2018). This effect can cause some of the date (specifically the most peripheral within a given phase) to yield a low 'agreement index' (Bronk Ramsey, 2009), suggesting that either the model is incompatible with the data, or those dates are problematic (for example, on account of laboratory errors). Uniform models provide two additional estimates for the duration of the phases, implemented in OxCal as the 'interval' and the 'span' commands. The span is computed as the difference between the earliest and the most recent directly dated events and is a reasonable estimation of the duration of a phase if we assume the dates are representative of its total activity. On the contrary, the interval is computed as the difference between the start and end events, and introduces the uncertainty of these parameters in the estimation (most noticeable when few dates are available). Technically, no minimum number of dates exists for the correct estimation of the parameters in this model, as it depends greatly on the individual uncertainties attached to each date and the part of the calibration curve involved. However, approximately five dates can be considered sufficient as a financially viable quantity of determinations for estimating the span of a phase (Bevan and Crema, 2021).

Statistical significance tests (such as χ^2) are used to assess the consistency of two or more radiocarbon determinations (Ward and Wilson, 1978). If the tests yield positive results, it is advisable to use a new combined value between dates, which can be also obtained through Bayesian analysis (*e. g.*, with the R_Combine function in OxCal; Bronk Ramsey, 2009). Although such tests were designed for radiocarbon determinations from the same sample or object, some authors have relaxed that assumption considering various dates obtained from the same context as representative of the same event. For instance, this is done with the intention of minimizing oversampling for paleodemographic estimation purposes (see for example Ahn and Hwang, 2015).

The general model presented here includes several overlapping phases, each corresponding to a grave with more than one radiocarbon determination. These phases, along with the remaining dates, are included in a general phase representing the total funerary activity recorded at the PP4-Montelirio sector. This model is aimed at estimating the duration of individual grave use while simultaneously determining the overall chronology of the PP4-Montelirio. The main assumption lies in considering each structure (regardless of its stratigraphic units) as a single, chronologically coherent burial episode, delimited by a start and an end date. Individual burial events within each structure (*i. e.*, the deposition of bodies, body parts or bones) are assumed to be uniformly distributed within that time lapse. Each of these individual phase models are integrated into a general model encompassing all dated burial activity at the PP4-Montelirio sector, including the dates coming from structures with only one radiocarbon determination. This general phase is also regarded as uniform, with the same mathematical properties. Thus, large uncertainties in the start and end boundaries for the structures with fewer dates are avoided (a phase model with only two dates may potentially yield uncertainties of several hundred years). Again, this general model assumes that burial features at the PP4-Montelirio sector of Valencina were made at a uniform 'pace' bound within the start and end boundaries of the general model. Arguably, this assumption may be seen as weak, insofar it may be incompatible with some phenomena. For example, if a burial structure was originally made to deposit various bodies simultaneously and some years later was re-opened to accommodate others, such assumption would prove incorrect and therefore incompatible with the data. Therefore, the individual phase models presented here are conceived as 'working hypotheses', involving the elimination of those dates with a low agreement index, as well as subsequent recalculations of the model until no date is discordant, in order to obtain a robust model and discuss the implications of its assumptions. The same approach was used previously in the modelling of the Montelirio *tholos* (Bayliss *et al.*, 2016). Additionally, multiple dates from the same individuals (as is the case with individual #15 from Structure 10.023 and #2 from Structure 10.044) were combined using the R_Combine function of OxCal, obtaining a more precise estimation.

As an alternative approach to assess the consistency of the burial episodes, statistical significance tests (χ^2) were conducted for all dates associated with each funerary structure. This procedure aims to evaluate their hypothetical contemporaneity, assuming the possibility that all the burials occurred as part of the same event (*e. g.*, simultaneous death of the individuals). Although this assumption is challenging to justify, the results of these tests, along with the estimations from the Bayesian model, have been used to support the interpretation of the available data and enhance the understanding of the temporality of burial practices.

Bayesian models were calculated with OxCal 4.4 software (Bronk Ramsey, 2009), using the IntCal20 calibration curve (Reimer *et al.*, 2020), while χ^2 tests for the individual structures described above were made in the R programming environment (R Core Team 2023). The codes for the reproducibility of the analyses are provided as SF6 and SF7.

Finally, in order to look at possible spatial patterns, isochrone maps were calculated using QGIS v. 3.16, and based on an 'Inverse Distance Weighted' (IDW) algorithm that estimates the value for a given variable on a point of space through inverse weighting of the distance to the nearest known values. The IDW interpolation algorithm, with a power coefficient of 2, uses known timing values and distance weights to determine unknown areas. In order to acquire single-point data for the interpolation, medians calculated using OxCal 4.4 with the IntCal20 calibration curve were used. Within the range of possible ages for each date at 2σ, medians have more than 50 % probability of representing the age of the event correctly and have been used in other approaches to the spatial modelling of radiocarbon dates (Isern *et al.*, 2017, p. 898; García Sanjuán *et al.*, 2022b). The model obtained as part of this study, described below, was based on the use of one date per structure, the oldest one in the case of burials with more than one date. Therefore, the model shows the spatial variation of the start date for all dated burials.

3. CONTEXTS

The PP4-Montelirio sector, located on the south-eastern quadrant of the Valencina mega-site (Fig. 1), was excavated between 2007 and 2008 in advance of the planned construction of a commercial centre that was never built. This sector is located immediately north of (and adjacent to) the Montelirio *tholos*, which was also excavated between 2007 and 2010, yielding a unique record of Copper Age burial practices (Fernández Flores *et al.*, 2016). The PP4-Montelirio rescue excavation extended over an area of almost 2 ha (18.878 m² specifically), which made it the largest excavation ever undertaken at Valencina. The work was carried out by a small team that included only one archaeologist and two or three workers, with the part-time help of a physical anthropologist. Given the large number of features recorded and the complexity of some of them, the dearth of human resources was reflected in a poor

Fig. 1. Location map of Valencina in the Iberian Peninsula showing the approximate coastline c. 5000 years BP. Design: Francisco Sánchez Díaz.

excavation record, particularly with regards to human remains.

Despite these problems, 134 Copper Age features were identified, including 61 funerary and 73 non-funerary ones (Fig. 2) (for a general description see Mora Molina *et al.*, 2013). In January 2011, the research group ATLAS of the University of Seville started a research project on the PP4-Montelirio collections and records, which to this date has largely focused on Structure 10.042-10.049, a remarkable megalithic burial. Several papers have looked into multiple aspects of this particular burial, including general overviews of its significance (García Sanjuán *et al.*, 2019), especially in connection with the Montelirio *tholos* (García Sanjuán *et al.*, 2018b) and the Iberian Copper Age burial record at large (García Sanjuán *et al.*, 2018a), as well as detailed scientific analyses of its material culture, including ivory (García Sanjuán *et al.*, 2013; Luciañez Triviño, 2018; Luciañez-Triviño *et al.*, 2014, 2022), rock crystal (Morgado-Rodríguez *et al.*, 2016), amber (Murillo-Barroso and García Sanjuán, 2013) and cinnabar (Rogerio-Candelera *et al.*, 2013). A recent study has shown the individual buried in Structure 10.049 to be a woman (Cintas-Peña *et al.*, 2023), which has significant implications for the analysis of early social complexity in Copper Age Iberia. Other papers have

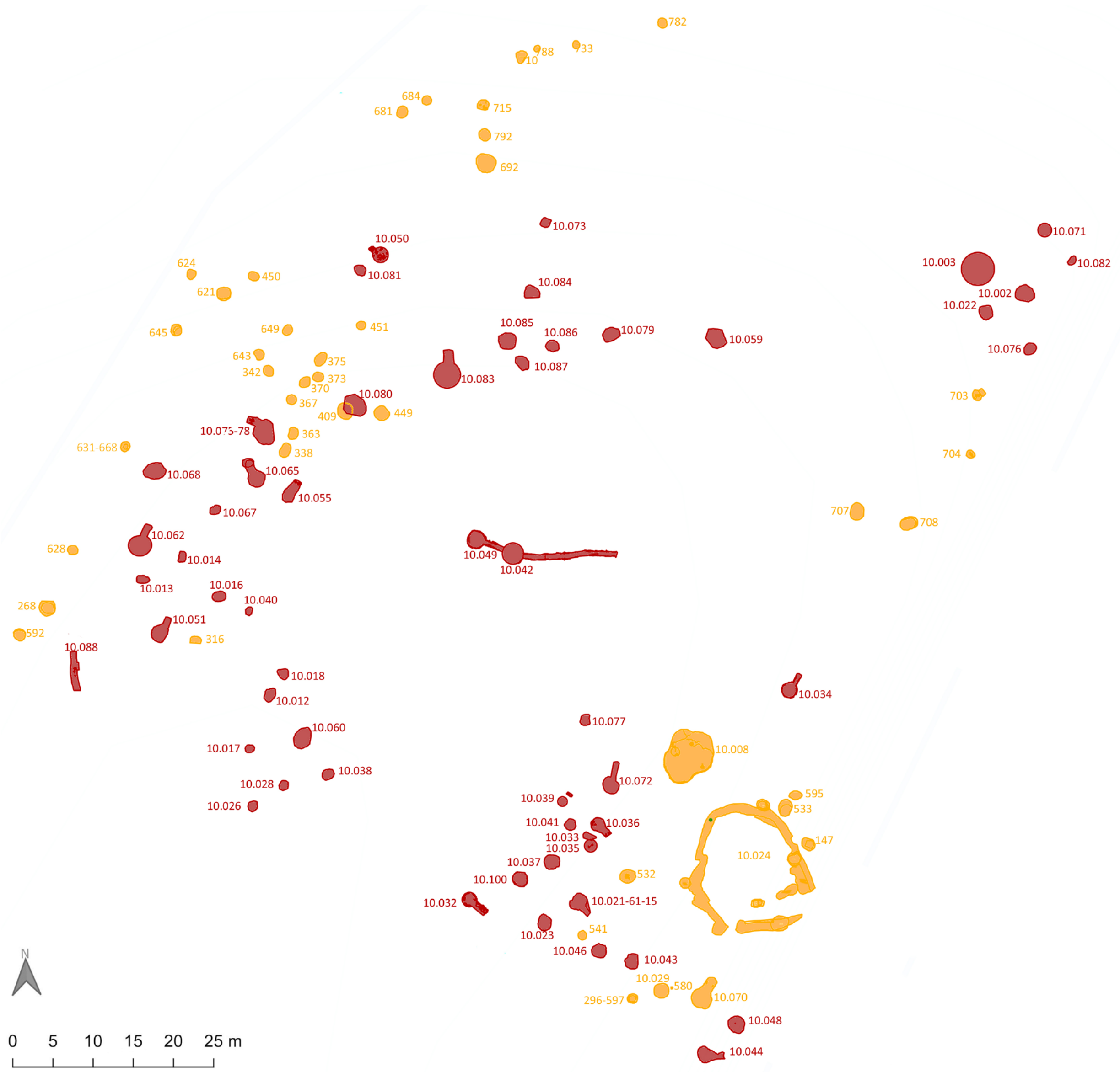

Fig. 2. Plan of the PP4-Montelirio sector. Funerary structures are shown in red. Non-funerary structures in yellow. Design: Coronada Mora Molina.

looked at aspects of the PP4-Montelirio sector such as the physical anthropology of various other burials (Robles-Carrasco and Díaz-Zorita Bonilla, 2013), aDNA (Villalba-Mouco *et al.*, 2021), faunal remains (Liesau *et al.*, 2014), grinding tools (Martínez-Sevilla *et al.*, 2020) and the large decorated gold foil found in Structure 10.029 (Murillo-Barroso *et al.*, 2015).

As mentioned above, the basic information for all 54 dates considered in this study is provided in Tab. 1. The sample encompasses 21 different structures, described in Tab. 2, including 2 megalithic graves (structures 10.042 and 10.049 are noted as a single feature), 7 negative features with stone elements and 12 negative features. While megalithic structures are characterised by the use of stone slabs (basically slate) to line corridors and chambers and, occasionally, to roof or seal the burial structures (Fig. 3), those structures referred to as 'negative features with stone elements' only present sporadic use of stone slabs (Fig. 4). Negative features are simple pits, about 1 m (or less) across, and shallow basins up to 2 or 3 m in size (Fig. 5).

A

B

Fig. 3. Megalithic structures: A) Structure 10.049; B) Structure 10.032. Photographs: José Peinado Cucarella.

In demographic terms, the sample dated here includes 87 individuals. Eight of the tombs yielded a Minimum Number of Individuals (MNI) of one, three yielded remains of two individuals, six had remains of three persons, and one each had remains of four, eight, nine and eleven people. Structure 10.023 is exceptional in that it contained remains of 23 individuals. One of the most interesting aspects of the burials dated here is the interplay between individual and collective inhumations. The fact that 8 of the 21 burials (38 %) can be described as individual inhumations is of the greatest interest, given that it has often been assumed that, in southern Iberia, individual inhumations were a prototypical feature of Early Bronze Age societies (c. 2200-1550 BC) with some Bell-Beaker precursor in the Late Copper Age (Lillios, 2014, p. 556). Clearly, as will be discussed below, they were a recurring feature at Valencina several centuries earlier.

In terms of material culture, a summary description of the grave goods retrieved in all tombs is provided in Tab. 2. Structure 10.042-10.049 totally stands out based on the wealth that was deposited in it, both in quantitative and qualitative terms. Indeed, in that particular sense, this grave is one of the most sophisticated ever found in Copper Age Iberia, which makes the woman buried in the lower level of Structure 10.049 an outstanding person – see discussion below. Up to ten graves (structures 10.023, 10.031, 10.032, 10.038, 10.040, 10.055, 10.060, 10.073, 10.074 and 10.075-10.078) yielded 'special' items such as marine shells of *Pecten maximus* (scallop) (structures 10.023, 10.038, 10.040 and 10.074) and *Cymbula nigra* (saffian limpet) (structures 10.038 and 10.073), ivory artefacts such as needles (10.032, 10.055 and 10.075-10.078) or a decorated baton (10.031), a copper punch (10.073) and a flint dagger blade (10.060), apart from ceramic vessels and faunal remains. A group of eight structures (10.002, 10.013, 10.028, 10.044, 10.059, 10.071, 10.084 and 10.077) yielded simpler sets of graves goods, normally a combination of one or two pottery vessels and one flint blade. Finally, in two structures (10.005 and 10.035) no grave goods were found.

In total, only one date is available for 10 of the structures, while two dates were obtained for six of them, and three (10.032 and 10.044) and four (10.028 and 10.071) dates were recorded for two structures. It is important to note that seven of the structures for which only one date was obtained are individual burials. For Structure 10.023, a negative feature with stone elements containing an MNI of 23, 19 dates are available.

ID	TYPE	MAX. DIAM (metres)	MNI	NUMBER OF C14 DATES	GRAVE GOODS (*)
10.032	M	1.97	8	3	2 whole ceramic vessels, 3 flint blades, 1 piece of flint debris, fragments of bone needles/punches
10.042	M	15.57	3	2	1 fired clay anthropomorphic figurine, 24 knapped lithic artefacts, including 11 arrowheads (plus one fragment) and 13 tools, more than 2.000 beads in the corridor (UE 542) and 20 in the chamber, a rectangular ivory box with diamond-like decoration in low relief and another indeterminate ivory object with perforations, 1 shell fragment of *Charonia lampas* (triton shell) with at least three perforations (possible pendant/ornament), 1 scallop valve (*Pecten* sp.) and various fragments of deer antler (*Cervus elaphus*) and abundant cinnabar pigment
10.049	M	4.62	1	0	Lower: 1 whole elephant tusk (*Loxodonta a. africana*), 1 whole ceramic plate of the 'almond rim' type, 12 ivory objects (2 vessel-like containers, 2 combs, a possible box or container, a fragment of a cylindrical object and 2 or 3 other unidentified objects), 1 flint dagger blade decorated with an amber pommel, 21 knapped flint blades, 1 small copper item (probably a punch) and abundant cinnabar pigment Upper: 5 complete or almost complete ceramic plates of the 'almond rim' type, 51 knapped flint objects including 38 blades and 13 different tools, 1 ostrich eggshell, 1 carved tusk of Asian elephant (*Elephas maximus*), 1 dagger with a rock crystal blade and ivory hilt and sheath, decorated with 90 perforated beads made in mother-of-pearls, and other very fragmented ivory remains which appear to correspond to one rectangular object, 1 or 2 rings or bracelets and 3 indeterminate objects
10.002	NS	1.09	2	1	1 whole pottery vessel
10.005	NS	1.00	2	1	No grave goods
10.028	NS	1.70	11	4	1 whole pottery vessel and 1 dog skull
10.031	NS	2.40	3	2	1 carved ivory 'baton'
10.035	NS	2.15	1	1	No grave goods
10.038	NS	1.70	3	1	1 flint blade, 1 large-sized shell of *Cymbula nigra* (saffian limpet) worked on both edges to create a roughly symmetric oval piece and 1 well-preserved large-sized shell of *Pecten maximus* (scallop)
10.040	NS	1.42	2	2	Fragments on 1 unidentified worked bone item and 1 well-preserved large-sized shell of *Pecten maximus* (scallop)
10.059	NS	1.65	1	1	1 whole pottery vessel, one flint blade and 1 small piece of knapped flint
10.060	NS	2.60	3	2	2 whole ceramic vessels and 1 flint dagger blade
10.071	NS	1.73	9	4	2 whole ceramic vessels
10.074	NS	1.60	1	1	1 whole vessel, 11 fragments of a second vessels and 1 whole shell of *Pecten maximus* (scallop)
10.077	NS	1.38	1	1	1 whole pottery vessels and fragments of a second vessel
10.013	NSSE	1.65	1	1	Some pottery fragments
10.023	NSSE	2.07	23	19	Fragments of several ceramic vessels, fragments of a *Bos taurus* (cattle) skull and 1 whole valve of *Pecten maximus* (scallop)
10.044	NSSE	2.07	3	3	1 whole pottery vessel and fragments of others
10.055	NSSE	3.34	1	1	6 whole ceramic vessels and fragments of others, 1 flint blade and 1 ivory needle
10.073	NSSE	1.19	3	2	2 whole ceramic vessels, 1 copper punch with bone handle, and 1 whole shell of *Cymbula nigra* (saffian limpet) with signs of carving on the inner face and polishing around the edges (probably used as container or 'spoon')
10.075 10.078	NSSE	2.56	4	2	3 pottery vessels, 1 flint blade, 1 ivory needle or punch and 2 fragments of the tip of a possible horn (unidentified)
10.084	NSSE	1.94	1	1	1 whole pottery vessel and 1 flint blade
TOTAL			87	54	

Tab. 2. Sampled Structures. Structure type: M (Megalith), NS (Negative Structure), NSSE (Negative Structure with Stone Elements). (*) Grave goods: faunal remains identified after Liesau *et al*., 2014; ivory remains after Luciañez Triviño, 2018.

Fig. 4. Negative Structures with Stone Elements: A) Structure 10.023, Stratigraphic Unit 225 (upper level); B) Structure 10.023, Stratigraphic Unit 497 (intermediate level); C) Structure 10.084, Stratigraphic Unit 869; D) Structure 10.044, Stratigraphic Unit 632. Photographs: José Peinado Cucarella.

Fig. 5. Negative Structures: A) Structure 10.005, Stratigraphic Unit 30; B) Structure 10.028, Stratigraphic Unit 189; C) Structure 10.059, Stratigraphic Unit 730; D) Structure 10.060, Stratigraphic Unit 670. Photographs: José Peinado Cucarella.

4. RESULTS

The ages obtained for this dataset are remarkably compact, ranging from 4277 ± 31 to 4072 ± 25 BP, and therefore spanning roughly 200 years (Fig. 6). The first Bayesian model with all dates (Figs. 7 and 8) showed a low agreement index (Amodel = 55.8; Aoverall = 41.2), indicating some incompatibility between the data and the model (named 'Model 1'). As a result, some dates were removed, including the following. For Structure 10.023, dates CNA-5406 (4230 ± 25) (A = 59), CNA-5421 (4240 ± 30) (A = 48.9) and CNA-5420 (4100 ± 35) (A = 32.2). The first two present a slightly low agreement index, suggesting they are too old to belong to a chronologically coherent set, while the third is too recent, showing a significantly low agreement index. For Structure 10.028, date SUERC-104560 (4077 ± 22) (A = 45), which is one of the most recent in the entire series. For Structure 10.042, CNA-1303 (4277 ± 31) (A = 13.7), which is one of the oldest in the dataset, with an extremely low agreement index in the first model. Since this structure has two radiocarbon determinations, the elimination of CNA-1303 involves the exclusion of its sub-phase. For Structure

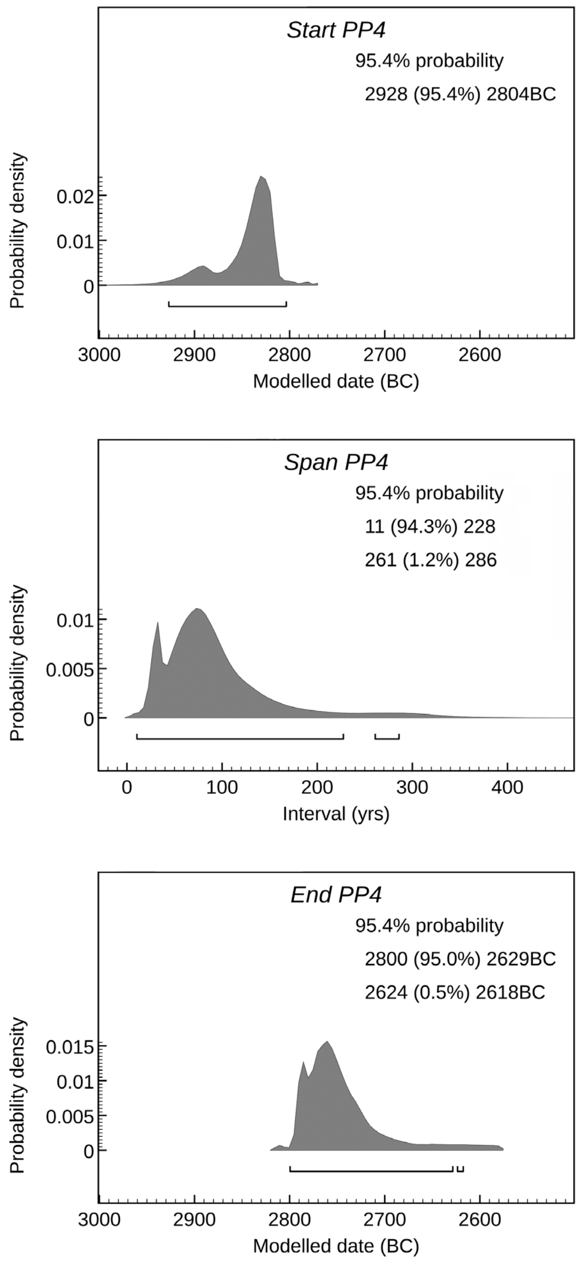

Fig. 6. Start, span and end of PP4 use (Model 1). OxCal v4.4.4 Bronk Ramsey (2021); r:5.

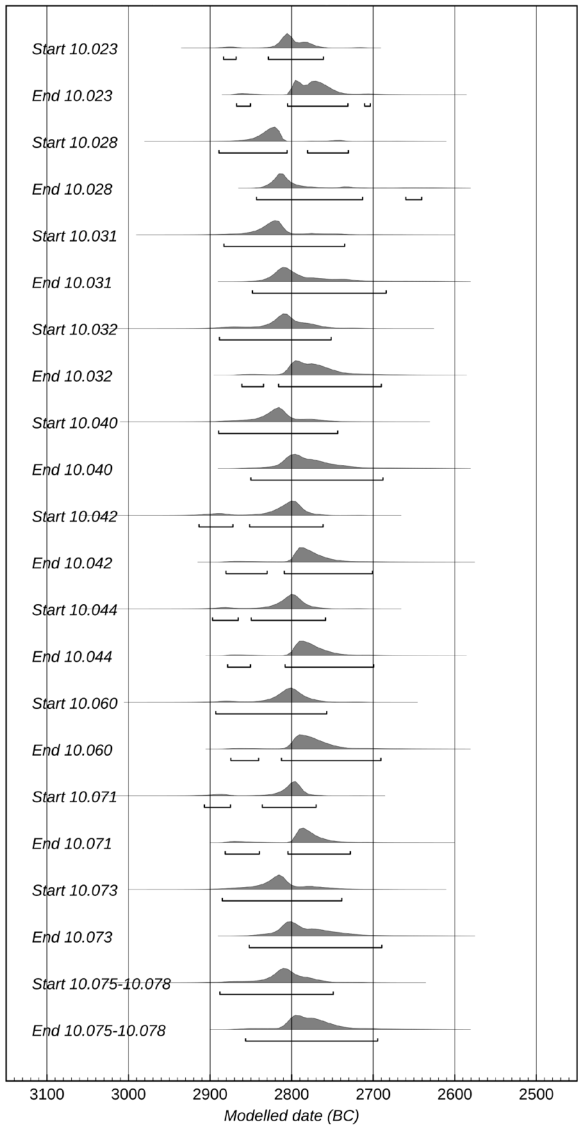

Fig. 7. Start and end of structures use (Model 1). OxCal v4.4.4 Bronk Ramsey (2021); r:5. Atmospheric data from Reimer *et al*. (2020).

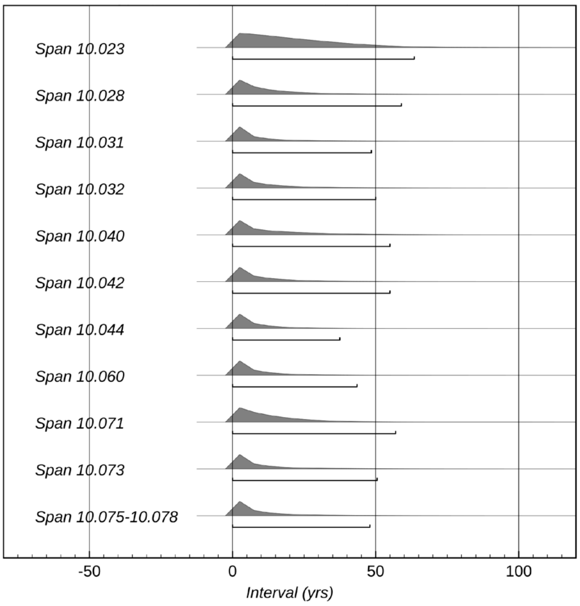

Fig. 8. Span of structures use (Model 1). OxCal v4.4.4 Bronk Ramsey (2021); r:5. Atmospheric data from Reimer *et al*. (2020).

10.071, date OxA-32370 (4277 ± 30) (A = 12.6) which, like the previous one, has a very low agreement index. Finally, the only date from Structure 10.038, SUERC-107032 (4072 ± 25) (A = 44.3), has been also removed, representing the most recent sample in the PP4-Montelirio sector.

After the second iteration of the model, date CNA-4794 (4090 ± 35), from Structure 10.040, was also removed, as it showed a low agreement index (A = 53.5) revealing a strong discordance with the other date available for this structure (CNA-4795 4200 ± 35). As a result, the phase of Structure 10.040 was removed from the model.

The third iteration of the model yielded a very high agreement index (Amodel = 116.9; Aoverall = 101.1), suggesting a strong compatibility between the model and the data. Therefore, inferences about the start and end of burial events as well as the duration of the use of each structure can be regarded as robust (according to the assumptions of the model). The breakdown of the results of this model is presented in Tab. 3. The start and end dates for each structure are extremely similar, making it difficult to postulate a sequence of use in their development (Fig. 7). On the other hand, the interval and span parameters are also quite similar. Spans never exceed 70 years of duration at 2σ probability, both in Model 1 and Model 2 (Fig. 8, Tab. 3 and SF1, 2, 3 y 4). Regarding intervals between the start and end, Structure 10.023 shows the lowest value due to the large number of dates within its phase, while all others have values between 0 and 120 years.

Phase	Start	End	Duration *(span) (interval)*
Structure 10.023	2884 BC - 2869 BC (3.1 %) 2829 BC - 2762 BC (92.3 %)	2868 BC - 2851 BC (2.5 %) 2806 BC - 2732 BC (92.1 %) 2711 BC - 2704 BC (0.8 %)	0 - 64 AD (95.4 %) 0 - 72 AD (95.4 %)
Structure 10.028	2890 BC - 2806 BC (88.6 %) 2781 BC - 2731 BC (6.8 %)	2844 BC - 2714 BC (94.1 %) 2661 BC - 2641 BC (1.3 %)	0 - 59 AD (95.4 %) 0 - 95 AD (95.4 %)
Structure 10.031	2884 BC - 2736 BC (95.4 %)	2849 BC - 2685 BC (95.4 %)	0 - 49 AD (95.4 %) 0 - 111 AD (95.4 %)
Structure 10.032	2889 BC - 2752 BC (95.4 %)	2862 BC - 2835 BC (2.7 %) 2817 BC - 2691 BC (92.8 %)	0 - 50 AD (95.4 %) 0 - 112 AD (95.4 %)
Structure 10.040	2890 BC - 2744 BC (95.4 %)	2851 BC - 2689 BC (95.4 %)	0 - 55 AD (95.4 %) 0 - 119 AD (95.4 %)
Structure 10.042	2914 BC - 2873 BC (9.6 %) 2852 BC - 2762 BC (85.9 %)	2881 BC - 2831 BC (5.5 %) 2810 BC - 2702 BC (90.0 %)	0 - 55 AD (95.4 %) 0 - 116 AD (95.4 %)
Structure 10.044	2898 BC - 2866 BC (6.0 %) 2850 BC - 2759 BC (89.5 %)	2879 BC - 2851 BC (3.2 %) 2809 BC - 2700 BC (92.3 %)	0 - 38 AD (95.4 %) 0 - 100 AD (95.4 %)
Structure 10.060	2894 BC - 2758 BC (95.4 %)	2875 BC - 2841 BC (3.1 %) 2813 BC - 2691 BC (92.3 %)	0 - 44 AD (95.4 %) 0 - 109 AD (95.4 %)
Structure 10.071	2908 BC - 2876 BC (9.2 %) 2837 BC - 2771 BC (86.3 %)	2882 BC - 2840 BC (6.7 %) 2805 BC - 2729 BC (88.7 %)	0 - 57 AD (95.4 %) 0 - 94 AD (95.4 %)
Structure 10.073	2886 BC - 2739 BC (95.4 %)	2853 BC - 2690 BC (95.4 %)	0 - 51 AD (95.4 %) 0 - 113 AD (95.4 %)
Structure 10.075-10.078	2889 BC - 2750 BC (95.4 %)	2857 BC - 2695 BC (95.4 %)	0 - 48 AD (95.4 %) 0 - 109 AD (95.4 %)
General	2928 BC - 2804 BC (95.4 %)	2800 BC - 2629 BC (95.0 %) 2624 BC - 2618 BC (0.5 %)	11 - 286 AD (95.4 %) 10 - 304 AD (95.4 %)

Tab. 3. General Bayesian model and submodels for structures (Model 1).

Tab. 4 shows the results of χ^2 testing for all structures, separating p. values according to whether the test included only the dates accepted by Model 2 or all of the available ones for each structure. According to χ^2 results, all dates accepted by the model for each structure are statistically consistent, except those for structures 10.040, 10.042 and 10.071, for which the alternative hypothesis was accepted, indicating that the dates are statistically different.

As was discussed in the Methodology section, these results cannot be taken as proof of 'synchronicity' in the inhumation events. And yet, the coherence of the results coupled with the short duration estimated by the model for all structures, reveal that all burial activity in the PP4-Montelirio sector occurred within a 'short' period of time (relative to the uncertainty of the measurements), spanning, at most, 200 years. At the same time, given the available number of dates and their accuracy, no differentiated episodes, or phases, of deposition inside the structures could be discerned. This must be pondered on the basis of further stratigraphic and taphonomic analysis, as clear differences of deposition may have existed that are below the temporal accuracy of the available dates.

5. DISCUSSION

The data resulting from the statistical models described above reveal interesting patterns in the temporality of the burial practices recorded at the PP4-Montelirio sector and, by extension, in the occupation dynamics of the Valencina mega-site.

Firstly, it is worth noting the position of these burials within the temporality of the site as a whole, especially in terms of its start and end. The oldest dates, corresponding to Structures 10.042 and 10.071, range approximately from 2900 to 2760 cal BC 2σ according to Model 1 (CNA-1303, 4277 ± 31 BP, OxA-32370, 4277 ± 30 BP). These dates place the start of burial activity at the PP4-Montelirio sector very shortly after one of the earliest recorded foci of Copper Age activity at Valencina, namely La Huera. A Bayesian model based on 16 dates revealed a period of use for La Huera starting in 3260-3100 cal BC and ending in 3020-2925 cal BC 2σ (García Sanjuán *et al.*, 2018c, p. 216). Activity at the PP4-Montelirio started shortly after or synchronously with La Huera. However, the nature of the burial practices undertaken at PP4-Montelirio was quite different from those of La Huera. The dates, rejected in Model 2 due to their low agreement index, suggest the possible existence of an early burial activity in the PP4-Montelirio sector, preceding the main episode of funerary constructions (better estimated by Model 2). Moreover, the χ^2 statistical tests for these structures indicate incompatibility with a synchronous funerary event for the other dated individuals buried within them, suggesting a possible reuse of the structures.

Seen from the wider perspective of the whole of the Valencina mega-site, burial activity at PP4-Montelirio started early on. The chrono-spatial model calculated in order to spatially assess the position of the PP4-Montelirio sector within the whole temporality of Valencina (Fig. 9), based on the earliest available date for all the radiocarbon-dated sectors of the site, reveals that the earliest activity, between c. 3200 and 2900 BC, took place at 'peripheral' locations of what centuries later would become the whole expanse of the mega-site. This includes La Huera and PP4-Montelirio on the East, Calle Dinamarca 3 on the West, and Cerro de la Cabeza to the North, all of which are burial contexts. The only exception to this is a date (MAMS-38.870) from the southern slope of Cerro de la Cabeza, which

Structure	p.value (only accepted dates)	p.value (all dates)
Structure 10.023	0.7931403	0.1388238
Structure 10.028	0.1866837	0.1000978
Structure 10.031	0.9378429	NA
Structure 10.032	0.1491826	NA
Structure 10.040	NA	**0.02626063 ***
Structure 10.042	NA	**0.01169741 ***
Structure 10.044	0.9378429	NA
Structure 10.060	0.4190203	NA
Structure 10.071	0.2700191	**0.03783858 ***
Structure 10.073	0.4190203	NA
Structure 10.075-10.078	0.4190203	NA

Tab. 4. Results of χ^2 testing. Values in bold are those for which the alternative hypothesis (according to this the dates are significantly different) was accepted.

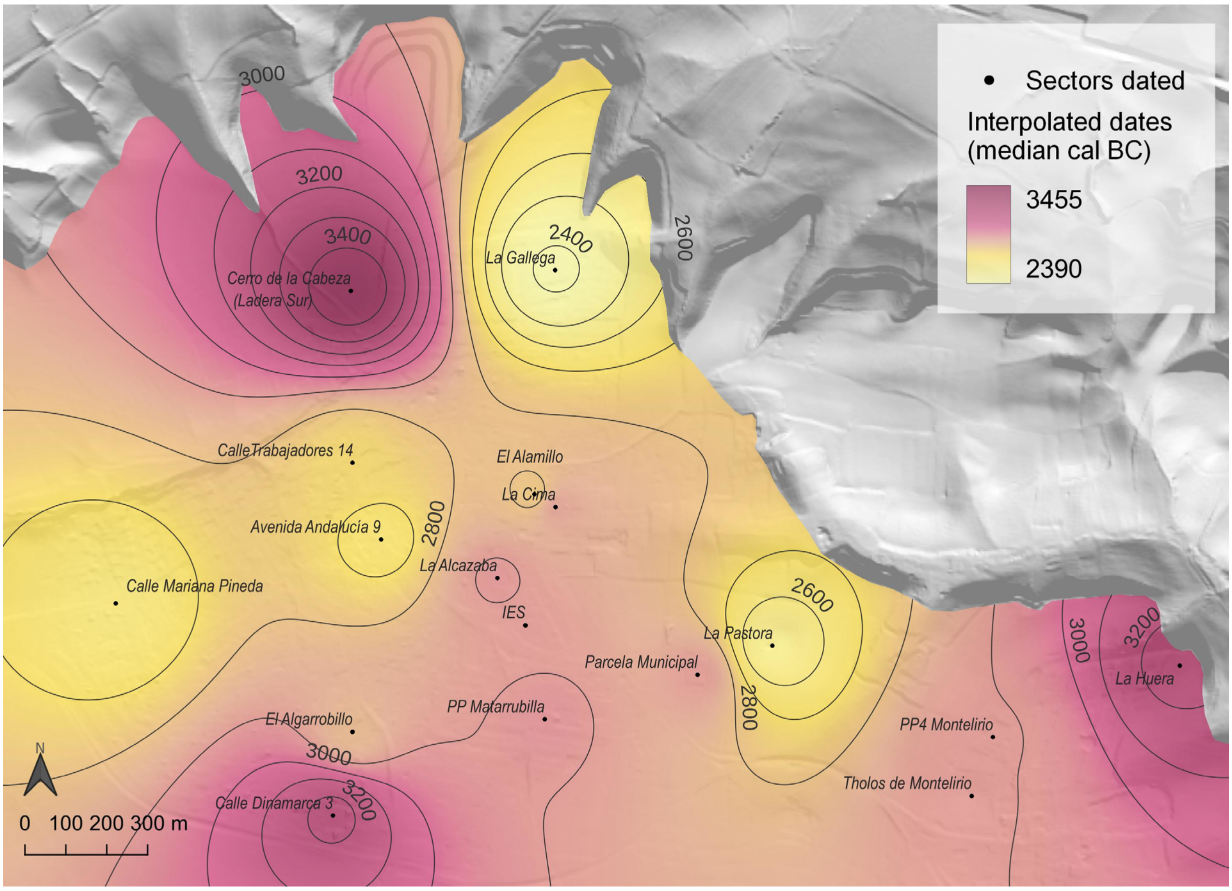

Fig. 9. Spatio-temporal model for the start dates of use in Valencina. Design: Francisco Sánchez Díaz. Dates used are listed on Supplementary Material SF5.

yielded an age of 4676 ± 54 (3626-3361 cal BC 2σ) (Mederos Martín *et al.*, 2021, p. 314), but this is a date from a non-articulated animal bone and therefore it is uncertain how its age correlates with the deposition event. The earliest dated activity at the sectors located in between those early and 'peripheral' three, such as, for example, La Gallega, Calle Trabajadores, Mariana Pineda and even the La Pastora *tholos*, occurred at a later stage, between c. 2650 and 2400 BC. This observation is important, as it runs counter to the hypothesis that Valencina developed outwardly, from a 'core' to a 'periphery', and that it was a 'village', with an exterior 'necropolis'. In fact, this is consistent with recently published evidence suggesting that at Los Millares "mortuary practices preceded the first evidence of housing activity by up to 230 years" (Aranda Jiménez *et al.*, 2020, p. 14). However, given the huge size of Valencina, despite the availability of a high number of radiocarbon dates, we regard this observation as preliminary and pending future corroboration.

The latest of the PP4-Montelirio dates, belonging to Structures 10.038 and 10.028 range approximately from 2850 to 2650 cal BC 2σ according to Model 1 (SUERC-107032, 4072 ± 25 BP, and SUERC-104560 4077 ± 22). Although Model 2 rejects both due to their low agreement index, the χ^2 statistical test for structure 10.028 indicates some compatibility with a single burial episode. However, considering that structure 10.028 contains a minimum of 11 individuals (with only 4 directly dated), the possibility of reuse activity in this structure is also plausible. Thus, these two dates could represent a residual funerary activity in the PP4-Montelirio sector, occurring after the main period of burial activity. It is important to note that once burial activity ended in c. 2650-2600 BC, the PP4-Montelirio sector was abandoned and never reused again, neither in the remainder of the Copper Age, or in later prehistoric periods such as the Bronze Age and Iron Age. The only ulterior evidence of activity in that area dates to the 4th to 6th centuries AD, when inhumation burials were made, as shown by a series of five still unpublished radiocarbon dates. The fact that for the rest of the Copper Age (c. 300 years until the decline and final collapse of activity at the site) the PP4-Montelirio sector never witnessed any further activity is highly significant. On the one hand, this might suggest that, once the final burials were made, the area became 'sacred' or 'taboo', and therefore beyond the limits of Copper Age social and cultural life. Other neighbouring sectors witnessed activity later on, such as, for example, the area surrounding the La Pastora *tholos* or the Parcela Municipal next to it, located barely 500 m to the west of the PP4-Montelirio sector. But the PP4-Montelirio area would remain unused.

On the other hand, this fact lends support to the possibility, already noted in previous discussions (García Sanjuán *et al.*, 2017, p. 254), that the large extent reached by the site at the end of its occupation (c. 450 ha) may have resulted from a palimpsest of shifting occupations (occasional, seasonal or, as appears to be the case with PP4-Montelirio, inter-generational) changing through time, rather than a dense and permanent occupation. To a degree which at this point cannot be ascertained with precision, the enormous size that Valencina was to reach at the end of its occupation may have resulted from the repetition of certain social practices over relatively short periods of time in contiguous and sometimes (but not always) overlapping sectors.

Secondly, an interesting result is the very duration of the use of the PP4-Montelirio sector. The general model shows that the duration of burial activity was less than 300 years, with a maximum of 200 years for the main funerary period (according to Model 2). Furthermore, the slight difference between the 'span' and 'interval' estimates (Tab. 3 and SF1) suggests that the samples are likely representative of the total burial activity. On the other hand, the span of the structures for which specific models exist shows an average duration of less than 70 years, which would have spanned approximately two generations. Conversely, the more conservative 'interval' estimate indicates a duration of less than 100 years for structures 10.028, 10.032, and 10.071, which might be less representative of their activity, given that only a small fraction of the minimum number of individuals were dated. While this is a relatively short period of time considering that recorded activity at the Valencina mega-site spans almost a thousand years (c. 3200-2300 BC), it is in keeping with the relatively 'short' duration of use of other burials at Valencina. Even though the majority of structures are compatible with a single burial episode according to the χ^2 test, we tend to interpret that funerary structures in which collective inhumations were made were generally used for a few decades or generations, while individual burials and other depositions involving human bones (like the group of skulls found together at Calle Trabajadores 14-18) appear to have been deposited in single events (García Sanjuán *et al.*, 2018c, p. 282). In this context, it is interesting to note that Structure 10.040, which shows a statistically significant difference between the dates in the χ^2 test and includes an early date rejected by Model 2 (possibly representing residual activity), does not exceed 55 years in duration according to the span of Model 1. This estimate can be considered representative, as both individuals from the grave were directly dated.

Similar time spans of use (below one or two centuries) have been detected at other southern Iberian megalithic monuments. That is the case of *tholos*-type structure #7055 at La Orden-Seminario, dated to between the 28th and 26th centuries cal BC, and with a span of use of 110 years (Linares Catela and Vera Rodríguez, 2021, p. 78), Grave 11 at El Barranquete (Níjar, Almería), with a Chalcolithic phase between 81 and 249 years long (Aranda Jiménez *et al.*, 2014), Panoría (Darro, Granada) where "tombs were built at different times and used at different temporal scales and intensities, ranging from a few decades to centuries" (Aranda Jiménez *et al.*, 2017) or Grave 75 at Los Millares, with a span of 1 to 245 years (Aranda Jiménez *et al.*, 2020). It is also worth noting that the 'proto-megalithic' burial at Campo de Hockey (Cádiz), made a thousand years earlier, revealed a "continuous occupation over several generations around 300 years" (Vijande-Vila *et al.*, 2022, p. 15).

Thirdly, regarding the previous point, it is also important to consider how the 'internal' use of the PP4-Montelirio sector unfolded during its, at most, c. 200-year timespan. As noted above, among the earliest dated burials are those from Structure 10.042-10.049, a megalithic construction that was found partly destroyed at the time of excavation (the first chamber was the most damaged part), and containing remains of five individuals. A statistical model based on two dates of those human bones set the start of burial activity in the first chamber in 3515-2875 cal BC (86 % probability), and its end in 2885-2155 cal BC (86 % probability) (García Sanjuán *et al.*, 2018c, p. 232). In contrast, Model 1 presented here suggests a more precise start between 2912 and 2760 cal BC and an end between 2880 and 2700 cal BC (with a 95.45 % probability), due to the greater availability of information from the PP4-Montelirio sector. Despite being largely destroyed, Structure 10.042 yielded a very special set of grave goods, including more than 2.000 beads (made in marine shell) covered in cinnabar pigment, fragments of a fired clay figurine, fragments of one or more deer antlers and fragments of 12 arrowheads, nine of which are of the long-barbed type of which Montelirio yielded 151 examples (see a full description in García Sanjuán *et al.*, 2019, pp. 1011-1017).

An important feature of Structure 10.042 is that, according to the excavator, it was 'connected' on its western side to Structure 10.049, also a megalithic construction of similar size (see full description in García Sanjuán *et al.*, 2019, pp. 1017-1029). Structure 10.049 yielded the inhumed remains of a single individual, first thought to be a male, but recently revealed to be a female (Cintas-Peña *et al.*, 2023) and an even more extraordinary set of grave goods, including cinnabar pigment as well as several remarkable objects in ivory, flint, rock crystal and ostrich eggshell. This woman was subsequently nicknamed 'The Ivory Lady'. Numerous attempts at dating her and the ivory objects found in Structure 10.049 have failed and therefore no reliable estimate exists as to the degree of contemporaneity between structures 10.042 and 10.049. However, if it is correct that both structures were connected, then it could be proposed that at around 2900 BC burial activity at the PP4-Montelirio started with the construction of what, at that time, was the most lavish and sophisticated burial monument ever made in Valencina. Not only was Structure 10.042-10.049 far more architecturally complex than the comparatively simpler 'artificial caves' built at the site up to that point (in the two or three previous centuries), as illustrated by La Huera and Calle Dinamarca nº 3, but the material culture deposited in it was also way more sophisticated, sumptuous and idiosyncratic.

In other words, the hypothesis presented here is that activity at the PP4-Montelirio sector may have commenced with a 'grand' funeral involving the construction of an impressive megalithic grave that contained the remains of a socially prominent person: a female leader buried with high-end sumptuous artefacts largely manufactured on exotic raw materials as well as special substances (the large ceramic plate placed next to her yielded residues of wine and cannabis). In the ensuing 200 years, intense activity occurred around her grave, including 61 individual and collective burials (totalling an estimated c. 200 individuals with their grave goods) and 73 non-funerary structures. This activity was undertaken respecting a buffer zone of about 25 m around the grave of 'The Ivory Lady' (Fig. 2). This rather remarkable feature has two implications. Firstly, there might have been an active memory, transmitted orally, of the social and cultural importance of 'The Ivory Lady', which lasted for, at least, the whole period PP4-Montelirio was in use. Secondly, it seems reasonable to suggest that all the users of the PP4-Montelirio sector abided by the principle that a buffer or respect zone had to be kept around the burial of the female forebear. It cannot be ruled out that her grave was marked (surrounded) by some kind of physical element (fence, wooden posts or sculptures) of which no trace has been found. What matters, however, is that for at least c. 200 years, about eight generations of people seemed to have revered the tomb of 'The Ivory Lady', whom they probably respected as a prominent ancestor (perhaps the founder of a lineage), a memorable leader, or both.

The unfolding of the ritual use of the area surrounding Structure 10.042-10.049 does not appear to have been linear or constant (Fig. 10). As noted above, after the likely initiation of structures 10.042-10.049, 10.023 and 10.044 in the 29th century BC, fourteen more burials were started throughout the 28th century BC which, predominantly, were simple pits and individual inhumations, although some burials were collective in character (including Structure 10.028, with a MNI =11 and Structure 10.032, a megalithic burial with MNI = 8). Throughout the 27th century burial activity decreased (Fig. 11), with only three new burials, all of them simple negative features.

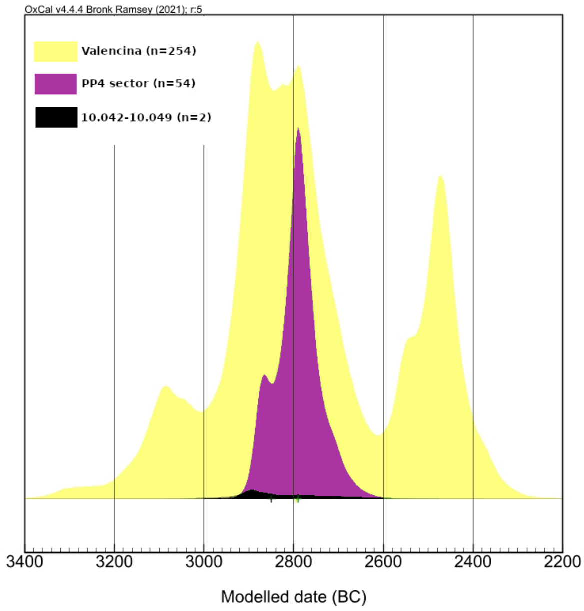

Fig. 10. Kernel density estimation of summed probability distribution of calibrated dates from structure 10.042-10.049 (black), PP4 sector (purple), and Valencina megasite (yellow).

As noted above, a remarkable aspect of the burial activity recorded at the PP4-Montelirio sector is the presence of a high number of individual inhumations: eight in total (38 % of the 21 burials included in this study). The evidence compiled recently as part of a comparative analysis (Cintas-Peña, 2020, pp. 194-195) shows that in a sample of 1.723 Iberian Copper Age individuals, only 35 were interred as individual inhumations. This represents a mere 2.03 %, much lower than the 38 % observed in the PP4-Montelirio sector sample used here. The fact that the occurrence of individual inhumations in PP4-Montelirio is almost 20 times higher than in the whole of the Iberian Copper Age rises several questions regarding previously held

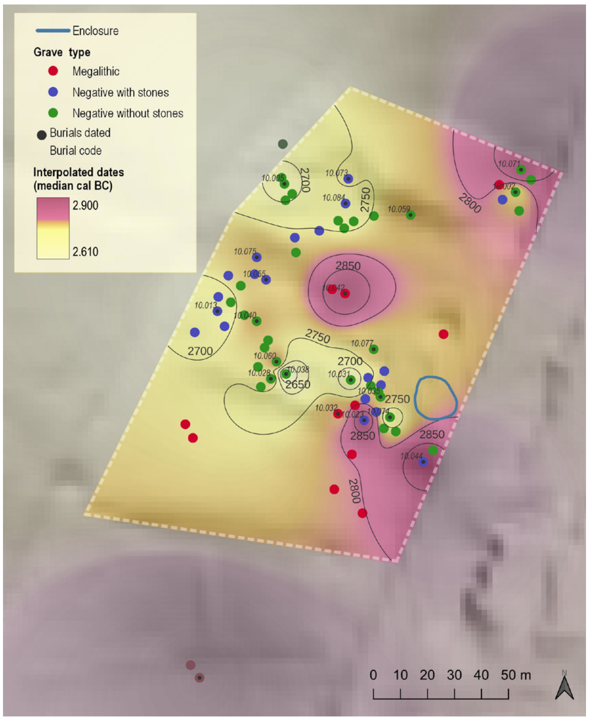

Fig. 11. Spatio-temporal model for the start date of all dated burials in the PP4-Montelirio Sector. Design: Francisco Sánchez Díaz.

assumption about the collective *vs*. individual character of burial practices in the 3rd and 2nd millennia BC. Traditional claims in the sense that individual inhumations were the 'trademark' of Early Bronze Age societies now appear questionable. On the other hand, were individual inhumations deposited early in the sequence a phenomenon restricted to the Valencina mega-site, in connection with the particular social dynamics occurring there (and of which 'The Ivory Lady' herself would be a prime example)? What do these inhumations reveal about the fabric of society in the first half of the 3rd millennium BC? Future advances in the anthropological and demographic analysis of the PP4-Montelirio sector, a unique window into Copper Age society, will undoubtedly provide more solid evidence to answer these questions.

Indeed, the most remarkable event occurring around burial 10.042-10.049 was the construction and use of the Montelirio *tholos*, built less than 100 m to the south. A Bayesian model published some years ago showed that Montelirio was probably built in 2875-2700 cal BC (95 % probability) or 2850-2805 cal BC (38 % probability) and was in use as a burial monument until 2805-2635 cal BC (95 % probability), with a timespan of 200 (95 % probability) or 100 years (68 % probability) (Bayliss *et al.*, 2016, p. 491). Montelirio surpassed Structure 10.042-10.049 in its architectural grandiosity and (to a lesser extent) in the sumptuousness of the material culture buried in it (see Fernández Flores *et al.*, 2016 for a full description). One crucial element to understand the social background behind these monuments is that the available statistical models show quite clearly that Montelirio was built after Structure 10.042-10.049 (93 % probability) (García Sanjuán *et al.*, 2018c, p. 284). In a way, therefore, the Montelirio *tholos* was part of the same social and cultural milieu that led to the formation of a formal deposition area around 'The Ivory Lady' – only on a much grander scale. The detailed stylistic and technological analysis of the material culture found on the upper level of Structure 10.049, right above 'The Ivory Lady', and, to a lesser degree, in the corridor of Structure 10.042, suggest that many of those offerings were made when Montelirio was built, thus creating a deliberate connection with the past (see full discussion in García Sanjuán *et al.*, 2018b).

In summary, the burial dynamics of the PP4-Montelirio sector started with the initial burial of 'The Ivory Lady', very probably around 2900 BC. That event was followed by a period of c. 200 years (c. 2900-2650 BC) in which the area surrounding her grave was used for burials and for the formal (structured) deposition of a great deal of material culture and faunal remains. The latter activity included the deposition of some extraordinary artefacts like the large decorated gold foil of Structure 10.029. Between c. 2850 and 2700 BC the Montelirio *tholos* was built in the vicinity, and a special contingent of people, mostly women, were buried in it within a very short period of time (maximum 30 years) or simultaneously. The women buried in the Large Chamber of Montelirio must have been socially prominent, as attested by the beaded attires decorated with pendants made of ivory and amber they wore when buried, by the rest of the material culture deposited with them, and by the fact that their bones had very high levels of mercury when they died (García Sanjuán *et al.*, 2024; see full description in Fernández Flores *et al.*, 2016). The fact that the 29th and 28th centuries cal BC represent the climax of use of the PP4-Montelirio sector is also consistent with the evidence available for Valencina as a whole (García Sanjuán *et al.*, 2018c, p. 281) and even for the Copper Age of the Iberian SW (Blanco-González *et al.*, 2018, p. 41), showing that those centuries concentrate the large majority of radiocarbon dates for the 3rd millennium, both in burials as in settlement contexts.

5. CONCLUSION

The high-resolution dating of the PP4-Montelirio sector, coupled with the chronometric information already published for neighbouring monuments, such as the artificial cave of La Huera or the Montelirio *tholos*, leads to a more precise understanding of the sequence and dynamics of use of the south-eastern quadrant of the Valencina Copper Age mega-site. Following earlier (very poorly understood) precedents in the first half of the 5th millennium BC, this quadrant of Valencina started to witness recurrent burial activity at around 3200 BC. First, this took the form of a rather unsophisticated artificial cave, La Huera, in which the remains of 22 people were interred over a period of c. 300 years, with a later inhumation on its upper level (García Sanjuán *et al.*, 2018c, p. 218).

Later, c. 2900 BC, a special megalithic monument was made to receive a very outstanding person, 'The Ivory Lady'. This woman was, by all counts, the most socially prominent person in the whole of Iberia at that time, based on a review resulting in a database of 1.723 Copper Age individuals (García Sanjuán *et al.*, 2018a; Cintas-Peña, 2020). Immediately, her grave became the focus of sustained ritual activity, including dozens of burials (of an estimated 200 people) and structured deposition of special objects and offerings, for a period of 200-250 years: this is what we refer to as the PP4-Montelirio sector. During that period, specifically between c. 2850 and 2700 BC, the Montelirio *tholos* was built less than a 100 m to the south of 'The Ivory Lady' grave. This was by far the largest and most lavish monument ever built at Valencina, and was endowed with artefacts of unparalleled wealth and sophistication. Architecturally, Montelirio ranks among the most remarkable *tholoi* of Copper Age Iberia, together with those at Antequera (Málaga, Spain) or Alcalar, in southern Portugal. But in terms of the material culture found in it, it stands alone as a unique example of the ingenuity, creativity, resourcefulness and wide-ranging connectivity of southern Iberian Pre-Beaker Copper Age communities.

By c. 2650 BC the entire PP4-Montelirio area was abandoned, possibly in connection with a decline of activity at the site as a whole. In the ensuing c. 300 years in which the Valencina mega-site was still active (including the construction of major monuments such as La Pastora), neither the grave of 'The Ivory Lady' nor the rest of the PP4-Montelirio sector were re-used. On the contrary, the sector was abandoned and never used again, which could mean that it either totally lost any ideological and symbolical significance, or, quite the contrary, it was invested with a great deal of it and was therefore deemed 'un-reusable'.

Altogether, the new chronometric evidence presented in this paper, combined with other recently published dates, allows for a chronologically detailed analysis of Valencina as a major locus of human activity in the 3rd millennium BC. This kind of analysis is seldom possible for the Late Prehistory of Iberia. The data now available suggest that in the period between the 29th and 27th centuries BC, the Copper Age communities living in the lower Guadalquivir Valley went through a remarkable period of economic abundance, supra-regional connectivity, technological and artistic creativity and social flourishing not attained before. It was a true 'prime time' of Iberian Copper Age communities, which subsequent developments before the end of this period at around c. 2300 BC would hardly match.

SUPPLEMENTARY FILES

The following supplementary materials are available on this journal's website:

- SF1. Start, span and end of PP4 use (Model 2).
- SF2. Start and end of structures use (Model 2).
- SF3. Span of structures use (Model 2).
- SF4. General Bayesian model and submodels for structures (Model 2).
- SF5. Selected data for the spatio-temporal model of start dates of use in Valencina (Fig. 9).
- SF6. OxCal Code.
- SF7. R Code.

ACKNOWLEDGEMENTS

We express our gratitude to Juan Manuel Vargas Jiménez, director of the Valencina Museum, for his help in the sampling process. We also thank Daniela Hofmann and Antonio Gilman for their helpful comments and suggestions on an earlier draft of this paper. We also thank both anonymous reviewers for their thorough and constructive reviews.

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.

FUNDING SOURCES

This study has been funded by the project 'Temporality, Landscape and Social Complexity in the Andalusian Major Megalithic Sites: Antequera and Valencina', Proyectos I+D+I FEDER Andalucía 2014-2020. The project has also received funding from European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie Grant

Agreement No 891776, project ‘WOMAM. Women, Men and Mobility: Understanding Gender Inequality in Prehistory’.

AUTHORSHIP CONTRIBUTION STATEMENT

Leonardo García Sanjuán: conceptualization, funding acquisition, project administration, methodology, data curation, writing – original draft, writing – review and editing.

Francisco Sánchez Díaz: data curation, formal analysis, methodology, visualization, writing – original draft.

F. Xavier Oms: formal analysis, investigation, writing – review and editing.

Jonàs Alcaina-Mateos: formal analysis, investigation, writing – review and editing.

Marta Cintas-Peña: funding acquisition, project administration, data curation, writing – review and editing.

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