

[Supplementary Material]

Isotopic evidence for mobility at large-scale human aggregations in Copper Age Iberia: the mega-site of Marroquies.

Marta Díaz-Zorita Bonilla^{1,2,3,*}, Jess Beck⁴, Hervé Bocherens^{2,3,5} & Pedro Díaz-del-Río⁶

¹ *Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Eberhardt Karls Universität, Schloß Hohentübingen, 72070 Tübingen, Germany*

² *Institut für Geowissenschaften, Eberhardt Karls University, Hölderlinstrasse, 12, 72074 Tübingen, Germany*

³ *SFB 1070 Ressourcenkulturen, Gartenstrasse 29, 72074 Tübingen, Germany*

⁴ *McDonald Institute for Archaeological Research, Downing Street, Cambridge CB2 3ER, UK*

⁵ *Senckenberg Centre for Human Evolution and Palaeoenvironment (HEP), Sigwartstrasse 10, 72076 Tübingen, Germany*

⁶ *Instituto de Historia, CSIC. C/Albasanz 26-28. 28037, Madrid, Spain*

* *Author for correspondence (Email: marta.diaz-zorita-bonilla@uni-tuebingen.de)*

Appendix 1

Laboratory methodology

Samples of ~8mg of tooth enamel or bone hydroxyapatite were extracted by drilling with a Dremmel© drilling device equipped with diamond-tipped drilling bits. Organic material was removed using 2% NaOCl solution for a 24 hour period, followed by a 0.1M Ca-acetate acetic acid buffer solution for another 24 hours, after which the sample was dried (Bocherens *et al.* 1996). Samples were analysed at 70°C using a ThermoFinnigan Gasbench II connected to a Finnigan Delta Plus XL CFIRMS at the University of Tübingen for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values of the carbonate fraction of bioapatite. Isotopic abundances are expressed as δ (delta) values in parts per mil (‰), as follows: $\delta^{13}\text{C} = ({}^{13}\text{C}/{}^{12}\text{C}_{\text{sample}}/{}^{13}\text{C}/{}^{12}\text{C}_{\text{standard}} - 1) \times 1000$ and $\delta^{18}\text{O} = ({}^{18}\text{O}/{}^{16}\text{O}_{\text{sample}}/{}^{18}\text{O}/{}^{16}\text{O}_{\text{standard}} - 1) \times 1000$. The standards are the marine carbonate V-PDB for carbon and oxygen and V-SMOW for oxygen. For fossil samples the analytical error is 0.1 and 0.2‰ for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$, respectively, based on multiple isotopic analysis of tooth enamel of elephant and hippopotamus prepared and analysed at the same time as the fossil samples.

Isotope ratio measurements were analysed using the FinniganMAT 262 Thermal Ionisation Mass Spectrometer (TIMS) located at the Isotope Geochemistry Group of the University of Tübingen. Sample material was weighed into Savillex© Teflon beakers. Tooth samples were dissolved in 65% HNO₃ in closed beakers on a hot plate at 80°C overnight and subsequently dried down. Samples were then redissolved in 2.5M HCl for the separation of Sr by conventional ion exchange chromatography using quartz glass columns filled with BioRad AG 50W-X12 (200-400 mesh). Subsequent purification of Sr was achieved in microcolumns filled with Eichrom© Sr-spec resin. Sr separates were loaded with a Ta-activator on Re single filaments and isotope ratio measurements were performed in dynamic mode. Analytical mass fractionation was corrected using a ⁸⁸Sr/⁸⁶Sr ratio of 8.375209 and exponential law. External reproducibility for NBS SRM 987 (N=5) is 0.710251±7 for the ⁸⁷Sr/⁸⁶Sr ratio. Total procedural blank (chemistry and loading) was <145pg for Sr.

References

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Appendix 2

Due to the fragmentary condition of many of the human skeletal remains, multiple techniques were used to estimate individual age-at-death. These included dental eruption, dental development, epiphyseal fusion and element size (Scheuer and Black 2004; AlQahtani *et al.* 2010) for subadults (individuals <18 years of age). Adult age was assessed using dental wear (Gilmore and Grote 2012), so that estimates from N1 and N2 were comparable to the dental analysis conducted at N4. See Beck (2016) for full details.

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Table 1. AMS radiocarbon dates. Calibrated using OxCal 4.3 (Bronk Ramsey 2009) with IntCal2013 (Reimer *et al.* 2013) at 1 σ (68.2% confidence) and 2 σ (95.4% confidence).

Field							Age				
ID	Location	Context	Element	Age	Sex	Lab	BP	sd	$\delta^{13}\text{C}$	1 σ	2 σ
										2570–	2860–
12	N1	CE13	Mandible	Middle Adult	Female	AA107185	3987	34	-19.2	2470	2490
										2480–	2830–
13	N1	CE13	Mandible	Young Adult	Male	AA107186	3934	32	-20.2	2345	2465
										2465–	2620–
7	N1	CE13	Mandible	Middle Adult	Female	AA107182	3902	32	-19.5	2345	2465
										2840–	2621–
14	N1	CE14	Mandible	Young Adult	Male	AA107187	4080	33	-20.5	2500	2465
										2570–	2622–
11	N1	CE14	Mandible	Middle Adult	Female	AA107184	4002	32	-20.4	2475	2465
										2580–	2620–
18	N1	CE15	Mandible	Young Adult	Female	AA107188	4027	34	-20.1	2485	2405
										2575–	2565–
10	N1	CE16	Mandible	Young Adult	Male	AA107183	4013	32	-19.7	2485	2305
										2575–	2485–
6	N1	CE22	Mandible	Young Adult	Male	AA107181	4011	33	-20.3	2480	2295
										2470–	2475–
20	N1	CE27	Mandible	Young Adult	Not Possible	AA107189	3919	32	-20.8	2345	2290

2013,2	N2	CE39	Femur	Adolescent/Adult	Not Possible	MAMS20041	3745	23	-21.5	2205– 2265	2580– 2345
103	N2	CE41	Tooth	Young Adult	Not Possible	AA107213	3970	32	-19.4	2565– 2460	2275– 2040
2013,3	N2	CE44	Femur	Adolescent/Adult	Not Possible	MAMS20042	3621	21	-22.3	2025– 1945	2140– 1975
2013,1	N2	CE45	Femur	Adolescent/Adult	Not Possible	MAMS20040	3675	22	-20,8	2135– 2020	2035– 1910
51	N4	Tomb I	Mandible	Young Adult	Female	AA107201	4136	31	-19.8	2865– 2630	2900– 2675
92	N4	Tomb I	Mandible	Child	Sub-adult	AA107210	4084	32	-19.6	2840– 2570	2875– 2615
50	N4	Tomb I	Mandible	Young Adult	Not Possible	AA107200	4084	33	-20.7	2840– 2570	2870– 2575
33	N4	Tomb I	Mandible	Young Adult	Not Possible	AA107192	4075	34	-19.9	2835– 2500	2875– 2495
69	N4	Tomb I	Mandible	Young Adult	Male	AA107206	4064	32	-19.8	2835– 2495	2860– 2495
86	N4	Tomb I	Mandible	Child	Sub-adult	AA107209	4057	31	-20.1	2830– 2495	2860– 2495
47	N4	Tomb I	Mandible	Young Adult	Not Possible	AA107198	4049	33	-20,1	2625– 2490	2860– 2490

										2625–	2850–
68	N4	Tomb I	Mandible	Young Adult	Male	AA107205	4049	31	-19.8	2490	2485
										2620–	2840–
53	N4	Tomb I	Mandible	Young Adult	Indeterminate	AA107202	4044	33	-19.9	2490	2475
										2620–	2840–
77	N4	Tomb I	Mandible	Young Adult	Female	AA107207	4035	33	-19.5	2485	2470
										2575–	2835–
85	N4	Tomb I	Mandible	Juvenile	Sub-adult	AA107208	4019	32	-20.5	2485	2475
										2575–	2835–
32	N4	Tomb I	Mandible	Middle Adult	Not Possible	AA107191	4013	32	-19.9	2485	2470
										2570–	2835–
34	N4	Tomb I	Mandible	Young Adult	Not Possible	AA107193	4002	32	-19.8	2475	2470
										2570–	2835–
35	N4	Tomb I	Mandible	Young Adult	Not Possible	AA107194	3997	32	-19.3	2475	2470
										2565–	2625–
48	N4	Tomb I	Mandible	Juvenile	Sub-adult	AA107199	3952	32	-20.5	2350	2470
		Tomb								2890–	2620–
118	N4	III	Mandible	Child	Sub-adult	AA107214	4204	32	-20.1	2705	2465
		Tomb								2860–	2620–
59	N4	III	Mandible	Not Possible	Not Possible	AA107203	4119	32	-20	2620	2465
		Tomb								2855–	2620–
41	N4	III	Mandible	Young Adult	Male	AA107196	4102	41	-20.3	2575	2465

		Tomb								2580–	2620–
27	N4	III	Mandible	Young Adult	Not Possible	AA107190	4031	33	-19.9	2485	2465
		Tomb								2580–	2620–
66	N4	III	Mandible	Young Adult	Not Possible	AA107204	4023	32	-19.9	2485	2465
		Tomb								2570–	2580–
40	N4	III	Mandible	Young Adult	Male	AA107195	4011	32	-20	2485	2460
		Tomb								2570–	2570–
96	N4	III	Mandible	Juvenile	Subadult	AA107211	4004	32	-20.7	2475	2340

Table 2. Summary statistics for $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{18}\text{O}$

Sample	N	Mean (1σ)	Minimum	Maximum
Faunal $^{87}\text{Sr}/^{86}\text{Sr}$	4	0.70810 \pm 0.00039	0.70776	0.70860
Human $^{87}\text{Sr}/^{86}\text{Sr}$	115	0.70847 \pm 0.00086	0.70762	0.71310
Faunal $\delta^{18}\text{O}_{\text{V-SMOW}}$	4	-4.91 \pm 1.55	-7.58	-2.40
Human $\delta^{18}\text{O}_{\text{V-SMOW}}$	115	-9.47 \pm 1.43	-13.72	-6.72

Table 3. Results of $\delta^{13}\text{C}_{\text{ap}}$, $^{87}\text{Sr}/^{86}\text{Sr}$, and $\delta^{18}\text{O}$. Individuals were assigned to age categories so as to be comparable to Cámara *et al.* (2012) using the midpoint of their estimated age range: preterm infant (prenatal), child (birth–6.9 years), juvenile (7–12.9 years), adolescent (13–17.9 years), very young adult (18–20.9 years), young adult (21–40 years), middle adult (41–60 years) and old adult (61+ years). Outliers Sample IDs are 11, 12, 20, 51, 78 & 80.

Sample ID	$\delta^{13}\text{C}_{\text{ap}}$	$\delta^{18}\text{O}$	$^{87}\text{Sr}/^{86}\text{Sr}$	2se	Age	Mortuary Area
1	-12.00	-10.06	0.708074	0.000009	Very Young Adult	N2
2	-12.07	-9.87	0.708323	0.000011	Young Adult	N2
3	-12.29	-7.30	0.707949	0.000009	Young Adult	N1
4	-12.86	-12.42	0.708743	0.000009	Very Young Adult	N1
5	-11.56	-12.01	0.708659	0.000009	Adolescent	N1
6	-12.44	-8.88	0.708148	0.000009	Young Adult	N1
7	-12.45	-9.63	0.708728	0.000012	Middle Adult	N1
8	-12.92	-7.92	0.708771	0.000001	Middle Adult	N1
9	-12.79	-9.00	0.708519	0.000009	Young Adult	N1
10	-12.50	-9.21	0.70781	0.000009	Young Adult	N1
11	-12.66	-10.91	0.711699	0.000011	Middle Adult	N1
12	-12.35	-7.56	0.710859	0.000012	Middle Adult	N1
13	-12.60	-10.02	0.708815	0.000001	Young Adult	N1
14	-12.77	-8.35	0.708622	0.000001	Young Adult	N1
15	-12.40	-13.72	0.708096	0.000009	Young Adult	N1
16	-12.69	-9.20	0.708915	0.000009	Young Adult	N1
17	-12.57	-10.37	0.707959	0.000009	Middle Adult	N1
18	-11.62	-7.94	0.708574	0.000001	Young Adult	N1

20	-13.68	-11.13	0.712731	0.000009	Young Adult	N1
21	-11.78	-9.42	0.708044	0.000009	Young Adult	N4
22	-12.40	-8.87	0.707998	0.000009	Young Adult	N4
23	-12.58	-7.04	0.708236	0.000012	Adolescent	N4
24	-12.58	-8.49	0.708238	0.00001	Young Adult	N4
25	-11.97	-9.27	0.709659	0.00001	Young Adult	N4
26	-12.90	-10.38	0.708236	0.000009	Not Possible	N4
27	-12.10	-8.44	0.70849	0.00001	Young Adult	N4
28	-11.87	-7.29	0.708307	0.000009	Young Adult	N4
29	-12.56	-8.74	0.70875	0.00001	Young Adult	N4
30	-11.67	-10.05	0.708142	0.00001	Young Adult	N4
31	-12.43	-11.1	0.708941	0.000009	Young Adult	N4
32	-11.88	-8.87	0.708374	0.000009	Middle Adult	N4
33	-12.66	-10.92	0.709821	0.00001	Young Adult	N4
34	-12.02	-11.64	0.7081	0.000009	Young Adult	N4
35	-12.13	-10.65	0.708091	0.000009	Young Adult	N4
36	-12.53	-9.94	0.708428	0.00001	Young Adult	N4
37	-12.18	-8.98	0.707995	0.00001	Young Adult	N4
38	-12.60	-8.27	0.708002	0.00001	Adolescent	N4
39	-12.61	-12.05	0.708843	0.00001	Middle Adult	N4
40	-12.69	-9.42	0.708539	0.000009	Young Adult	N4
41	-12.80	-7.98	0.708751	0.000011	Young Adult	N4
42	-11.99	-9.77	0.708894	0.00001	Young Adult	N4
43	-11.78	-10.54	0.708012	0.000011	Young Adult	N4
44	-12.75	-9.11	0.708059	0.00001	Young Adult	N4
45	-12.96	-9.56	0.708679	0.000011	Young Adult	N4
46	-12.33	-10.64	0.708165	0.00001	Juvenile	N4
47	-12.26	-10.13	0.708049	0.000009	Young Adult	N4
48	-12.28	-9.83	0.708114	0.000011	Juvenile	N4
49	-12.26	-8.44	0.709112	0.00001	Young Adult	N4
50	-11.97	-8.11	0.709952	0.000011	Young Adult	N4
51	-13.42	-7.65	0.713107	0.00001	Young Adult	N4
52	-12.07	-12.03	0.708371	0.00001	Young Adult	N4

53	-12.38	-10.97	0.708281	0.000011	Young Adult	N4
54	-12.14	-10.42	0.708582	0.00001	Young Adult	N4
55	-12.39	-9.21	0.708168	0.000009	Young Adult	N4
56	-11.68	-8.83	0.707626	0.00001	Young Adult	N4
57	-12.69	-9.02	0.708554	0.000011	Young Adult	N4
58	-11.91	-8.44	0.708862	0.00001	Young Adult	N4
59	-12.01	-11.69	0.70803	0.000009	Not Possible	N4
60	-12.83	-10.94	0.708312	0.000011	Young Adult	N4
61	-12.18	-7.17	0.70819	0.00001	Young Adult	N4
62	-11.69	-6.92	0.708645	0.00001	Young Adult	N4
63	-12.22	-8.78	0.708822	0.000011	Young Adult	N4
64	-12.06	-10.81	0.708132	0.000011	Very Young Adult	N4
65	-12.43	-8.99	0.708522	0.00001	Young Adult	N4
66	-11.83	-8.88	0.708268	0.000008	Young Adult	N4
67	-12.27	-11.25	0.708253	0.00001	Juvenile	N4
68	-12.72	-11.8	0.708241	0.00001	Young Adult	N4
69	-11.72	-10.71	0.707895	0.00001	Young Adult	N4
70	-12.30	-9.74	0.708826	0.000009	Young Adult	N4
71	-12.77	-9.57	0.7092	0.000009	Young Adult	N4
72	-12.56	-9.62	0.708152	0.000011	Young Adult	N4
73	-12.16	-8.34	0.707974	0.00001	Young Adult	N4
74	-12.19	-10.74	0.708045	0.00001	Young Adult	N4
75	-11.97	-8.24	0.708243	0.00001	Young Adult	N4
76	-12.42	-9.61	0.708539	0.00001	Young Adult	N4
77	-12.61	-9.16	0.708205	0.00001	Young Adult	N4
78	-12.63	-7.97	0.710443	0.00001	Child	N1
79	-13.21	-8.34	0.708376	0.00001	Child	N1
80	-13.22	-12.28	0.710474	0.000014	Juvenile	N1
81	-12.93	-7.57	0.708003	0.000011	Child	N1
82	-12.55	-7.53	0.708188	0.000009	Child	N1
83	-12.10	-10.09	0.707913	0.000009	Child	N4
84	-12.68	-10.23	0.707903	0.00001	Adolescent	N4
85	-12.48	-11.77	0.708545	0.00001	Juvenile	N4

86	-11.23	-10.1	0.708002	0.000013	Child	N4
87	-11.50	-7.48	0.708514	0.000013	Child	N4
88	-12.55	-11.9	0.707977	0.00001	Juvenile	N4
89	-11.81	-11.16	0.707996	0.00001	Child	N4
90	-12.72	-8.42	0.70795	0.00001	Child	N4
91	-12.49	-11.9	0.708153	0.000011	Very Young Adult	N4
92	-12.16	-11.23	0.708006	0.00001	Child	N4
93	-11.62	-7.50	0.708082	0.00001	Child	N4
94	-12.57	-9.52	0.708051	0.00001	Juvenile	N4
95	-12.02	-7.64	0.70798	0.000009	Child	N4
96	-12.54	-9.26	0.708036	0.00001	Juvenile	N4
97	-11.99	-9.02	0.708036	0.00001	Juvenile	N4
99	-11.39	-7.63	0.708441	0.00001	Not Possible	N2
100	-12.55	-10.38	0.708143	0.000014	Young Adult	N2
101	-12.16	-9.36	0.708136	0.000014	Young Adult	N2
102	-12.62	-9.80	0.708092	0.00001	Young Adult	N2
103	-12.92	-7.96	0.707881	0.000009	Young Adult	N2
104	-11.90	-10.03	0.708053	0.00001	Young Adult	N2
105	-12.19	-9.57	0.708092	0.00001	Young Adult	N2
106	-12.56	-9.04	0.708068	0.000011	Young Adult	N2
107	-14.06	-3.40	0.708606	0.000009	Fauna (Lepus. Tibia L)	N4
108	-11.26	-7.58	0.707805	0.000012	Fauna (Lepus tooth)	N4
110	-10.15	-6.27	0.707766	0.000008	Fauna (Lepus tooth)	N4
113	-13.04	-2.40	0.70823	0.000008	Fauna (Ovicaprid Tibia. R)	N4
114	-12.10	-6.72	0.708064	0.00001	Juvenile	N2
115	-12.30	-8.25	0.708277	0.000011	Child	N4
116	-11.97	-7.34	0.708212	0.000011	Child	N4
117	-12.28	-8.70	0.70786	0.000011	Child	N4
118	-11.34	-9.23	0.70775	0.00001	Child	N4
119	-12.35	-8.86	0.707945	0.000009	Child	N4
120	-11.14	-9.32	0.70796	0.000009	Child	N4

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