

## Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see [Authors & Referees](#) and the [Editorial Policy Checklist](#).

### Statistical parameters

When statistical analyses are reported, confirm that the following items are present in the relevant location (e.g. figure legend, table legend, main text, or Methods section).

n/a Confirmed

- The exact sample size ( $n$ ) for each experimental group/condition, given as a discrete number and unit of measurement
- An indication of whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- The statistical test(s) used AND whether they are one- or two-sided  
*Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
- A description of all covariates tested
- A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- A full description of the statistics including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- For null hypothesis testing, the test statistic (e.g.  $F$ ,  $t$ ,  $r$ ) with confidence intervals, effect sizes, degrees of freedom and  $P$  value noted  
*Give  $P$  values as exact values whenever suitable.*
- For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- Estimates of effect sizes (e.g. Cohen's  $d$ , Pearson's  $r$ ), indicating how they were calculated
- Clearly defined error bars  
*State explicitly what error bars represent (e.g. SD, SE, CI)*

*Our web collection on [statistics for biologists](#) may be useful.*

### Software and code

Policy information about [availability of computer code](#)

Data collection

Authorized database: ASTER GDEM v2 Worldwide Elevation Data (1 arc-second Resolution) (<https://gdex.cr.usgs.gov/gdex/>); EMODnet Bathymetry data (7.5 arc-second Resolution) (<http://portal.emodnet-bathymetry.eu/?menu=19>); Alboran Sea bathymetry (100 m resolution) Instituto Español de Oceanografía (IEO)-Secretaría General de Pesca Marítima and Gibraltar Strait (25 m resolution) Sociedad Española de Estudios para la Comunicación Fija a través del estrecho de Gibraltar, SA (SECEGSA).

Data analysis

Software Global Mapper v.16, Oxcal 4.3 software,

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [guidelines for submitting code & software](#) for further information.

## Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

Described archaeological collections are housed at Museo Arqueológico de Málaga, Spain. Publisher's note: Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

## Field-specific reporting

Please select the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

Life sciences  Behavioural & social sciences  Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/authors/policies/ReportingSummary-flat.pdf](https://www.nature.com/authors/policies/ReportingSummary-flat.pdf)

## Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Based on Bayesian analyses, a total of 26 radiocarbon dates, including 17 new ones, show that replacement at Bajondillo took place in the millennia centering on ~45-43 cal ka BP, well before the onset of Heinrich event 4 (~40.2 to 38.3 cal ka BP).
Research sample	Different marine shells, Burnt flint and Carbonaceous/ash sediments.
Sampling strategy	In archeological studies one or two radiocarbon dates are enough in order to obtain the age of one archeological level. In this studie we present a total of 26 radiocarbon ages, and key archeological levels has been dated by more than 4 radiocarbon dates and these performed at different laboratories and also used different methods.
Data collection	Samples were collected by Dr. Miguel Cortes-Sanchez during archeological excavations.
Timing and spatial scale	49048 to 31540 yrs Cal BP from Bajondillo Cave, compared with South Iberian archeological sites.
Data exclusions	Yes, we obtained one abnormal radiocarbon date not included in the manuscript, but can be included if necessary. Radiocarbon date correspond to archeological level Bj/13 and age obtained is 8.2 ka cal BP (samples details: Mytilidae; Laboratory code: CNA-3215.2.2; radiocarbon age 7631±42 Calibrated age 8253-7980). We interpreted that this matherial was contaminated by contact with present day radiocarbon matherial during sampling or laboratory treatments.
Reproducibility	We include a detail figure that indicate where samples were taken with high resolution. Archeological samples and levels still present and a re-sampling is possible.
Randomization	We performed analyses in different organism and matherials using different tecniques in order to get a robust chonological control.
Blinding	We used three different blinded laboratories in order to obtain a robust age control and avoid single laboratory methodological byass. Sample selection tried to be equidistance along each archological level.
Did the study involve field work?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

## Field work, collection and transport

Field conditions	Samples were taken during one month during summer.
Location	36.622694 N 4.496608 W Bajondillo Cave is a ca. 30 m long rock shelter that opens within a 30 m high travertine formation in the city of Torremolinos
Access and import/export	Bajondillo Cave is located in a cliff and required scaffold and safety infraestructure.
Disturbance	Five cubic meter of sediments were excavad

## Reporting for specific materials, systems and methods

## Materials &amp; experimental systems

- | n/a                                 | Involvement                         | Involved in the study       |
|-------------------------------------|-------------------------------------|-----------------------------|
| <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Unique biological materials |
| <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Antibodies                  |
| <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Eukaryotic cell lines       |
| <input type="checkbox"/>            | <input checked="" type="checkbox"/> | Palaeontology               |
| <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Animals and other organisms |
| <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Human research participants |

## Methods

- | n/a                                 | Involvement              | Involved in the study  |
|-------------------------------------|--------------------------|------------------------|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | ChIP-seq               |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Flow cytometry         |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | MRI-based neuroimaging |

## Palaeontology

## Specimen provenance

The Bajondillo cave faunal analyses were allowed to one of the authors (MC-S) by the Consejería de Cultura of the Junta de Andalucía (Spain) (UPPH/49/06).

## Specimen deposition

Described archaeological collections are housed at Museo Arqueológico de Málaga, Spain

## Dating methods

Different faunal remains (marine shells) and charcoal fragments were selected from different archeological levels and preventing contamination from modern carbon (Radiocarbon dates) or light (thermoluminescence dates). A chemical pretreatment for Radiocarbon Dating samples acid-base-acid (ABA) was performed. Laboratory codes used were Ua: Ånström laboratory, University of Uppsala (Sweden); CNA: National Center for Accelerators (Spain); MAD: Dating and Radiochemistry Laboratory, Universidad Autónoma de Madrid. Radiocarbon has been calibrated using Oxcal 4.3 software (<https://c14.arch.ox.ac.uk/oxcal.html>) along with Intcal13 and marine13 curves (Reimer et al., 2013; Ramsey, 2009). The local variation of the reservoir age, estimated from recent samples, in the westernmost Mediterranean is 280±36 yr (Siani et al., 2000). However, it is not applied to the calibration of marine samples from Bajondillo site because this value is unknown for the Mediterranean Sea during from 50 to 20 ky (glacial period), and apply the present reservoir effect have a nil effect on the obtained calibrated values.

- Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.