

Reporting Summary

Nature Portfolio 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 Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (<i>n</i>) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on 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 <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
☒	☐ 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 statistical parameters 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. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable.</i>
☒	☐ 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 <i>d</i> , Pearson's <i>r</i>), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

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

Data collection	3D scanning software supplied with the EinScan Pro HD scanner (ExSan Pro v3.5.0.8) and NextEngine scanner (ScanStudio).
Data analysis	Excel's Data Analysis module (Microsoft Office Professional Plus 2019), Real Statistics Resource Pack Add-in (Release 7.6, www.real-statistics.com), Chi-square calculator (https://www.socscistatistics.com), reduced major axis regression JAVA v. 1.21 (http://www.kimvdlinde.com/professional/rma.html), two-tailed t-test of the slopes Analytics Calculators (https://www.analyticscalculators.com/calculator.aspx?id=103), Blender 3.6, MeshLab v2023.12, Adobe Photoshop C5.1 Extended, and Adobe Acrobat 9 Pro. For ESR dating, ROSY Ver. 1.41 ESR dating software and VFIT software. For bone surface modifications: Mountains surface imaging & metrology software: MountainsMap Premium (Digital Surf, 2015) (www.digitalsurf.fr/en/mntkey.html); and JMP statistical software (https://www.jmp.com/en_us/home.html). For archaeomagnetic and palaeomagnetic analyses: PaleoMag 3.1 (https://cires1.colorado.edu/people/jones.craig/PMag3.html) and Stereonet 11 (https://www.rickallmendinger.net/stereonet).

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 and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [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 description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Major and trace element data for the SM1 YTT samples are available in Supplementary Tables 2-4. Data for ESR dating are available in Supplementary Table 5. Data for the SM1 stone points are available in Supplementary Table 6. Paleomagnetic data are available in Supplementary Table 13. Isotopic data for the fossil and modern specimens are available in Supplementary Tables 14, 18, and 23. Supplementary Data files of SM1 points shown in Fig. 3 with 3D files, photographs, and drawings are available at <https://doi.org/10.18738/T8/WV9CLN>. All other data supporting the findings of this study are available upon request from the authors. The artifacts and faunal remains from SM1 are accessioned in the National Museum, Addis Ababa, Ethiopia.

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender

Reporting on race, ethnicity, or other socially relevant groupings

Population characteristics

Recruitment

Ethics oversight

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is 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/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

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

Study description

Research sample

Sampling strategy

Data collection

Timing and spatial scale

Data exclusions

Reproducibility

Randomization

Blinding

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	Not applicable for an archaeological excavation.
Location	Approximately 37 P 177814 1393858, 575 m elevation.
Access & import/export	Research permit first issued in 1997 and thereafter by the Ethiopian Heritage Authority. All Ethiopia laws and regulations were followed. There were two Ethiopian government representatives on site at all times to ensure adherence to the regulations. Export of samples was authorized by the Ethiopian Heritage Authority and National Museum, Addis Ababa, Ethiopia, the Ethiopia Ministry of Mines and Petroleum, and the Ethiopian Wildlife Conservation Authority.
Disturbance	The excavation site and sampling trenches were backfilled at the end of each season.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☐	☒ Palaeontology and archaeology
☐	☒ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Palaeontology and Archaeology

Specimen provenance	Research permit first issued in 1997 and thereafter by the Ethiopian Heritage Authority. All Ethiopian laws and regulations were followed. There were two Ethiopian government representatives on site at all times to ensure adherence to the regulations. Export of samples authorized by the National Museum of Ethiopia, the Ethiopia Ministry of Mines and Petroleum, and the Ethiopian Wildlife Conservation Authority.
Specimen deposition	Archaeological and paleontological collection is accessioned in the National Museum of Ethiopia, Addis Ababa, Ethiopia.
Dating methods	Electron spin resonance (ESR) dates obtained from bovid teeth recovered from the SM1 excavation as described in Methods Note 2, Supplementary Note 2, with data presented in Supplementary Table 5, and work completed in the Dr. Anne Skinner lab at Williams College, irradiation completed at Albany, NY, and McMaster University. Software included ROSY Ver. 1.41 ESR dating software and VFIT software (also noted above).
☒ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.	
Ethics oversight	Ethiopian Heritage Authority and Ministry of Tourism.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Animals and other research organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research, and [Sex and Gender in Research](#)

Laboratory animals	Not applicable.
Wild animals	Not applicable.
Reporting on sex	Not applicable.
Field-collected samples	Teeth were collected from skeletons of already deceased domestic cows and goats in the area around the SM1 excavation and stored

Field-collected samples in individually labeled clean, clear polyethylene plastic zip-sealing bags, and exported with permission of the Ethiopian Heritage Authority and the National Museum, Addis Ababa, Ethiopia.

Ethics oversight Ethiopian Heritage Authority and Ministry of Tourism.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Plants

Seed stocks Not applicable.

Novel plant genotypes Not applicable.

Authentication Not applicable.