

Reporting Summary

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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 (n) 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
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 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. 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

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

MSD ChemStation D.01.02.16 15-JUNE-2004
ISODAT 3.0
Probe for EPMA version 10.0.4

Data analysis

Excel version 15.23.2, Paldir version 5.5 software for paleomagnetic demagnetization diagrams (Utrecht University); Stereonet version 9.6 (R.W. Allmendinger, Cornell University); R software version 3.5.1 for biome calculations from pollen data; Probe for EPMA version 10.0.4 for analysis of EPMA data on glass composition, Bayesian stratigraphic code (<https://github.com/brenhinkeller>, Keller, 2018); a data analysis version of the $^{40}\text{Ar}/^{39}\text{Ar}$ dating software is available at no cost from adeino@bgc.org

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. 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

Correspondence and requests for material should be addressed to yhaileselassie@cmnh.org. Data are available as tables in Supplementary Information. Associated raw data: Figure 1 - Table 1,2,3,4; Figure 2; Table 2,3,4,6,8,9,10; Ext Dat Fig 1 - Table 1; Ext Dat Fig 2 - Table 2, 5; Ext Dat Fig 3 - Table 4,6,7,8,9; Ext Dat Fig 4,5,6 - Table 3; Ext Dat Fig 7 - Table 4; Ext Dat Fig 8 Table 9, 10. Any data that support the findings of this study, but are not included in the Supplementary Information, are available from the corresponding authors upon reasonable request.

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	Area around fossil discovery site in the Godaya River Valley of the Woranso Mille project area, Ethiopia.
Research sample	Samples of basalt, volcanic tuff, sediment from the study area plus all identifiable mammalian vertebrate fossils from MRD-VP-1.
Sampling strategy	Tuff and sediment samples were collected from measured stratigraphic sections and basalt samples from across the study area.
Data collection	Basalt samples were collected by M. Alene and recorded by him. Tuff samples were collected by B. Saylor for tephrochemistry and A. Deino for Ar/Ar dating and recorded by them. Sediment samples were collected by L. Gibert for paleomagnetic work. N. Levin and Mark Peale collected sediment samples for analysis of botanical remains. Y. Haile-Selassie directed the project and the collection of vertebrate fossils with assistance from S. Melillo.
Timing and spatial scale	Samples were collected over multiple field seasons, starting in 2011, with a push during 2017. Sampling focused on well exposed sections near the fossil site.
Data exclusions	Tephra geochemistry: Analyses with totals less than 97.5 or greater than 102.5 were excluded except for MRD-17-4 for which analyses with water adjusted totals less than 89.5 were excluded. Ar/Ar dating: In the case of WM18/LHG-1, each grain was analyzed in one or two low-power steps to allow a preliminary assessment of age and chemistry; grains that were too old (>10 Ma, n=12) or exhibited a Ca/K ratio of plagioclase (n=1) were omitted, leaving eight grains taken to completion of the incremental heating sequence. For the calculation of the age-probability density plot omitted analyses based were based on distance from the median age, with the cutoff level of 2.0 'normalized median absolute deviations' 46. For sample WM12/LHG-6, n=8 out of 10 isochron results are included in the weighted mean; for sample WM18/LHG-1, n=6 out of 8 results are included. Plant wax: 16 samples were analyzed for plant wax biomarkers, one sample yielded biomarker concentrations too low for isotopic analyses.
Reproducibility	Paleomagnetic measurements: At least two specimens from each sample (total of 79 specimens) were thermally demagnetized in a non-inductive furnace (<10 nT), at 50°C steps up to 650°C to remove secondary magnetizations and to isolate the primary characteristic magnetic direction. Plant wax carbon and hydrogen isotopic analyses were replicated at target responses of 2.5-6 V and 3-6 V respectively; replicates outside of the dynamic range set by the prior linearity tests were excluded; all attempts at replicate measurement in that range were successful. Basalt geochemistry: Table 1: Chemical error based on replicate analyses of BHVO-2, a United States Geological Survey Geochemical Standard
Randomization	This is not relevant for our study because samples were analyzed individually and not assigned to groups.
Blinding	Blinding was not relevant to this study because it was a field study not an experimental study.
Did the study involve field work?	☒ Yes ☐ No

Field work, collection and transport

Field conditions	Arid, limited tree cover, low relief river valley between high, basalt covered plateaus, and hot.
Location	Area around fossil discovery site in the Godaya River Valley of the Woranso Mille project area, Afar Region, Ethiopia (11°32'59.5" N; 40°27'54.6" E)
Access and import/export	Access and sample export followed the laws and regulations of Ethiopia and the Afar state, with permission from the Authority for Research and Conservation of Cultural Heritage (ARCCCH) of the Ministry of Culture and Tourism of Ethiopia, dated November 17, 2015 (Ref. # 08/KT-69/005), allowed us to conduct field research that led to the discovery of the subject of this manuscript, collect geological samples, and export them for further analysis.
Disturbance	Camping, road access, and sample collection provided minimal disturbance.

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
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

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

Palaeontology

Specimen provenance

Samples were collected with permits from the Authority for Research and Conservation of Cultural Heritage of Ethiopia. Field work at the site is conducted with permits from the Authority for Research and Conservation of Cultural Heritage of the Ministry of Culture and Tourism of Ethiopia issued on November 17, 2015, Ref. # 08/KT-69/005.

Specimen deposition

Fossil specimens are deposited in the Paleoanthropology Laboratory of the National Museum of Ethiopia

Dating methods

$^{40}\text{Ar}/^{39}\text{Ar}$ laser incremental heating dating of single crystal phenocrysts in felsic volcanic tuffs. $^{40}\text{Ar}/^{39}\text{Ar}$ dating was conducted at the Berkeley Geochronology Center (BGC) in Berkeley, California, USA.

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