

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](#).

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
<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. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P 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 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 Data were collected with the inbuilt computer program of the Neptune mass spectrometer, and other spectrometers used.

Data analysis Data were analysed with excel, the Isoplot Excel add-in and the DATA program. For the latter two, references are given

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

The data that support the findings of this study are included in the Supplementary Information. Additional data 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

Ecological, evolutionary & environmental sciences study design

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

Study description	We tried to establish the age of the Kabwe fossil. We have analysed the fossil directly as well as any material which could be relevant to assess its age
Research sample	We have analysed the fossil directly as well as any material which could be relevant to assess its age
Sampling strategy	The sampling strategy developed over more than 25 years, dependent on sample availability and progress in micro-analytical techniques/
Data collection	Data were recorded by the relevant scientific equipment, mainly mass spectrometers and ESR spectrometers.
Timing and spatial scale	Data were produced between 1994 and 2019.
Data exclusions	All data are given. For data exclusion, the rationale is given.
Reproducibility	Due to the small sample size and the overall strategy to minimise any destructive analysis, only one sample was analysed with multiple methods (see ED Figure 6 and SI Tables 3, 7, 8)
Randomization	Was not applied due to small sample size
Blinding	Does not apply when working on unique fossil specimen.
Did the study involve field work?	☐ Yes ☐ No

Field work, collection and transport

Field conditions	No field work was carried out
Location	No field work was carried out
Access and import/export	All relevant permissions were obtained and samples were carried in person to the relevant labs and back to the Museum of Natural History.
Disturbance	<i>Describe any disturbance caused by the study and how it was minimized.</i>

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		Methods	
n/a	Involved in the study	n/a	Involved in the study
☒	☐ Antibodies	☒	☐ ChIP-seq
☒	☐ Eukaryotic cell lines	☒	☐ Flow cytometry
☐	☒ Palaeontology	☒	☐ MRI-based neuroimaging
☒	☐ Animals and other organisms		
☒	☐ Human research participants		
☒	☐ Clinical data		

Palaeontology

Specimen provenance	All materials were given to the Natural History Museum London in 1921 by the Broken Hill mining company.
Specimen deposition	All specimens are housed in the Natural History Museum London

Dating methods

The Methods Summary and Supplementary Information provides detailed descriptions of each dating method. U-series was carried out on calcitic materials as well as bones. These ages have to be regarded as minimum age estimates. To further constrain the age of the Kabwe skull, ESR was carried out on the tooth enamel of the Kabwe specimen.

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