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Research Article

# Antarctica as a 'natural laboratory' for the critical assessment of the archaeological validity of early stone tool sites

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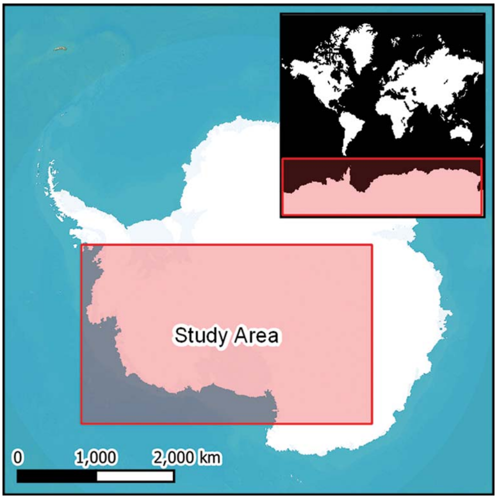


Lithic technologies dominate understanding of early humans, yet natural processes can fracture rock in ways that resemble artefacts made by *Homo sapiens* and other primates. Differentiating between fractures made by natural processes and primates is important for assessing the validity of early and controversial archaeological sites. Rather than depend on expert authority or intuition, the authors propose a null model of conchoidally fractured Antarctic rocks. As no primates have ever occupied the continent, Antarctica offers a laboratory for generating samples that could only have been naturally fractured. Examples that resemble artefacts produced by primates illustrate the potential of 'archaeological' research in Antarctica for the evaluation of hominin sites worldwide.

Keywords: Antarctica, Pleistocene, lithic technologies, conchoidal fracture, archaeological knowledge production

## Introduction

For at least three million years, extinct species of hominins and *Homo sapiens* made tools using various types of rock that fracture conchoidally, for example, flint, obsidian and basalt (Harmand *et al.* 2015). There is also evidence to suggest that both living and past non-human

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primates can exhibit behaviours that might lead to rock fracture (Mercader *et al.* 2002; Proffitt *et al.* 2016; Falótico *et al.* 2019). Natural processes, however, can also fracture or alter rock and have been doing so for far longer than hominins and primates (Warren 1914; Barnes 1939; Hiscock 1985; Pevny 2012; Andrefsky, Jr. 2013). Such processes include fluvial and glacial actions, falls and landslides, temperature extremes, animal trampling and sediment consolidation (Eren *et al.* 2010; Andrefsky, Jr. 2013). The comparison of primate-made stone tools and naturally fractured rocks demonstrates potential similarities or overlap in some morphological and technological elements (Figure 1). This is because certain elements associated with primate-made stone tools can also occur in naturally fractured rocks. These include: flake morphology; percussion bulbs; distal termination types; platform types; platform angles; sharp edges; regularised or continuous retouch; 'patterned' or 'intentional' flaking; and size, shape and spatial patterning (Manninen 2007; Eren *et al.* 2011; Andrefsky 2013; Borrazzo 2016, 2020; Borrero 2016). Moreover, elements associated with naturally fractured rocks, such as natural cleavage planes, frost-fracturing, physical and chemical weathering, post-depositional damage and natural transport processes, can also characterise or affect primate-made stone tools or assemblages (Borrazzo 2016). Such overlap can become even more challenging to differentiate when knappers take advantage of features such as natural platforms or naturally formed acute angles to initiate intentional fracture, or, alternatively, where natural processes modify a primate-made stone tool assemblage (Manninen 2007: 77; Andrefsky, Jr. 2013).

This overlap in the morphological and technological elements of hominin-induced and natural conchoidal fracture creates an identification problem. Differentiation is especially challenging when seeking to identify the earliest occupations of regions by stone tool-using hominins, because such stone artefacts may be low in frequency, crude in form, found in equivocal contexts, or lack other associated artefactual data, leading to potential ambiguity as to hominin agency (Meltzer 1994; Dennell & Hurcombe 1995; Bar-Yosef & Belfer-Cohen 2001). This issue is critical, since such early occurrences are inevitably chronologically 'anomalous' with respect to other regional data. At best, this creates potential controversy (e.g. Dennell & Hurcombe 1995; Driver 2001a; Gillespie *et al.* 2004; Gao *et al.* 2005; Surovell *et al.* 2022) and, at worst, could lead to a Type I error (i.e. falsely accepting a result as positive when it is actually negative), resulting in the construction of false knowledge within the field.

To distinguish between naturally occurring and hominin-induced conchoidal fractures, archaeologists often rely on expert authority, experience or intuition to determine whether or not a stone object is an artefact (Driver 2001b; Gillespie *et al.* 2004; O'Connor 2007; Meltzer 2015; Borrero 2016; Boehm & Anderson 2021). In some cases, the archaeological validity of an artefact or assemblage of artefacts is determined by the consensus of several experts. One of the reasons that we must currently rely on authority, experience, intuition and consensus to determine archaeological validity is that, in some cases, we do not have a realistic understanding of how many elements are shared between primate-made and naturally fractured assemblages. There have been numerous experiments that illustrate how natural processes can produce specimens that appear to be primate-made (e.g. Warren 1914; McPherron *et al.* 2014; Borrazzo 2016, 2020), and these serve as an important reservoir of interpretative cautionary tales. No experiment, however, can replicate reality with exact





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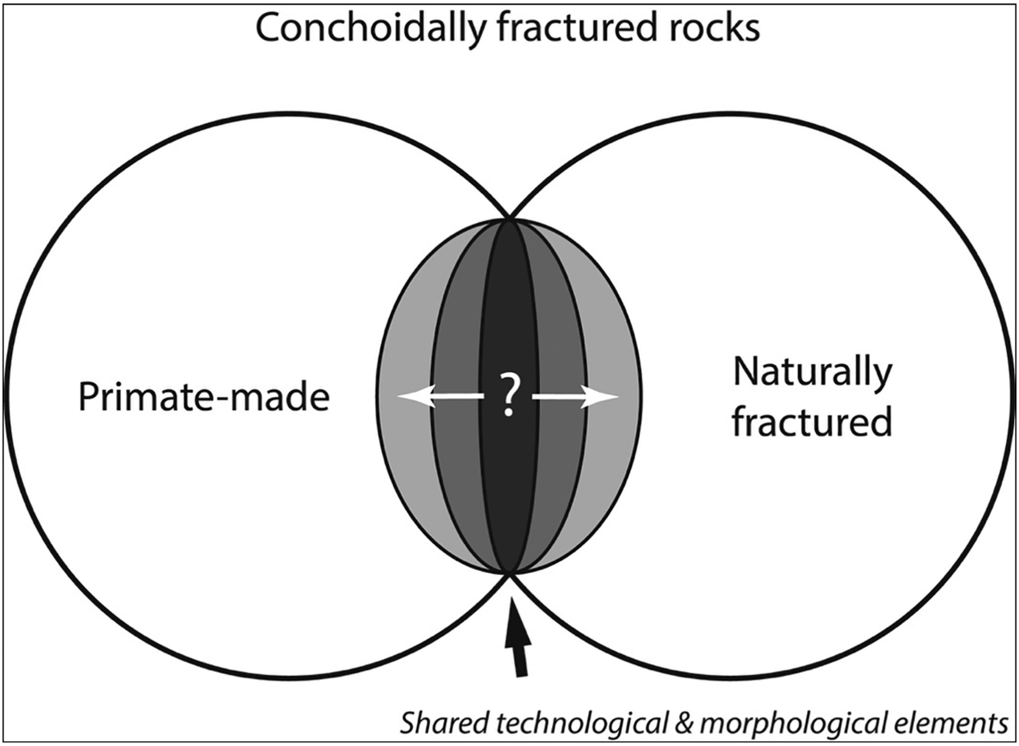


*Figure 1. There is overlap in technological and morphological elements between primate-made and naturally fractured rocks, but how much overlap is currently poorly understood (figure produced by M.I. Eren and S.J. Lycett).*

precision, and an experiment's relationship to the parameters of direct interest (i.e. the natural world) requires specific assumptions and inferences (Lycett & Eren 2013: 526).

In particular, there are three unavoidable drawbacks to lithic experiments in terms of their application to our understanding of how many elements are shared between primate-made and naturally fractured assemblages. First, while an experiment can demonstrate how a specific natural process can create specimens that appear to be primate-made, it cannot demonstrate how frequently such an event occurred in the past. Consider, for example, animal trampling. Numerous experiments have demonstrated that trampling can produce 'knapped' flakes with sharp edges (e.g. Warren 1914; Lopinot & Ray 2007; Domínguez-Solera *et al.* 2021), 'retouched' tools (e.g. McBrearty *et al.* 1998; Pargeter & Bradfield 2012), and 'bend-break' fractures (e.g. Warren 1914; Eren *et al.* 2011; Jennings 2011; Andrefsky, Jr. 2013). But how often, in reality, did animals walk over blocks of stone and create a lithic scatter? This question is not one an experiment can answer, because all experiments are, by their nature, somewhat contrived (Lycett & Eren 2013: 527). A second unavoidable drawback to lithic experiments is that some natural processes may be difficult, or even impossible, to replicate. For instance, it is currently unclear how an experiment could convincingly replicate the effect of glacial activity on rocks that possess conchoidal fracture properties. The third drawback is the short time duration of lithic experiments relative to singular, or multiple, natural processes that may occur over decades, centuries, millennia, or even longer.





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These three drawbacks highlight the need for a sustained field research programme that complements experimental efforts (e.g. Eren & Bebber 2019; Magnani 2019a, 2019b; Borrazzo 2020) by investigating what natural processes do to conchoidally fracturing rocks outside of the laboratory. In other words, archaeological research would benefit tremendously from the development of a null model of conchoidally fractured rocks that developed entirely from natural processes, against which potential archaeological samples could be compared. Such a model should not only include quantitative and qualitative information on morphological (e.g. size and shape), technological (e.g. flake scar counts and patterning) and raw material (e.g. chert, obsidian, limestone) attributes of conchoidally fractured specimens, but also specimen frequency and density at particular geographical locales, the context of specimens (e.g. cave, coastline) and their distribution across broader landscapes.

Unfortunately, the global distribution of primates means that archaeologists cannot exclude the possibility that what they believe to be naturally fractured rocks were, in fact, produced by living or extinct primates. As such, in most regions of the world, the construction of a null model based on a long-term field research programme would depend on the authority, experience and intuition of lithic experts to determine which specimens or locales to include or exclude as 'natural'. Given that the sole purpose of the proposed null model is to eliminate authority, experience and intuition in such determinations, the inherent circularity of this situation should be readily apparent. Consequently, archaeologists need a primate-free 'natural laboratory' from which a null model of naturally fractured rocks can be constructed. Here, we propose that Antarctica can act as such a natural laboratory, because no hominin or non-human primate has ever occupied the continent. As proof of concept, we present a series of Antarctic rock specimens that exhibit conchoidal fracture and, which if found anywhere beyond 'the ice', could easily be mistaken for stone artefacts produced by hominins—even *Homo sapiens*.

## Conchoidally fractured rocks from Antarctica

The Polar Rock Repository (https://prr.osu.edu/) in Columbus, Ohio, forms part of the Byrd Polar and Climate Research Center of The Ohio State University. As of March 2022, it curates nearly 59 000 rock samples from Antarctica, the southern oceans, and South America, as well as small collections from Africa and Australia. Using the Center's searchable online database, we requested samples of raw materials, such as chert, basalt and obsidian, commonly used by primates to make stone tools. Upon visual inspection of the samples at the Polar Rock Repository, we quickly identified several dozen that could easily be miscategorised as primate-produced, of which we present 14 here (see Figure 2 and Table 1; see also the online supplementary material (OSM)). We limit our presentation to these 14 out of an abundance of caution; unlike some other specimens we examined, the selected samples show no recent marks, such as those that could be produced by a modern geological hammer. The set of 14 conchoidally fractured rocks, collected from numerous locations across Antarctica (Figure 3), comprises a variety of forms, including those that could be mistaken for flakes, cores and even bifaces. The lithologies include chert, quartzite, hornfels, basalt and obsidian (Table 1).





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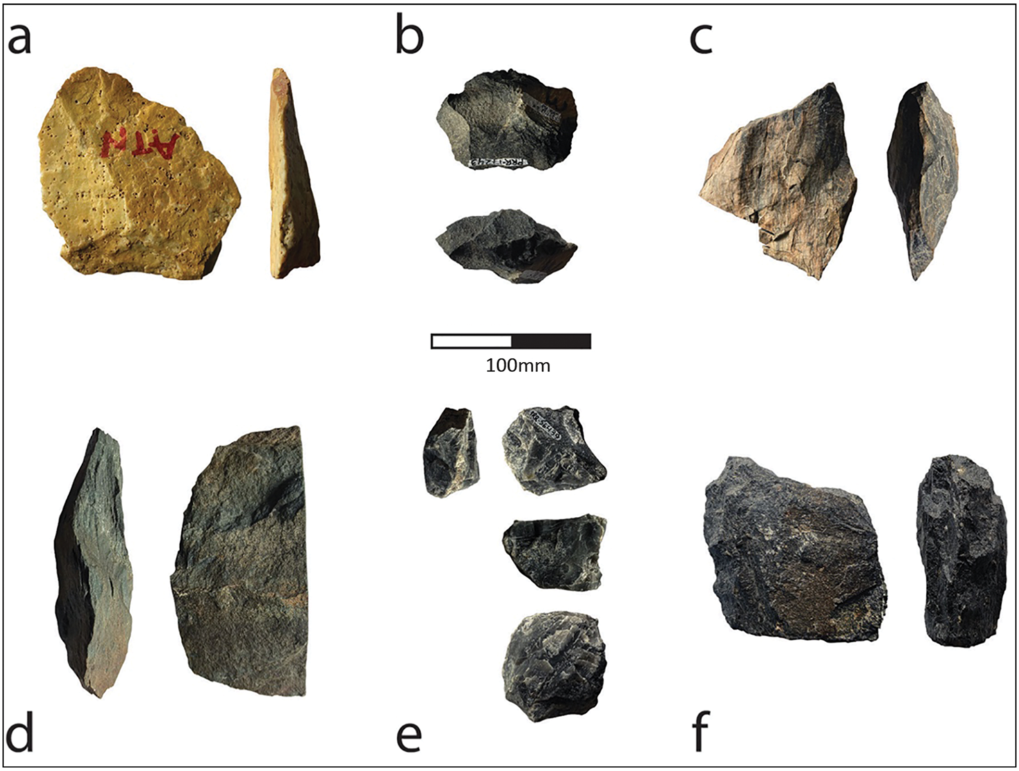


*Figure 2. Examples of Antarctic rock samples that bear resemblance to proposed human- or non-human primate-made stone tools: a) PRR-37153, 'large flake'; b) PRR-17243, 'discoid core'; c) PRR-37115, 'core'; d) PRR-23389, 'biface'; e) PRR-56439, 'bipolar core'; f) PRR-34869, 'chopper'. For more specimens and images, see the online supplementary material (OSM) (figure produced by M.I. Eren and M.R. Bebber).*

## Going forward

There are numerous instances in which the archaeological validity of early stone tool sites and lithic artefacts is either contentious or unknown and which could therefore be strengthened or weakened by comparison to a null model of naturally fractured rocks. Targeted field research could assess analogous contexts and raw materials in Antarctica for comparison with proposed archaeological stone tool assemblages from: caves (e.g. Ardelean *et al.* 2020, 2022; Chatters *et al.* 2022); rockshelters (e.g. Meltzer *et al.* 1994; Boëda *et al.* 2021, 2022; Coutouly 2022); open-air sites (e.g. Domínguez-Rodrigo & Alcalá 2016, 2019; Zhu *et al.* 2018; Harmand *et al.* 2019); deglaciated landscapes (e.g. Overstreet & Kolb 2003; Joyce 2006, 2013); coasts or ancient river courses (e.g. Parfitt *et al.* 2005, 2010); mountainous or desert regions (e.g. Rowe *et al.* 2022); or under water (e.g. O'Shea 2014; Lemke 2021; White 2021). Once a null model is created from the specific context(s) in question, quantitative and qualitative morphological, technological, frequency and density comparisons could be made between the null model(s) and the proposed archaeological dataset (s), such that objective and probabilistic statements of archaeological validity can be made. The documentation of the geological and other natural processes in Antarctica will be





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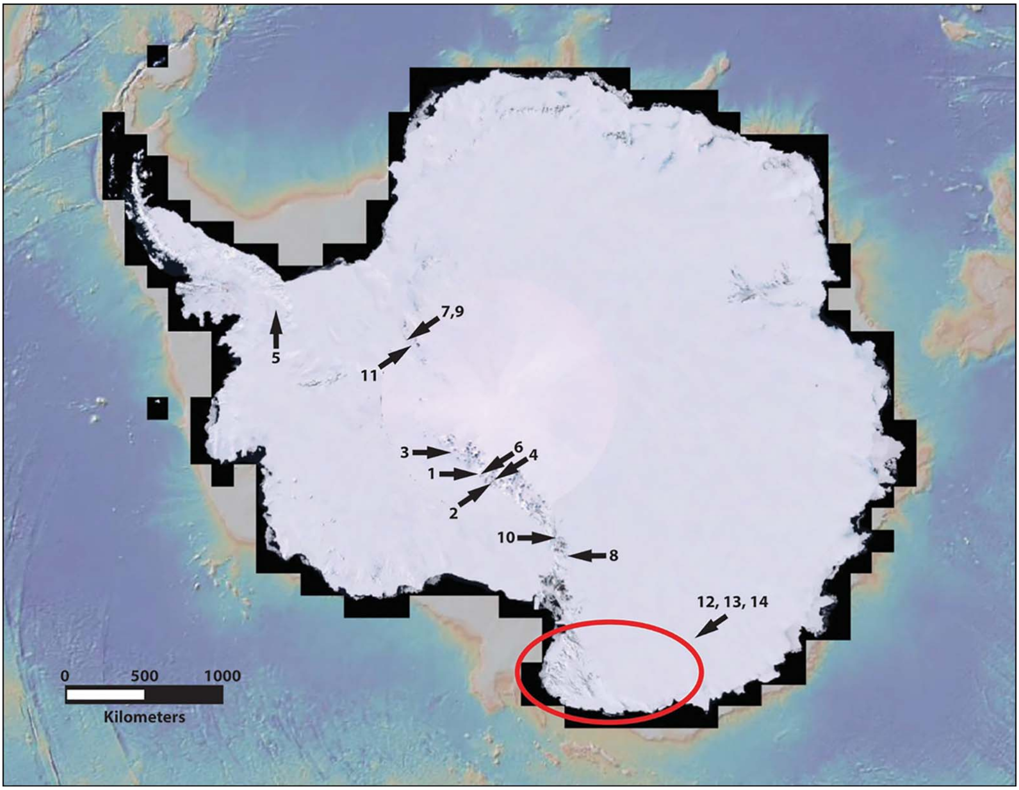


*Figure 3. The geographic locations where the presented specimens were collected. For specimen identification, see Table 1. Source of base map: Polar Rock Repository (https://prr.osu.edu/) (figure produced by M.I. Eren).*

fundamental for this research, in order to identify the conchoidal fracturing—or lack thereof—of different types of rock. Detailed contextual documentation is especially important, given that current polar rock databases do not present or report such information for key raw materials such as cherts, basalts and obsidian.

Readers of this proposal may disagree with the conclusion that the 14 specimens presented here could be mistaken for tools produced by primates. They are entitled to that view, but if that is all the reader takes away, then they have missed our point entirely. Two main facts underpin the proposal that Antarctica would make an excellent natural laboratory for generating null models of conchoidally fractured rock: 1) its variety of natural processes; and 2) the specimens presented here are made from rocks with properties that support conchoidal fracture. It is entirely beside the point for the purpose of generating null models whether some of these specimens appear to be from the Lower, Middle or Upper Palaeolithic, or whether they appear to be formal cores or expediently made. That some specimens do appear to resemble those that are made by hominins does suggest, however, that future Antarctic null models have the potential to substantially weaken the validity of some controversial archaeological sites. Conversely, the comparison of material from a controversial site to an Antarctic null model could potentially strengthen the validity of the archaeological interpretation of the site.





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Table 1. Rock specimens possessing natural conchoidal fracture from Antarctica.

| Specimen | Location | Technological identification | Raw material identification | Mass (g) | Maximum length (mm) | Supplementary image | Number on map |
|---|---|---|---|---|---|---|---|
| PRR-37153 (Figure 2a) | Mt. Fairweather, Southern Transantarctic Mountains | Large flake | Chert (Quartzite) | 401 | 145 | Figures S1 & S2 | 1 |
| PRR-23389 (Figure 2d) | Mt. Orndorf, Southern Transantarctic Mountains | Biface | Chert (Quartzite) | 594 | 151 | Figures S3 & S4 | 2 |
| PRR-37869 | Mt. Fiedler, Southern Transantarctic Mountains | Blockshatter/core | Chert | 262 | 115 | Figures S5 & S6 | 3 |
| PRR-23342 | Mt. Greenlee, Southern Transantarctic Mountains | Core | Chert (Quartzite) | 1016 | 149 | Figures S7 & S8 | 4 |
| PRR-03367 | Potter Peak, Ellsworth Land | Core | (Quartzite) | 363 | 109 | Figures S9 & S10 | 5 |
| PRR-37115 (Figure 2c) | Mt. Fairweather, Southern Transantarctic Mountains | Core | Chert (Quartzite) | 825 | 138 | Figures S11 & S12 | 6 |
| PRR-17430 | Mt. Nervo, Pensacola Mountains | Biface | Hornfels | 64 | 67 | Figures S13 & S14 | 7 |
| PRR-34869 (Figure 2f) | Butcher Ridge, Southern Victoria Land | Chopper | Obsidian | 753 | 133 | Figures S15 & S16 | 8 |
| PRR-17428 | Mt. Nervo, Pensacola Mountains | Biface | Hornfels | 136 | 109 | Figures S17 & S18 | 9 |
| PRR-56439 (Figure 2e) | Mt. Tuatara, Southern Victoria Land | Bipolar core | Chert | 102 | 57 | Figures S19 & S20 | 10 |
| PRR-17243 (Figure 2b) | Mt. Hobbs, Pensacola Mountains | Discoid core | Chert (Quartzite) | 158 | 76 | Figures S21 & S22 | 11 |
| n/a | Probably Southern Victoria Land | Large flake | Basalt | 497 | 155 | Figures S23 & S24 | 12 |
| n/a | Probably Southern Victoria Land | Large flake | Basalt | 679 | 139 | Figures S25 & S26 | 13 |
| n/a | Probably Southern Victoria Land | Large flake | Basalt | 348 | 126 | Figures S27 & S28 | 14 |

While not all 14 specimens presented here are necessarily highly convincing examples, in the sense that they might be misidentified as artefacts made by primates, they do provide strong examples relative to proposed artefacts from some early and/or controversial archaeological sites. Consider, for example, the 'discoid core' from Chiquihuite Cave (Ardelean *et al.* 2020: 91) or the 'cultural lithics' from the Hebior and Schaefer sites (Joyce 2013: 475). These proposed tools are directly comparable to the specimens from Antarctica presented here. Given the absence of other strong evidence to support the archaeological validity of these sites (e.g. Grayson & Meltzer 2015; Chatters *et al.* 2022), the similarities between the 'artefacts' from Chiquihuite or Hebior and Schaefer and the Antarctic specimens presented here suggests that they cannot be automatically taken as evidence of primate manufacture. Moreover, if more 'complex' specimens, such as proposed discoid cores or bifaces, possess Antarctic 'doppelgängers', then bashed or split cobbles, flakes and microflakes should certainly be compared with specimens from Antarctic contexts (e.g. Parfitt *et al.* 2005, 2010; Lemke 2021; Rowe *et al.* 2022).

Generating the Antarctic null datasets proposed above will be neither quick nor easy. It will take years, possibly decades, and will require multidisciplinary collaboration and detailed field research. Documenting each Antarctic rock dataset and context will, however, complement the plethora of existing lithic experiments by contributing to archaeologists' broader understanding of the extent of overlap that exists between primate-produced and naturally fractured rocks, thereby reducing dependency on authority, experience and intuition in the assessment of the archaeological validity of proposed early sites around the world.

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## Data statement

All data generated or analysed during this study are included in this article (and its online supplementary material).

## Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.15184/aqy.2023.4.

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