Surprisingly young age of the *Homo naledi* fossil site

Update #2 to *Human Origins: How diet, climate and landscape shaped us*

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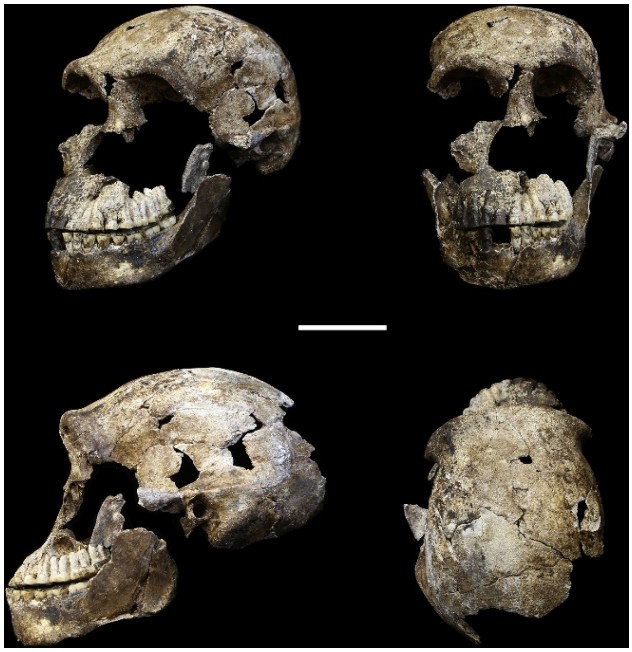
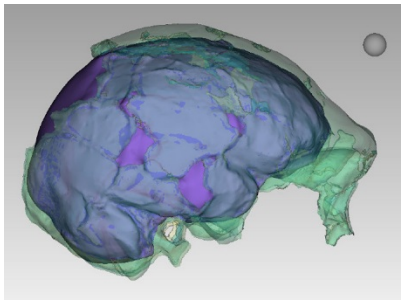
The age of the fossil-rich *Homo naledi* fossil site within the Rising Star cave system in the Cradle of Humankind World Heritage Site near Johannesburg, South Africa was frustratingly unknown until recently. The exceptionally large number of fossil bones scattered on the cave floor proved difficult to date, but an international team of scientists has applied several dating techniques (optically stimulated luminescence, uranium/thorium and palaeomagnetism) to constrain the age of the deposit to between 414 and 236 thousand years old (Dirks and others, 2017). This age is supported by the estimated age of several fossil teeth from the deposit, independently dated to between 335 and 183 thousand years old using a combination of uranium series and electron spin resonance (US-ESR) methods. The US-ESR methods directly date the fossils, but rely on a number of complex model assumptions that result in a large amount of uncertainty. Although not terribly precise, these ages are considered fairly robust and are surprisingly young for fossils whose features (or traits) suggest that they are much older. Prior to the age determinations, many estimated that the fossils, given their mix of australopith and early *Homo* features, would date to around when our genus *Homo* first appeared in the fossil record between 3 and 2 million years ago (Ma). How, then, is such a young age explained for fossils that retain so many old features?

A mosaic of features

One of the striking aspects of the *Homo naledi* fossils is the odd mix or mosaic of features they display. The amazingly rich fossil find from the Rising Star cave system includes a total of over 1500 bones from the Dinaledi Chamber alone (Berger and others, 2015), with more bones recently discovered in the separate Lesedi Chamber (Hawks and others, 2017). All of the bones recovered from both caves are considered to belong to *Homo naledi* and comprise a minimum of 15 individuals. Such a large number of bones provides a fairly complete skeleton of *Homo naledi* who stood 1.4-1.6 m high and weighed 40-55 kg. One of the most notable features is the small size of the skull, having an interior volume (endocranial capacity) of between 460 and 610 cc. This range in volume is based on three skulls and is intermediate between the mean skull size of the australopiths and the earliest *Homo* species for which skulls are available that date to around 2 Ma. Such a small skull suggested that *Homo naledi* represented one of the earliest members of our genus *Homo*, which branched from the australopiths around 2.8 to 2.3 Ma, based on fossil teeth and jaws from East Africa (Villmoare and others, 2015). In contrast, its foot shares many features similar to ours. Comparing *Homo naledi* to other species is difficult to do because for most other species there are simply not enough fossil bones to compare. However, overall, *Homo naledi* much more closely resembles early *Homo* (*H. habilis* and *H. erectus*) than it does us (*H. sapiens*) or our predecessor species (‘archaic’ *H. sapiens*). The close resemblance to early *Homo* suggested to many that the age of the deposit would be similar in age to when early *Homo* appeared circa 2.5 Ma and not the reported age of less than 0.5 Ma.





Skull of *Homo naledi* (LES1) from the Lesedi Chamber (scale bar 5 cm) and the digital reconstruction of the endocranial volume of 610 cc, scale sphere is 10 mm (Hawks and others, 2017).

The most likely explanation is that *Homo naledi* represents one of the earliest members of our *Homo* lineage and that it managed to retain many features of early *Homo* up until at least 414 to 236 thousand years ago. While retaining many of its early features, it also appears to have acquired features that closely resemble later features, which either evolved independently (convergent evolution) or were acquired through interbreeding (hybridization) with other, later-evolved *Homo* species (but probably not our species, which only appeared by around 200 to 150 thousand years ago).

What is remarkable is that *Homo naledi* persisted for so long in a region occupied by other, later-evolved *Homo* species. For example, the skull from the Florisbad fossil site is thought to represent our predecessor species and was likely contemporary with *Homo naledi*, the two living within several hundred kilometres of one another. One possible explanation of their co-existence is that they occupied distinctly different habitats. Although their feet and aspects of their hands are similar to ours*, Homo naledi*'s fingers are curved. Curved fingers suggest that they were adapted for living in and moving about in trees. Therefore, they may have resided within heavily treed habitats, such as forest canopies, whereas our predecessor species was living primarily in more open grassland and savannah habitats. Although such niche partitioning may explain the co-existence of different species of *Homo*, it is remarkable that a species with so many early features, including such a small brain, managed to survive until just prior to when our species *Homo sapiens* evolved onto the scene.

Hangers on

Homo naledi is not the only member of our *Homo* lineage who managed to persist over such a long period of time. *Homo erectus*, for example, managed to survive in Asia long after they had become locally extinct in Africa, surviving up until around 300 thousand years ago in China and Java. And, in many respects, the suite of unusual features of *Homo naledi* reflect those of *Homo floresiensis*, the 'hobbit", which also retains features of early *Homo* (*H. habilis* and *H. erectus*) and lived up until just 50 thousand years ago on the island of Flores (Sutikna and others, 2016). The persistence of *H. floresiensis* on the somewhat remote island of Flores seems more plausible than a group within the

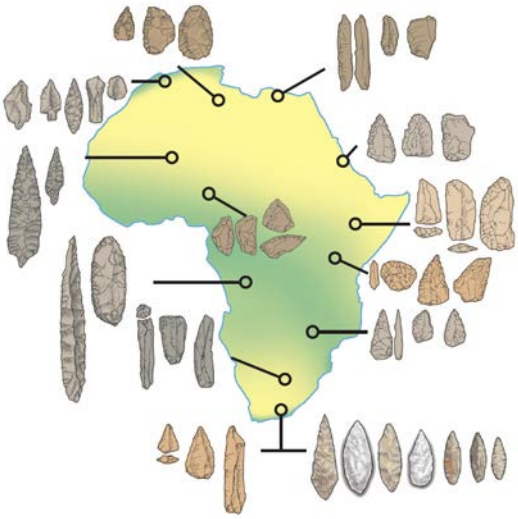
African continent, but perhaps this reflects the fact that groups in Africa were adapted to specific habitats that effectively isolated them from other groups. Population densities were likely low and, along with the diversity of habitats, may have facilitated the survival of earlier groups for long periods of time. More recently evolved species might have been widely dispersed in part because of their big brain, sophisticated tools and control of fire, but were perhaps spread thinly enough over the landscape to have permitted pockets of earlier evolved groups to hang on. What the hobbit and *Homo naledi* seem to indicate is that among the more recently evolved members of our lineage, older groups managed to persist, either within distinct habitat or niche holdouts – perhaps culturally as much as physically isolated from other groups. The fossil record is so limited it may have hidden from us or we may have tended to underestimate the amount of variability in features, such as brain and body size that existed in the past.

Homo naledi culture?

Typically an archaeological site has hundreds to thousands of stone artefacts but very few if any fossil bones of those who made the artefacts. And whether or not any bones of the makers of the stone tools are found, it is common to find the bones of other animals at many archaeological sites. Hence, the Rising Star cave sites present the most unusual case: many bones of *Homo naledi* not in association with any stone tools or other cultural artefacts, nor any other large animal bones. Hence, although we know a lot about what *Homo naledi* looked like, we have very little idea of what they made or what other animals they lived among.

This lack of context makes it difficult to know much about the habitat in which they lived and how they lived. They most clearly did not live in the deep caves where they ended up as fossils. It is conceivable that they fell into or were washed down into the caves through surface openings connected to deep cave chambers. But in that case we would expect other large animals to have fallen in or been washed into the caves along with them. Some have proposed that they were intentionally disposed of into cave openings and that this disposal may indicate a type of ritual burial (Berger and others, 2017). Ritual burial is a cultural behaviour that has so far only been associated with our species, with the earliest hints (mortuary defleshing) dating to around 160 thousand years ago, and proper burials with grave goods not until around 100 thousand years ago. It is possible they disposed of their dead into the caves as a form of good housekeeping, but it is hard to imagine that small-brained *Homo naledi* had the mental ability to practice ritual burials, and evidence to substantiate ritual disposal into the caves remains lacking.

The complete absence of stone tools makes it difficult to know what stone tools, if any, were used by *Homo naledi*. They possess the wrists and hands capable of making and using stone tools, but did they? The age of the site falls within the Middle Stone Age (MSA), a time of regionally diverse stone tool industries throughout Africa. Some have suggested that *Homo naledi* may have been the maker of some of these stone tools (Berger and others, 2017), but so far there is no direct evidence to support this idea. The appearance of stone tool use has been dated as far back as 3.3 Ma and associated with australopiths having brains similar to or smaller sized than *Homo naledi*, but these early stone tools are a far cry from the diversity and sophistication of MSA stone tools that existed throughout much of Africa by 300 thousand years ago. Hopefully future finds of *Homo naledi* in association with cultural artefacts will shed some light on where and how they lived.



A 3.3 Ma Lomekwian stone tool (left; Harmand and others, 2015) and regionally diverse MSA stone tools throughout Africa 300-200 thousand years ago (right).

Further Reading

Berger. L., and others, 2017. *Homo naledi* and Pleistocene hominin evolution in subequatorial Africa. eLife 2017;6:e24234. DOI: 10.7554/eLife.24234

Berger, L., and others, 2015. *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. eLife 2015;4:e09560. DOI: 10.7554/eLife.09560

Dirks, P., and others, 2017. The age of *Homo naledi* and associated sediments in the rising star Cave, South Africa. eLife 6:e24231. doi: 10.7554/eLife.24231

Harmand, S., and others, 2015. 3.3-million-year-old stone tools from Lomekwi 3, West Turkana, Kenya. *Nature* 521, 310–318.

Hawks, J., and others, 2017. New fossil remains of *Homo naledi* from the Lesedi Chamber, South Africa. eLife 6:e24232. DOI: 10.7554/eLife.24232

Sutikna, T., and others, 2016. Revised stratigraphy and chronology for Homo floresiensis at Liang Bua in Indonesia. Nature 532, 366–369.

Villmoare, B., and others, 2015. Early *Homo* at 2.8 Ma from Ledi-Geraru, Afar, Ethiopia. *Science* 347, 1352–1355.