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FACT SHEET

QUESTIONS AND ANSWERS

ABOUT *HOMO NALEDI*

THE DIFFICULTY WITH DATING

THE DINALEDI CHAMBER

DELIBERATE BODY DISPOSAL

v) Did all the fossil hominins die at the same time, and was there some sort of catastrophe?
w) Why can't the fossils have been brought in from surface by flowing water or mud, like in the case of Malapa site?
x) Why can't the fossils have been brought in from surface by predators or scavengers?
y) How did the hominins find their way into the Dinaledi Chamber?
z) Why are there so many hominins in the Dinaledi Chamber?

INTO THE FUTURE

aa) Why does the team include such a large number of early-career scientists?
bb) When will more new research on *H. naledi* appear?

FOOT AND ANKLE

cc) Why is the *H. naledi* foot so important?
dd) What parts of the foot and ankle have been recovered from the Dinaledi hominins?
ee) Does the Dinaledi foot look more like a human foot or a chimpanzee foot?
ff) Did *H. naledi* walk like we do?
gg) How much smaller were the Dinaledi hominins' feet?

HAND

hh) Why is the *H. naledi* hand skeleton an important find?
ii) What are the implications of the *H. naledi* hand for human evolution?
jj) Are other *H. naledi* hand bones found at the site in addition to this one hand?
kk) How common are relatively complete hand skeletons on the hominin fossil record?
ll) How does the hand of *H. naledi* compare with the *Homo habilis* "handy man" hand fossils?
mm) Have stone tools been found in the Dinaledi Chamber of the Rising Star cave system?

ABOUT *HOMO NALEDI*

a) How do you know that this is a new species?

The unusual combination of characters that we see in the *Homo naledi* skulls and skeletons is unlike anything that we have seen in any other early hominin species. It shares some features with australopiths (like Sediba, Lucy, Mrs Ples and the Taung Child), some features with *Homo* (the genus that includes Humans, Neanderthals and some other extinct species such as *erectus*), and shows some features that are unique to it, thus it represents something entirely new to science.

b) How do you know it belongs in the genus *Homo*?

The brain of *H. naledi* is small; similar to what we see in australopiths, but the shape of the skull is most similar to specimens of *Homo*. For instance, it has distinct brow ridges, weak postorbital constriction (narrowing of the cranium behind the orbits), widely spaced temporal lines (attachments for chewing

muscles), and a gracile set of jaws with small teeth, alongside a whole host of other anatomical details that make it appear most similar to specimens of *Homo.* Also, the legs, feet and hands have several features that are similar to *Homo*.

c) Where does *H. naledi* fit within the human lineage?

This is a more difficult question, since our understanding of the human lineage has changed in recent years owing to a large number of new fossil discoveries like sediba and *Ardipithecus ramidus*. However, given that *H. naledi* shares some characters with australopiths, and other characters with species of early *Homo* such as *H. habilis* and *H. erectus*, it is possible that this new species may be rooted in the initial origin and diversification of the genus *Homo*. At the same time, *H. naledi* shares characters that are otherwise encountered only in *H. sapiens*. As a result, our team has proposed the testable hypothesis that the common ancestor of *H. naledi*, *H. erectus*, and *H. sapiens* shared humanlike manipulable capabilities and terrestrial bipedality, with hands and feet like *H. naledi*, an australopith-like pelvis and the *H. erectus*-like aspects of cranial morphology that are found in *H. naledi*. Future fossil discoveries in the Dinaledi Chamber and elsewhere will certainly help us to test this hypothesis.

d) Why is the combination of features in *H. naledi* unusual or unexpected?

Until recently, most anthropologists believed that brain size and tool use emerged together with smaller tooth size, higher-quality diet, larger body size and long legs. In this view, transformations in the body in early *Homo* were tied to changes in behaviour that influenced diet and the brain. *H. naledi* shows that these relationships are not what anthropologists expected. It has small teeth and hands that seem to have been effective for toolmaking but also a small brain. It has long legs and humanlike feet but also a shoulder and fingers that seem effective for climbing. The features that were supposed to go together are not found together in *H. naledi*, and that creates an interesting puzzle that will force us to review our present models of the origins of our genus.

e) How can we be sure that the different features are not just variation among different individuals?

So far, the team has recovered remains of at least 15 individuals from the Dinaledi Chamber. This number is determined from the repetition of teeth from individuals of the same and different ages. Across the skeleton, nearly all body parts have been recovered from multiple individuals. Surprisingly, these are extremely similar to each other in almost every case. The distinctive features of *H. naledi* are found in every part that the team has found in the chamber, often multiple times.

f) Could *H. naledi* be a pathological modern human?

Unlike the often contested “hobbits”, *Homo floresienses* from the island of Flores in Indonesia, we have discovered many individuals that all share the same unusual features. This is not what one would expect to find in pathological individuals, which would vary from individual to individual.

g) What ages of individuals are represented in the Dinaledi Chamber?

Approximate ages for each of the individuals can be established from the teeth found in the collection. The youngest individual died near or at the time of birth, the oldest was an old adult individual with extremely worn teeth. Out of the 15 individuals found so far, eight were children of various ages and five definitely adults, with two either young adults or older adolescents.

h) What should we make of recent claims of an especially early appearance for the genus *Homo*?

Given the unusual combination of australopith-like and *Homo*-like characters encountered in *H*. *naledi*, and also in other species such as *Au*. *sediba*, it is becoming increasingly apparent that fragmentary and/or isolated fossil remains are unlikely to be accurate guides to the identity of early *Homo*. Without knowing what the rest of the skull and skeleton looked like, attempts to identify something like the earliest *Homo* based on fragments of jaws, or in some cases isolated teeth, are likely to be unrealistic. Had we found only small pieces of *H*. *naledi*, instead of relatively complete skeletons, we might have erroneously attributed them to one or another species instead of correctly seeing the overall pattern.

i) What happens if *H. naledi* is very old? Or very young?

If it turns out that *H*. *naledi* is old, say older than around 2-million-years, it would represent the earliest appearance of *Homo* that is based on more than just an isolated fragment. On the other hand, if it turns out that *H*. *naledi* is young, say less than 1-million-years old, it would demonstrate that several different types of ancient humans all existed at the same time in southern Africa, including an especially small-brained form like *H*. *naledi*. Given its primitive skeletal adaptations, this might have profound implications for the development of the African archaeological record. It would also have profound implications for our understanding the origins of complex behaviours previously thought to arise only with the origins of hominins not very different from our own species as recently as 350,000 years ago.

j) Can *H. naledi* shed any light on that other recent, controversial fossil species, *H. floresiensis*?

Although at present we cannot speculate on any evolutionary linkage to *H*. *floresiensis*, what *H*. *naledi* does do is demonstrate that indeed there were other species of small-brained, primitive-looking humans in existence in the past, that nonetheless shared some quite humanlike features. If nothing else, *H*. *floresiensis* no longer stands out as such an anomaly.

k) Do these fossils prove that humans originated in South Africa?

While a South African origin for humans is certainly possible, we may never be able to prove where humans originated. We are limited to finding fossils where they were preserved, not necessarily across the whole area that human ancestors existed when they were alive. Here's what we know: *H*. *naledi* existed in South Africa, and left some spectacular traces of their passing that we are only now coming to grips with.

l) What are some of the broader implications of *H. naledi*?

It is clear that we have missed some key transitional forms in the fossil record, as *H*. *naledi* represents an unexpected combination of australopith-like and human-like features that, until now, was entirely

unknown to science. This serves to highlight our ignorance about our own genus across the span of the African continent. There are obviously many unknown fossil species yet to be discovered. In addition, we must recognise that some species of ancient humans exhibited very human-like behaviors, which in turn will have profound implications for the archaeological record.

THE DIFFICULTY WITH DATING

m) Why is it so hard to date the fossils?

Unlike other cave deposits in the Cradle the fossils are not found in direct association with fossils from other animals making it impossible to provide a faunal age. There are also few flowstones that can be directly linked to the fossils, and those that exist are contaminated with clays making them hard to date. On top of that, the fossils are contained in soft sediments and they are partly re-worked and re-deposited making it difficult to establish their primary stratigraphic position. Taken together, this makes it hard to obtain a definitive date for the fossils.

n) How old are the fossils? And why have they not yet been dated?

We have tried three approaches that have failed to give dates for the actual fossils, and are currently working on further attempts. Because of the uniqueness of the fossils and the situation in which they are found, we only want to publish age limits for them when we are absolutely sure that they are right. We do not want to cause confusion over the age.

THE DINALEDI CHAMBER

o) How were the fossils found?

Two cavers, Rick Hunter and Steven Tucker, when probing a narrow fracture system to the back of the cave system found the entrance into the Dinaledi Chamber and discovered the fossils. When they showed pictures of the fossils to Pedro Boshoff another caver and geologist, he recognised the fossils as potentially significant and alerted Professor Lee Berger to the find. Further detailed investigations followed, which quickly demonstrated the significance of the find.

p) How many Hominin fossils are there in the Dinaledi Chamber?

We don't know. So far we have recovered 1550 separate bones and bone fragments from the floor surface of the cave chamber, and from a one small excavation near a bone concentration in the back of the chamber. Based on duplicate bone elements it can be shown that these bones belong to at least 15 separate individuals. Shallow probes in other parts of the Dinaledi Chamber suggest that there are bones across the chamber floor and we therefore expect to find many more bones from many more individuals as excavations continue.

q) Why are there no other fossils apart from the hominins?

The cave chamber in which the fossils occur is very inaccessible now and has always been very inaccessible. To get into the chamber involves a steep climb up a sharp lime stone block called “the Dragon’s Back”, and a drop down a narrow crack. All this has to be done deep inside the cave, in the dark zone in the total absence of light. No other large animals, apart from *H. naledi* ever found their way this deep into the cave.

r) Apart from the current complex route into the Dinaledi Chamber, has there ever been a more direct route into the cave?

Our mapping indicates that the roof to the Dinaledi Chamber consists of a chert horizon which is unbroken. Likewise, on surface, above the cave there is no indication of a direct vertical entrance way into the chamber. In other words, we have found no evidence that there is, or ever was a more direct entrance into the Dinaledi Chamber.

s) How do you know that there were no other entrance ways into the Dinaledi Chamber?

The sediments in the Dinaledi Chamber are different from the sediments in other chambers in the cave in a number of important ways: they are fine-grained and mud-rich, and contain no coarse-grained clastic components; they are relatively poor in quartz; and they are chemically distinct and derived almost completely from the cave itself.

These sedimentary characteristics indicate that the Dinaledi Chamber was isolated from the earth surface and from other chambers in the Rising Star cave. The way the sediments are distributed in the Dinaledi Chamber, with fossil-bearing units accumulating below the current entry point indicate that this was always the entry point into the chamber, even at the time the fossils entered the chamber.

t) Is the environment of the Dinaledi Chamber special in some way?

The hominin-bearing sediments in the Dinaledi Chamber are very different from hominin-bearing deposits in Sterkfontein, Swartkrans or Malapa for instance. Unlike these other well-known deposits the Dinaledi deposits occur in largely unconsolidated soft clays. The hominin bones were never fully fossilised within hard ‘breccia’. Instead they are embedded in soft, rubbly deposits that largely consist of mud-clasts that have not been fully lithified. This is an unusual geological setting, and is very distinct.

u) Do the hominin fossils occur as complete skeletons?

Remains are currently found in partly articulated, disarticulated and fragmentary states. This includes delicately articulated remains of hands and feet. This suggests that bodies entered the cave whole but disarticulated after deposition as a result of reworking of the sediments in which the fossils were originally deposited.

Sedimentological evidence suggests that bodies were brought into or dropped into the cave chamber, landing in muddy sediment on the floor. Whole bodies probably ended up within the muddy sediments of the Dinaledi Chamber, but over time, sediments drained out of the chamber through holes in the

chamber floor. As a result, some of the fossils were redistributed across the chamber floor, and ended up lying as dispersed fragments across the floor.

DELIBERATE BODY DISPOSAL

v) Did all the fossil hominins die at the same time, and was there some sort of catastrophe?

Fossil parts are found in different parts of the stratigraphy, suggesting that the fossils entered the cave over an extended period of time, and therefore we think that they did not die during a single catastrophic event.

w) Why can't the fossils have been brought in from surface by flowing water or mud, like in the case of Malapa Site?

The sediment matter in the Dinaledi Chamber (primarily very fine clay) is (so far) unique in the cave as it has been derived almost completely from the cave itself, and there is no evidence of any water or mud flowing into the cave with enough force to transport bones.

Apart from this, some parts of the hominin skeletons were found with the bones either in partial articulation or in close anatomical association, which suggests that parts of the bodies were only partially decomposed at the time of deposition; i.e. bodies entered the chamber whole.

x) Why can't the fossils have been brought in from surface by predators or scavengers?

None of the bones that have been recovered from the cave show evidence of bite marks made by predators or other large animals. We also have found no fossil remains of any predator species in association with the hominins. It would also be unlikely that predator animals would take their prey deep into the cave all the way into the Dinaledi Chamber deep into the dark zone, and that they would only take in cadavers of *H. naledi*.

y) How did the hominins find their way into the Dinaledi Chamber?

This is a puzzling question. Our geological investigation indicates that the Dinaledi Chamber was always in the dark zone, and the route to get there was probably very complex involving navigating difficult terrain. This suggests that they may have used fire to guide them into the cave.

z) Why are there so many hominins in the Dinaledi Chamber?

This is the big question. Our investigations show that the bodies came in whole. They were probably deposited over a period of time and entered the chamber using the same entrance as today. So far we have found no evidence on any the bones for any form of trauma as a result of a fall, or due to predators. So far we have also not found any evidence of cannibalism like cut-marks, like on some of the hominin assemblages in European caves. All this is very hard to explain and suggests that at some point *H. naledi* entered the cave on purpose to deposit bodies in the Dinaledi Chamber.

This hypothesis is hard to prove definitively and it will require further work. As excavations proceed and the stratigraphy of the deposit is better exposed, and more bones are recovered we will be able to better answer this question.

INTO THE FUTURE

aa) Why does the team include such a large number of early-career scientists?

Training and involving a new generation of scientists is an integral part of the project. The Rising Star Expedition began this tradition with the involvement of extraordinarily skilled excavators underground and young scientists aboveground. With so many hominin fossil specimens, the Dinaledi fossil collection presented a unique opportunity to involve a broad array of specialists with experience studying different parts of the anatomy of fossil hominins. Bringing this group of scientists together to do the work at Wits here in South Africa created many exciting synergies between people who might not have worked together otherwise.

bb) When will more new research on *H. naledi* appear?

Describing such a large collection of fossils is a huge job, and our team of experts has been examining every body part. Detailed descriptions of the articulated hand and foot remains, the most complete ever discovered, will appear shortly. Additional papers on other parts of the skeleton and the biology of *H. naledi* have been written by our team and are now in the process of peer review.

FOOT AND ANKLE

cc) Why is the *Homo naledi* foot so important?

It's important for two reasons. Firstly *H. naledi* is a brand new species of fossil hominin, and its foot is a crucial part of the discovery as it tells us something about how it moved around. Second, walking upright is one of the defining features of the human lineage, and as feet are the only structure that make contact with the ground in bipeds, they can tell us a lot about our ancestors' way of moving.

dd) What parts of the foot and ankle have been recovered from the Dinaledi hominins?

The excavation team was able to recover at least one specimen of almost every single bone in the foot. There are more than 100 foot bones in the current *H. naledi* sample; including a nearly complete foot that is missing only a few bones. It is one of the most complete feet known in the hominin fossil record (there are also partial feet from at least 2 other adults and 2 children).

ee) Does the Dinaledi foot look more like a human foot or a chimpanzee foot?

Overall, they look much more like human than chimpanzee feet. The joints between the bones looked like ours, and they likely had similar ranges of motion. The middle part of their foot was likely stiff while

walking, whereas in chimps it is far more flexible. Their big toes were in-line with the rest of the foot, unlike the grasping, opposable big toe in chimps. *H. naledi's* toes could also bend up (dorsiflex) as much as ours can, which is critical to the "toe-off" phase of the human walking cycle. However, the Dinaledi feet were not entirely human-like. They likely had minimally developed longitudinal foot arches (i.e., flatter feet), which is uncommon (but not unknown) in living people. Their toes were also slightly curved – not as much as a chimp's toes – but more than in humans.

ff) Did *Homo naledi* walk like we do?

Mainly, but not exactly. This is for two reasons. Firstly, although very like our own, the *H. naledi* foot does have a few features that are not entirely human-like. Its toes would have been slightly more curved and it may have had a lower arch than the average human. The second reason is that the way a creature moves does not just depend on its foot. One has to look at the rest of the skeleton as well. When we look at the whole skeleton of *H. naledi*, we see a creature that walked upright, but was also comfortable climbing in the trees a little bit.

gg) How much smaller were the Dinaledi hominins' feet?

We have a very good idea of how small the most complete foot is because we have its entire length, from heel to the tip of the big toe. We suspect it's a female foot because we have two size groups – a bigger group (presumably male) and a smaller group (presumably female) – and the most complete foot is in the smaller group. If this Dinaledi lady went shopping for shoes in South Africa, the United Kingdom, or the United States, then she'd look for the smallest adult size possible.

HAND

hh) Why is the *H. naledi* hand skeleton an important find?

This fossil human hand is important for several reasons, but especially because it is so complete. There are 27 bones in each human hand and this fossil hand preserves all of the bones of the right hand, except for one wrist bone called the pisiform. These bones were found partially articulated (i.e., joined together)—an extremely rare event in the hominin fossil record—meaning that they belonged to one individual. Within this single hand, there is a mix of features that has never been seen before in any other hominin species. The wrist bones, particularly those on the thumb-side of the hand, show several adaptive features for tool-related behaviours that are consistently found only in modern humans and Neandertals whereas the finger bones are more curved than most australopiths. Thus, this one hand suggests that even after the hominin hand had become well-adapted for complex manipulation, some hominins were still spending large amounts of their time climbing.

ii) What are the implications of the *H. naledi* hand for human evolution?

One of the most contentious debates in human evolution is whether early hominins spent significant amounts of time climbing or were strictly walking on two feet on the ground all the time. *H. naledi* sheds

important new light on this debate. The presence of such strongly curved fingers (rather than the straight fingers of humans/Neandertals) suggests that its fingers were curved for a reason: *H. naledi* regularly used its hands for climbing.

Furthermore, depending on how old (geologically) the *H. naledi* remains turn out to be, there will be important implications for interpreting the South African archaeological record, who made the various stone tools that have been found, and what anatomical adaptations were necessary to craft these implements.

jj) Are other *H. naledi* hand bones found at the site in addition to this one hand?

Yes, over 150 hand bones have been found in the Dinaledi Chamber so far. These include bones from both adults and juveniles. They vary slightly in size, with some being a little smaller (presumably female) and others being slightly larger (presumably male), but they all show the same anatomical features found in Hand 1.

kk) How common are relatively complete hand skeletons on the hominin fossil record?

Nearly complete hand skeletons are rare in the hominin fossil record but are known for Neandertals (~60, 000 years ago), *Australopithecus sediba* (1.98 million years ago), and *Ardipithecus ramidus* (4.4 million years ago). There is also a "composite" hand of *Australopithecus afarensis* (Lucy's species), that is composed of bones from multiple individuals and localities. Much of the early hominin fossil record (i.e., australopiths and early *Homo*) consists of isolated hand bones that cannot be associated to a particular individual or species. The OH7 hand of *H. naledi* (the "handy man") (1.75 million years old) discovered in the early 1960s is well-known as it was described as the first "tool-maker"; however, only a few wrist and finger bones are preserved.

ll) How does the hand of *H. naledi* compare with the *Homo habilis* "handy man" hand fossils?

The *H. habilis* hand preserves three of the eight wrist bones in the human hand, but these fossils are fragmentary. However, based on what is preserved, the anatomy is different than in *H. naledi* suggesting that *H. habilis* was more like australopiths and did not have the same suite of features related to tool-use or tool-making that is shared among *H. naledi*, Neandertals and humans. However, the fingers of the *H. habilis* hand are also curved like those of *H. naledi*, and suggest that both species spent a substantial amount of time climbing.

mm) Have stone tools been found in the Dinaledi Chamber of the Rising Star cave system?

No, stone tools have not yet been found in association with the *H. naledi* fossils. Future discoveries will hopefully help answer this question.