***Homo naledi* FACT SHEET**

EMBARGOED UNTIL TUESDAY 9 May 2017 – 10 am South African Time / 4 am EDT / 9 am London / 6 pm Sydney, Australia

QUESTIONS AND ANSWERS

ABOUT THE LESEDI CHAMBER

1) What does the name "Lesedi" mean?

The word "Lesedi" means "light" in the Setswana language, which is one of the languages commonly spoken in this part of South Africa. The word "naledi" means "star" in the Sesotho language, and the word "Dinaledi" means "stars".

2) Where in the Rising Star cave system is the Lesedi Chamber? Is it near the Dinaledi Chamber?

The Rising Star cave system includes more than 2 kilometers of mapped underground passages. The Lesedi Chamber is in a different part of the cave system from the Dinaledi Chamber, and the shortest route between these chambers is 145 meters long, involving multiple squeezes and climbs, totally in the dark zone.

3) How were the fossils found?

Rick Hunter and Steven Tucker, who discovered the fossil remains in the Dinaledi Chamber in September, 2013, also entered what we now recognise as the Lesedi Chamber, but they did not recognise the hominin remains in the chamber at that time. Later, as the team carried out fieldwork in the Dinaledi Chamber in November 2013, these same explorers located the fossil hominin remains in the Lesedi Chamber. Two new fossil areas within the Lesedi Chamber were discovered by Hannah Hilbert-Wolf during geological survey of the chamber.

4) Who excavated the fossils?

The fossils were excavated by Wits teams of scientists including former "Underground Astronaut" Dr Marina Elliott.

5) How does the excavation team reach the Lesedi Chamber? Is it as hard to enter as the Dinaledi Chamber?

The Lesedi Chamber is approximately 30 meters underground. To enter the chamber, the team uses a path that goes more than 80 meters from the surface, twisting and turning through the cave, with one tight squeeze that only small team members can fit through, and some dangerous drops. This chamber is not as difficult to enter as the Dinaledi Chamber, which can

be entered only through the 18-cm (7 ½ inch)-wide entry chute, which is a vertical 12 meter (40-foot) climb. But the fossil remains in the Lesedi Chamber are in a small, cramped side tunnel that can only accommodate a single excavator at a time. It is a very challenging situation for the team to work in.

THE FOSSILS FROM THE LESEDI CHAMBER

6) How many hominin fossils have been recovered from the Lesedi Chamber?

The team has recovered 131 fossil hominin specimens from the Lesedi Chamber. By itself, this is one of the most productive hominin sites in Africa.

7) How many individuals are represented by the fossil remains in the Lesedi Chamber?

The team has excavated hominin fossil remains from three areas within the Lesedi Chamber. Based on differences between adult and juvenile skeletal remains, and the repetition of the same parts of the skeleton, the fossils include the remains of at least two adults and one juvenile individual. Fossils come from three separate areas within the chamber, and it is likely that the minimum number is an underestimate.

8) Who is 'Neo'?

The majority of the remains recovered so far look like parts of the skeleton of a single adult male individual, designated LES1. It is traditional in the study of human evolution to name skeletons when we can recognise individuals, and the name "Neo" means "gift" in the Sesotho language, one of the languages commonly spoken in this part of South Africa today. The name resembles a character from the film, *The Matrix*, however, this resemblance is coincidental.

9) How does the Neo skeleton compare to other skeletons in the hominin fossil record?

Because of the presence of a nearly-complete skull with other parts of the skeleton, this find is truly exceptional. The skull and jaw includes fragile parts of the face very rarely preserved in other fossils. The preserved parts of the arms, legs, wrist and hand, spine, and ribs represent every other region of the skeleton, except for the lower legs and feet. The two thigh bones (femora) are somewhat different in parts that may suggest that one of them comes from a different individual, although if so, the two individuals would be of very similar size. The remains are among the most complete ever discovered.

10) How do you know Neo is an adult male?

The bones and teeth of Neo all indicate that he had completed development, and the teeth exhibit considerable wear, showing he was a relatively old individual. Neo's skull is a bit larger than any of the skulls found in the Dinaledi Chamber, and has prominent attachments for the

muscles of the jaw and neck, which tends to be true of males within human and other primate species.

11) How can we be sure that the skeletal remains in the Lesedi Chamber belong to *Homo naledi* and not some other species?

H. naledi in the Dinaledi Chamber is distinguished from other species based on features across the skeleton, from the skull, jaw and teeth, to the shoulder, hand, spine, pelvis, leg, and foot. Some of the features of *H. naledi* are unique, while others occur in a pattern never found before in other fossil or living species. The remains from the Lesedi Chamber include a nearly complete skull and jaw, all the teeth, parts of the arms and legs, parts of the spine and ribs, femora and pelvic remains. This wealth of evidence has enabled the team to carry out some of the strongest tests ever accomplished for a fossil skeleton compared to other species. All of the features of the Lesedi Chamber hominins are consistent with *H. naledi*, and every other species can be clearly eliminated.

12) Why are there fewer hominin fossils from the Lesedi Chamber than from the Dinaledi Chamber?

The team's investigation of both chambers is at a very early phase, and we do not yet know the total number of skeletal remains in either chamber, but less sediment has been accumulated and preserved in the Lesedi Chamber.

13) Are the Dinaledi and Lesedi *Homo naledi* individuals close relatives?

Until we manage to obtain DNA from these fossils it will be impossible to test whether the two groups include close genetic relatives. All we can say is that they are very much alike and that makes their relatedness seem more likely.

14) Are there other animal bones from the Lesedi Chamber?

The team has recovered fragmentary remains of many animals from the Lesedi Chamber. Nearly all of these belong to rodents or small carnivores, such as small cats, foxes, and mongooses. We do not know if the remains of these animals entered the Lesedi Chamber at the same time as Homo naledi, or whether they entered at other times.

ABOUT THE GEOLOGICAL AGE OF THE FOSSILS

15a) What approach did the team take in determining the geological age of the fossils from the Dinaledi Chamber?

The team developed a strategy that involved three separate steps. First, the Dinaledi chamber was carefully mapped and the various sediments and flowstones in the chamber were placed in a stratigraphic order; i.e. the order of relative timing of the geological units as interpreted by

the researchers. Using this stratigraphy, geological units below and above the fossil remains were targeted for dating, so that the age of the unit containing the *naledi* fossils can be bracketed. Thirdly, some of the fossil material, namely three teeth, was dated directly. All three approaches were consistent with one another, which confirms our geological interpretations and provides us with confidence in the final results.

15b) What dating methods did the team use to determine the geological age of the fossils from the Dinaledi Chamber?

The team applied six different methods to determine the range of time when the fossils were deposited. Two of these (radiocarbon and paleomagnetism) do not place boundaries on the age of the fossils, although they add some information about the age of the sediments in the Dinaledi Chamber. The most informative method was ESR dating (Electron Spin Resonance) directly upon samples of *H. naledi* teeth, which was combined with U-Th dating of the teeth. The team also measured the amount of uranium and thorium within samples of flowstone from the Dinaledi Chamber. Where flowstone layers lie above fossil hominin remains, the age of the fossils must be older than the flowstone. In this way, the minimum age of the fossils was constrained to 236 ka. Additionally, the team found some tiny quartz grains within some of the older sediments in the chamber, and used a method called OSL (Optically Stimulated Luminescence) to estimate the length of time those grains had been buried in a dark place with no light. The boundaries of the possible time that the fossils were deposited come from the ESR and uranium-thorium methods. The other methods give consistent results, and confirm the interpretation of the general stratigraphy in the chamber.

15c) Why did it take so long to obtain a date?

It has been very challenging to date the *H. naledi* fossils accurately for several reasons.

Firstly, whilst it is possible to date the fossils directly (and in the end we did date the fossils directly), this is a destructive approach which we only want to follow in exceptional cases, and only after the fossils had been fully described and analysed. But even then, only few direct dating techniques are available (in this case combined U-Th and ESR), and these techniques have relatively large error margins and they rely on model assumptions so everything needed to be checked, preferably with independent techniques.

Secondly, fossils can be dated by targeting the sediments in which they are embedded. The problem in the case of *H. naledi* is that the sediments are not yet consolidated, and that there is clear evidence for repeated reworking of the sediments including the fossils. This means that it has been extremely difficult to determine the exact context of the fossils. There were also a number of technical issues relating to the specific conditions in the cave (for example excessive radon loss in the sediments, and unknowns around the burial history because of the reworking), which made it hard to acquire reliable ages.

Thirdly, we used a large number of techniques and a double blind approach of some of the most important techniques, which has meant that the efforts of 10 separate laboratories in Australia, Europe and South Africa had to be coordinated. Some of the techniques have long lead times, for others careful coordination and sample preparation was required. This in combination with the technical difficulties in the cave meant that it took time to get good results.

16) How does ESR dating work?

The crystalline structure of enamel in teeth is quite stable over time, and can be targeted for dating. After a tooth is buried, very low levels of natural radiation in the teeth themselves as well as the surrounding sediments and groundwater cause some of the electrons in the crystals to move to a higher energy state, creating small electromagnetic field effects. The strength of these effects builds up over time. In the laboratory, scientists can measure these effects, and use them to estimate the time a tooth has been buried. These calculations are complicated and require assumptions about the boundary conditions that affect how the levels of radiation within the teeth, and to a lesser degree the sediments of the site changed over time. To help constrain the boundary conditions, the U and Th values in the teeth were measured directly, and this information was modelled and combined with the ESR calculations. Final ages using the combined ESR and U-Th techniques were obtained for a maximum and a minimum age scenario, with the true age falling somewhere in between. To be sure of the results, the measurements were carried out on the same teeth by two independent laboratories, so that results could be compared. For these reasons, the range of uncertainty in our estimate of the geological age for the *H. naledi* teeth is quite large.

17) Do the Lesedi Chamber remains come from the same time period as those in the Dinaledi Chamber?

The team does not have any information yet from the geology of the Lesedi Chamber that says directly how old those fossils are, but the Lesedi fossils are very similar to the Dinaledi fossils of *Homo naledi*, just as similar as human skeletons from a single population. This suggests that both chambers contain individuals that may have lived at roughly the same time. The team is working now to discover the age of the Lesedi hominin fossils to test this hypothesis.

18) When in time did the species *Homo naledi* originate?

The individuals of *Homo naledi* found in the Dinaledi Chamber lived between 236,000 and 335,000 years ago. Their anatomy suggests that their ancestors diverged from the ancestors of modern humans much earlier in time. Some scientific results have suggested that the *H. naledi* lineage may have originated as early as 2.5 million years ago, others as late as one million years ago. The wide range of uncertainty means that we will need to discover much more about other primitive members of our genus before we can answer how long *H. naledi* may have existed.

19) When did *Homo naledi* become extinct?

The fossils of *H. naledi* in the Dinaledi and Lesedi Chambers almost certainly were not the last *H. naledi* to have lived. The evidence cannot say how long *H. naledi* may have survived, and the team does not rule out the hypothesis that *H. naledi* was present much later than 236,000 years ago.

20) Why is it important to find a "primitive" hominin at such a recent time period?

It was once commonly believed that no "primitive" species could have survived the intensifying competition from larger-brained humans, with their advanced social and technological behaviours. Recent discoveries show that this view is false. A diversity of hominin species and populations existed through much of the last two million years. Very different hominin forms, some like *H. naledi* and *H. floresiensis* with small brain sizes, some with closer connections to humans such as Neanderthals and Denisovans, continued to exist. *H. naledi* is important because it shows not only the size of the brain, but also many other aspects of skeletal adaptations were diverse.

21) With such a recent geological age, is it possible that the *Homo naledi* fossils contain DNA?

The team has attempted to obtain ancient DNA from the Dinaledi Chamber fossils but so far has had no success.

21b) The age range of 236-335 ka is still very long. Will you be able to constrain this age further in future?

Yes, work in the Dinaledi chamber is on-going, and as more geological units are being dated, the age of the fossils will no doubt be further constrained.

21c) You indicate that that the dating was done using double-blind experiments. What does that mean?

To ensure that the age results that we have published are robust, we had several labs independently date the same samples using the same techniques. This was done without one lab knowing the results from the other labs. We used this approach for the techniques that were most critical for obtaining a date for the fossils, namely U-Th and ESR. The results from the different labs showed a great deal of consistency, meaning that the age results are reproducible and therefore robust. Such a rigorous approach has rarely been used before in dating fossil deposits.

HOMO NALEDI AND HUMAN EVOLUTION IN SUBEQUATORIAL AFRICA

22) Why is the subequatorial region of Africa important?

During the past million years or more, the region south of the tropical rain forests of Africa has been home to vast and contiguous areas of grasslands, savannas, and open woodlands, where hominins may have lived. Like many other animal species that live in such habitats, modern humans have their highest diversity in subequatorial Africa. The discovery of *Homo naledi* suggests that the hominin diversity in this region was even higher in the past.

23) Is *Homo naledi* a "relict species"?

A relict species is one that remains after a more diverse array of its ancient relatives becomes extinct. Fossil discoveries and genetic evidence show us that *H. naledi* lived at the same time as many diverse lineages of hominins, both within subequatorial Africa and in other parts of the world. Today's people are the last survivors of this ancient diversity. In that sense, modern humans (*H. sapiens*) are a relict species. It is not clear whether *H. naledi* also had many close relatives that earlier became extinct, so we cannot say if it was a relict.

24) Does *Homo naledi* show that South Africa was a kind of biological "cul de sac", isolated from the mainstream of human origins?

No. Africa south of the equator is one of the world's most biologically diverse regions. During the last two million years, the savanna and open woodland habitats for hominins were larger and more connected south of the equator than in northeastern Africa. A greater diversity in subequatorial Africa is evident in the genetics of many animal species that live in these habitats today. *H. naledi* now helps to confirm that diverse hominin populations also thrived in the areas of Africa south of the equator. Far from being isolated, this area now looks like the mainstream.

25) Does the survival of *H. naledi* indicate a long period of evolutionary isolation, like that suggested for *H. floresiensis*?

No. While Flores is an island with a unique animal community that evolved in isolation, this area of Africa shares most of its animal species or their close relatives with the grasslands, savannas and open woodlands of the rest of the continent. *H. naledi* is not a product of evolutionary isolation.

26) Where else did *Homo naledi* live?

The anatomy of *H. naledi* suggests it may have been wide-ranging, using landscapes in the way that humans have done. But as yet the team has found evidence of *H. naledi* only in these two localities, and we have no evidence about the full geographic area it may have occupied.

27) Do these discoveries show that the genus *Homo* evolved in South Africa?

It is too soon to say where our genus may have evolved. Ten years ago, it was common to hear scientists assume that the genus *Homo* must have evolved in East Africa or the Great Rift Valley, because of the important fossil discoveries from that region. Today, the primitive nature of *H. naledi* and the accumulating evidence of diversity of hominins within subequatorial Africa now suggest that this diverse region may have been important to our origins. But still, fossil evidence has come from only very small areas of Africa. Only more exploration can answer this question.

DELIBERATE BODY DISPOSAL

28) How did *Homo naledi* get into the two chambers?

After intensive exploration and investigation, the team has found no evidence to exclude the hypothesis that *H. naledi* deliberately deposited bodies in the Dinaledi Chamber. The Lesedi Chamber discovery adds yet another instance, similar and form and content to the Dinaledi Chamber. This appears to present further evidence that *H. naledi* was using the Rising Star cave system for a repeated behavior.

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

The occurrence of *H. naledi* skeletal remains within two chambers, far separated from each other with no direct underground connection and no easy connection from the surface, is strong evidence against the idea that they were victims of any single catastrophic event.

30) Did *Homo naledi* bury bodies in the Lesedi Chamber as well as the Dinaledi Chamber?

The evidence suggests that *H. naledi* may have used both the Lesedi and Dinaledi Chambers in a similar way, as places where they deposited their dead. At some other sites, carnivores killed and ate the hominins, or the hominins fell into a “death trap”, or their remains were carried or relocated by water and gravity within caves. The evidence from the Lesedi Chamber rules out all of these, just as the Dinaledi Chamber evidence rules them out. It is a reasonable hypothesis that *Homo naledi* themselves entered the cave and used these chambers for depositing their dead.

31) Was the cave equally difficult to access in the past as it is today?

The team does not yet know how difficult it may have been to reach the Dinaledi or Lesedi Chambers at the time *H. naledi* lived. The evidence shows that the Dinaledi Chamber was always very difficult to enter and separate from neighboring chambers, and both the Dinaledi and Lesedi Chambers were always in the dark zone of the cave. However, some of the current squeezes and physical constraints through the cave system may have been different in the past.

But note that with the relative young age of the fossils, the underground geometry of the cave systems will not have changed as much as would have been the case if the fossils had been old.

32) Did *Homo naledi* have fire?

It is a reasonable hypothesis that *H. naledi* must have controlled fire in order to repeatedly use areas deep within the Rising Star cave system. However, the team has not yet confirmed any physical or chemical evidence of ancient fires in either the Dinaledi or Lesedi Chambers. Controlled use of fire is known from other sites in South Africa in excess of 1 million years ago, including Swartkrans which is just 800 meters from the entrance of the Rising Star cave system.

HOMO NALEDI AND OTHER SPECIES

33) Where does *Homo naledi* fit within the human lineage?

Studies of the skull and teeth have suggested two possible scenarios for the relationships of *H. naledi*. The species may have emerged near the origin of our genus, *Homo*, around the same time that *H. habilis*, *H. rudolfensis* and *H. erectus* first existed. This would make *H. naledi* one of an initial radiation of our genus, or possibly an ancestor or close relative of *H. erectus*. A second scenario is that *H. naledi* may actually be more closely related to modern and archaic humans, making *H. erectus* a more divergent branch of the *Homo* family tree. The evidence does not yet allow us to exclude either of these possibilities.

34) Does the recent geological age mean that *Homo naledi* cannot be an ancestor of *Homo erectus* or *Homo sapiens*?

Some populations of *H. naledi* lived between 235,000 and 336,000 years ago, but other populations may have lived much earlier, as suggested by the many features that *H. naledi* shares with much earlier fossils. It is possible that these earlier populations may have given rise to either *H. erectus* or *H. sapiens*, or these species may have emerged from common ancestors.

35) Can *Homo naledi* shed any light on that other recent, controversial fossil species, *Homo floresiensis*?

Both *H. naledi* and *H. floresiensis* were primitive species that existed into the relatively recent past. The team working on *H. naledi* includes some experts who have directly studied *H. floresiensis*, and the team has examined their similarities and differences. Mostly, the features that are similar between the two are primitive and do not indicate a close relationship, while each of these species has areas of derived anatomy different from the other.

36) Is *Homo naledi* a "primitive *Homo erectus*"?

No. A few outside experts made public statements immediately after the announcement of *H. naledi* in 2015 that the fossils were not truly a new species but instead a "primitive *Homo erectus*". These claims have not held up under scientific examination. Since that original description was published less than two years ago, hundreds of pages of peer-reviewed scientific research has been published on the Dinaledi Chamber fossils, both by the original team and by other independent researchers. All of this scientific research supports the team's conclusion that *H. naledi* is a unique new species. No scientific articles have been published that question the team's description of *H. naledi* as a new species.

HOMO NALEDI AND THE ARCHAEOLOGICAL RECORD

37) Did *Homo naledi* use stone tools?

The team has not found stone tools together with the remains of *H. naledi*. Studies of its hands suggest that *H. naledi* had the anatomy of a capable tool maker. Stone tools are much more common than fossil hominin remains, and are known from southern parts of Africa from roughly the same range of time that *H. naledi* lived. But it is not clear which hominin populations made those tools.

38) Did *Homo naledi* create the assemblages that archaeologists have previously ascribed to modern humans?

The stone tools that are common during the period between 236,000 and 335,000 years ago in southern Africa are attributed to the "Middle Stone Age" (MSA) set of traditions. Archaeologists have often associated the MSA to modern humans and their immediate ancestors. However, very few modern human fossil remains are in direct association with MSA in this region, and none from the early MSA time of *H. naledi*. Until stronger evidence placing fossil hominin remains together with stone tool assemblages is discovered, we will not know which hominin populations may have made these stone tools.

39) Did *Homo naledi* meet modern humans?

The evidence does not say whether *Homo naledi* met modern humans (*Homo sapiens*). The earliest fossil remains of modern humans are those from the Omo Kibish region of Ethiopia, nearly 200,000 years old. No modern human fossil remains are known from subequatorial Africa as early as this. It is possible that some populations of *Homo naledi* came into direct contact with modern humans or their ancestors, but we have no evidence at this time.

40) Did *Homo naledi* meet archaic humans?

The fossil record suggests that some archaic human populations existed in subequatorial Africa during much of the existence of *H. naledi*. This evidence includes the Kabwe skeletal remains from Zambia, and the Florisbad skull from South Africa. It is not clear whether these populations lived in the same areas as those occupied by *H. naledi*, whether they were in direct contact with each other, or whether they may have made similar or different stone tool traditions.

INTO THE FUTURE

41) What additional research is being done on *Homo naledi*?

The team continues to carry out research in the laboratory and in the Rising Star cave system. Since the initial announcement of *H. naledi* in 2015, more than 400 pages of peer-reviewed research have been published by the team, providing more detailed analysis of the anatomy of most parts of the *H. naledi* skeleton, more detail on the geological and taphonomic context of the Dinaledi Chamber, and testing hypotheses about the relationship of *H. naledi* to other hominin species. That scientific productivity is being carried forward with more papers set for publication this year, and new research underway on the Lesedi Chamber remains.

42) What are the prospects for finding more evidence of *Homo naledi* from other sites?

The team has been surveying more potential fossil sites in the Cradle of Humankind, and there are excellent prospects for discovering more new hominin-bearing caves. We hope to make an announcement of exciting new naledi fossils very soon. In addition, it is possible that fragments of *H. naledi* have already been found at sites in other parts of Africa but not recognized. A re-examination of fossil evidence across the continent may provide more discoveries.