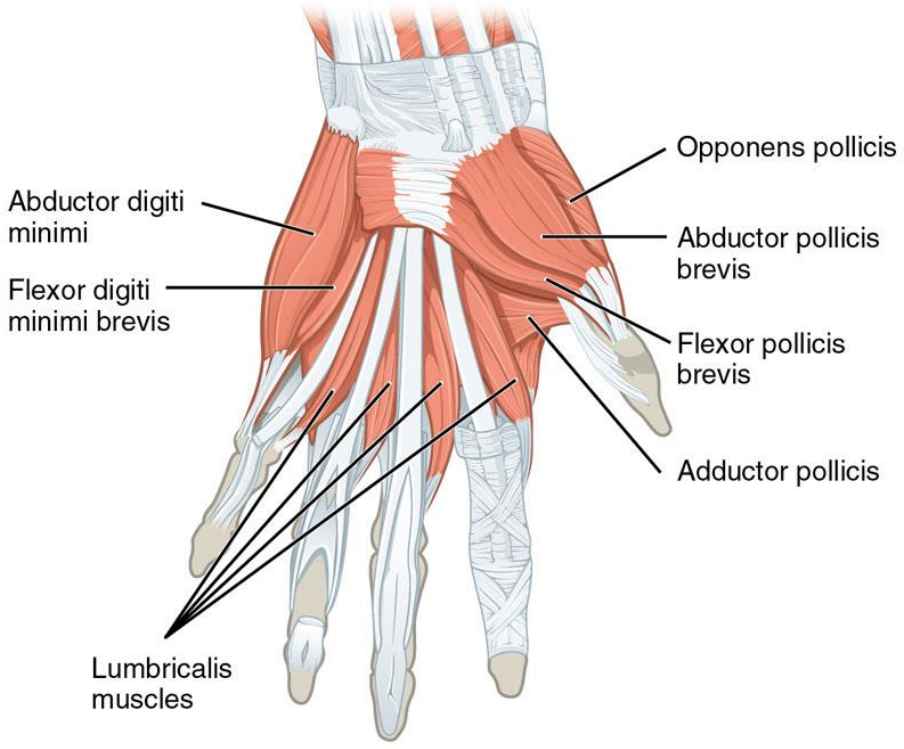
Human evolution and migrations

The ancestry of our opposable thumbs (February 2021)

Since the appearance of smart phones and the explosion of social media our thumbs have found a new niche; typing while holding a mobile. At a desktop keyboard, most of us don't use thumbs very much, unless we have mastered fast touch typing, but for a huge variety of manual tasks thumbs are essential. The first makers of sophisticated stone tools must have been able to grip between fingers and thumb to manipulate the materials from which they were made and to perform the various stages in creating a razor sharp edge. To do that, as most of us are aware, the tip of the thumb must be capable of touching the tips of all four fingers; an opposable thumb is essential for the 'precision grip'. Being able to tell when opposable thumbs evolve depends, of course, on finding hand-bone fossils. Being made of many bones disarticulated hands are a lot more fragile than long bones or those of the skull. Complete fossil hands are rare, as are feet, but a number have been found more or less complete. Whichever hominin had evolved opposable thumbs, their potential would have given them a considerable advantage over those that hadn't.



The main muscles that control the movements of modern human fingers and thumb (Credit: Wikipedia)

Simply comparing the shapes of fossilised bones of fingers and thumbs with those of modern humans and other living primates has, so far, not proved capable of resolving with certainty which hominin groups either did or did not have opposable thumbs. The key lies in the muscles that operate them. It has become commonplace to reconstruct faces and even whole bodies from fairly complete skeletal remains by modelling musculature from the positioning and shape of the points of attachment of muscles to bone. But that become

increasingly difficult for the small-scale and intricate attachments in hands. The critical muscle for opposable thumbs is known as the *Opponens pollicis* (the Latin for thumb is *Digitus pollex*); a small triangular muscle that operates in conjunction with three others (with *pollicis* in their Latin names).

Fotios Karakostis and six colleagues from German, Swiss and Greek universities have devised software that can model muscles in 3-D (F.A. Karakostis *et al*. 2021. Biomechanics of the human thumb and the evolution of dexterity. *Current Biology, v.**31,*** online; DOI: 10.1016/j.cub.2020.12.041). Based on the anatomy of human and chimpanzee hand muscles and the positions of their attachment to individual bones, they have been able to establish a series of parameters that clearly distinguish the morphological and probably functional characteristics of the thumbs of these living primates. Complete sets of thumb bones from four Neanderthal skeletons show that they were significantly, but only slightly, different from anatomically modern humans. Those from three species of *Australopithecus* (*africanus*, *sediba* and *afarensis*) lie between ours and chimps', with significantly closer affinity to chimpanzees. It seems that australopithecines of whatever age were not equipped with opposable thumbs and were possible tool producers and users with the very limited capabilities of modern chimps; holding, pounding and poking. A single set of hominin thumb bones from about two million years ago that were found in the famous Swartkrans Cave in South Africa show just as close affinity in thumb opposability to humans as do Neanderthals. So at 2 Ma there was a hominin species sufficiently dextrous to make and use sophisticated tools. The problem is, the bones are not directly associated with others and have been ascribed by different authors either to *H. habilis* or *Paranthropus robustus*. Interestingly, this paranthropoid has also been suggested (controversially) to have been the first known hominin to use fire, and it also used digging sticks. No one has ever suggested that the genus *Homo* descended from a paranthropoid ancestor or *vice versa*; these massively jawed beings did coexist with early humans in East Africa for over a million years. The other hominin who left hands in the geological record was *Homo naledi*; a controversial species because it was found in a barely accessible cave chamber, and took a while to date. This context gave rise to the notions that it was the direct ancestor of humans and that it buried its dead in a special place. However, it turned out to be relative recent, at about 280 ka (see: *Homo naledi: an anti-climax*; May 2017). *Homo naledi* does seem to have had opposable thumbs, but there is no associated evidence to suggest either tool making or use.

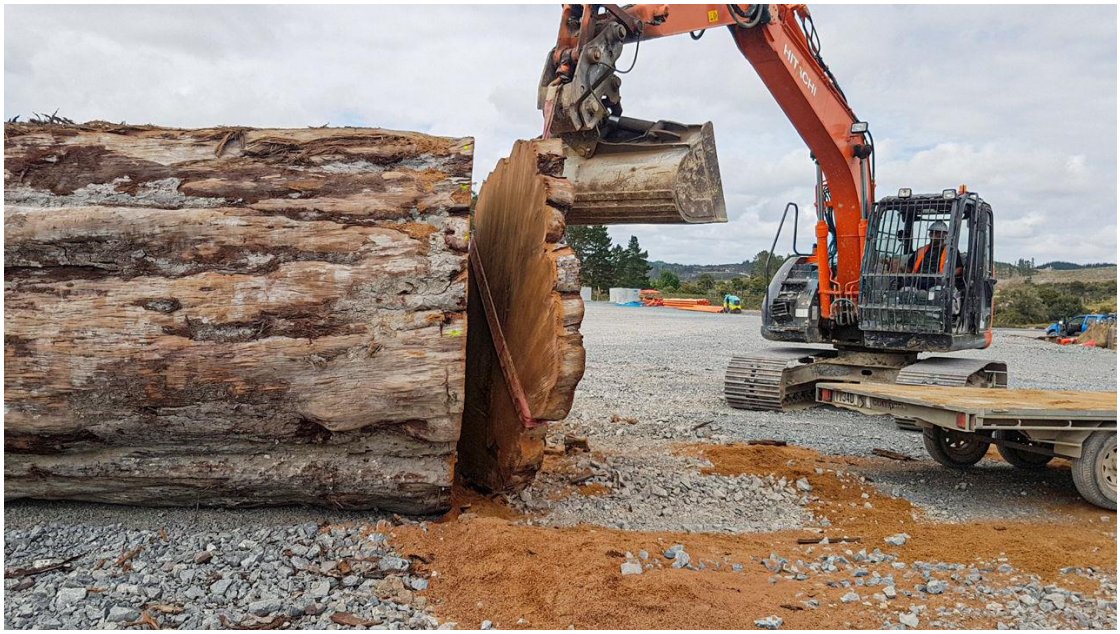
Fascinating as the methodology outlined by Karakostis *et al.* is, their findings do not take early human capabilities very much further than what is already known. Tools were made and used as far back as 3.3 Ma ago, and we know that *H. habilis* was doing this by about 2.6 Ma; i.e. long before the first evidence for opposable thumbs, and who had them first is uncertain. What is clear is that sophisticated tools, such as the bifacial Acheulian artifacts whose manufacture demands great dexterity, only appeared after the potential for nimble dexterity (about 1.8 Ma). The same goes for the first migration out of Africa, at about the same time, which demanded resourcefulness that may have sprung from the ability to manipulate natural materials effectively and carefully

See also: Handwerk B. 2012. How dexterous thumbs may have helped shape evolution two million years ago. (*Smithsonian Magazine*, 28 January 2021); Bower, B. 2021. Humanlike thumb dexterity may date back as far as 2 million years ago. (*Science News*, 28 January 2021)

Another snippet: Neanderthal link to our brain (February 2021)

Elizabeth Pennisi reports on a 'Petri-dish' experiment that substitutes a Neanderthal gene for a modern human one in a culture of human brain tissue. It gives some idea of how our very close relative may have thought differently from us. Pennisi, E. 2021. Neanderthal-inspired 'minibrains' hint at what makes modern humans special. *Science*, online news item; DOI:10.1126/science.abh0331

Could a magnetic reversal have decimated the Neanderthals? (February 2021)



An ancient kauri tree log recovered by swampland excavations in New Zealand. (Credit: Jonathan Palmer, in Voosen 2021)

A rumour emerged last week that the Neanderthals met their end as one consequence of an extraterrestrial, possibly even extragalactic influence. Curiously, it stems from a recent discovery in New Zealand, where of course Neanderthals never set foot and nor did anatomically modern humans, the ancestors of Maori people, until a mere 800 years ago. It started with an ancient log from a kauri tree (*Agathis australis*), a species that Maoris revere. Found in excavations of boggy ground, the log weighed about 60 tons, so it was a valuable commodity, especially as it is illegal to fell living kauri trees. The wood is unaffected by burial and insect attack, has a regular grain and colour throughout, so is ideal for monumental Maori sculpture. Such swamp kauri also preserves their own life history in annual growth rings, and the log in question has 1700 of them. Using growth rings to chart climate variation gives the most detailed records of the recent past, provided the wood can be dated. Matching growth ring records from several trees of different ages is key to charting local climate with annual precision over several millennia.

Radiocarbon dating indicates that this particular kauri tree was growing around 42 thousand years ago. That is close to the upper limit for using ^{14}C concentration to date organic matter because the isotope has a short half-life (5730 years). In this case samples of the log would contain only about 0.7 % of its original complement of radioactive carbon. Cosmic rays generate ^{14}C when they hit nitrogen atoms in the atmosphere and it enters CO_2 and thus the

carbon cycle. Carbon dioxide taken up by photosynthesis to contribute carbon to plants contains only about one part per trillion of ^{14}C. Consequently wood as ancient as that in the kauri log contains almost vanishingly small amounts, yet it can now be measured using mass spectrometry to yield an accurate radiometric age.

The particularly interesting thing about the 42 ka date is that it coincides with the timing of the last reversal of the Earth's magnetic field, known as the Laschamps event. The kauri tree bears detailed witness through its growth rings to the environmental effects of a decrease in that field to almost zero as the poles flipped. The bulk of cosmic rays are normally deflected away from the Earth by the geomagnetic field, but during a reversal a great many more pass through the atmosphere, the most energetic reaching the surface and the biosphere. The kauri growth rings record fluctuations in the generation of ^{14}C by their passage and thereby the geomagnetic field strength, which was only 6% of normal levels from 42.3 to 41.6 ka (Cooper, A. and 32 others 2021. A global environmental crisis 42,000 years ago. *Science*, v. **371**, p. 811-818; DOI: 10.1126/science.abb8677). This coincided with an unrelated succession of periods of low solar activity and a reduced solar 'wind', which also provides some cosmic-ray protection when activity is at normal levels; a 'double whammy'. One consequence may have been destruction of stratospheric ozone by cosmic rays and thus increased ultraviolet exposure at ground level.

Combined with the highly precise growth-ring dating, the climatic changes over the 1700 year lifetime of the kauri tree can be linked to other records of environmental change across the world. These include glacial ice- and lake-bed cores together with stalactite layers. Apparently, the Laschamps geomagnetic reversal coincided with abrupt shifts in wind belts and precipitation, perhaps triggering major droughts in the southern continents. Highly plausible, but some of the other speculations are less certain. For instance, sometime around 42 ka, but far from well-established, Australia's marsupial megafauna experienced major extinctions, the Neanderthals disappear from the fossil record and modern humans started decorating caves in Europe (20 ka after they did in Indonesia). In fact, speculation becomes somewhat silly, with suggestions that early Europeans went to live in caves because of increased exposure to UV (they knew, did they, while Neanderthals didn't?), their painting and, by implication, their entire culture shifting through the shock and awe of mighty displays of the aurora borealis. Just because the number 42 is (or was), according to the late Douglas Adams's *Hitchhiker's Guide to the Galaxy,* 'the answer to life, the universe and everything', the authors tag the episode as the 'Adams Event'. In their summary for The Conversation they include an animation with a quintessential Stephen Fry narrative, which Earth-logs readers can judge for themselves. Perhaps 'Lockdown Trauma' has a lot more to answer for, other than upsurges in Zoom conferences, knitting and baking banana bread …

See also: Voosen, P. 2021. Kauri trees mark magnetic flip 42,000 years ago. *Science*, v. **371**, p. 766; DOI: 10.1126/science.371.6531.766

Snippet: Early human collection of useless objects (April 2021)

The Ga-Mohana rock shelter in North Cape Province, South Africa (Credit: Jayne Wilkins, University of the Witwatersrand)

We all, especially as kids, have collected visually interesting objects for no particular reason other than they 'caught our eye': at the beach; from ploughed fields; river gravel, or at the side of a path. They end up in sheds, attics and mantel shelves. In an online *News and Views* article at the *Nature* website Pamela Willoughby discusses the significance of a paper on an archaeological site in the southern Kalahari Desert, North Cape Province South Africa (Willoughby, P.R. 2021. Early humans far from the South African coast collected unusual objects. *Nature*, v. **323**, online *News and Views*; DOI: 10.1038/d41586-021-00795-5). Jayne Wilkins and co-workers from South Africa, Australia, Canada, Austria and the UK have investigated a rock shelter, with floor deposits going back over 100 thousand years. The researchers have, in a sense, continued the long human habit of seeking *objets trouvée* by using trowels and sieves to excavate the shelter's floor sediments. They found a collection of cleavage fragments of white calcite and abundant shards of ostrich shell. Ga-Mohana Hill is still a place that locals consider to have spiritual significance. The authors consider the original collectors to have had no other motive than aesthetic pleasure and perhaps ritual, and that this signifies perhaps the earliest truly modern human behaviour. Yet, in 1925 a cave on the other side of South Africa, in Limpopo Province, yielded a striking example of a possible 'collector's piece' from much earlier times. It is associated with remains of australopithecines and has been dated to around 3 Ma ago (see: Earliest sign of a sense of aesthetics, November 2020).

Source: Wilkins, J. *et al.*2021. Innovative *Homo sapiens* behaviours 105,000 years ago in a wetter Kalahari. *Nature*, v. **323** DOI: 10.1038/s41586-021-03419-0

Relationships between modern humans and Neanderthals (April 2021)

Before 40 thousand years (ka) ago Europe was co-occupied by Neanderthals and anatomically modern humans (AMH) for between five to seven thousand years; about 350 generations – as long as the time since farming began in Neolithic Britain to the present day. Populations of both groups were probably low given their dependence on hunting and foraging during a period significantly colder than it is now. Crude estimates suggest between 3,000 to 12,000 individuals in each group; equivalent to the attendance at a single English Football League 2 match on a Covid-free winter Saturday afternoon. Moving around Europe south of say 55°N, their potential range would have been around 5 million square kilometres, which very roughly suggests that population density would be one person for every 200 km^2. That they would have moved around in bands of, say, 10 to 25 might seem to suggest that encounters were very infrequent. Yet a hybrid Neanderthal-Denisovan female found in Siberia yielded DNA that suggested a family connection with Croatia, 5,000

km away (see: Neanderthal Mum meets Denisovan Dad, August 2018); early humans moved far and wide.

The likely appearances ofa European Neanderthal and a anatomically modern human recently arrived from Africa, when they first met between 50 and 40 thousand years ago. (Credit: Jason Ford, New York University)

A sparsely populated land can be wandered through with little fear other than those of predators, sparse resources or harsh climate and lack of shelter. But it still seems incredible for there to have been regular meetings with other bands. But that view leaves out knowledge of good places to camp, hunt and forage, which assure shelter, water, game and so forth, and how to get to them: a central part of hunter-gatherers' livelihoods. There would have been a limited number of such refuges, considerably increasing chances of meeting. Whatever the physiognomic differences between AMH and Neaderthals, and they weren't very striking, meeting up of bands of both human groups at a comfortable campsite would be cause for relief, celebration, exchanges of knowledge and perhaps individuals of one group to partner members of the other.

As well as that from Neanderthals, ancient DNA from very early European AMH remains has increasingly been teased out. The latest comes from three individuals from Bacho Kiro Cave in Bulgaria dated to between 45.9 to 42.6 ka; among the earliest known, fully modern Europeans. One had a Neanderthal ancestor less than six generations removed (perhaps even a great-great grandparent 60 years beforehand). Because of the slight elapsed time, the liaison was probably in Europe, rather than in the Middle East as previously suggested for insertion of Neanderthal genes into European ancestry. The genetic roots of the other two families stemmed back seven to ten generations – roughly 100 to 150 years (Hajdinjak, M. and 31 others 2021. Initial Upper Palaeolithic humans in Europe had recent Neanderthal ancestry. *Nature*, v. **592**, p. 253–257; DOI: 10.1038/s41586-021-03335-3). The interpretation of these close relationships stems from the high proportion of Neanderthal DNA (3 to 4 %) in the three genomes. The segments are unusually lengthy, which is a major clue to the

short time since the original coupling; inherited segments tend to shorten in successive generations. The groups to which these AMH individuals belonged did not contribute to later Eurasian populations, but link to living East Asians and Native Americans. They seem to have vanished from Europe long before modern times. The same day saw publication of a fourth instance of high Neanderthal genetic content (~3 %) in an early European's genome, extracted from a ~45 ka female AMH from Zlatý kůň (Golden Horse) Cave in Czechia (Prüfer, K. and 11 others 2021. A genome sequence from a modern human skull over 45,000 years old from Zlatý kůň in Czechia**.** *Nature Ecology & Evolution* DOI: 10.1038/s41559-021-01443-x). In her case, too, the Neanderthal DNA segments are unusually lengthy, but indicate 70 to 80 generations (~2,000 to 3,000 years) had elapsed. Her DNA also suggests that she was dark-skinned and had brown hair and brown eyes. Overall her genetics, too, do not have counterparts in later European AMH. The population to which she belonged may have migrated westwards from the Middle East, where one of her ancestors had mated with a Neanderthal, perhaps as long as 50 ka ago. But that does not rule out her group having been in Europe at that time. A later modern human, dated at 42 to 37 ka, is a young man from the Petştera cu Oase cave in Romania, whose forbears mixed with Neanderthals. His genome contains 6.4% of Neanderthal DNA, suggesting that his Neanderthal ancestor lived a mere 4 to 6 generations earlier, most likely in Europe, and was perhaps one of the last of that group.

The data suggest that once modern humans came into contact with their predecessors in the Middle East and Europe, mixture with Neanderthals was 'the rule rather than the exception'. Yet their lack of direct relationship to later Europeans implies that AMH colonisation of Europe occurred in successive waves of people, not all of whom survived. As Palaeolithic specialist Chris Stringer of the Natural History Museum in London cautions, of these multiple waves of incomers 'Some groups mixed with Neanderthals, and some didn't. Some are related to later humans and some are not'. Even five thousand years after 'first contact', relations of modern humans with Neanderthals remained 'cordial', to say the least, including with the last few before their extinction.

See also: Gibbons, A. 2021. More than 45,000 years ago, modern humans ventured into Neanderthal territory. Here's what happened next. *Science*, v. **372**, News article; DOI: 10.1126/science.abi8830. Callaway, E. 2021. Oldest DNA from a *Homo sapiens* reveals surprisingly recent Neanderthal ancestry. *Nature*, v. **592**, News article; DOI: 10.1038/d41586-021-00916-0. Genomes of the earliest Europeans (*Science Daily*, 7 April 2021). Bower, B. 2021 Europe's oldest known humans mated with Neandertals surprisingly often (*ScienceNews*, 7 April 2021)

Wider traces of the elusive Denisovans (May 2021)

We know that when anatomically modern humans (AMH) arrived in Asia they shared the landscape with 'archaic' humans that had a much longer pedigree. In 2010 an individual's little-finger bone dated to around 30 to 49 ka old was found in the Denisova Cave in central Siberia (at 50°N). It yielded a full genome that was distinctly different from those of AMH and Neanderthals (see: Other rich hominin pickings; May 2010). Four other fossils found subsequently in the Denisova Cave contained similar DNA. Checking the DNA of living humans and fossil Neanderthal remains revealed that the newly discovered human group had interbred with both. In the case of AMH, segments of Denisovan DNA are found in the

genomes of indigenous people living in East and South Asia, Australia, the Pacific Islands and the Americas, at levels of 0.2%, rising to 6% in Melanesian people of Papua-New Guinea. But such introgressions have not been found in Europeans (but see below), suggesting that the Denisovans were restricted to Asia.

There have been suggestions that at least some of the 'archaic' human remains found widely and abundantly in China may have been Denisovans; although they might equally be of *Homo erectus*, or a series of groups that evolved from it in Asia. But none of the Chinese fossils have been subjected to gene sequencing – those found in caves outside tropical and sub-tropical climates might retain DNA just as well as Neanderthal and even older remains in temperate Europe. Yet a partial lower jaw discovered in a cave on the Tibetan Plateau (at 35°N) did yield proteins that had close affinities to those recovered from Siberian Denisovans. Now similar analyses have been performed on an abnormally large molar found in a cave in Northern Laos, showing that it too is most likely to be from a young – as suggested by its being little worn – possibly female Denisovan (it lacks male-specific peptides),. The locality lies at about 20°N, far to the south of the other two Denisovan sites (Demeter, F. *et al*. A Middle Pleistocene Denisovan molar from the Annamite Chain of northern Laos. *Nature Communications*, v. **13**, article 2557; DOI: 10.1038/s41467-022-29923-z). Sparse as the evidence is, Denisovans were able to tolerate climate differences across 30 degrees of latitude.

A probable Denisovan molar from 164 to 131 ka old cave sediments in northern Laos. (credit: Demeter, et al.; Fig. 2)

The Wikipedia entry for Denisovans is a mine of additional information. For instance, detailed analysis of the roughly 5% of their genome that indigenous people of New Guinea carry suggests that the two groups may have interbred *there* as late as 30 ka. Since Both New Guinea and Australia were until 8 thousand years ago part of the Sahul landmass when sea level was low during the last ice age, these inferences add tropical occupancy to the Denisovan range. Perhaps this suggest that Papuans and indigenous Australians migrated

together with Denisovans. Or maybe the latter crossed the sea from Timor earlier and independently, after moving from Asia by 'hopping' from island to island through eastern Indonesia. There is a possibility that Denisovans could even have survived in Sahul until as late as 14.5 ka. Even more odd, modern Icelandic people are unique among Europeans in having detectable traces of Denisovan DNA. However, rather than having been directly shared between Denisovans and ancestral Scandinavians – a possibility – it may have been carried by Neanderthal-Denisovan hybrids migrating westwards from Siberia with whom the Icelanders' ancestors interbred. There are other interesting points in the Wikipedia entry. One is that the consistently lower Denisovan ancestry in living East Asians compared with people of Oceania, may indicate two separate waves of eastward migration by AMH. The latter may have arrived first, had greater contact with Denisovans and then moved on across seaways to remain isolated from the later migrants.

Finally, something that puzzles me, as a non-geneticist. If both Denisovans and Neanderthals died out as genetically distinct groups tens of millennia ago how could the genetic traces of interbreeding with AMH have been retained at such high levels until the present; i.e. through thousands of generations? Each of us carries a 50% deal of genes from our parents. Then with each subsequent generation the proportion is diluted, so that we inherit 25% from grandparents, 12.5 % from great-grandparents and so on. Yet Papuans still have 5 to 6 percent of Denisovan DNA: much the same holds for Europeans' Neanderthal heritage. Does such a high level of retention of this ancestry suggest that a large proportion of the earliest migrating AMH individuals stemmed from generation to generation interbreeding on a massive scale? Did the 'newcomers' and 'locals' band eventually together almost completely to merge genetically, or am I missing something … ? Probably

New dating questions previous ideas about early hominins (July 2021)

The face of an Australopithecus africanus: 'Mrs Ples'. (Credit University of Zurich)

The Sterkfontein cave 40 km northwest of Johannesburg in South Africa first sprang to the attention of scientists in 1936, with the discovery there of an adult hominin skull. This

showed clear affinities with another find in 1924 400 km to the SW of the fossil skull of a juvenile primate, which Raymond Dart claimed to be ancestral to modern humans, naming it *Australopithecus africanus*. Sterkfontein has since yielded more than 500 hominin fossils, many of which are *Au. africanus*.

Limestone cave deposits are difficult to date precisely, unlike sediments that are interbedded with volcanic rocks, the most amenable material being that deposited by water flowing through the cave to form flowstone or speleothem. Using the U-Pb method of radiometric dating yielded an age of between 2.1 to 2.6 Ma for flowstone that cements the breccia in which the *Au. africanus* fossils occur. Clearly, the flowstone formed after burial so that was a minimum age for the sediment, awaiting the use of a different chronological tool to suggest when burial of the bones took place.

An almost complete skeleton of another australopithecine found in another part of the Sterkfontein cave system was dated in 2015 by a different approach. This used the decay of ^{10}Be and ^{26}Al isotopes that high-energy cosmic rays produce in quartz grains while they are exposed at the surface. Burial of irradiated sedimentary grains protects them from such bombardment, and the two isotopes then steadily decay at a known rate. Quartz grains associated with this specimen (fondly known as 'Little Foot') turned out to be far older than the flowstone U-Pb age, with a cosmogenic burial age of about 3.7 Ma. Its much greater antiquity prompted scientists to regard 'Little Foot' as a different species – *Au. prometheus* – despite being similar to *Au. africanus*.

Since that success, much the same team from South Africa, the US and France has been working on sedimentary grains buried with the abundant *Au. africanus* specimens from Sterkfontein (Granger D.E. *et al*. 2022. Cosmogenic nuclide dating of Australopithecus at Sterkfontein, South Africa. *Proceedings of the National Academy of Sciences*, v. **119**, article e2123516119; DOI: 10.1073/pnas.2123516119). Their newly published efforts show that "Little Foot's" burial took place between 3.41 and 3.49 Ma, more than a million years earlier than suggested by the flowstone U-Pb dating and just ~200 ka younger than the 'Little Foot' skeleton. More surprising is that *Au. africanus lived* during the same period (3.4 to 3.7 Ma) as did *Au. afarensis* – the species to which 'Lucy' belonged – 3500 km to the north in Ethiopia.

So it is no longer justifiable to suggest that the first known human species (*Homo habilis* ~2.3 to 1.65 M) is either a more 'advanced' australopithecine or a direct descendant from that genus, for the new dating opens a million-year gap in the history of human evolution. That age range does contain stone tools but no plausible candidates for an australopithecine-human evolutionary connection. One of the most recently suggested links is *Au. sediba* (see: Another candidate for earliest, direct human ancestor, October 2011; and Australopithecus sediba: is she or is she not a human ancestor? April 2013). The snag with that candidate is that the well-established age (2.0 Ma) of known specimens falls in the middle of the range for *H. habilis*. The two may have been cohabiters of Africa but are very different.

The million years that separated *Au. africanus* together with *afarensis* from *H. habilis* is the period when the defining character of humans, tool making, evolved. So the hunt is on for hominins associated with stone tools in that huge stratigraphic gap. One of the drawbacks with famous sites, such as the 'Cradle of Humankind' that includes Sterkfontein, is that they

almost become clichés so that scientists return to them again and again, while the key that they seek may well lie elsewhere.

The earliest upright ape (August 2021)

Published on August 26, 2022 Leave a comment

an account of a new find in Chad (see: Bonanza time for Bonzo; July 2002). A fossil cranium, dubbed *Sahelanthropus tchadensis* (nicknamed *Toumaï* or 'hope of life' in the Goran language), appeared like a cross between a chimpanzee and an australopithecine. The turmoil erupted partly because of its age: Upper Miocene, around 7 Ma old. Such an antiquity was difficult to reconcile with the then accepted ~5 Ma estimate for the evolutionary split between humans and chimpanzees, based on applying a 'molecular clock' approach to the difference between their mtDNA. The other point of contention was the size of *Sahelanthropus's* canine teeth: far too large for australopithecines and humans, but more appropriate for a gorilla or chimp.

Cast of the cranium of Sahelanthropus tchadensis. (Credit: Didier Descouens, University of Toulouse)

In the absence of pelvic- and foot bones, or signs of the *foramen magnum* where the spinal cord enters the skull – crucial in distinguishing habitual bipedalism or being an obligate quadruped – encouraged the finders of a 6.1 to 5.7 Ma-old Kenyan hominin *Orrorin tugenensis* to insist that its skeletal remains – several teeth, fragments of a lower jaw, a thigh bone, an upper arm and of a finger and thumb but no cranial bones – were of 'the earliest human ancestor'. In *Orrorin's* favour were smaller canine teeth than those of later australopithecines. At the time of the dispute, centred mainly on absence of crucial evidence, doyen of hominin fossils Bernard Wood of George Washington University and an advocate of 'untidy' evolution, suggested that both early species may well have been

evolutionary 'dead ends' (see: A considered view; October 2002). And there the 'muddle' has rested for 20 years.

In 2002 not only a cranium of *Sahelanthropus* had been unearthed. Three lower jaw bones and a collection of teeth suggested that as many as 5 individuals had been fossilised. A partial leg bone (femur) and three from forearms (ulna) cannot definitely be ascribed to *Sahelanthropus* but, in the absence of evidence of any other putative hominin species, they may well be. It has taken two decades for these remains to be analysed to a standard acceptable to peer review (Daver, G. *et al*. 2022. Postcranial evidence of late Miocene hominin bipedalism in Chad. *Nature* v. **608**, published online; DOI: 10.1038/s41586-022-04901-z). The authors present convoluted anatomical evidence that *Toumaï's* femur, which had been gnawed by a porcupine and lacks joints at both ends, and have suggested that it was indeed suited to upright walking. Yet the arm bones hint that it may have been equally comfortable in tree canopies. But the cranium does look very like that of an ape rather than a hominin.

Much the same conclusion has been applied to *Australopithecus afarensis*, indeed its celebrated representative 'Lucy' met her end through falling out of a large tree ~3.2 Ma ago (see: Lucy: the australopithecine who fell to Earth?; September 2016). So, dual habitats may have been adopted by hominins long after they emerged. Yet *Au afarensis* was capable of trudging through mud as witnessed by the famous footprints at Laetoli in Tanzania. Only around 3 Ma has reasonably convincing evidence for upright walking similar to ours been discovered in *Au africanus*. The full package of signs from pelvis and foot for habitual bipedalism dates to 2 Ma ago in *Au sediba*. Even this latest-known australopithecine seems to have had a gait oddly different from that of members of the genus *Homo*.

So, in many respects the benefits of full freeing of the hands to develop manipulation of objects, as first suggested by Freidrich Engels, may have had to await the appearance of early humans. Earlier hominins almost certainly did make tools of a kind, but the revolutionary breakthrough associated with humanity was more than 5 million years in the making.

See also: Callaway, E. 2022. Seven-million-year-old femur suggests ancient human relative walked upright. *Nature (News)*24 August 2022; Handwerk, B. 2022. Seven Million Years Ago, the Oldest Known Early Human Was Already Walking. *Smithsonion Magazine*, 24 August 2022 (click the link 'published today in Nature' in 2nd paragraph to access complimentary PDF of Daver *et al)*

Earliest Americans and Denisovan art (September 2021)

It was Mary Leakey's jaw-dropping discovery in the 1970s of the footprints of two adult *Australopithecus afarensis* and an accompanying juvenile in 3.6 Ma-old volcanic ash at Laetoli, Tanzania that provided the oldest palpable evidence of a bipedal hominin species. Just seeing a high-resolution image of this now legendary trackway made me determined to call my book on Earth and human evolution *Stepping Stones: the Making of our Homeworld*. Human footprints have figured several times in Earth-logs articles. A jumble of footprints in 1.0 to 0.78 Ma old Pleistocene interglacial sediments at Happisbugh on England's Norfolk coast marks the presence there of *Homo antecessor*: the earliest known, northern Europeans. In The first volcanologists (March 2003) I noted the discovery of evidence that

Neanderthal children played in 350 ka volcanic ash on the Roccamonfina volcano in Italy. The emotion generated by seeing such relics has never left me. Two similarly important proofs of human presence emerged in September 2021.

Footprints thought to have been made by children and teenagers between 23 and 21 thousand years ago in lake shore muds at White Sands, New Mexico. (Credit Bennett et al. 2021)

Since 2011 a variety of evidence has accumulated that the Americas began to be populated by anatomically modern humans before what had long been assumed to be the 'first arrivals': the Clovis people who made finely-worked stone spear points first found in 13 ka-old sediments in New Mexico. To the pre-Clovis artefacts that suggested earlier immigrations have been added indisputable signs of human presence even earlier than anticipated. They were uncovered in lake sediments beneath the gypsum sand dunes of White Sands National Park in New Mexico. The site is not far from where Robert Oppenheimer exclaimed to himself 'Now I am become Death, the destroyer of worlds' after he witnessed his creation, the first detonation of a nuclear weapon on 9 July 1945. These lake sediments have yielded thousands of human and animal footprints over the years, but the latest have been dated at between 23 to 21 ka (Bennett, M.R. and 13 others 2021. Evidence of humans in North America during the Last Glacial Maximum. *Science*, v. 373, p. 1528-1531; DOI: 10.1126/science.abg7586). As with the Happisburgh and Roccamonfina human trackways, size analysis suggests that they were made mainly by children and teenagers! Other animal trackways show that the lake edge was teeming with game at the height of the last Ice Age: abundant food for hunter-gatherers generally results in lots of free time. So maybe these early American people were having fun too. When ice sheets were at their maximum extent sea level had fallen, leaving the Bering Strait dry. The broad Beringia land-bridge made the Americas accessible from Eurasia. Whatever objections have previously been raised as regards human penetration south from Alaska during the Last Glacial Maximum, the White Sands find sweeps them away; people overcame whatever obstacles there were.

Travertine outcrop covered with hand- and footprints at Quesang on the Tibetan Plateau (Credit: Zhang et al., Fig. 1c)

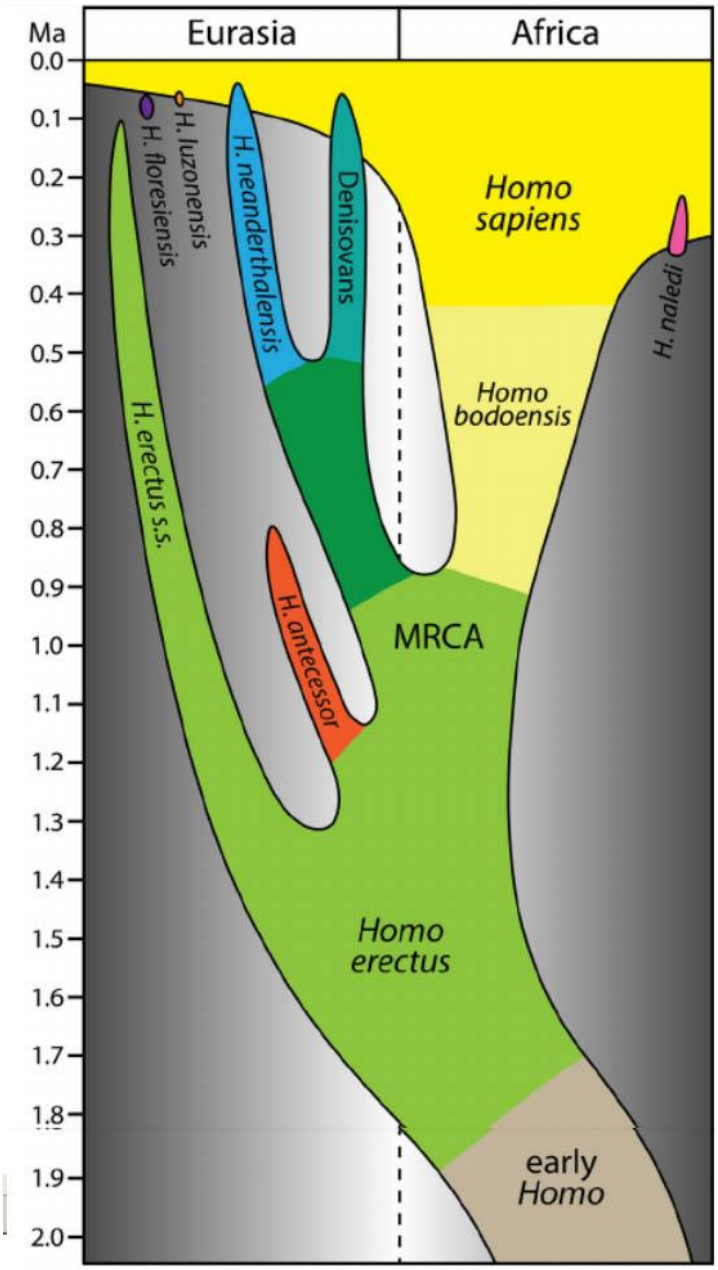
Much older footprints and handprints, preserved in a biogenic carbonate (travertine) deposit from the Tibetan Plateau – more than 4,000 metres above sea level – are reported in an article soon to be published by Elsevier (Zhang, D.D. and 17 others 2021. Earliest

parietal art: hominin hand and foot traces from the middle Pleistocene of Tibet, *Science Bulletin* v 66 online; DOI: 10.1016/j.scib.2021.09.001). Travertine forms when calcium carbonate is precipitated from lime-rich spring water onto films of algae or bacteria. At first it is soft and spongy, hardening as more carbonate is precipitated and solidifying when dried out to form a porous rock. People made a jumble of prints when they pressed their hands and feet into the originally spongy biofilm. Three-dimensional images of the slab provide the basis for interpreting how the prints were made. There are 5 handprints and 5 footprints. From comparing their sizes with modern humans' feet and hands, it seems that the handprints were made by a single 12-year-old, and the footprints by a child of about 7. Although the travertine layer would have been steep and slippery none of the prints show signs of falling or sliding. They seem to have been deliberately placed close to one another, with suggestions that at least one thumb was wiggled. The authors argue that the prints are a form of art similar to the hand stencils commonly seen on Palaeolithic cave walls. It could be that a couple of kids took delight in leaving signs that they had been there, 'messing around': but still an art form. What is especially exciting is their age, between 169 and 226 ka. The children are unlikely to have been anatomically modern humans, who first reached Tibet only a little before 21 ka. One alternative is that they were Denisovans (see: Denisovan on top of the world, May 2019.

See also: Bennett, M.R. 2021. Fossil footprints prove humans populated the Americas thousands of years earlier than we thought. *The Conversation*, 23 September 2021. 2021Metcalf, T. 2021. Art or not? Ancient handprints spark debate. *NBC News*, 16 September 2021.

A new, 'bureaucratised' hominin* – Homo bodoensis *(November 2021)

Palaeoanthropologists are in a bit of a muddle about the early humans of the Middle Pleistocene (~780 to 130 ka), namely *Homo heidelbergensis* and *H. rhodesiensis*. The first was defined in 1907 based on a massive lower jaw or mandible (but no cranium) found near Heidelberg in Germany. Fourteen years later a massively browed cranium (but no mandible) turned up near Kabwe in what is now Zambia (then Northern Rhodesia). That specimen became, in true colonialist fashion, *H. rhodesiensis*. Since then scientists have unearthed more such highly 'robust', 'archaic' remains in Africa, Asia and especially Europe: including at least 28 individuals in the Sima de los Huesos ('pit of bones'), part of the World Heritage Site in the Atapuerca mountains of northern Spain. Do these widespread fossils really represent just two species or do specimens just happen to fit within two broadly similar morphological types? These days, most scientists experience discomfort with a reference to the legacy of Cecil Rhodes, so several sacks full of bones were metaphorically lumped into *H. heidelbergensis.* So widely dispersed are their sources and their ages covering such a wide span of time that the specimens might be expected to contain a diverse range of genetic signatures. Yet only a single specimen from northern Spain, dated around 400 ka, has yielded DNA. The Sierra de Atapuerca provided an even more archaic European dated between 1.2 to 0.8 Ma (Early Pleistocene), from which dental proteins have been extracted. Comparative proteomics have encouraged *H. antecessor* to be considered as a possible common ancestor for anatomically modern humans (AMH), Neanderthals and Denisovans … and *H. heidelbergensis*.



A new, simplified model for the evolution of the genus Homo over the last 2 million years- dark green may represent the ancestors of both Neanderthals and Denisovans (Credit: Roksandic et al Fig 1)

A group of palaeoanthropologists has proposed a way to clear such muddy waters (Roksandic, M. & Radović, P. *et al*. 2021. Resolving the "muddle in the middle": The case for *Homo bodoensis* sp. nov.. *Evolutionary Anthropology*, v. **30**, early-release article 21929; DOI: 10.1002/evan.21929). Their device is to abolish the two previous species and lump together many human remains from the Middle Pleistocene of Africa into a new species named after the Bodo site in the Awash Valley of Ethiopia. It was there that a human cranium that bears characteristics similar to all the African specimens was found in 1976. Originally it was allocated to *H. heidelbergensis*, but now the composite group of archaic Middle Pleistocene Africans is proposed to be assigned to *H. bodoensis*. This composite species is also reckoned by the authors to be the ancestor of all surviving, anatomically modern humans. European examples of *H. heidelbergensis* are to be slotted into an early population of Neanderthals.

Since the Denisovans of Asia are only known by DNA from tiny skeletal fragments, the taxonomic rearrangement logically should assign Asian archaic humans to early members of that mysterious but well-defined group. But a spanner in the works is that the sole example of *H. heidelbergensis* DNA (mitochondrial) – from northern Spain – more closely resembles Denisovans than it does that of Neanderthals (see: Mitochondrial DNA from 400 thousand year old humans; Earth-logs December 2013).

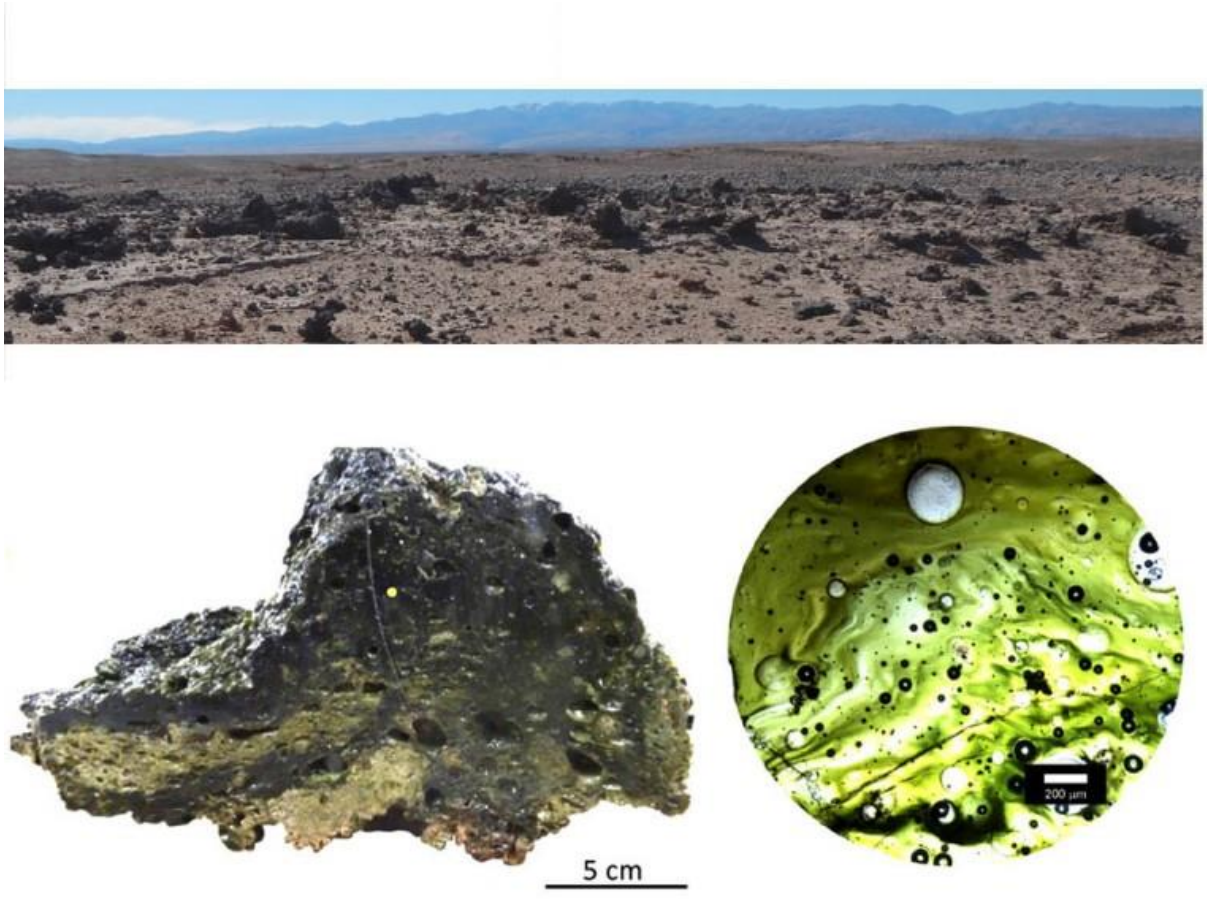
There is also a bit of a problem with *H. antecessor*. There aren't many specimens, and they are all from Atapuerca. Yet they are a plausible candidate, according to the proteomic analyses, for the most recent common ancestor (MRCA) of all subsequent humans (whatever taxonomists care to call them). But they do not fit in the taxonomic model suggested by Roksandic *et al*., who reject them as MRCA, on grounds that they are European. They consign them to an anomalous 'spur' that petred out in Spain while the real action was in Africa. So what happens if a cranium that bears close similarity to both *H antecessor* and *H. bodoensis* pops out of African Early Pleistocene sediments (older than about 700 ka)? There is at least one candidate from ~1 Ma sediments in Eritrea (Abbate, E. and 16 others 1998. A one-million-year-old *Homo* cranium from the Danakil (Afar) Depression of Eritrea. *Nature*, v. **393**, p. 458-460; DOI: 10.1038/30954), which is said to display 'a mixture of characters typical of *H. erectus* and *H. sapiens*'. And there are others of that antiquity from Ethiopia.

Since the time of Charles Darwin there have been taxonomists who were (and are) either habitual 'lumpers' or 'splitters'. There are more with a propensity for splitting because a new species carries the name of its initiator into posterity! So I expect the paper by Roksandic *et al*. to raise a cloud of academic dust. Yet taxonomic lumping has its stand-out species in the field of human evolution – *H. erectus*. A great many 'archaic-looking' human remains from the period after ~1.9 Ma until as recently as 200 ka have been dubbed 'Erects', giving the group an unsurpassed survival span of over a million years. A few early examples from Africa have been 'split' away to give *H. ergaster*, on taxonomic grounds that some palaeoanthropologists do not fully accept. Yet there are signs of later diversity that 'splitters' have, so far, not dared to slice-off from the mainstream consensus. So common are these 'Erect' fossils in China, that it is almost state policy that it was they who gave rise to living Han Chinese people! The lumpers are likely to hold sway in the absence of ancient DNA sequencing, which may never be possible outside temperate climates or for ages greater than that of the Spanish *H. antecessor*. With the knowledge that several anatomically very distinct hominin groups occupied the Earth together at several times in the last 300 ka – think *H. floresiensis* and *H. naledi* – it seems likely that the proposed pan-African *H. bodoensis* may not reflect past reality and the hypothesis needs considerably more testing

A cometary air-burst over South America 12 thousand years ago (November 2021)

Earth-logs has previously covered quite a few hypotheses involving catastrophic astronomical events of the past, often returning to them as new data and ideas emerge. They range from giant impacts, exemplified in the mass extinction at the K-Pg boundary to smaller-scale events that may have coincided with important changes in climate, such as the sudden onset of the Younger Dryas, and a few that have been suggested as agencies affecting local human populations such as the demise of Sodom by a cosmogenic air-burst.

Some of the papers that spurred the Earth-pages posts have been widely regarded in the geoscience community. Yet there have been others that many have doubted, and even condemned. For instance, data used by the consortium that suggested an extraterrestrial event triggered the frigid millennium of the Younger Dryas (YD) have been seriously and widely questioned. A sizeable number of the team that were under close scrutiny in 2008 joined others in 2019 to back the YD air-burst hypothesis again, using similarly 'persuasive' data from Chile. Members of the original consortium of academics also contributed to the widely disputed notion of a cosmic air-burst having destroyed a Bronze Age urban centre in Jordan that may, or may not, have been the site of the Biblical Sodom. Again, they cited almost the 'full monty' of data for high-energy astronomical events, but again no crater or substantial melt glass, apart from tiny spherules. Now another paper on much the same theme, but none of whose authors contributed to those based on possibly 'dodgy' data, has appeared in *Geology* (Schultz, P.H. *et al*. 2021. Widespread glasses generated by cometary fireballs during the Late Pleistocene in the Atacama Desert, Chile. *Geology*, published online November 2, 2021; doi: 10.1130/G49426.1).



Chilean glass occurrence: panorama of large glass fragments in the Atacama Desert; a specimen of the glass; thin section of glass showing bubbles, folding and dusty particles (Credit: Schultz et al. 2021; Figs 1B, 2D and 2C)

Peter Schultz of Brown University, USA and colleagues from the US and Chile make no dramatic claims for death and destruction or climate destabilisation, and simply report a fascinating discovery. In 2012 one of the authors, Nicolas Blanco of the Universidad Santo Tomás in Santiago, Chile, found slabs made of glassy material up to half a metre across. They occurred in several 1 to 3 km^2 patches over a wide area of the Atacama Desert. Resting

on Pleistocene glacio-fluvial sediments, they had been exposed by wind erosion of active sand dunes. The glass is dark green to brown and had been folded while still molten. For the glass slabs to be volcanic bombs presupposes a nearby volcano, but although Chile does have volcanoes none of the active vents are close enough to have flung such large lumps of lava into the glass-strewn area. The glassy material also contains traces of vegetation, and varies a great deal in colour (brown to green). Its bulk chemical composition suggests melting of a wide variety of surface materials: quite unlike volcanic glasses.

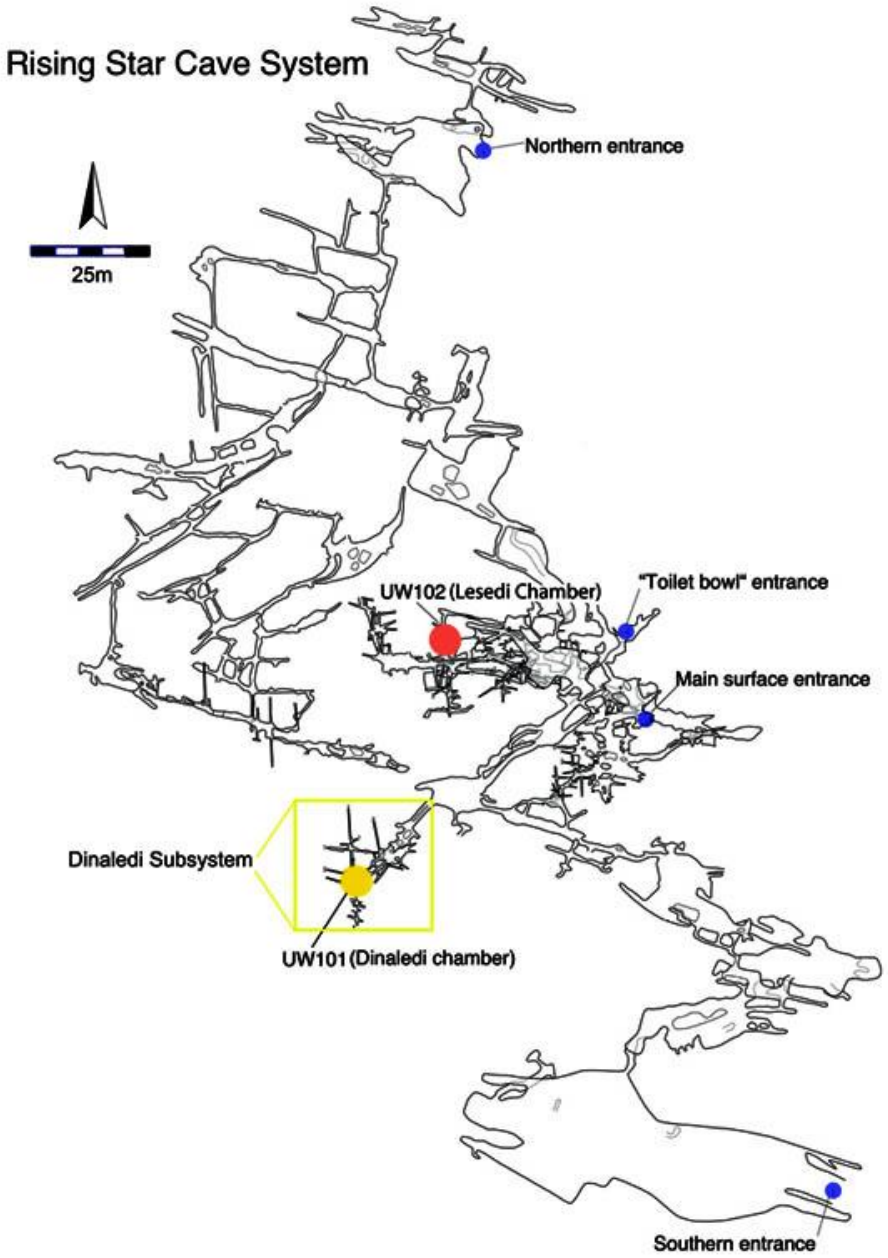
Microscopic examination of thin sections of the glasses also reveals nothing resembling lava, except for gas bubbles. The slabs are full of exotic fragments, some of which closely resemble mineral assemblages found in meteorites, including nickel-rich sulfides embedded in ultramafic material. Others are calcium-, aluminium- and titanium-rich inclusions, such as corundum (Al_2O_3) and perovskite ($CaTiO_3$), thought to have originated as very-high temperature condensates from the pre-solar nebula: like the celebrated 'white inclusions' in the Allende meteorite. Some minute grains resemble dust particles recovered by the NASA Stardust mission to Comet 81P/Wild-2 which returned samples to Earth in 2006. Zircon grains in the glasses, presumed to be locally derived, have been decomposed to zirconium oxide (baddeleyite), suggesting melting temperatures greater than 1670°C: far above the highest temperature found in lavas (~1200°C). Interestingly, the green-yellow silica glass strewn over the Sahara Desert around the southern Egypt-Libya border also contains baddeleyite and cometary dusts, together with anomalously high platinum-group elements and nanodiamonds that are not reported from the Chilean glass. Much prized by the elite of pharaonic Egypt and earlier makers of stone tools, the Saharan glass is ascribed to shock heating of the desert surface by a cometary nucleus that exploded over the Sahara. Unsurprisingly, Schultz *et al*. come to the same conclusion.

Any object entering the Earth's atmosphere does so at speeds in excess of our planet's escape velocity (11.2 km s^{-1}). Not only does that result in heating by friction with the air, but much of the kinetic energy of hypersonic entry goes into compressing air through shock waves, especially with objects larger than a few tens of metres. Such adiabatic compression can produce temperatures well above 10,000 °C. Hence the 'fireballs' associated with large meteorites. With very large air-bursts the flash of radiant energy would be sufficient to completely melt surface materials in microseconds, though rugged topography could protect areas shadowed from the air-burst by mountains, perhaps explaining the patchy nature of the glass occurrences. (**Note:** the aforementioned papers on the YD and Sodom 'air-bursts' do not mention large glass fragments, whereas some surface melting would be expected). Some of the Chilean glass contains carbonised remnants of vegetation. Radiocarbon dating of four samples show that the glass formed at some time between 16.3 to 12.1 ka. Yes, that does include the age of the start of the YD (12.9 ka) and human migrants had established themselves in northern Chile and coastal Peru after 14.2 ka. Yet the authors, perhaps wisely, do no more than mention the coincidence, as well as that with the disappearance of South American Pleistocene megafaunas – more severe than on any other continent. With a very distinctive product, probably spanning a far larger area of South America, and attractive to humans as an ornament or a resource for sharp tools, expect follow-up articles in the future.

See also: http://www.sci-news.com/space/atacama-desert-comet-10247.html, *Science News*, 8 November 2021; Vast patches of glassy rock in Chilean desert likely created by ancient exploding comet, *Eureka Alert*, 2 November 2021.

Some Homo naledi news (December 2021)

In 2015 the remains of about 15 hominins, new to science, were found in a near-inaccessible South African cave (See: The 'star' hominin of South Africa; September 2015), that number having risen to more than 24 at the time of writing. The 'star' status of *Homo naledi* (named after the cave's name, *Naledi* meaning star in the local Sotho language) arose partly from an extraordinary barrage of promotion by the organisers of the expedition that unearthed them. But it was indeed one of the most extraordinary discoveries in palaeoanthropology. The remains were recovered by a team of women archaeologists who are small and lithe enough to wriggle through a maze of extremely narrow cave passages.



Map of the Rising Star cave system in Gautong Province South Africa. The yellow dot marks the chamber where Homo naledi fossils were first found; the red one is the site of a new discovery. (Credit: Elliott et al 2021, PaleoAnthropology. Issue 1.64, Fig. 1)

The bones in the remote chamber were complete, with no sign of physical trauma, except gnawing by snails and beetles. Few hominin fossils were found in the more accessible parts of the cave. One likely explanation was that a living *H. naledi* group had deliberately carried the bodies through the cave system for burial – at less than 1.5 m tall with a slender build they could have done this far more easily than the modern excavators. A plausible alternative is that a group of *H. naledi* scrambled deep into the cave on being panicked by large predators, and suffocated as CO_2 built-up to toxic levels.

Initially, the bones were estimated to be 2 Ma old. The fossils are so well-preserved that most aspects of their functional anatomy are known in great detail, such as the articulation of their hands and feet. Although not a single tool was found in the cave deposit, to get into the far reaches of the labyrinthine cave system they must have lit the way with firebrands. The anatomy of *H. naledi* is far more advanced than that of contemporary *H. habilis*. The discoverers speculated that the group may have been a species that gave direct rise to the later *H. ergaster* and *erectus*, and ultimately us. Alternatively, the individuals' diminutive size suggested parallels with much later *H. floresiensis* and *H. luzonensis* from the other side of the world. Much of this hype was later blunted by more reliable geochronology indicating an age of between 236 ka and 335 ka: i.e. about the time when anatomically modern humans were already roaming Africa. A more plausible conclusion, therefore, is that *H. naledi* was one of at least 6 hominin groups that co-occupied the late-Pleistocene world: i.e. similar to *H. floresiensis*.

Now the partial skull and half a dozen teeth of an immature *H. naledi* has been recovered from another remote chamber in the cave system (Brophy, J.K. *et al*. 2021. Immature Hominin Craniodental Remains From a New Locality in the Rising Star Cave System, South Africa. PaleoAnthropology. Issue 1.64; DOI: 10.48738/2021.iss1.64). Fossils of young humans are rare, their bones being thinner and much more fragile than those of adults, so the skull had to be reconstructed from 28 fragments. Unlike the older individuals from the main chamber, there are no other bones associated with the skull. Oddly, the supposedly young *H. naledi*'s brain volume (between 480 to 610 cm^3) is between 90 to 95 % that of adults. A possible explanation for this degree of similarity is that these beings reached maturity far more quickly than do anatomically modern humans. The evidence for youth is based on close dental similarity with those of other 'immature' specimens from the main bone deposit, and most importantly that two of the teeth are demed to be deciduous ('milk') teeth. Yet the 'milk' teeth show severely chipped enamel as do the permanent teeth of more mature specimens, to the extent of being unique in the fossil record of hominins. Clearly, their diet was sand-rich.

Shortly after publication in the journal *PaleoAnthropology* during early November 2021 the world's media leapt on the two papers rorting these new finds. Yet it is hard to judge why it was deemed by science journalists to have truly popular appeal. It actually adds very little to the *H. naledi* story, apart from specialised anatomical description. Despite the skull being bereft of the rest of the individual's body, the authors '…regard it as likely that some hominin agency was involved in the deposition of the cranial material'. Perhaps the 'star' status was rekindled because the press release from the University of the Witwatersrand used the word 'child' again and again – a sure fire way of getting wide attention. The published papers properly refers to it as an 'immature hominin individual', which it undoubtedly is. The same sort of attention came the way of Raymond Dart from a small skull of *Australopithecus africanus* found in 1924 by workers in a limestone quarry – he

called it ‘the Taung Child’. Of course, *H. naledi* is one of the best-preserved hominins known. But how does its current newsworthiness rank above *H. floresiensis*? Now, that *was* a surprise, but the hype about that tiny human has died down. And when *H. naledi* was originally deemed to be 2 Ma old, it too was astonishing. But since its true, quite young age was determined, it too is no longer such a big deal.

Interestingly, South African scientists self-proclaimed the name ‘Cradle of Humankind’ for the area in Gautung Province close to Johannesburg, which is rich in limestone caves and has a long history of fossil hominin discoveries since Raymond Dart’s Taung Child. But the earliest anatomically modern human remains are from Jebel Irhoud in Morocco, and the oldest known hominin fossils are from Chad, and most advances in early hominin evolution have stemmed from Ethiopia, Kenya and Tanzania. The fossiliferous part of Gautung Province rightly has World Heritage status, but not under that name. Instead it is called more accurately ‘Fossil Hominid Sites of South Africa”

See also: Partial skull of a child of Homo naledi: Insight into stages of life of remarkable species. *Science Daily*, November 2021.