*** OLLI Human Evolution Science Update

August 2024

by

Charles J Vella PhD

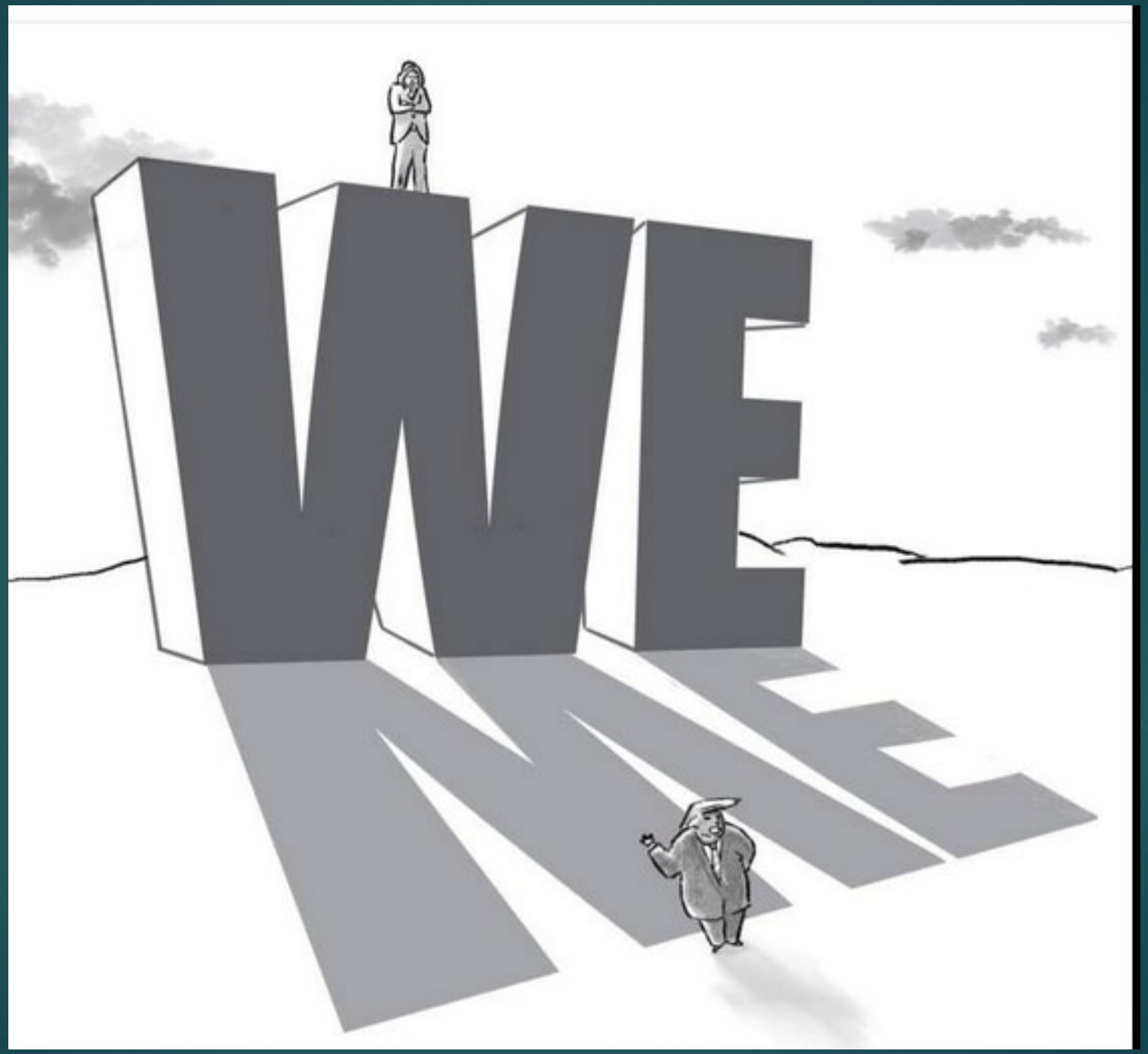
Decision options for the group

- I have too much new material:
- 1 – Abric Pizarro Ns, Ice Age Europe, Clovis pikes, Spatial sampling, H. floresiensis, Native American Languages
- 2 - 4 major 2024 papers on H. naledi = 260 slides
- 3- H. antecessor; Lucy's 50th Anniversary
- 3 – 2 new Origin of Language books: Neanderthal Language – Botha & Language Puzzle - Mithen

- Options: 1 extra monthly session in Sept or Nov? 2nd and 4th Weds?

**** 4 major 2024 papers on *H. naledi*

- 1 - What we know and do not know after the first decade of Homo naledi -- Paul Pettitt & Bernard Wood
- 2 - Preprints, press releases and fossils in space: What is happening in South African human evolution research? -- By Robyn Pickering and Dipuo Kgotleng, 2024
- 3 - No Sedimentological Evidence for Deliberate Burial by Homo naledi – A Case Study Highlighting the Need for Best Practices in Geochemical Studies Within Archaeology and Paleoanthropology – K. Foecke
- 4 - Evidence for deliberate burial of the dead by Homo naledi -- Lee R Berger…J. Hawks, et al., Aug 12 2024, BioRx preprint = 160 pages!


WE
ME

DeepMind controls industrial robot to play table tennis

Pitted DeepMind AI-controlled robot against 29 humans. DeepMind's robot arm beat all of the beginners and about 55% of the intermediate players, but it got trounced by advanced players. In an international rating system, it would be a solid amateur player.

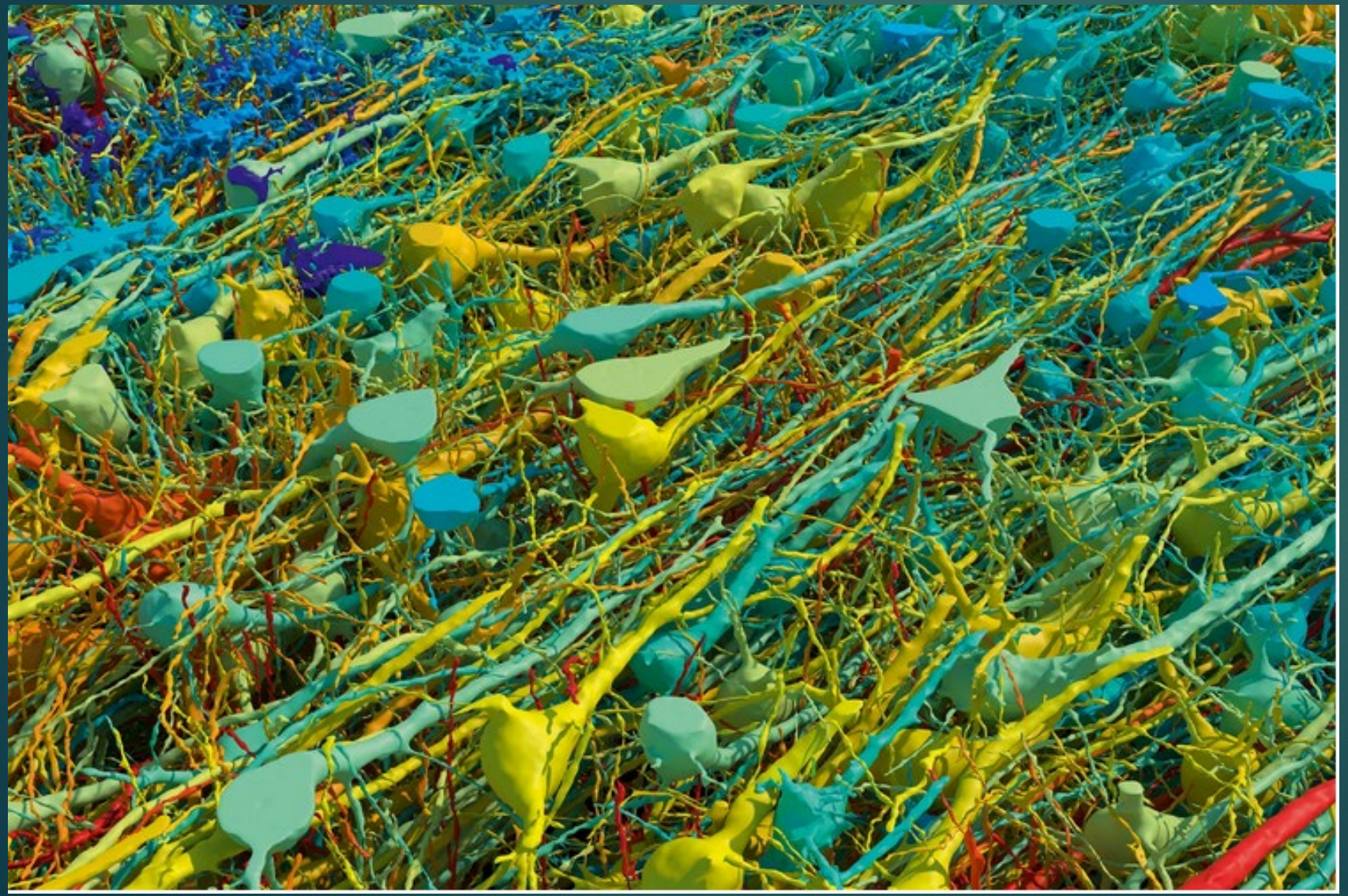
Teratogenic Effects of Pure Evil in Ursus Teddius Domesthicus

Many worms can regenerate into two new worms if they're cut in half. Deepsea flatworms called acoel regenerate into *three* new worms if they're severed in two. Plus, they have a symbiotic relationship with algae living inside their bodies that provide energy through photosynthesis.

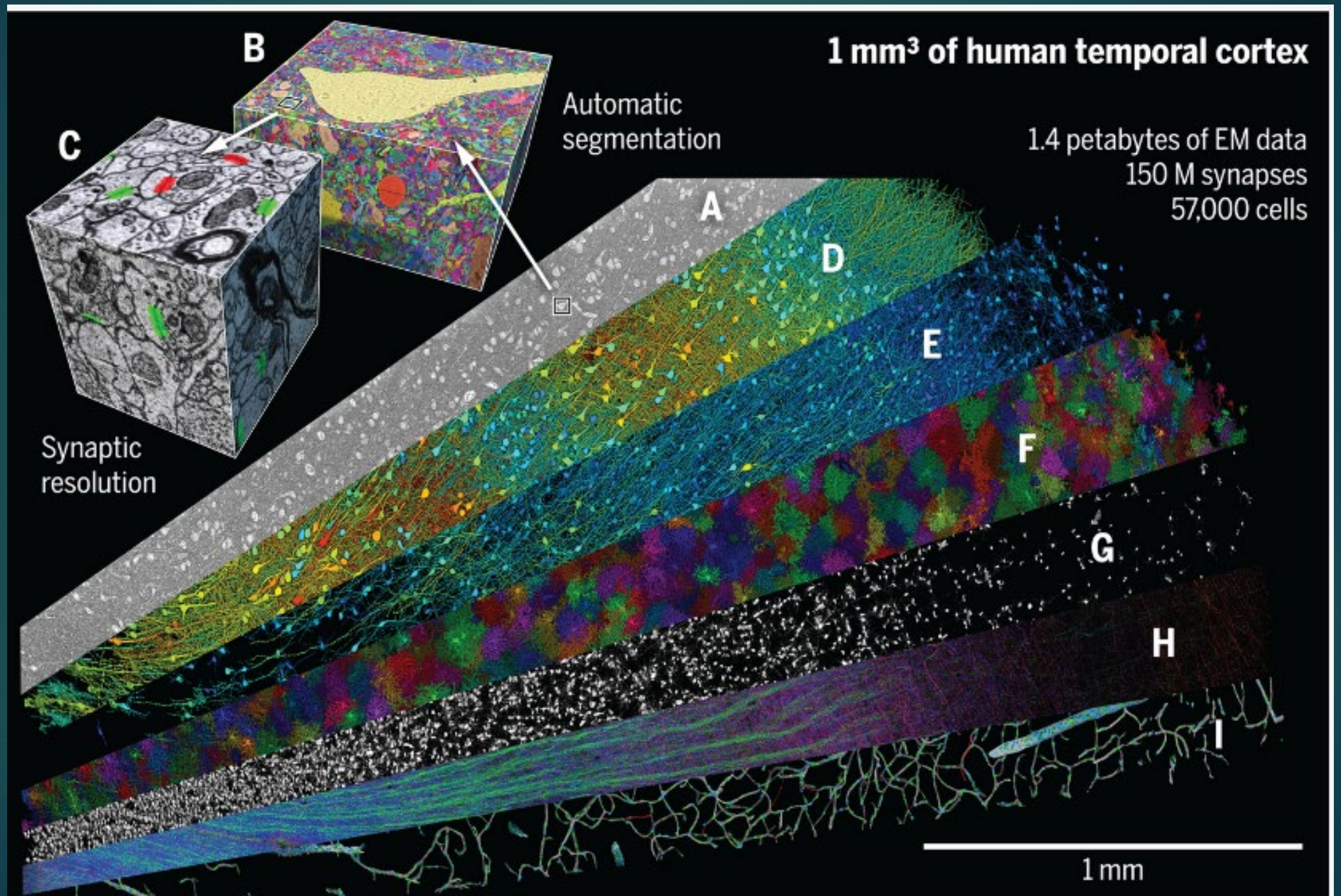
The green coloring on this acoel comes from symbiotic algae. Eric Pöttinger

The green coloring on this acoel comes from symbiotic algae.

*** A petavoxel fragment of human cerebral cortex reconstructed at nanoscale resolution

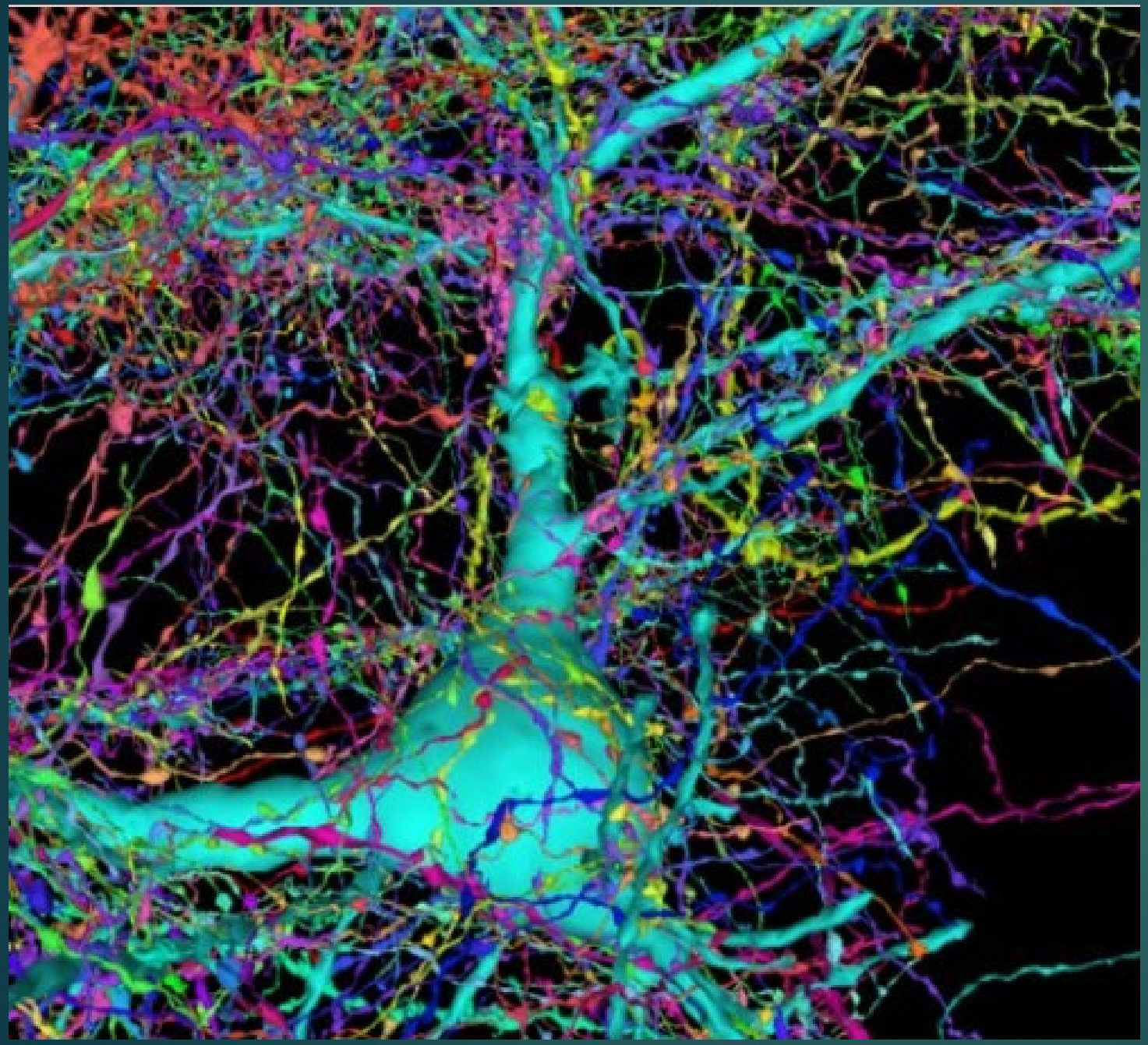


This Is the Most Detailed Map of Brain Connections Ever Made


1 mm³ of human temporal cortex
B
C
Automatic segmentation
1.4 petabytes of EM data
150 M synapses
57,000 cells
A
D
E
F
G
H
I
Synaptic resolution
1 mm

Cubic millimeter of cortex

- In a world first, Harvard biologists worked with Google to diagram a cubic millimeter of human cerebral cortex at the subcellular level
- In 2014, a woman undergoing surgery for epilepsy had a tiny chunk of her cerebral cortex removed. This cubic millimeter of tissue has allowed Harvard and Google researchers to produce the most detailed wiring diagram of the human brain that the world has ever seen.
- Biologists and machine-learning experts spent 10 years building an interactive map of the brain tissue, which contains approximately 57,000 cells and 150 million synapses.
- It shows cells that wrap around themselves, pairs of cells that seem mirrored, and egg-shaped “objects” that, according to the research, defy categorization.



All ~4k incoming connections for a pyramidal cell

A petavoxel fragment of human cerebral cortex reconstructed at nanoscale resolution

- Created the brain map by taking subcellular pictures of the tissue using electron microscopy. The tissue from the 45-year-old woman's brain was stained with heavy metals, which bind to lipid membranes in cells. This was done so that cells would be visible when viewed through an electron microscope, as heavy metals reflect electrons.

- The tissue was then embedded in resin so that it could be cut into really thin slices, just 34 nanometers thick (in comparison, the thickness of a typical piece of paper is around 100.,000 nanometers). Created a mammoth 1.4 petabytes of data.

- Public access: https://h01-release.storage.googleapis.com/landing.html

*** Old age and Cognitive ability change

- Focusing on only those with poor brain health misses more than half the population. In the six years after turning 75, about half of people showed little to no change in their physical, biological, hormonal and cognitive functioning, whereas the other half changed quite a lot.
- A longer-term study followed more than 2,000 individuals with an average age of 77 for up to 16 years. It showed that the three quarters who did not develop dementia showed little to no cognitive decline.
- Studies of successful aging have shown that genes account for 30 to 50 percent of physical and cognitive changes. But factors like a healthy way of life and good self-esteem are also consequential.

Upside of old age

- Research has also busted the myth that there is no upside to aging past 70 or so. The ability to resolve conflicts strengthens, for instance. Aging is also associated with more positive overall emotional well-being, which means older adults are more emotionally stable than younger adults, as well as better at regulating desires.

- The cliché that age brings wisdom is also backed up by science. If you think of the brain as a computer, there's a lot more on the hard disk with age. Older adults can draw on their experience and often have much better solutions to problems than younger adults

Wiser

- A study, published in 2010, found that participants older than 60 were more likely to emphasize multiple perspectives, to compromise, and to recognize the limits of one's own knowledge.

- A meta-analysis combining data on more than 7,000 older adults found they were significantly more likely than younger adults to lean toward the positive versus the negative when processing information.

*** Dodos were fast and powerful, not slow and inept, definitive preserved specimen suggests

New research shows dodos played an important role in the ecosystem of Mauritius.

The Dodo

- The dodo, a bird that humans hunted to extinction in the 1600s, wasn't the slow, clueless ball of feathers that has been depicted in popular culture.
- By poring through early records and descriptions of the dodo and a related species called the solitaire, researchers cleared up misconceptions about the iconic creatures. It turns out, the vanished birds were powerful and speedy,
- The few written accounts of live Dodos say it was a fast-moving animal that loved the forest

Gone by 1662

- The dodo (*Raphus cucullatus*) was the first recorded extinction directly caused by humans and witnessed in real time.
- When Dutch sailors arrived on Mauritius in 1598, it was teeming with adorably chubby, flightless birds that stood about 3 feet tall (1 meter) and weighed about 45 pounds (20 kilograms), according to the Oxford University Museum of Natural History (OUMNH) in the U.K.
- As the Dutch colonized the island, they introduced predatory invasive species, chopped down forests, destroyed the dodos' nests and hunted the birds rapaciously. Less than 70 years later, the species was extinct; the last known sighting was in 1662,

Which description

- For centuries, the dodo has been used as an evolutionary cautionary tale, its name synonymous with ineptness.
- With no known predators on Mauritius, the story went, the dodo grew large and lost its ability to fly. Its lack of predators also made it too trusting of the new human hunters that had arrived on the island.
- Part of the problem is that scientists weren't actually clear about which dodo species actually existed, with several mythological birds being described in early literature, according to the statement. Records of the birds were confusing, inconsistent and unreliable.

Type specimen

- To clear that up, the study authors tracked down early specimens, reports of seeing live creatures and early taxonomic descriptions of the species, and sorted fact from fiction. They found that while many species, such as the Nazarene dodo, were fictional, the solitaire (*Pezophaps solitaria*) — a species that's closely related to the dodo and that some thought was mythological — actually existed and lived on the Mauritian island
- They also identified an iconic "type specimen" for the dodo — meaning the single preserved specimen that serves as the reference for the species. Using that, they determined that both the dodo and the solitaire were members of the family that includes pigeons and doves.

Bringing back the Dodo

- Using that type specimen, the team also looked at what dodos were actually like, clearing up popular misconceptions about the iconic birds.

- Evidence from bone specimens suggests that the Dodo's tendon which closed its toes was exceptionally powerful, analogous to [those of] climbing and running birds alive today,

- Scientists with Colossal Biosciences are trying to bring back the iconic flightless birds, which they hope to reintroduce to Mauritius to stabilize the ecosystem. The same company is trying to bring back the woolly mammoth.

South American Lungfish: Largest animal genome sequenced — and just 1 chromosome is the size of the entire human genome

The South American lungfish has the largest genome out of any animal tested. (Image credit: Katherine Seghers / Louisiana State University)

Big genome

- These air-breathing fish carry a whopping 91 billion base pairs, or letters, of DNA in their genomes.
- That's enough letters to fill 100,000 books. Yet only 20,000 genes actually code for proteins, meaning the rest may be mostly junk. More than 90% of the genetic material was made of transposable elements (TEs), or highly repetitive "jumping" genes that were copied from elsewhere in the genome.
- Not the largest genome overall. That honor belongs to a weird fern that harbors 160 billion letters in its genome — more than 50 times the letters found in human cells.

Largest, most complete stegosaurus ever found sold for a record $44.6 million at auction. The giant, 150-million-year-old fossil, nicknamed Apex, is 3.4 meters tall and 8.2 meters long. An old guy who shows signs of rheumatoid arthritis. Sold to a hedge fund founder, who wants to loan the specimen to a US institution.

Deep sea nodule: oxygen? Not from photosynthesis

Shock discovery reveals deep sea nodules are a source of oxygen

- Sea-floor nodules raise oxygen levels in the deep ocean, suggesting they may have a valuable role in ecosystems and adding to concerns about the impact of deep-sea mining
- Metallic nodules scattered across the seabed in the Indian and Pacific oceans are a source of oxygen for nearby marine life – a finding that could upend our understanding of the deep ocean.
- Abyssal plains in some regions are scattered with potato-sized nodules packed with valuable cobalt, manganese and nickel, a target for deep-sea mining activity.

Oxygen increasing

- Sweetman and his colleagues were sending machines down to the ocean floor to seal off a 22 centimeter square patch of seabed and measure its oxygen flux. Instead of oxygen content decreasing in the monitored sections, the data suggested it was increasing.
- But without any noticeable plant life, that didn't make sense, says Sweetman. "I've been taught from a very young age that oxygenated ecosystems are only possible through photosynthesis," he says.
- Then, in 2021, Sweetman was on another research cruise in the Pacific and machines returned the same finding – increasing oxygen levels on the seabed. Using a different measurement approach yielded the same result.

Geobattery producing oxygen

- He and his colleagues deduced that the metallic nodules must be playing a role in raising the oxygen levels in the deep sea. Lab testing, which involved poisoning the sediment and nodules, ruled out the presence of oxygen-producing microbes.

- Instead, Sweetman says the materials in the nodules are acting as a "geobattery", generating an electric current that splits seawater into hydrogen and oxygen.

Electrical potential

- Each nodule can produce up to 1 volt of electric potential, the team discovered by probing the rocks. If the rocks were clustered together to join forces, there would be enough voltage to split seawater into hydrogen and oxygen via electrolysis, explaining the elevated oxygen levels.
- “Potentially we have discovered a new natural source of oxygen,” says Sweetman. “How pervasive that is in time and space, I don’t know. But it’s something that’s very, very interesting.”
- There are many outstanding questions. For example, the source of energy generating the electric current remains a mystery. It is also unclear whether the reaction happens continuously, under what conditions and the contribution this “dark” oxygen plays in sustaining surrounding ecosystems. “We don’t have all of the information yet, but we know it’s happening,” says Sweetman.

Metals company rebuttal?

- In deep-sea environments devoid of sunlight and plants, some life forms get their energy from chemicals that erupt from the sea floor at hydrothermal vents. Some scientists think life on Earth first appeared at these vents, but these early organisms would have needed a source of oxygen to make food from inorganic compounds. The findings raise the possibility that nodules could have been the source of that oxygen to help life get started, says Sweetman.
- Sweetman's study was part-funded by The Metals Company (TMC), a deep-sea mining company looking to harvest metallic nodules in the Clarion Clipperton Zone. In response to the study, Patrick Downes at TMC said he has "serious reservations" about the findings, adding that its own analysis suggests Sweetman's results are due to oxygen contamination from external sources. "We will be writing a rebuttal article," Downes said in a statement to *New Scientist*.
- However, the findings are likely to strengthen calls for a ban on deep-sea mining, a position backed by many oceanographers who say our understanding of such areas is still developing

***These reviled birds of prey literally save people's lives

India’s loss of vultures

- India saw its native vulture population fall from tens of millions to only a few thousand in the 1990s, with terrible effects for the human population.
- The extinction of India’s vultures had far-reaching consequences for the humans who lived alongside the birds. In just a few years, the species’ s disappearance contributed to the deaths of hundreds of thousands of Indians.
- Paper studies the collapse of vultures in India, triggered by the expiration of a patent on a drug. The drug in question, diclofenac, had been introduced because it was a cheap way to treat fevers and inflammation in farm animals. The medicine was banned once Indian officials learned of its role in the vulture die-off, but by then, the damage was already done.

Value of vultures: sanitation function

- Results suggest the functional extinction of vultures — efficient scavengers who removed carcasses from the environment — increased human mortality by over 4% because of a large negative shock to sanitation. These effects are comparable to estimates of heat deaths from climate change.

- Scavengers functioned as a natural sanitation system for communities with a less developed infrastructure than the US or Europe, helping control diseases that could otherwise be spread through the carcasses they consume.

How the loss of critical species can have disastrous effects on human populations that depend on them

- The human costs of India's extinct vultures: estimate that from 2000 to 2005, an additional 500,000 people died in India above the preexisting trend, after the rapid dying off of vultures in the 1990s.

- The near-extinction was an unexpected (and for a long time unknown) byproduct of the country's farmers introducing a medication to livestock that had previously only been prescribed to humans.

- Within a few years, 95 percent of the country's vulture population was wiped out, dropping from tens of millions to a few thousand. A decade later, researchers discovered the drug led to kidney failure and death in the vultures when they fed on dead livestock that still had it in their system.

Death rates

- Compared death rates in the years following the die-offs between regions that had previously been home to vulture populations and those that hadn't, finding that people started dying at higher rates in areas where the birds had lived.

- In the communities that lost vultures, there were an estimated 104,000 excess deaths annually — deaths that may be attributed to the species' near-extinction — from 2000 to 2005, the years immediately following their dramatic decline that were the focus of Sudarshan and Frank's study. It adds up to more than half a million deaths over five years, costing India an estimated $69 billion annually.

Keystone animal species are vital to human health

- The largest sanitation shock you could imagine, where you have 50 million carcasses every year not being disposed of.
- Scientists have also suspected that the role of keystone animal species is so important that their loss could have life-and-death consequences for human beings
- In India, vultures are known to be extremely efficient scavengers, eating nearly all of a carcass less than an hour after finding it. Before the extinction, Indian regions that were home to vultures already recorded lower baseline mortality rates than those without them. After the birds died off, people in affected areas reported seeing more feral dogs and more rotting carcasses building up in fields.

Feral Dogs are less efficient

- Without vultures to consume them, there were more dead animals lying around, which sometimes ended up in rivers or other bodies of water, tainting local water supplies.
- The absence of vultures became an opportunity for other scavengers, such as rats and dogs.

- Dogs and rats are less efficient than vultures at fully eliminating flesh from potentially disease-carrying carcasses, creating more opportunities for a person to come in contact with infected remains. They're also more likely to transmit diseases like anthrax and rabies to people. Orders for the rabies vaccines started to rise in the years after the vulture population plummeted.

Template for studying the impacts of species loss on human health

- Vultures remain critically endangered in India, with only a few thousand individuals.

- Vultures' life cycles will make them difficult to restore: They lay, at most, one egg in a year and take years to sexually mature.

- The enormous consequences of their near-extinction in India remind us that promoting biodiversity means embracing every species, not only those that look good on a T-shirt; they and we are all part of a whole.

*** When Dogs Smell Your Stress, They Act Sad

Dogs can smell cortisol

- Humans and dogs have been close companions for perhaps 20,000 years, according to anthropological and DNA evidence. So it would make sense that dogs would be uniquely qualified to interpret human emotion. They have evolved to read verbal and visual cues from their owners, and previous research has shown that with their acute sense of smell, they can even detect the odor of stress in human sweat.
- Now researchers have found that not only can dogs smell stress—in this case represented by higher levels of the hormone cortisol—they also react to it emotionally.
- Recruited 18 dogs of varying breeds, along with their owners. Eleven volunteers who were unfamiliar to the dogs were put through a stress test involving public speaking and arithmetic while samples of their underarm sweat were gathered on pieces of cloth

Dogs and human stress

- The results imply that when dogs are around stressed individuals, they're more pessimistic about uncertain situations, whereas proximity to people with the relaxed odor does not have this effect

- Being able to sense stress from another member of their dog pack was likely beneficial because it alerted them of a threat that another member of the group had already detected.

*** Komodo dragons: These dragons really do have iron teeth

A trio of Komodo dragons use their steak knife–like teeth to carve up a goat carcass on Rinca Island in Indonesia.

Komodo dragons

- Komodo dragons are some of nature's boldest and most fearsome eaters. Up to 3 meters long and capable of taking down prey many times their size, the reptiles slice and dice their meals like a celebrity chef.
- They use these rows of razor-sharp, steak knife–shaped teeth to cut into their prey and tear off chunks to swallow, That tooth shape is something you see repeated a lot of times in predatory dinosaurs.
- Discovered what may be the key to keeping Komodo teeth sharp and tough: a coating of iron on the reptile's tooth serrations and tips.
- Komodo dragons are the world's largest predatory lizards. They're distantly related to dinosaurs, sharing a common ancestor 300 million years ago.

Iron is protective coating on teeth

- When the scientists started to view museum specimens of dragon teeth under a microscope, they discovered something unexpected: a clear line of orange along the serrated edges—a sign of iron within the tooth tips.

- To make sure this wasn't staining caused by the Komodo's food, the scientists looked at baby teeth that were still developing in the reptiles' gums.

- Chemical and structural imaging revealed orange there, too, suggesting the coating is part of the Komodo's typical tooth design.

Iron on the cutting edges of teeth in Komodo dragons

Also in other species of monitor lizards, including the crocodile monitor (V. salvadorii), Rosenberg's monitor (V. rosenbergi), and mangrove monitor (V. indicus); American alligators and saltwater crocodiles; and orange coloration in the teeth of beavers, shrews, and even some fish. = to lesser degree

No evidence on fossilized dino teeth.

- The iron coating is also resistant to acid. Their teeth have thin enamel. And even though these reptiles replace their teeth regularly, they also need to have “structurally strong teeth,” because they vigorously shake their prey.

- Found no evidence of iron coatings in any of the fossil dino teeth they examined. The process of fossilization involves organic tissues being replaced with minerals, which obscures the very thing LeBlanc’s team set out to find.

*** Pregnancy and the brain

How pregnancy transforms the brain to prepare it for parenthood

- Surveys show that 50–80% of people who have been through pregnancy and birth report memory deficits, ‘brain fog’ or other cognitive issues.
- Two to three months after giving birth, multiple regions of the cerebral cortex were, on average, 2% smaller than before conception. And most of them remained smaller two years later.
- Although shrinkage might evoke the idea of a deficit, the team showed that the degree of cortical reduction predicted the strength of a mother’s attachment to her infant, and proposed that pregnancy prepares the brain for parenthood.
- Confirmed that the cortical regions that shrink during pregnancy also function differently for at least a year after giving birth.

Rats vs humans

- Virgin female rats, for example, typically ignore rat pups or kill them[3]. But injecting the animals with pregnancy-mimicking hormones leads them to behave like mothers, grooming and protecting pups
- The rule seems to be that any brain region that changes size during pregnancy shrinks. Numerous brain structures are affected, including the ventral striatum, which is involved in reward processing, and the hypothalamus, which is instrumental in controlling instinctive behaviors. The hippocampus, a structure essential for memory, also transiently shrinks during gestation. But the impacts are largest in the cerebral cortex
- Data from the second and third trimesters revealed that the entire cortex shrinks by nearly 5% across pregnancy.

Hormones

- After birth, most changes quickly and fully reverse — except in the default mode
- These alterations are probably driven by hormones. Studies have independently observed that the magnitude of neuroanatomical changes correlates with levels of estrogen and related hormones network.
- But what do these changes mean for behavior? Accumulating data show that the degree of change in the default mode network correlates with the strength of the mother–infant attachment, maternal responses to infant pictures and nesting behaviors — and inversely with problems in the bonding process
- Research on neural metabolites indicates it's unlikely that neurons are being lost.

Transitions

- This suggests that the processes of gestation and giving birth induce a neurodevelopmental transition — akin to the hormonally driven brain changes that accompany adolescence. Indeed, both life phases are marked not just by cortical shrinkage, but also by a flattening of the cortex's folded surface. These changes might allow the individual to transition to a new stage of life — in adolescence, into independence; after pregnancy, into having someone depend on you.
- Memory deficits, however, are consistently observed during the third trimester[7]. These might be linked to decreases in hippocampal volume, but they are rarely clinically significant or detrimental to daily life,
- Post-partum data are much less conclusive. Some studies show deficits. Some studies show no differences. Some studies even show some enhancements,.
- One skill that might get a boost is executive function

Psychiatric changes

- A year after giving birth, mums that subjectively reported cognitive deficits showed no difference in lab tests compared with non-mothers

- Worldwide, postpartum depression affects 17% of new mothers — with the highest rates occurring in low- and middle-income countries. Psychosis and obsessive–compulsive disorder also occur at elevated frequencies, although their absolute prevalence is very low.

- Again, hormones are one likely culprit. It's well known that progesterone falls precipitously at birth, but it was only last year that the first oral treatment for postpartum depression, zuranolone, was approved in the United States.

*** Psilocybin desynchronizes the human brain

- A single dose of psilocybin, a psychedelic that acutely causes distortions of space–time perception and ego dissolution, produces rapid and persistent therapeutic effects in human clinical trials.
- In animal models, psilocybin induces neuroplasticity in cortex and hippocampus.
- Here we tracked individual-specific brain changes with longitudinal precision functional mapping (roughly 18 magnetic resonance imaging visits per participant). Healthy adults were tracked before, during and for 3 weeks after high-dose psilocybin (25 mg) and methylphenidate (40 mg), and brought back for an additional psilocybin dose 6–12 months later.
- Psilocybin massively disrupted functional connectivity (FC) in cortex and subcortex, acutely causing more than threefold greater change than methylphenidate.
- Psychedelics rapidly induce synaptogenesis in the hippocampus and cortex, effects that seem to be necessary for rapid antidepressant-like effects in animal models

Default Mode network major effect

- These FC changes were driven by brain desynchronization across spatial scales (areal, global), which dissolved network distinctions by reducing correlations within and anticorrelations between networks.
- Psilocybin-driven FC changes were strongest in the default mode network, which is connected to the anterior hippocampusd.
- DMN = internal mentation, which includes mind-wandering/day-dreaming , social cognition, and self-referential processes, such as remembering the past, imaging future, sense of self.
- Individual differences in FC changes were strongly linked to the subjective psychedelic experience. Performing a perceptual task reduced psilocybin-driven FC changes.
- Psilocybin caused persistent decrease in FC between the anterior hippocampus and default mode network, lasting for weeks.

*** One of the four newly translated cuneiform tablets

Newly Deciphered, 4,000-Year-Old Cuneiform Tablets Used Lunar Eclipses to Predict Major Events

- Ancient Babylonians linked astronomical phenomena to pestilence, the death of kings and the destruction of empires

- According to NASA, the Babylonians learned how to predict lunar eclipses in advance and would sometimes appoint “substitute kings … who would bear the brunt of the gods’ wrath” while the real ruler remained unharmed.

Babylonian tablets

- The four tablets analyzed in the new study date to the middle and late Old Babylonian periods (circa 1894 to 1595 B.C.E.), some 4,000 years ago. They are the "oldest examples of compendia of lunar-eclipse omens yet discovered
- Although the British Museum acquired the tablets between 1892 and 1914, this recent breakthrough marks the first time the cuneiform has been completely translated and linked to a system of astronomical predictions.
- While some of these predictions may have been rooted in actual experiences—where a catastrophic event followed a celestial phenomenon—most were likely the result of a complex, speculative system of divination.

*** 13,000 ya: oldest astronomical calendar, at Gobekli Tepe

- V shaped markings on the lunisolar calendar, which combines the movements of the moon and sun, recorded a major astronomical event that had a huge impact on Earth — making the ancient pillar part of an ancient version of a memorial.
- The intricate carvings at Gobekli Tepe tell the story and document the date when fragments of a comet — which came from a meteor stream — hit Earth roughly 13,000 years ago. The comet strike, which the latest research has placed in the year 10,850 B.C.,
- Dr. Sweatman has been able to connect the impact of the comet to the site in Turkey. In 2017, he linked the two in an academic paper in which he contended that the carvings at Gobekli Tepe were memorialized in the pillars, and that the site was used as a place to observe space.

Martin B. Sweatman, 2024

Gobekli Tepe

Solar calendar

- Researchers now believe that the V-shaped carvings found on one of its pillars represent a sophisticated lunisolar calendar. This calendar tracked the cycles of the moon and sun, marking the passage of time and the change of seasons. Remarkably, this system included 12 lunar months plus 11 extra days, accounting for a full solar year. The summer solstice was given special significance, symbolized by a V-shaped marking worn around the neck of a bird-like figure, possibly representing a constellation observed at that time.
- Researchers propose that they commemorate a devastating comet strike around 10,850 B.C., an event believed to have ushered in a mini ice age lasting over 1,200 years.

Gobekli Tepe reconstruction

Oldest calendar tracking the movements of the moon and the sun in today's Turkey.

Representations of calendars and time at Göbekli Tepe and Karahan Tepe support an astronomical interpretation of their symbolism

Younger Dryas comet impact hypothesis

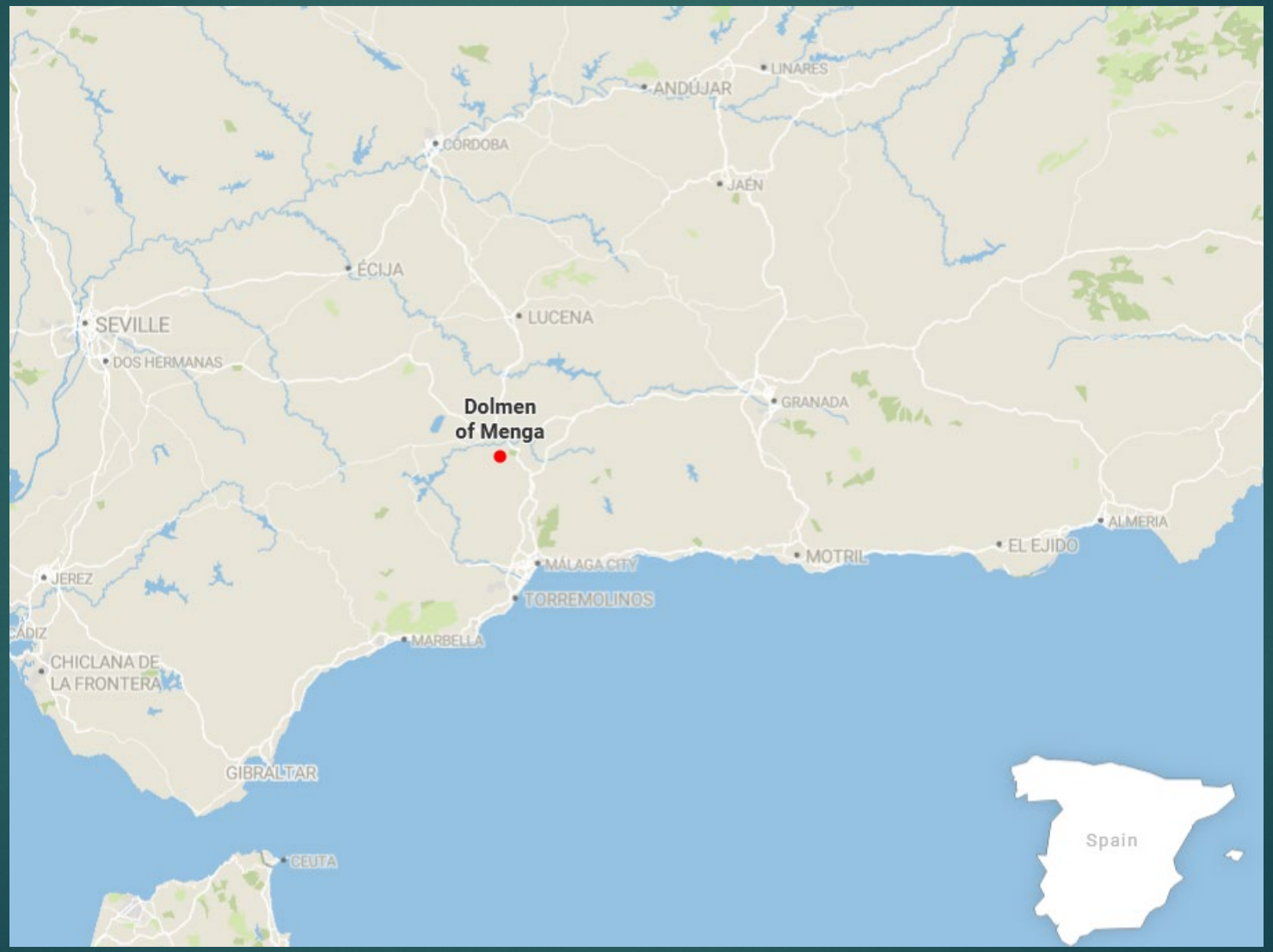
- Study presents evidence for lunisolar and lunar calendar systems at Taş Tepeler sites that support an astronomical interpretation of their symbolism. Included in that astronomical interpretation is a record of both the date and the mechanism of the Younger Dryas impact. Essentially, we can view Pillar 43 at Göbekli Tepe as a memorial to that that event (at 10,835 ± 50 BCE)
- The basis of this astronomical interpretation is that the animal symbols on the broad sides of Göbekli Tepe's pillars can be interpreted as constellations, similar to those known by ancient Greek and Mesopotamian cultures.

Accurate dating by this ancient civilization

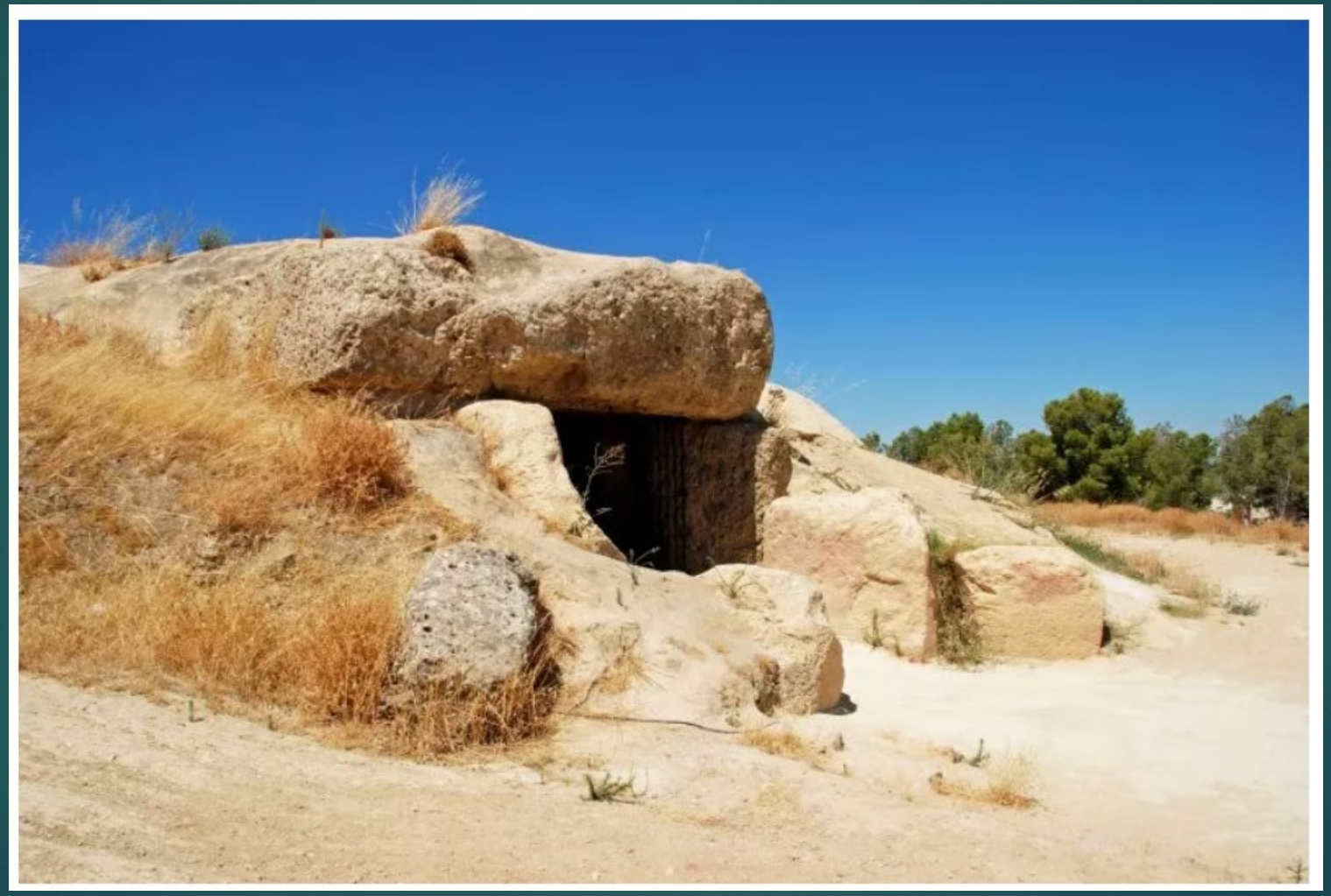
- Also documents annual Taurid meteor stream: This suggests that the ancient people of Göbekli Tepe had an understanding of precession—the gradual wobble in Earth's axis that changes the position of constellations over millennia—long before it was formally documented by ancient Greek astronomer Hipparchus around 150 B.C.

- The discoveries at both Babylonia and Göbekli Tepe offer a fascinating glimpse into the minds of our ancient ancestors. The Babylonians, with their celestial omens, and the people of Göbekli Tepe, with their solar calendar, demonstrate an early human drive to interpret and record the cosmos' influence on earthly life. These ancient practices reveal not only a sophisticated understanding of astronomy but also a deep-seated belief in the interconnections of the heavens and human fate.

Location of Menga, a Neolithic dolmen (Antequera, Spain).



Early science and colossal stone engineering in Menga, a Neolithic dolmen (Antequera, Spain).

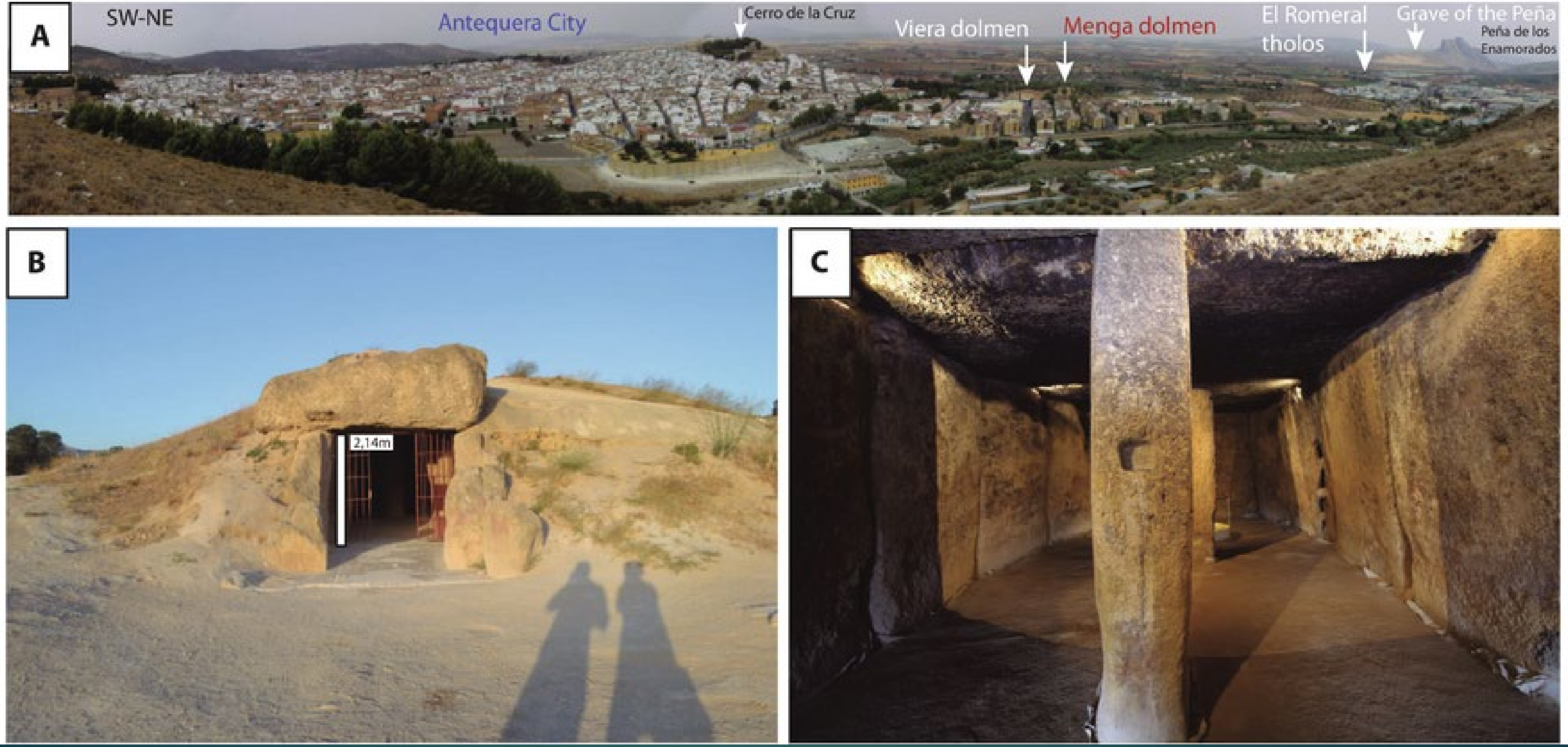


Dolmen

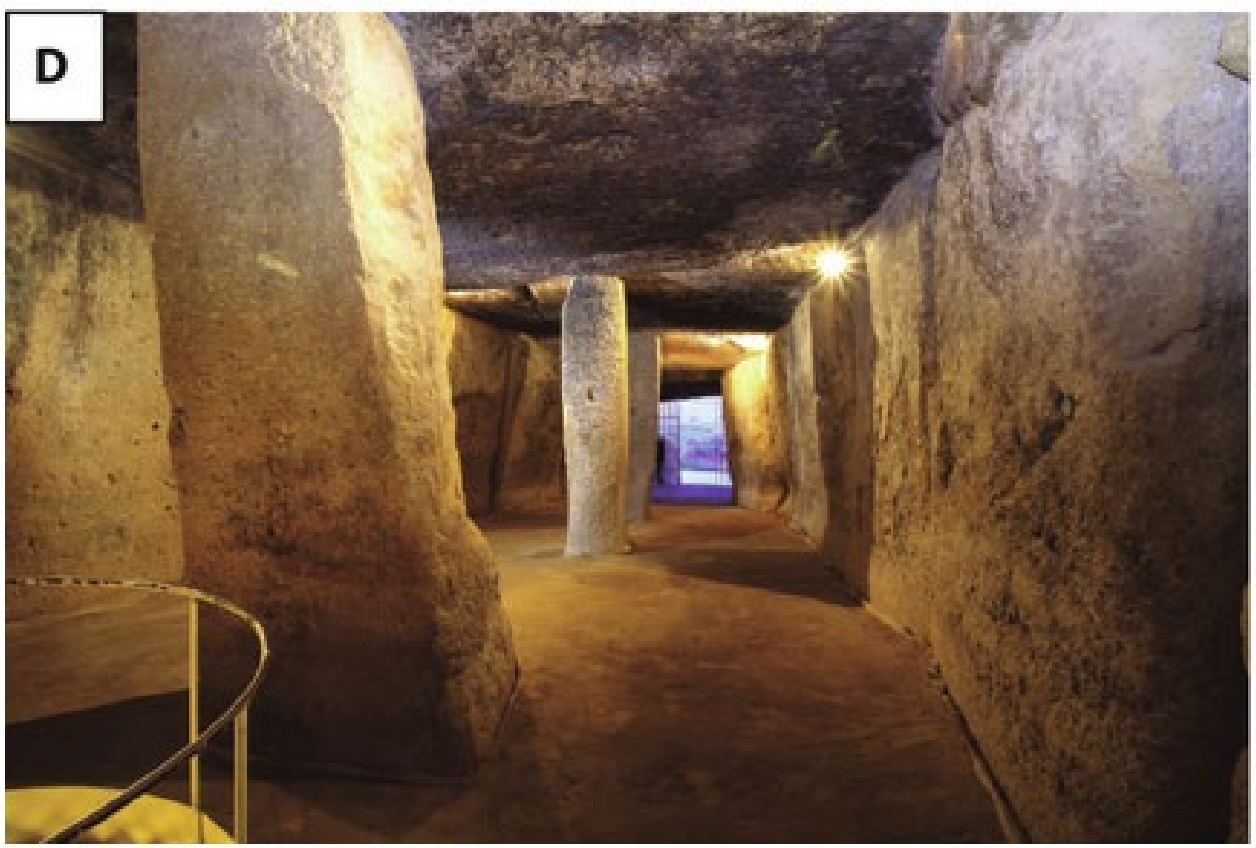
- A dolmen is a type of single-chamber prehistoric tomb constructed using large stones, known as megaliths.

- Constructed between 3800 and 3600 B.C.—around a thousand years before the oldest known pyramid in Egypt—the Menga dolmen consists of 32 massive stones forming a roof, walls, and pillars, with a total weight of approximately 1,140 tons.

- Menga, the oldest of the great dolmens on the Iberian Peninsula, has long intrigued archaeologists and historians alike because of its sheer size and the apparent complexity of its construction.

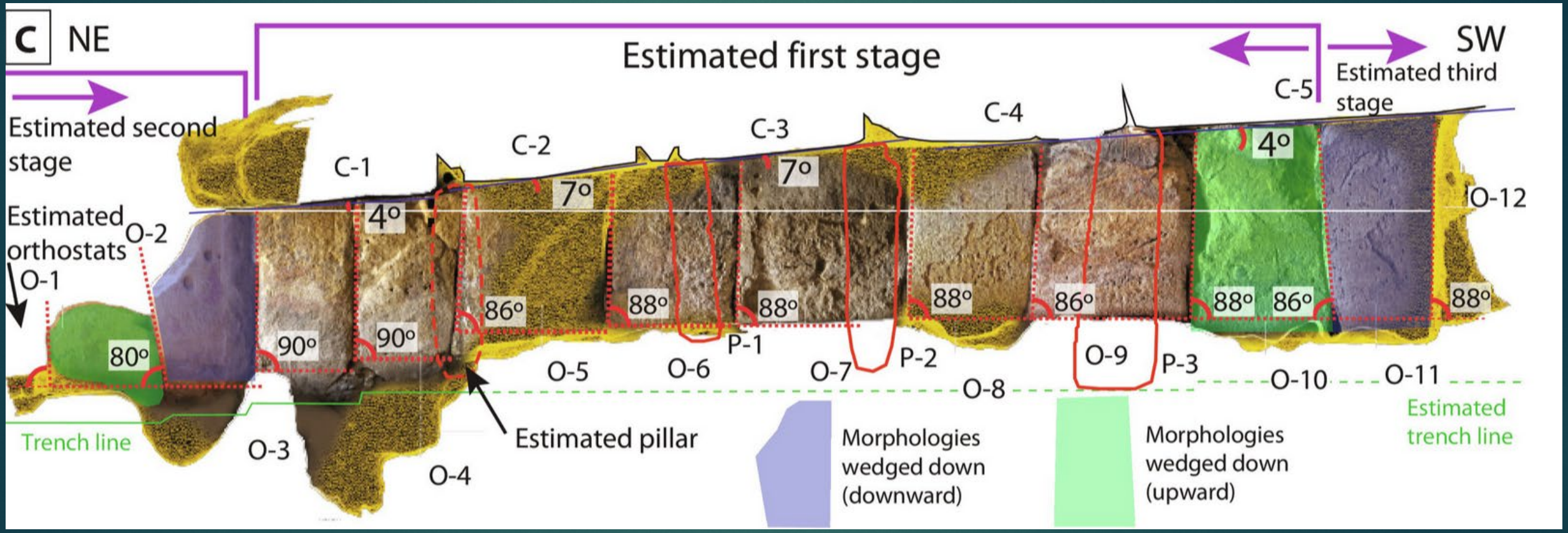

A
SW-NE
Antequera City
Cerro de la Cruz
Viera dolmen
Menga dolmen
El Romeral
tholos
Grave of the Peña
Peña de los
Enamorados
B
2,14m
C

Interior



Construction plan

Precision of interior walls

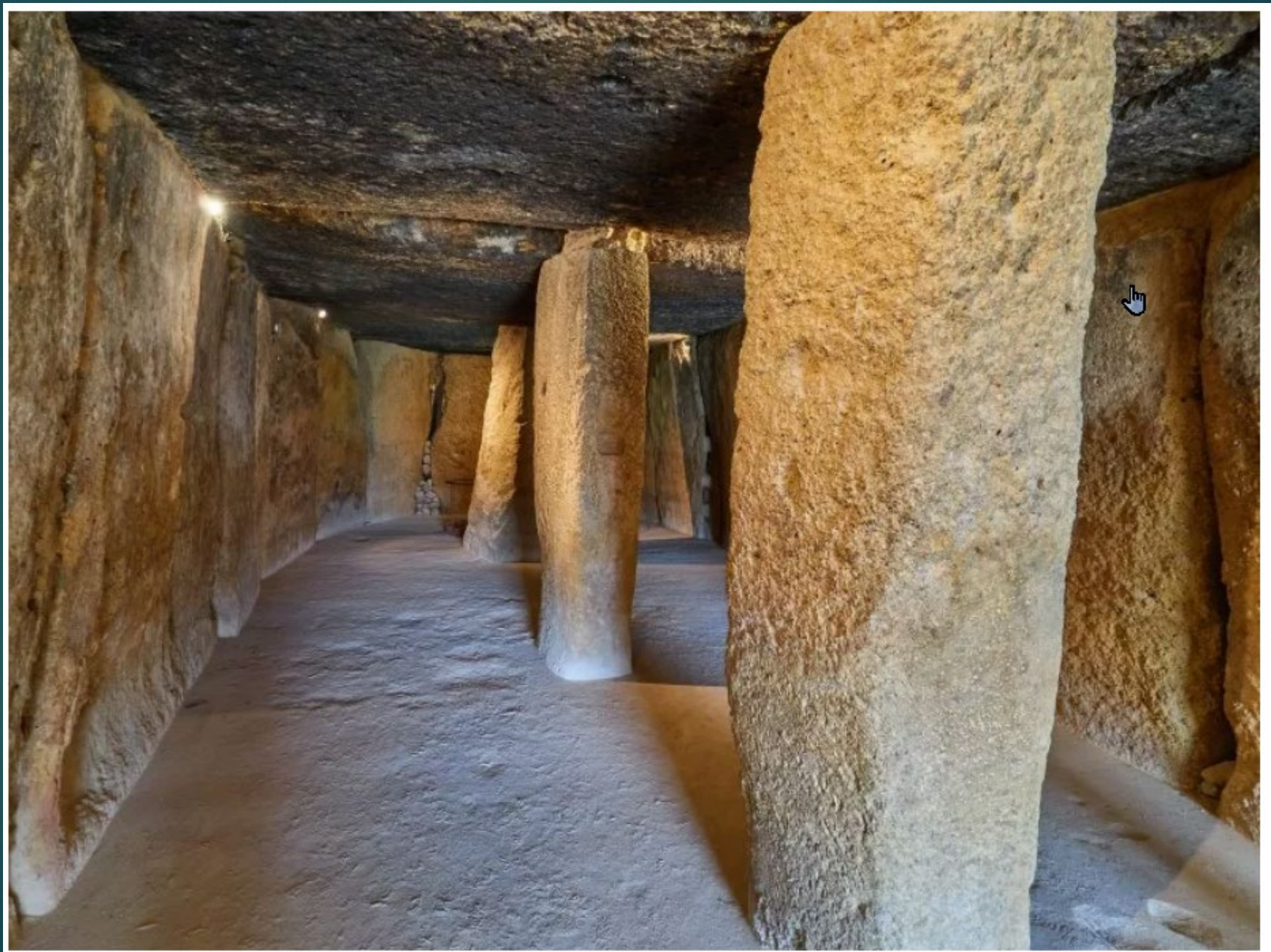


Construction

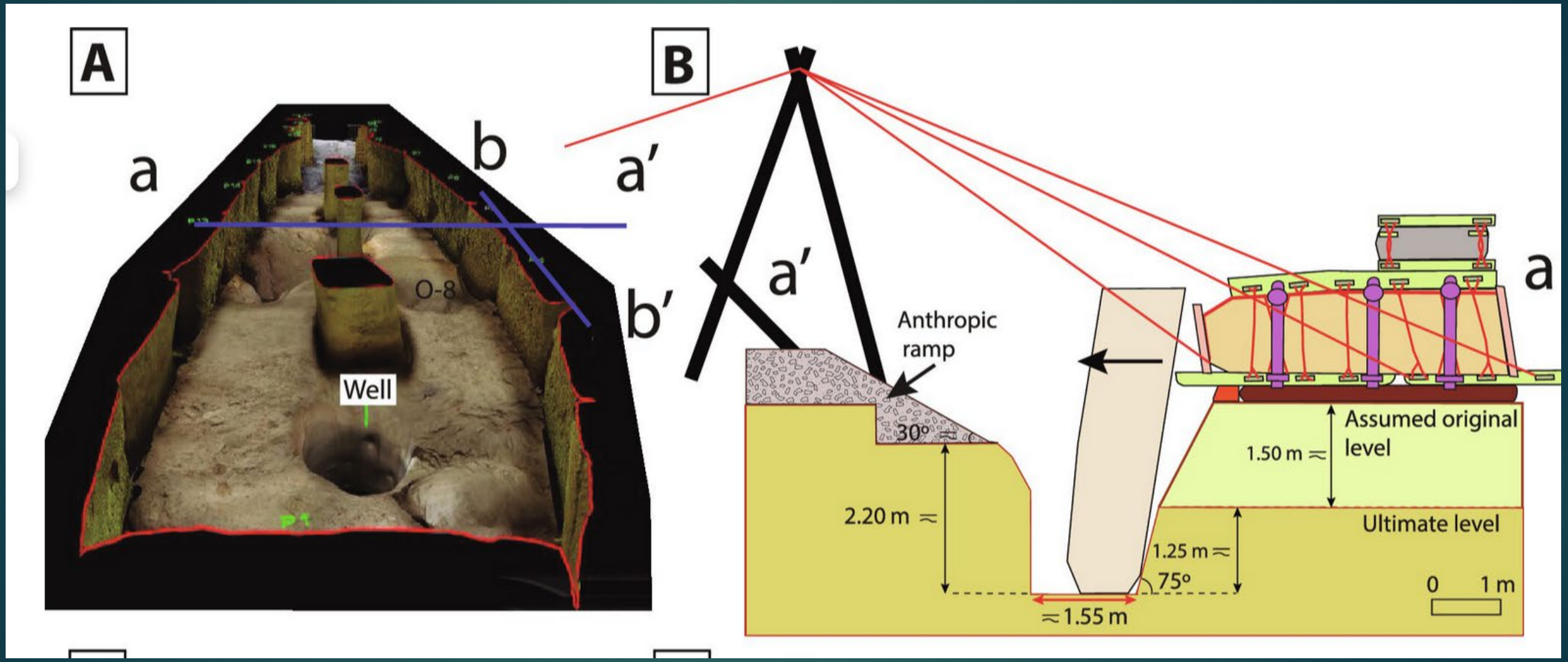
- Constructed from the inside and without any use of ramps. The fragile rocks were transported by sled.

- Among the capstones is one, referred to as No. 5, that weighs 150 tons—making it the heaviest known from a prehistoric dolmen. Largest stone at Stonehenge was only 30 tons.
- In addition, the researchers found that the supporting wall stones were placed with millimeter-scale precision, creating a trapezoidal effect that added stability to the structure. Many of these wall stones interlocked through lateral facets, and both wall and pillar stones were wedged into the bedrock, further enhancing the dolmen's durability.

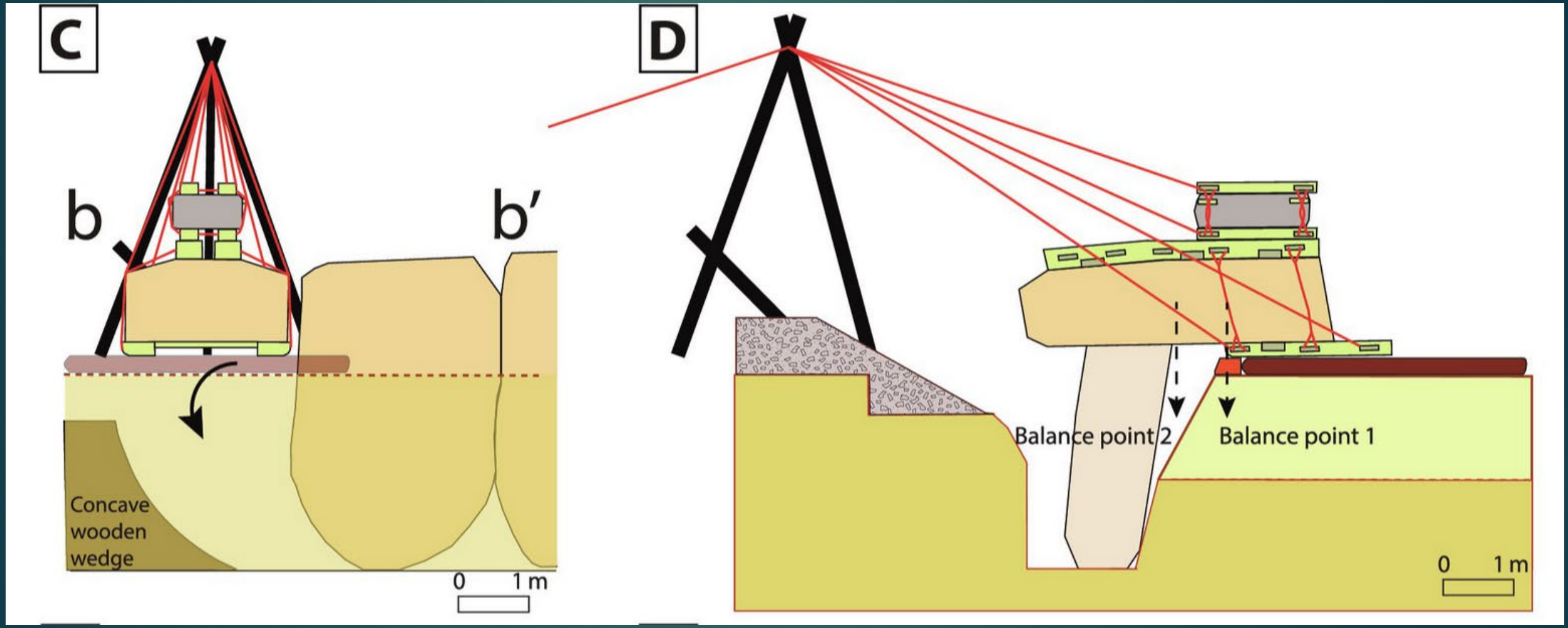
The interior chamber of the Menga dolmen



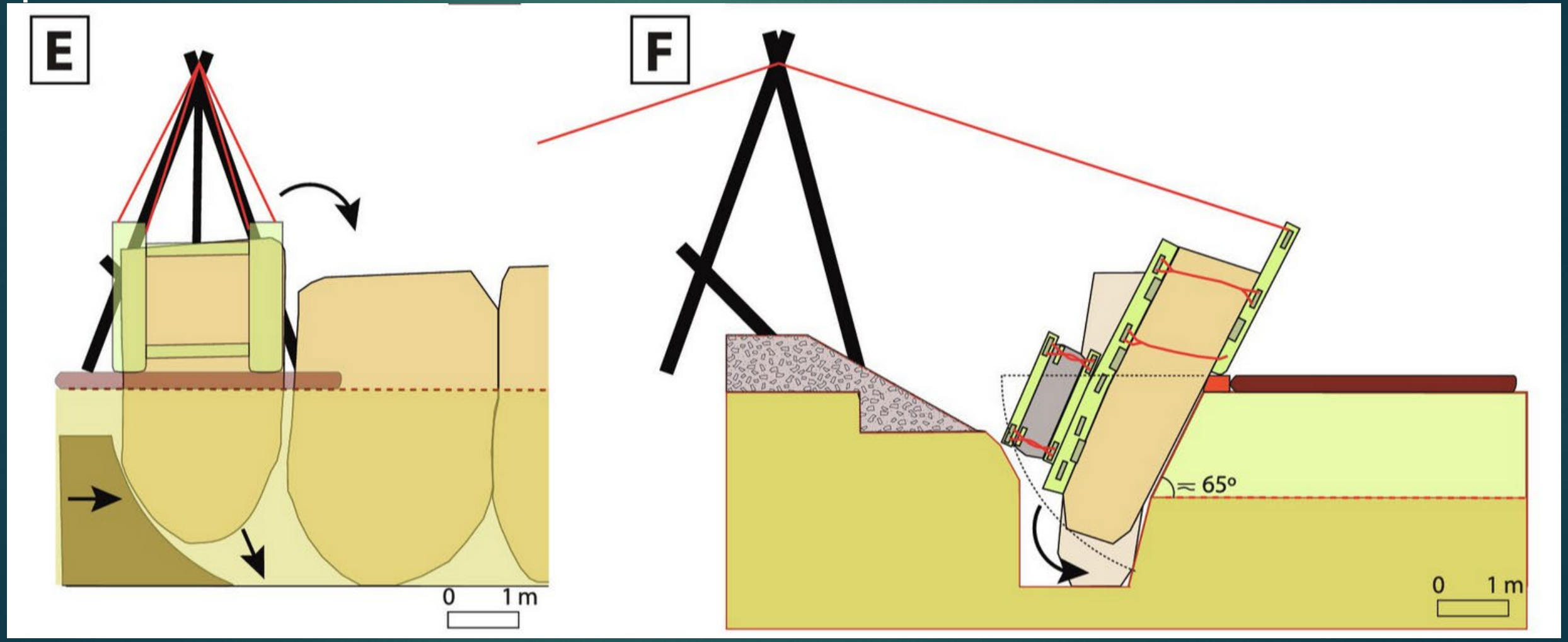
Tilting

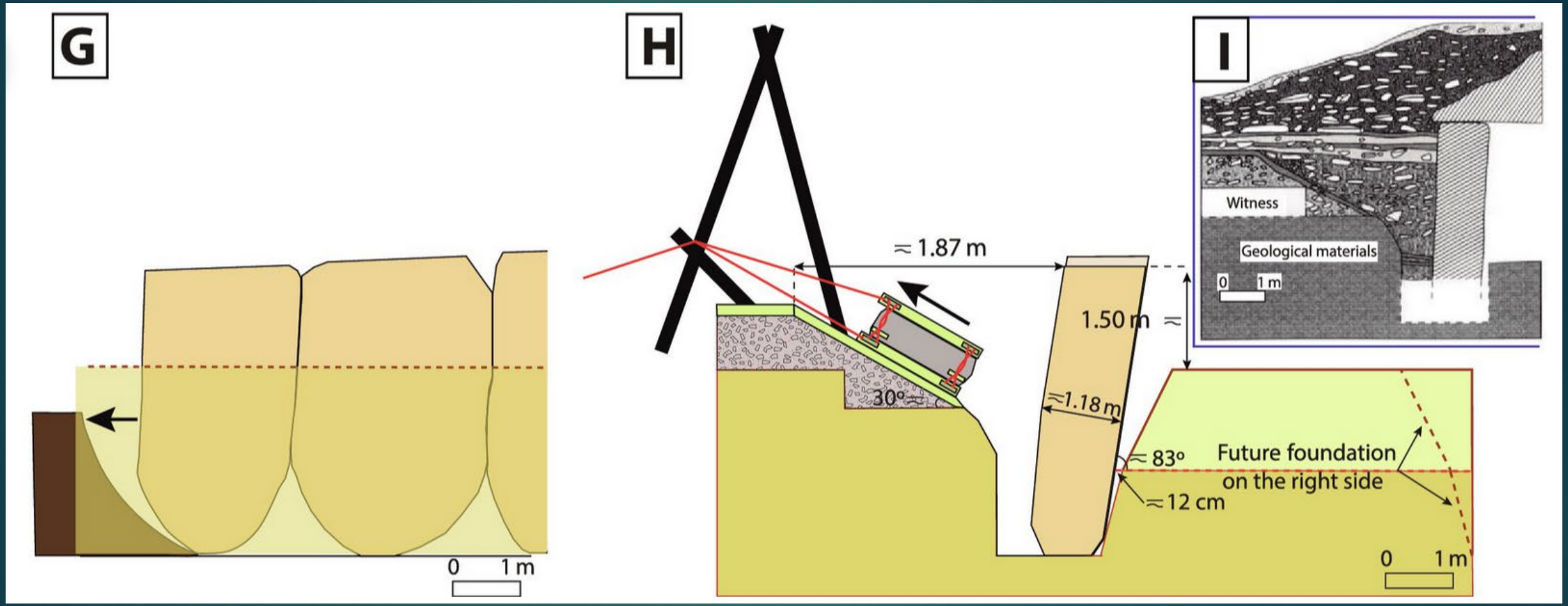

A
a
b
a′
b′
O-8
Well
B
a′
Anthropic
ramp
30°
a
Assumed original
level
1.50 m ≈
2.20 m ≈
Ultimate level
1.25 m ≈
75°
0
1 m
≈1.55 m

Construction Method

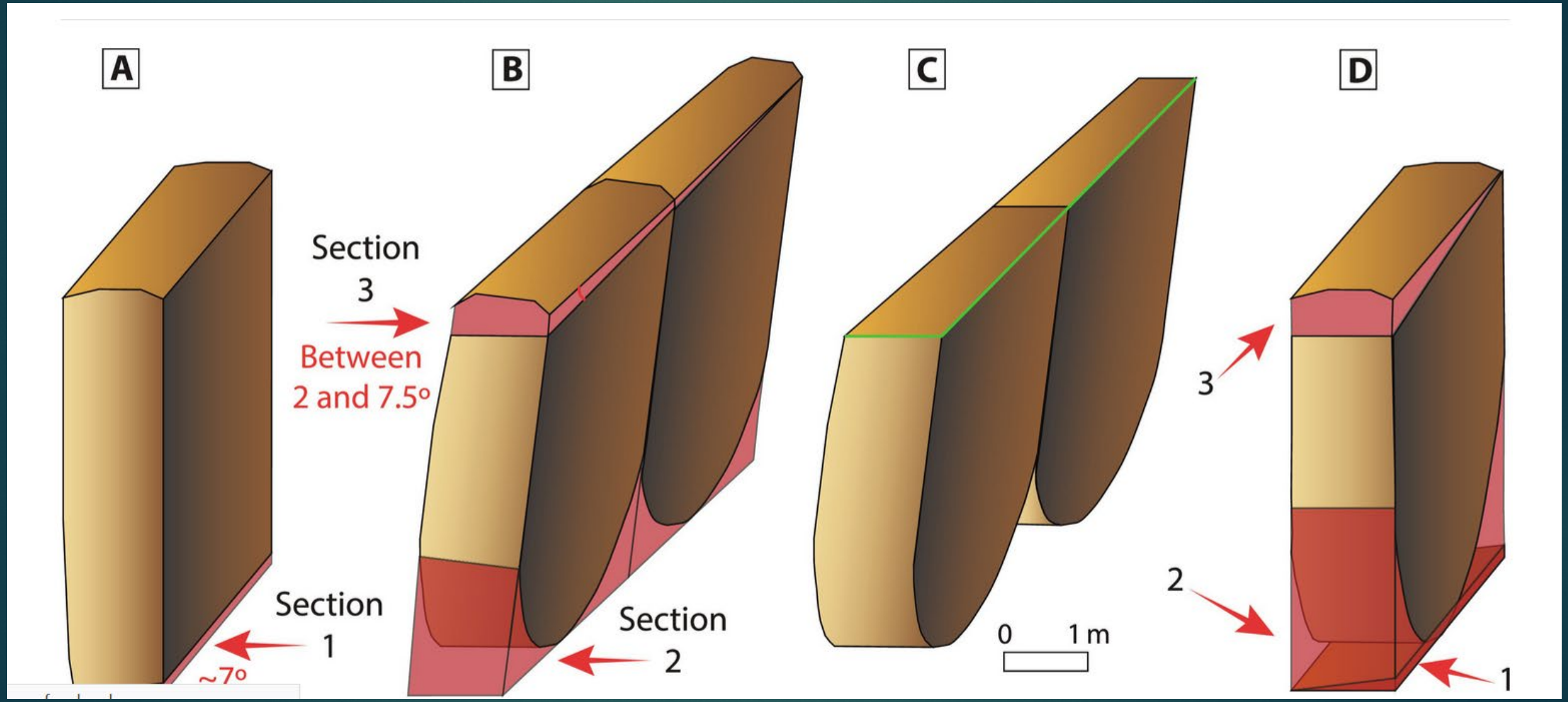


Counterweight and tilting of the upright as a result of the change in the balance point, while at the same time the wooden wedge exerts horizontal pressure to easily adjust it laterally to the upright already placed on its side

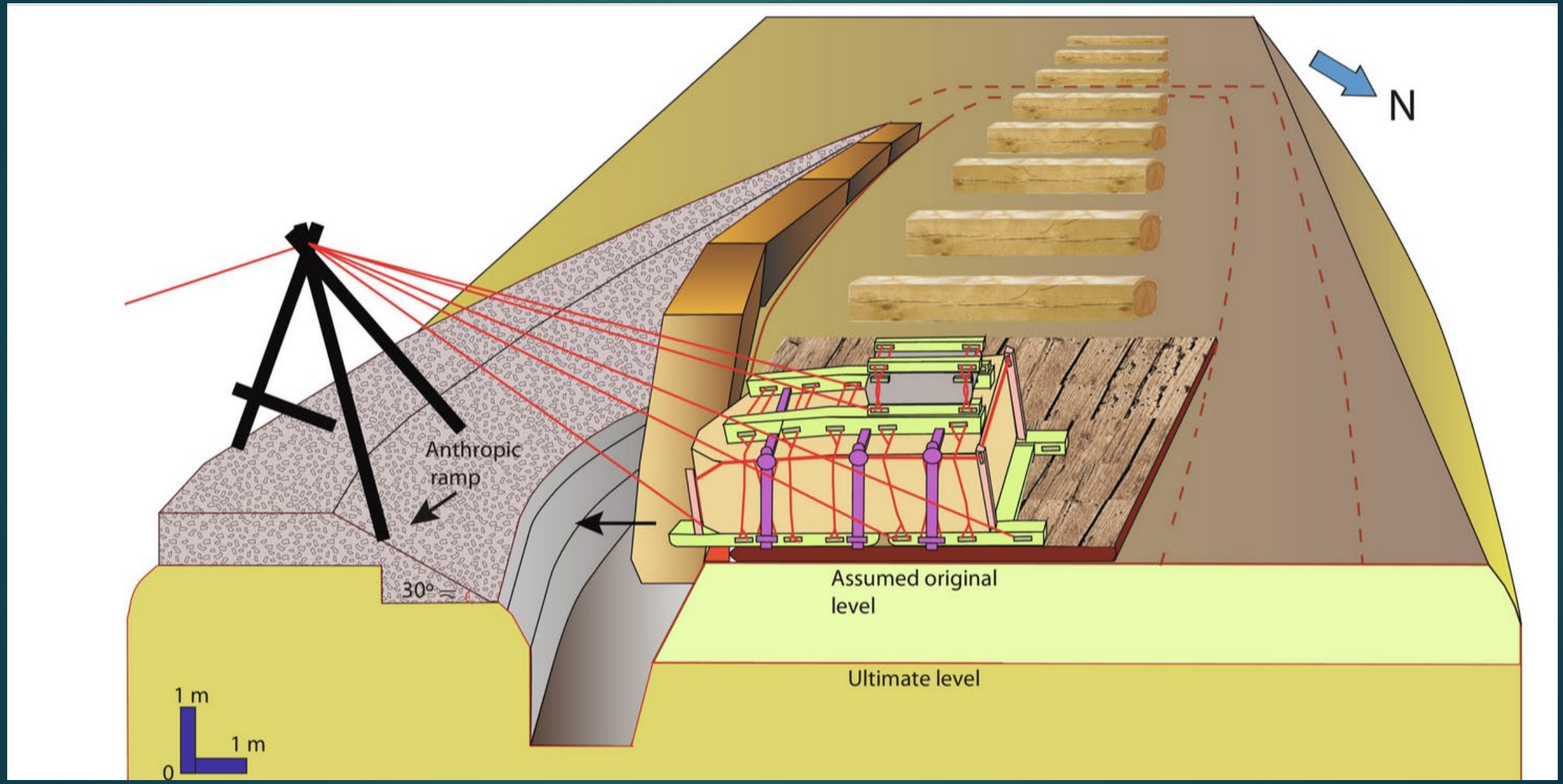


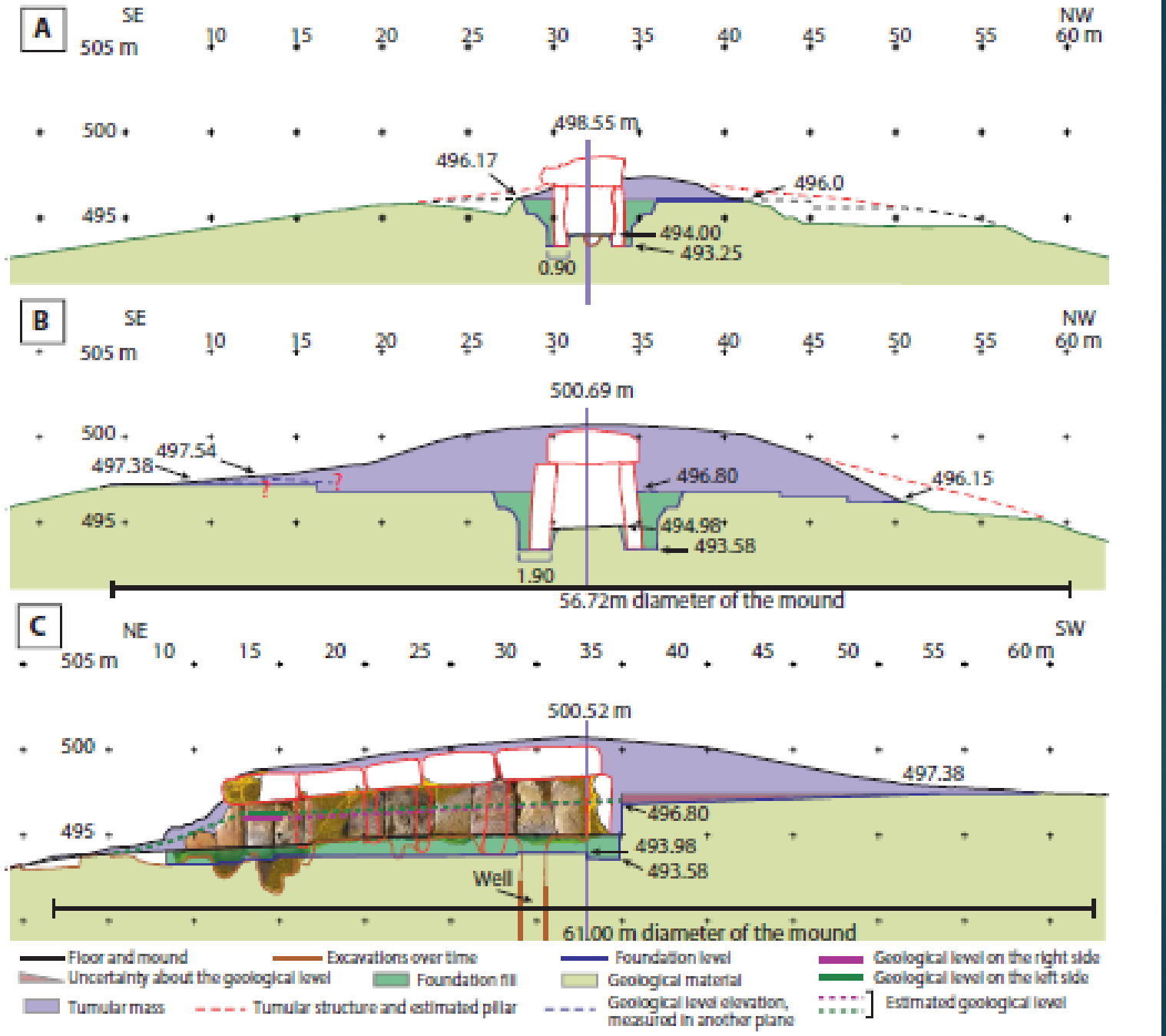

G
0
1 m
H
≈ 1.87 m
30°
1.50 m
≈1.18 m
≈ 83°
Future foundation
on the right side
≈12 cm
0
1 m
I
Witness
Geological materials
0
1 m

Stone trimming



The efficiency of the counterweight was experimentally demonstrated. Egyptians had similar methodology.





orthwest (transversal) and northeast-southwest sections of Monga based on the topographic data produced by IDTEC

No precedents

- No precedents have been found in Iberia suggesting a gradual, steady increase in the development of engineering expertise through trial and error. On the basis of the evidence at hand, Menga is one of the first great monumental buildings ever engineered with colossal stones. Not only no precedents existed in Iberia for such a monument when Menga was built but also no comparable monument was later made throughout all of Late Prehistory. Or at least, we have no record left.
- The first large megalithic constructions were made in the Near East during the Neolithic revolution (10th to 8th millennia BCE), as exemplified in Göbekli Tepe. These constructions, however, were not entirely built in stone, as the roofing was made in timber. The architectural design of Göbekli Tepe consisted of standing stones—the basic element of their structure was a T-shape stone pillar-fixed into sockets that were hewn out the bedrock, around 9600 to 8800 BCE.

Megaliths

- Other megalithic structures with astronomical alignments are found in southern Egypt, at the place known a Nabta Lake, dating from the Late and Terminal Neolithic (5500 to 3400 BCE).
- In Europe, megalithic architecture occurred on the French Atlantic coast from Normandy to the Gironde. These are the corridor dolmens that are dated to the last centuries of the third millennium BCE. These are dry-rigged chambers, with a false dome roof, preceded by a narrow corridor, and covered by a circular mound. The same model can exist with small orthostats that delimit the chamber and the corridor. A variety of these monuments are found in the middle Loire basin that extends to the Cendée and inland Brittany. These are the “Angevin dolmens.” Among them are the most imposing megalithic constructions in all of France: La Roche aux Fées, Ille-etVilaine; Bagneux, Maine-et-Loire.

Unique

- They are large corridor dolmens dating to between 4300 and 3500 BCE, and they could be contemporary or somewhat older than Menga. In Europe, monuments built in later periods, such as the Copper Age and Bronze Age, were far less complex
- In summary, Menga is unique for its time for several reasons. The use of pillars to support the gigantic capstones, the embedding of a large portion of the edifice in the bedrock to attain extra-stability—acquiring earthquake-resistant properties, and the inter-locking of the uprights through lateral facets dressed at similar angles are features not seen in any other megalithic construction

Use of early science

- An in-depth knowledge of the properties (and location) of the rocks available in the region, notions of elementary physics (friction, activation energy, optimal ramp slope, mass center estimation, available rock load-bearing capacity, among others) was necessary to move and place the gigantic stones.
- Other forms of advanced knowledge deployed to build Menga include geometry and astronomy. This is revealed by the millimeter-scale use of obtuse and straight angles on the facets of the uprights, or the precise alignment of Menga's central symmetry axis to 45°, thus matching the natural plane of orientation of La Peña de los Enamorados northern cliff to which the dolmen faces.

Great engineering

- The incorporation of advanced knowledge in the fields of geology, physics, geometry, and astronomy shows that Menga represents not only a feat of early engineering but also a substantial step in the advancement of human science, reflecting the accumulation of advanced knowledge.
- Menga demonstrates the successful attempt to make a colossal monument lasting over thousands of years. In Antequera, this early science materialized in the construction of a great engineering building made of stone.
- Lozano Rodríguez, J. A., García Sanjuán, L., Jiménez-Espejo, F. J., Álvarez-Valero, A. M., Arrieta, J. M., Fraile-Nuez, E., García-Alix, A., Montero Artus, R., & Martínez-Sevilla, F. (2024). Early science and colossal stone engineering in Menga, a Neolithic dolmen (Antequera, Spain). *Science Advances*, *10*(34). https://doi.org/10.1126/sciadv.adp1295

The megaliths

- From simple rock arches to Stonehenge, tens of thousands of imposing stone structures dot Europe's landscapes. The origins of these megaliths have long been controversial. A new study suggests that large rock constructions first appeared in France and spread across Europe in three waves.
- The earliest megaliths were built in what's now northwestern France as early as around 6,800 years ago, says archaeologist Bettina Schulz Paulsson of the University of Gothenburg in Sweden. Knowledge of these stone constructions then spread by sea to societies along Europe's Atlantic and Mediterranean coasts,

*** Megaliths

- The world “megalith” is derived from the Greek words for “big stone
- Among the earliest of the European megaliths are apparently the Carnac stones in Brittany, which date to about 4,700 BCE. Even older are complex earthen tombs, dolmens, in the same region that go back about 5,000 years — Paulsson in a new study figures they were all built in a relatively brief 200- to 300-year period. From there, the timeline reveals, construction spread outward, with building styles evolving gradually over time.
- The Brittany region is the only one with evidence of pre-megalithic building that could have led to the megaliths.
- The original megaliths from Brittany are etched, surprisingly, with ocean imagery, including sperm whales and other ocean creatures. This suggests that their builders were part of seagoing culture, an activity not previous suspected. One of the odd questions about megaliths has been why they’re so concentrated near coasts, and the revelation that the people who started it all were seafarers helps explain this. Only France have boats depicted.

Megaliths

- Megaliths are located in coastal areas. Their distribution is along the so-called Atlantic façade, including Sweden, Denmark, North Germany, The Netherlands, Belgium, Scotland, England, Wales, Ireland, northwest France, northern Spain, and Portugal, and in the Mediterranean region, including southern and southeastern Spain, southern France, the Islands of Corsica, Sardinia, Sicily, Malta and the Balearics, Apulia, northern Italy, and Switzerland.
- Interestingly, they share similar or even identical architectonic features throughout their distribution. Megalithic graves were built as dolmens and as passage or gallery graves.
- There is evidence all across Europe for an orientation of the graves toward the east or southeast in the direction of the rising Sun.

- The most common type of megalithic construction in Europe is the dolmen - a chamber consisting of upright stones (orthostats) with one or more large flat capstones forming a roof.

- A dolmen is a type of single-chamber megalithic tomb.

- 40% of the world's dolmens are found in Korea

Carnac stones in Brittany. dated to about 4,700 BCE.

The dolmen Er-Roc'h-Feutet in Carnac, Brittany, France

Crucuno dolmen in Plouharnel, Brittany, France

Callanish on the Isle of Lewis in Scotland

The megalithic grave Dolmen de Sa Coveccada on Northeast Sardinia

Megalithic grave Dolmen de Fontanaccia, Corsica.

T-shaped Hunebed D27 in Borger-Odoorn, Netherlands

Poulnabrone dolmen, the Burren, County Clare, Ireland

Dolmens in Amadalavalasa, Andhra Pradesh, India

Trethevy Quoit – one of the best-preserved in Cornwall, UK dated to around 3500–2500 BCE

Dolmen de las Ruines, Catalonia

*** Radiocarbon dates and Bayesian modeling support maritime diffusion model for megaliths in Europe – B. Schulz Paulsson

- There are two competing hypotheses for the origin of megaliths in Europe.
- The conventional view from the late 19th and early 20th centuries was of a single-source diffusion of megaliths in Europe from the Near East through the Mediterranean and along the Atlantic coast. Following early radiocarbon dating in the 1970s, an alternative hypothesis arose of regional independent developments in Europe; megaliths emerged independently among a handful of European farming communities. This model has dominated megalith research until today.
- Applied a Bayesian statistical approach to 2,410 currently available radiocarbon results from megalithic, partly premegalithic, and contemporaneous nonmegalithic contexts in Europe to resolve this long-standing debate.

Stared 5000 BCE

- The radiocarbon results suggest that megalithic graves emerged within a brief time interval of 200 y to 300 y in the second half of the fifth millennium calibrated years BC in northwest France, the Mediterranean, and the Atlantic coast of Iberia -- from the Ring of Bodnar in the Scottish Orkney Islands to Stonehenge in the English countryside, to the Carnac stones in France. We found decisive support for the spread of megaliths along the sea route in three main phases. Thus, a maritime diffusion model is the most likely explanation of their expansion
- European megaliths were products of mobile, long-distance sea travelers,
- Around 35,000 megalithic graves, standing stones, stone circles and stone buildings or temples still exist, many located near coastlines.
- Radiocarbon dating has suggested that these structures were built between roughly 6,500 and 4,500 years ago (4500-2500 BCE). As it turns out that it all started with single hunter-gatherer culture in an area now known as Brittany, France some 7,000 years ago (5000 BCE).

3 waves

- The earliest megalithic graves consisted of two or more standing stones topped by a third stone or by a mound of earth. That construction style spread from northwest France down the Atlantic coast and into the Mediterranean in the second half of the fifth millennium calibrated years (cal) BC within a time interval of 4794 BCE to 3986 BCE
- Large earthen graves without stones were built shortly before the rise of megaliths and appear only at sites in northwest France, pegging that region as the likely birthplace of megalithic graves,.
- By 4,300 BCE, monuments were appearing along the coasts of southern France, the Mediterranean, and the Atlantic side of the Iberian Peninsula.

First wave

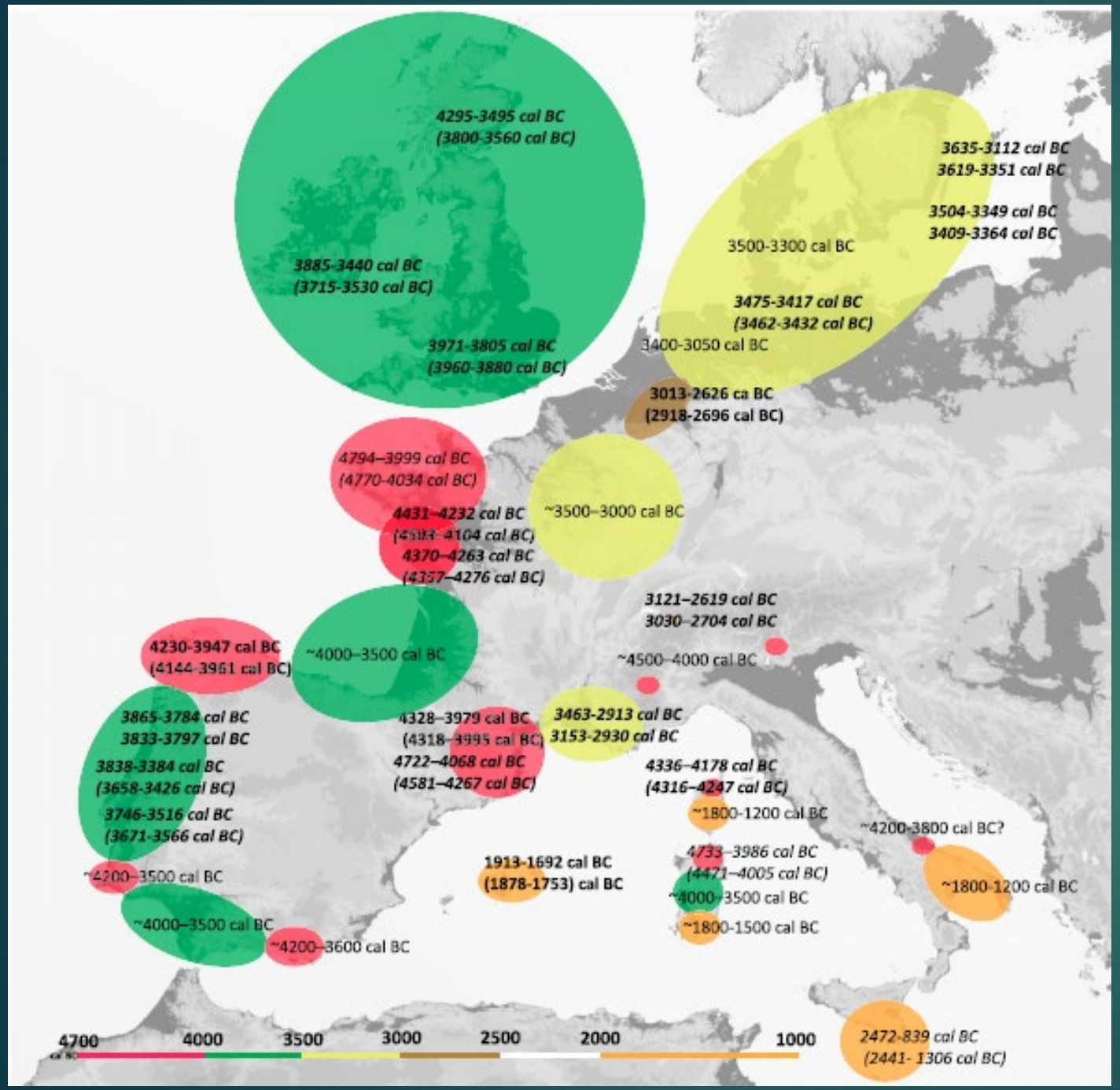
- The first wave occurred in the fifth millennium BCE, with megaliths unlike previous local structures appearing in Catalonia, southern France, Corsica, Sardinia, and probably the western Iberian Peninsula and Italian mainland.
- In the fourth millennium BCE, passage graves were constructed "along the Atlantic coast of the Iberian Peninsula, Ireland, England, Scotland, and France. "By the second half of that millennium, they'd reached Scandinavia and the Funnelbeaker areas.
- Stonehenge dates back to about 2,400 BCE.

Stonehenge

2nd and 3rd periods

- A second type of megalith gained widespread popularity between about 6,000 and 5,500 years ago (4000 to 3500 BCE). Thousands of "passage graves," consisting of a narrow stone passage connected to one or more burial chambers covered in earth or stone, were built at sites along coasts of Portugal, Spain, Ireland, England, Scotland and France.
- Sea voyagers plying established trade routes must have linked those areas and led to a major change in burial practices, signified by the proliferation of passage graves.
- Finally, after around 5,500 years ago, passage graves reached Scandinavia and north-central Europe and other megalithic structures spread to additional coastal sites. Massive boulders were raised at Stonehenge in southwestern England around 4,400 years ago
- Unanswered: the monuments are built in strongly local regional architectural traditions

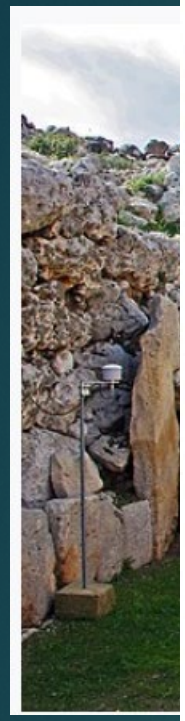

4295-3495 cal BC
(3800-3560 cal BC)
3635-3112 cal BC
3619-3351 cal BC
3504-3349 cal BC
3409-3364 cal BC
3500-3300 cal BC
3885-3440 cal BC
(3715-3530 cal BC)
3475-3417 cal BC
(3462-3432 cal BC)
3971-3805 cal BC
(3960-3880 cal BC)
3400-3050 cal BC
3013-2626 ca BC
(2918-2696 cal BC)
4794–3999 cal BC
(4770-4034 cal BC)
3121–2619 cal BC
3030–2704 cal BC
4230-3947 cal BC
(4144-3961 cal BC)
4500-4000 cal BC
3463-2913 cal BC
(3153-2930 cal BC)
4328–3979 cal BC
(4318–3995 cal BC)
4722–4068 cal BC
(4581–4267 cal BC)
4327–4266 cal BC
(4302–4273 cal BC)
~4000–3500 cal BC
1913-1692 cal BC
(1878-1753) cal BC
4733–3986 cal BC
(4471-4005 cal BC)
~4200-3800 cal BC?
~4200–3600 cal BC
2472-839 cal BC
(2441- 1306 cal BC)



Map showing the hypothetical route of the megalithic expansion in three main phases (red−green−yellow), periods of megalithic stasis (brown−white), and episode of a megalithic Mediterranean revival (orange) in the second millennium cal BC, with the estimated start of megalithic graves in the different European regions

Megalithic Temples of Malta, 3600 to 2500 BCE

Malta, 12 temples



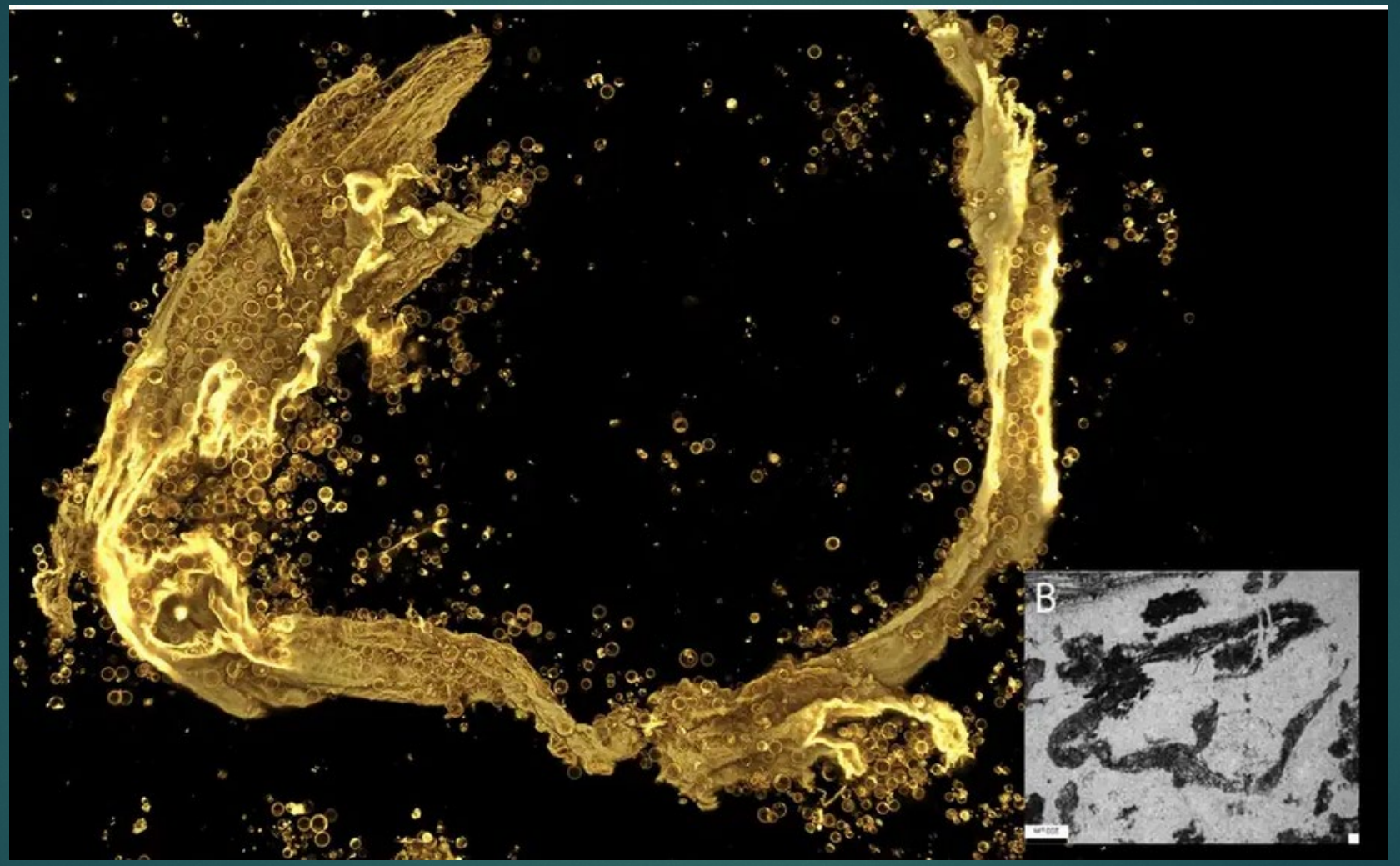
*** Butchered bones hint humans were in South America 21,000 years ago

- Prehistoric mammal bones found at a construction site in Argentina appear to have been cut with stone tools, suggesting that humans lived in the region much earlier than previously thought
- Marks found on the 21,000-year-old bones of a giant, armadillo-like animal in Argentina may be the oldest evidence of humans in southern South America.
- If confirmed through additional excavation and research, the findings could push back the date humans were known to be living in the area by about five millennia, to the end of the last glacial period. That would predate the currently accepted arrival of humans on either American continent by at least 1000 years.

Earlier into the Americas

- Recently, the apparent discoveries of butchered bones in Mexico from up to 26,000 years ago and jewellery made of giant sloth bones in Brazil from up to 27,000 years ago have made researchers question whether humans reached the Americas much earlier,
- Surveyors uncovered multiple hip and tail bones and shell parts of what was once a 1.5-meter-long mammal called a glyptodont, which resembled an armadillo, in this case from the genus *Neosclerocalyptus*.
- Its bones and shells were marked by 32 straight cuts that looked like they had been made by stone tools, given the inner stripes within the grooves and their V-shaped form. Radiocarbon dating placed the specimen in the last glacial maximum, as late as 21,000 years ago.
- A red flag is the total absence of any associated human-made artefacts with these [bones]

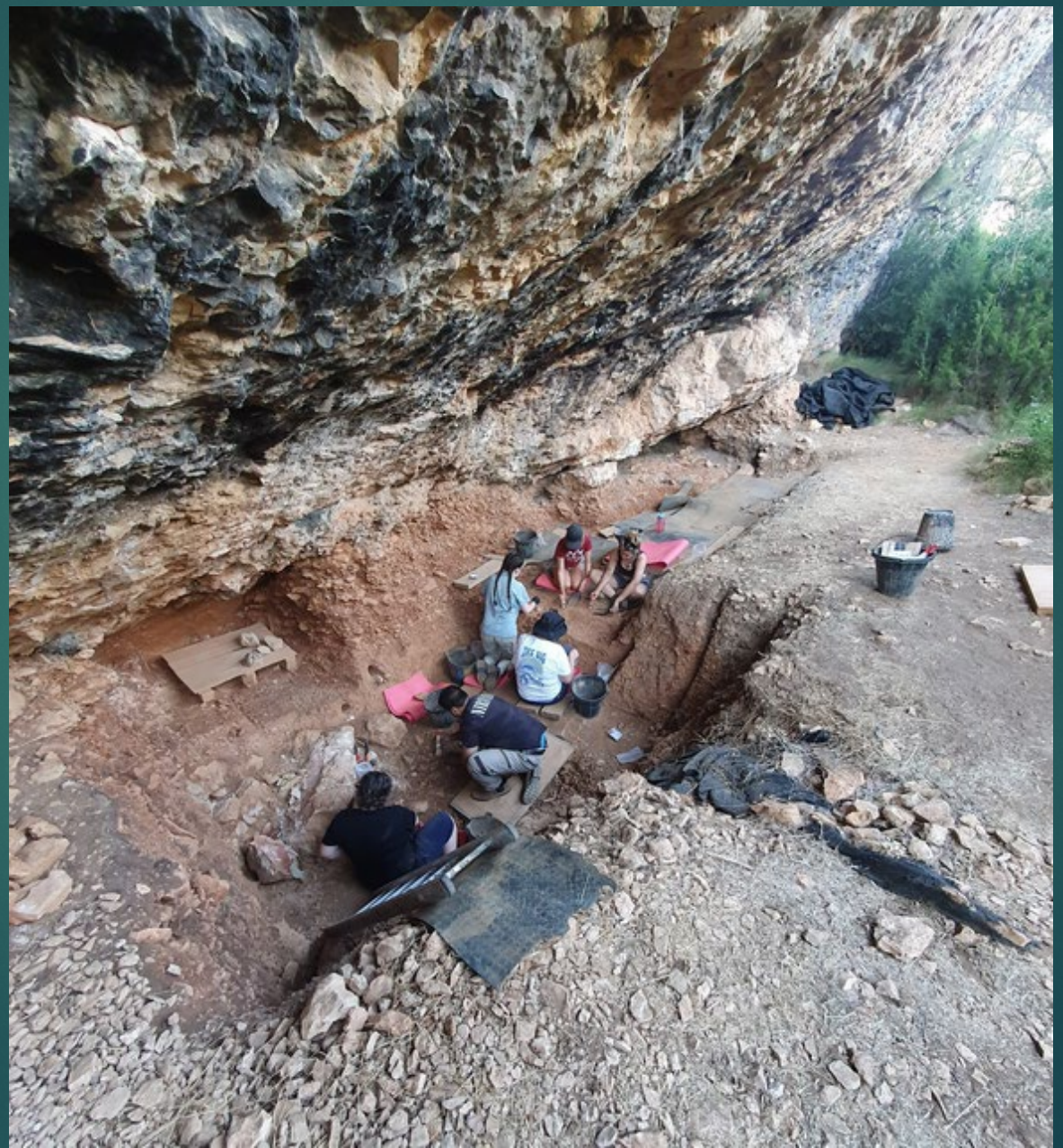
Oldest rocks on Earth may contain strange and ancient life forms



Unusual cells without walls can create structures (main image) that resemble those found in 3.4-billion-year-old rocks from Buck Reef, South Africa (inset)

*** Archaeological site reveals 'surprising' Neanderthal behavior at Pyrenees foothills

Archaeologist Dr. Sofia Samper Carro says the insights found at Abric Pizarro challenge widespread beliefs that Neanderthals only hunted large animals



Abric Pizarro: Ns hunting not just large mammals

- Abric Pizarro is one of only a few sites worldwide dating from 100,000 to 65,000 years ago during a period called MIS 4. The researchers have gathered hundreds of thousands of artifacts, including stone tools, animal bones and other evidence, providing significant data about the Neanderthal way of life during that time
- The findings reveal Neanderthals were highly adaptable to their environment and to the type of fauna available. Neanderthals knew the best ways to exploit the area and territory and were resilient through harsh climate conditions. They successfully exploited the surrounding fauna, hunting red deer, horses and bison, but also eating freshwater turtles and rabbits, which imply a degree of planning rarely considered for Neanderthals. Neanderthals were capable of hunting small animals

*** Living on the edge: Abric Pizarro, a MIS 4 Neanderthal site in the lowermost foothills of the southeastern Pre-Pyrenees (Lleida, Iberian Peninsula)

- Extensive research carried out during the last 30 years in the lowermost foothills of the Southern Pyrenees has revealed the significance of this area for studying Neanderthal lifestyle and settlement histories in the Iberian Peninsula.
- Here we present the chronostratigraphic, technological, faunal, and paleoenvironmental results from Abric Pizarro, a recently discovered site from the region. Its archaeological sequence is centered on MIS 4, a poorly known period in Neanderthal history.

Sofia C. Samper Carro, et al., 2024

Abric Pizarro

- The application of three different dating methods (newly obtained single-grain optically stimulated luminescence and U-series fossil teeth ages, in addition to previously published thermoluminescence ages) provides an accurate chronology for a site where the exceptional preservation of faunal remains leads to significant interpretations of Neanderthal hunting abilities and adaptability
- Although chronologically more recent than the archaeological units documented in Abric Pizarro, the taxonomic representation identified in Abric Romaní present similarities with Pizarro.
- Red deer and horse are present in every unit analyzed from Abric Romania accompanied by large-sized herbivores (Bos primigenius and Stephanorhinus hemitoechus). Nevertheless, the low number of small-sized herbivores and caprines observed in Abric Romani contrast with their relative abundance in the lower unit of Abric Pizarro (Q), and a relatively stable presence throughout the sequence.

Adept hunters

- Anthropogenic modifications support interpretations of high efficiency in Neanderthal hunting of mammals of a different size range. As such, the Abric Pizarro assemblage indicates Neanderthals ability to exploit the local landscape.
- The preliminary results from Abric Pizarro suggest that Neanderthal groups were adept hunters, with a broad knowledge of the surrounding landscape, which they exploited efficiently, as demonstrated in MIS 3 sites documented in the NE of the Iberian Peninsula (e.g. Abric Romani, L'Arbreda) and in Southwestern France (e.g. Les Pliradelles, Chez-Pinaud, Mauran (Rendu).

Neanderthal cooking skills put to the test with birds and stone tools

- In an effort to understand ancient Neanderthal food preparation techniques, researchers butchered five wild birds using flint stone tools and roasted them

- Archaeologists have cooked and prepared five wild birds using only fire, their hands and stone tools to learn more about the culinary abilities of Neanderthals. The experiment shows it took considerable manual skill for our ancient relatives to butcher animals using flint blades without injuring themselves.

Cooking birds ala N

- All five birds were plucked by hand. A crow and a dove were butchered uncooked and the remaining three birds were baked on a bed of coals. The cooked birds could be easily pulled apart without stone tools, but the raw birds required considerable effort using the flint blades.
- Palaeolithic knives were indeed very sharp, requiring careful handling. “The precision and effort needed to use these tools without causing self-injury emphasized the practical challenges Neanderthals might have faced in their daily food-processing activities.”
- The burn marks and tool scars were then compared with Neanderthal food remains from the Figuiera Brava and Oliveira archaeological sites, both in Portugal. Bird bones with burning stains and cut marks found at the sites align with those seen in the team’s replications

Barbecued chicken

- Neanderthals were skilled enough to catch and cook small, quick animals like birds. This study highlights the cognitive abilities of Neanderthals, demonstrating their capacity to catch and process small, fast-moving prey like birds, thus challenging the traditional notion that Neanderthals were not capable of such complex tasks

- In this case, one of the main findings was that cooked birds don't need tools to be prepared for eating, which could mean some bones won't necessarily have tool scars. "They learned you can just rip a cooked wild bird apart the same way we eat a barbecue chicken

*** Ice Age Europeans: Climate change caused a drastic decline in hunter–gatherers

The cold north

- A large-scale study of fossil human teeth from Ice Age Europe shows that climate change significantly influenced the demography of prehistoric humans. Using the largest dataset of human fossils from Ice Age Europe to date, an international research team shows how prehistoric hunter–gatherers coped with climate change in the period between 47,000 and 7,000 years ago.

- Population sizes declined sharply during the coldest period, and in the West, Ice Age Europeans even faced extinction,

450 teeth

- About 45,000 years ago, the first modern humans migrated to Europe during the last Ice Age, marking the beginning of the so-called Upper Paleolithic. These early groups continuously populated the European continent—even during the so-called Last Glacial Maximum about 25,000 years ago, when glaciers covered large parts of northern and central Europe.

- Newly compiled collection includes dental data of 450 prehistoric humans from all over Europe, covering the period between 47,000 and 7,000 years ago.

Population turnover in western Europe at ~28 ka

- The researchers focused on "morphological" tooth traits—small variations within the dentition, such as the number and shape of crown cusps, ridge and groove patterns on the chewing surface, or the presence or absence of wisdom teeth. These traits are heritable, which means we can use them to trace genetic relationships among Ice Age humans without requiring well-preserved ancient DNA

- We tested a range of competing demographic scenarios using a coalescent-based machine learning Approximate Bayesian Computation (ABC) framework that we modified for use with phenotypic data. Mostly in agreement with but also challenging some of the hitherto available evidence, we identified a population turnover in western Europe at ~28 ka, isolates in western and eastern refugia between ~28 and 14.7 ka, and bottlenecks during the Last Glacial Maximum.

Aurignacian & Gravettian cultures

- Initial and Early Upper Paleolithic and Aurignacian groups: they have contributed little to the gene pool of successive populations, indicating that they went largely extinct or were assimilated by subsequent dispersals.
- They are followed by, or merged into, a new group of people associated with the archaeologically defined Gravettian culture, a pan-European technocomplex with widespread similarities in lithic artifacts, weaponry, mortuary practices, and shared symbolic expressions.
- During the Gravettian, climate became increasingly cold and dry, forming open steppe environments capable of sustaining large mammal herds, which were the main subsistence resource for hunter-gatherers, and traces of complex settlements suggest a growth in population size relative to previous periods with milder climatic conditions

Ice cometh…

- During the second half of the Gravettian, temperatures dropped to the lowest levels of the entire Upper Paleolithic, accompanied by a rapid advance of northern hemisphere ice sheets, leading to a shift in vegetation from steppe to predominantly tundra environments, which affected the habitats of prey mammals.

- These changes resulted in a marked reduction of human net primary production and biomass, a decline in human population density with regional occupation hiatuses, and a breakdown of long-distance social networks .

- Climate deteriorations culminated in the Last Glacial Maximum (LGM) at ~26.5 to 19 ka, during which ice sheets reached their maximum extent, covering most of the northern and central European continent.

Refugia

- Consequently, human populations in northern latitudes are hypothesized to have either gone extinct, or declined substantially in numbers, with some migrating to environmentally more favorable regions in southern glacial refugia, such as the Iberian peninsula and southern France, the Italian peninsula, the Balkans, and the southeastern European plain.

- Some LGM refugia might have been more favorable than others, and population extinctions, declines, and isolation events likely led to a loss of genetic diversity, which might be reflected in distinct skeletal morphology differences between pre and post-LGM groups

Magdalenian and Epigravettian cultures

- After the LGM, temperatures steadily increased, glaciers retreated, and steppe and woodland vegetations returned, enabling the first (seasonal) reoccupations of previously abandoned areas, perhaps as early as ~19 ka.
- Post-LGM populations in western and central Europe, associated with the archaeologically defined Magdalenian culture, are thought to have spread either unidirectionally from the Franco-Cantabrian refugium or bidirectionally from both western and eastern European refugia.
- Conversely, post-LGM populations in southern and southeastern Europe, associated with the archaeologically defined Epigravettian culture, may have expanded from the Balkans, but the origin, mode, and timing of this diffusion are not well understood

Inferring population history of Upper Paleolithic Europe from dental remains

- The available evidence suggests several demographic transitions during the Last Glacial, which likely relate to marked climatic and environmental fluctuations and associated changes in habitat suitability and human mobility behavior, prompting sociocultural adaptations

- We were able to explicitly test a range of alternative models of European Ice Age population history with unprecedented numerical quality. Through this approach, we have generated six intriguing insights. = Very technical discussion

*** To kill mammoths in the Ice Age, people used planted pikes, not throwing spears

Clovis points and foreshafts under braced weapon compression: Modeling Pleistocene megafauna encounters with a lithic pike - R. Scott Byram, et al., 2024

- How did early humans use sharpened rocks to bring down megafauna 13,000 years ago? Did they throw spears tipped with carefully crafted, razor-sharp rocks called Clovis points? Did they surround and jab mammoths and mastodons? Or did they scavenge wounded animals, using Clovis points as a versatile tool to harvest meat and bones for food and supplies?

- UC Berkeley archaeologists say the answer might be none of the above.

Spears that impaled charging megafauna

- Instead, researchers say humans may have braced the butt of their pointed spears against the ground and angled the weapon upward in a way that would impale a charging animal. The force would have driven the spear deeper into the predator's body, unleashing a more damaging blow than even the strongest prehistoric hunters would have been capable of on their own.

- Drawing upon multiple sources of writings and artwork, a team of Berkeley archaeologists reviewed historical evidence from around the world about people hunting with planted spears.

Abstract

- Drawing from historical examples of pike use against lions, jaguars, boars, grizzlies, carabao and warhorses we consider the possibility of a fluted lithic pike.
- However our review of Late Holocene pike use in megafauna encounters indicates the sharp tip becomes less important after hide or armor has been pierced because compression is sustained. Thus, foreshaft collapse after hide entry may not limit but rather increase the efficacy of the braced weapon.
- New insights into the use of Clovis points have emerged through experimental archaeology. Researchers hypothesize that these points were part of a larger weapon system known as braced pikes—portable, long-handled weapons designed to withstand the immense forces generated by charging large animals.

Braced pikes

- Braced pikes were likely used by Clovis people to hunt megaherbivores such as mammoths and to defend against predators like the saber-toothed cat.

- The experiments demonstrated that Clovis point spears, when braced properly, could withstand the powerful forces exerted by large animals, validating the hypothesis that these weapons were designed for high-impact hunting.

- Unlike traditional thrown spears, braced pikes allowed hunters to plant their weapon securely in the ground, increasing their chances of successfully stopping and killing large prey.

Braced weapon bear hunting in Northern Eurasia, 19th century.

The pike

- Megafauna such as brown bears, lions, jaguars, boars, carabao and warhorses were often slain with a braced piercing weapon, sometimes known as a pike, that uses the animal's momentum to impale the animal and arrest its movement toward the pike wielder. Pike impalement often causes more massive injury than a thrust or launched spear can produce.
- The key elements of the pike are a sharp tip for entering thick hide or armor and a long, sturdy shaft that could be braced in the ground to receive a charge with deadly force resistance.
- Pikes were used for well over two millennia to stop charging warhorses in battle, and they can also be used as a long thrusting spear.

Use in pikes

- We conduct preliminary static experiments to model a fluted pike that adjusts during compression such that haft collapse and point detachment (when point jams on impact with bone) preserve the fluted biface, beveled rod and wooden mainshaft tip.

- In addition to Clovis stone points and bone rods, potential archaeological correlates of Clovis pike use include the high frequency of Clovis point isolates and concentrations of complete points with unbutchered mammoth remains at sites such as Naco in Arizona.

How did communities in North America actually use Clovis points, which are among the most frequently unearthed items from the Ice Age?

- Thousands of them have been recovered across the U.S.—some have even been unearthed within preserved mammoth skeletons.

- The intricately designed bone shafts at the end of the weapon are sometimes found, but the wood at the base of the spear and the pine pitch and lacing that help make them function as a complete system have been lost to time.

- Study mined archival records, spanning anthropology to art to Greek history, to trace the arc of planted pikes as weapons. It was used for stopping horses in warfare.

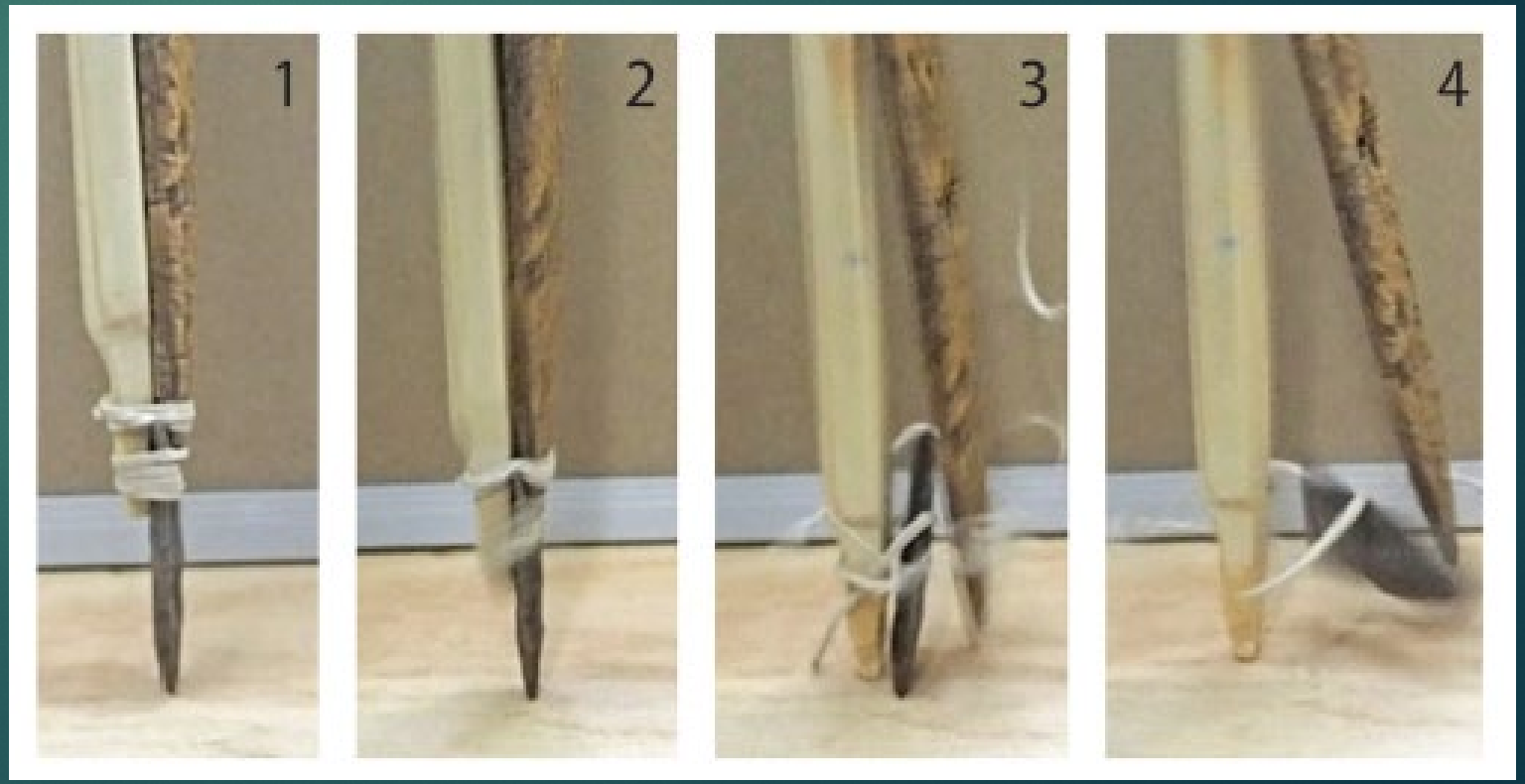
A piercing system

- They also ran the first experimental study of stone weapons that focused on pike hunting techniques, revealing how spears react to the simulated force of an approaching animal.

- Once the sharpened rock pierced the flesh and activated its engineered mounting system, the spear tip functioned like a modern day hollow-point bullet and could inflict serious wounds to mastodons, bison and saber-toothed cats.

A planted Clovis-tipped pike made impact with a massive, fast-moving mammal.

- The kind of energy that you can generate with the human arm is nothing like the kind of energy generated by a charging animal. It's an order of magnitude different. These spears were engineered to do what they're doing to protect the user.



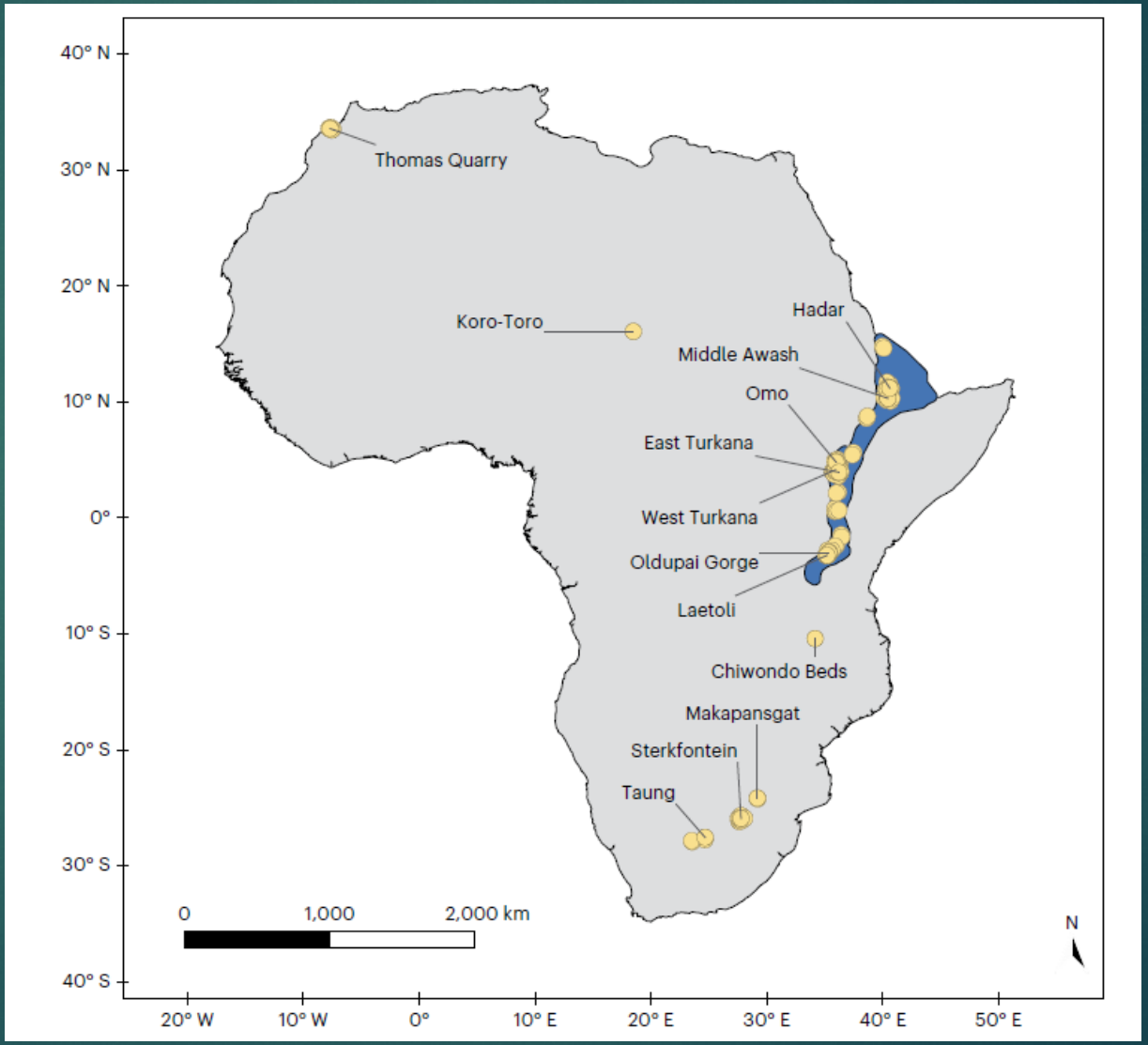
Experimental hafted pike

Fig 12. Experimental splint hafted pike with replica Clovis point tip, resin cast of East Wenatchee beveled bone rod (shown without lashing in Fig 3), yellow pine mainshaft and tanned buckskin strips for lashing.

*** Spatial sampling bias influences our understanding of early hominin evolution in eastern Africa - W. Andrew Barr & Bernard Wood , 2024

- The eastern branch of the Eastern African Rift System (EARS) is the source of a large proportion of the early hominin fossil record, but it covers a tiny fraction (ca. 1%) of the continent.
- Here we investigate how this mismatch between where fossils are preserved and where hominins probably lived may influence our ability to understand early hominin evolution, using extant mammals as analogues.
- We show that the eastern branch of the EARS is not an environmentally representative sample of the full species range for nearly all extant rift-dwelling mammals. Likewise, when we investigate published morphometric datasets for extant cercopithecine primates, evidence from the eastern branch alone fails to capture major portions of continental-scale cercopithecine cranial morphospace.

Map of Africa with selected early hominin fossil sites labelled with yellow dots.



East Rift Valley is not representative of all of Africa

- We suggest that extant rift-dwelling species should be used as analogues to place confidence intervals on hominin habitat reconstructions.

- Furthermore, given the north–south orientation of the eastern branch of the EARS, morphoclines that are not aligned along this major north–south axis are likely to be poorly sampled by sites in the eastern branch.

Africa: 2 major fossil areas

- Darwin had suggested that Africa to be the central theater of hominin evolution.
- In the twentieth century, fossil evidence recovered from two distinct areas in Africa gradually began to confirm these earlier predictions: the karstic cave sites in the high veldt of southern Africa and the open-air sites in the Eastern African Rift System (EARS).
- The sites in southern Africa are extraordinarily fossiliferous, but they sample a very small geographic area, and historically they have been difficult to date reliably, though recent advances are improving this situation5. The sites in the EARS, which are much more geographically extensive and are reliably dated using radiometric dating techniques, preserve an especially rich record of mammalian evolution between 4 and 1 million years ago

Few sites, mostly in sedimentary basins

- Despite the great importance of the EARS for understanding human evolution, the available fossil and contextual data derive from a small number of locations where geological conditions have allowed the preservation and subsequent exposure of sediments containing fossil and archaeological evidence.
- The sites where these sediments are exposed represent a tiny fraction of the entire African continent, so geological contingency severely limits and inevitably influences
- There is spatial bias in the fossil record: As vertebrate fossils are typically preserved in sedimentary rocks, the first-order control on where fossils get preserved is the geographic distribution of sedimentary basins.

Sedimentary basins

- Sedimentary basins act as traps, within which sediments eroding from adjacent areas accumulate, facilitating the rapid burial of bones and teeth, which increases the likelihood of their preservation as fossils.

- Globally, sedimentary basins represent an environmentally unrepresentative sample of Earth's surface. Approximately 27% of Earth's terrestrial land surface is characterized by an arid climate regime, while fully 60% of the land surface in sedimentary basins is arid

Sampling bias

- Given that sedimentary basins reflect a more arid, environmentally biased sampling of terrestrial environments globally, and that sedimentary basins within the EARS dominate our understanding of early human evolution, it is important to consider the potential impact of this environmental bias on interpretations of the hominin fossil record.

- While the impacts of a biased hominin fossil record have been considered in the human evolution literature, most studies have been concerned with the impacts of temporal sampling bias rather than focusing on how spatial bias may have influenced the hominin fossil record and its interpretation.

Eastern Branch

- The EARS is a geologically ancient feature that started to form by the early Miocene (ca. 25 million years ago).

- For the purposes of this paper, we treat the Eastern Branch, the Main Ethiopian Rift and the portion of Turkana Depression connecting the two, as a single entity we call the 'eastern branch'.

- The eastern branch of the rift contains many distinct sedimentary basins in which post-depositional faulting and erosion have resulted in the exposure of ancient fossil and archaeological remains on the modern land surface, and it is where many of the most productive early hominin fossil sites (for example, Oldupai (Olduvai) Gorge, East and West Turkana, Hadar, Middle Awash) are located

Actual geographic range of early hominins

- While the actual geographic range of each early hominin population is unknowable, it is unlikely to be confined to the locations where the fossil and archaeological record are sampled.
- The present study presents two analyses that use extant mammals as analogues, each of which is designed to estimate the magnitude and directionality of potential bias introduced by the limited spatial extent of the eastern African fossil record.
- The first set of analyses focus on environmental reconstruction. We use the distribution of modern mammal species living in the eastern branch to determine how well that restricted sample reflects environments across the full range of each species. The second set of analyses asks an analogous question in relation to morphological variation.

Analysis

- We analyze previously published morphometric datasets of cercopithecine primate crania to see how well the subset of specimens that come from the eastern branch capture the observed morphological variation across the actual range of these medium-sized, widely distributed primate groups.

- Across the 106 modern mammal species in our dataset that occur in the eastern branch of the rift, we compared the spatial overlap (%) between the within-rift portion of each species' range and the full range.

Eastern branch

- We compared the environmental summary statistics of the within-rift portions of the ranges with the same environmental statistics computed on the full ranges, to determine whether the eastern branch comprises an environmentally representative portion of species ranges.

- All of the environmental variables except for annual mean temperature and precipitation of the driest month showed significant differences between the within-rift portion of the species range as compared with the full range. The eastern branch portion of each species range is on average grassier and shrubbier and has fewer trees than the full ranges, reflecting the fact that currently the eastern branch is generally drier, and has less marked precipitation seasonality, than the adjacent regions.

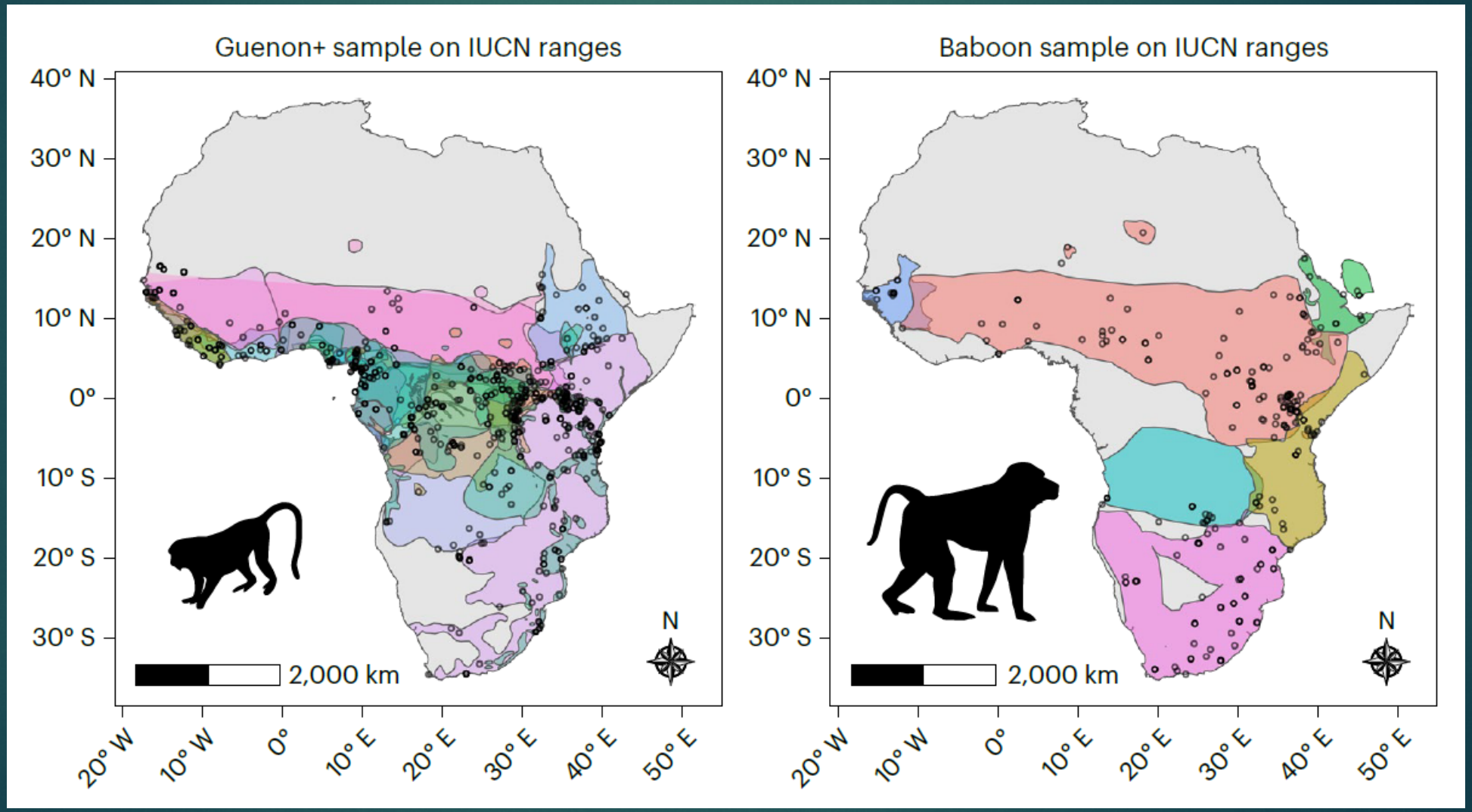
Guenon monkeys and baboons

How much cranial variation does the eastern branch capture?

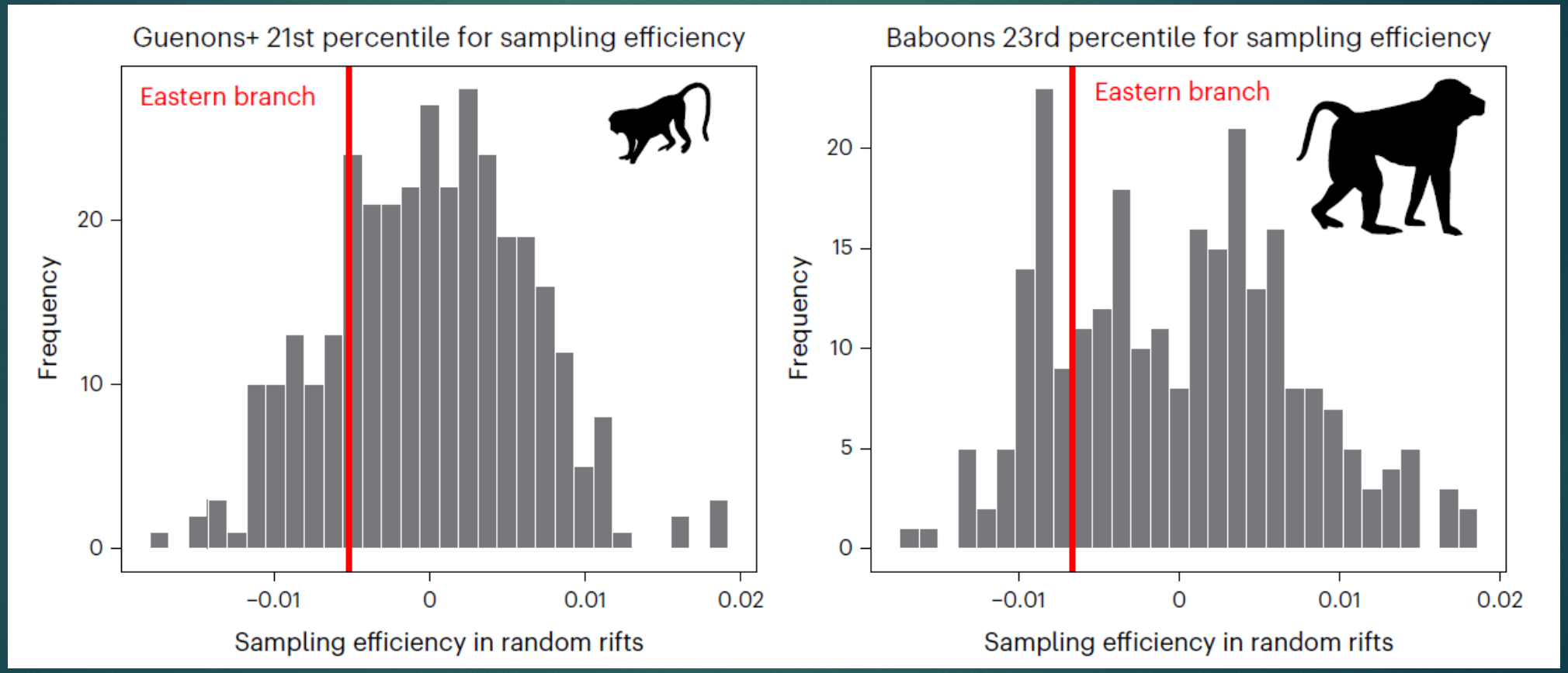
- We analyzed published cranial morphometric datasets of guenons+ (members of tribe Cercopithecini, including guenons plus close relatives) and baboons drawn from natural history museum collections obtained from locations across Africa

- As measured by the three-dimensional (3D) volume, the eastern branch reflects only 6.4% of the full guenon+ morphospace volume, while for baboons the equivalent percentage is 14.3%.

Geographic distribution of cranial specimens analyzed overlaid onto the species range maps



Histograms showing the sampling efficiency of ‘random’ rifts in guenons+ and baboons compared with the sampling efficiency of the actual eastern branch (vertical red line).



Eastern branch unrepresentative

- Our results demonstrate that the modern eastern branch reflects a limited view of the environmental tolerances of extant rift-dwelling species, characterized by lower precipitation, fewer trees and more shrubs and grass.
- With respect to cranial morphospace, we show that morphological samples restricted to the eastern branch alone would miss major portions of extant baboon and guenon+ morphological variation. Taken together, these findings have implications for the interpretation of early hominin morphology and the relationship between early hominins and their environment.

Not representative

- Using modern mammal species as analogues, we suggest that the eastern branch—where ancient bones and teeth are fossilized and preferentially exposed on the land surface—is not likely to be a representative sample of the environments in which early hominins lived.
- This observation complicates attempts to link environmental change with hominin evolution. For example, the disappearance of Australopithecus afarensis and the appearance of genus Homo has been linked to environmental shifts towards more open, grassy environments.
- Australopithecus afarensis has been shown to persist for half a million years, under varied environmental conditions at the site of Hadar, and it occupied habitats that were substantially drier and further from permanent water at Laetoli.

Linking evolutionary events with environmental change?

- If the eastern branch comprised merely a small portion of the geographic range of Australopithecus afarensis, as is typical for nearly all modern rift-dwelling taxa, then the range of habitats that Australopithecus afarensis was capable of thriving in probably exceeded this already impressive range.
- A widely distributed species with broad environmental tolerances is an unlikely candidate for extinction in response to long-term changes in environment such as those that occurred during the eastern African Plio-Pleistocene. Given our results, it would be prudent to consider environmental reconstructions as minimum estimates, which means even more caution should be exercised when linking evolutionary events with environmental change

Ardipithecus

- The results of our analyses serve as a reminder that species such as Ardipithecus ramidus very likely had ranges that were larger than those reflected at sites in the eastern branch and, thus, were probably able to tolerate a wider range of environmental conditions than those preserved at Aramis.

- Not all morphoclines are equally well sampled. Most of the random sampling units we imposed on the continent of Africa showed higher sampling efficiency than the eastern branch, which suggests that the rift is not particularly good at capturing the cranial variation of living guenons+ and baboons.

-

‘Thinking outside the rift’

- We urge paleoanthropologists and paleoecologic to keep potential spatial biases of the fossil record in mind, by ‘thinking outside the rift’ when characterizing early hominin paleoenvironments and morphology.

- We are encouraged by the recent focus on fieldwork outside of traditional palaeontological hotspots and in distinct environmental contexts, and we believe that future finds expanding the spatial range of the fossil record will allow for more accurate characterization of variation in early hominin populations.

*** Early evolution of small body size in *Homo floresiensis*

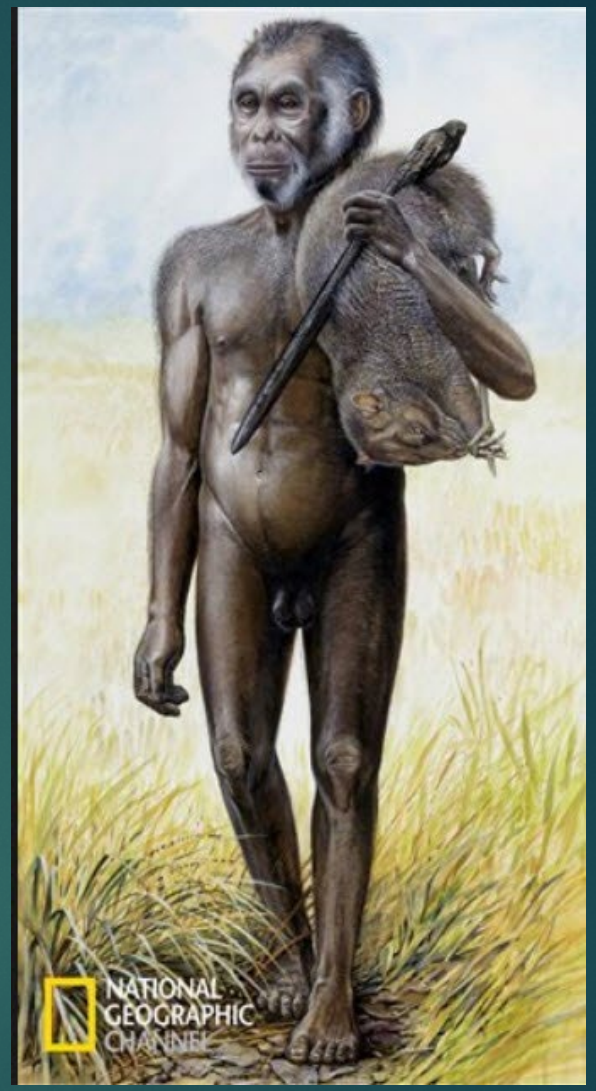
- The discovery of extremely rare early human fossils from the Indonesian island of Flores, including an astonishingly small adult limb bone.
- Dated to about 700,000 years old, the new findings shed light on the evolution of Homo floresiensis, the so-called "Hobbits of Flores," whose remains were uncovered in 2003 at Liang Bua cave in the island's west by a team co-led by Australian-New Zealand archaeologist Professor Mike Morwood (1950–2013).
- There has been much debate about the origin of the mysterious humans from Flores. It was first hypothesized that Homo floresiensis was a dwarfed descendant of the early Asian Homo erectus.

Yousuke Kaifu, et al., 2024

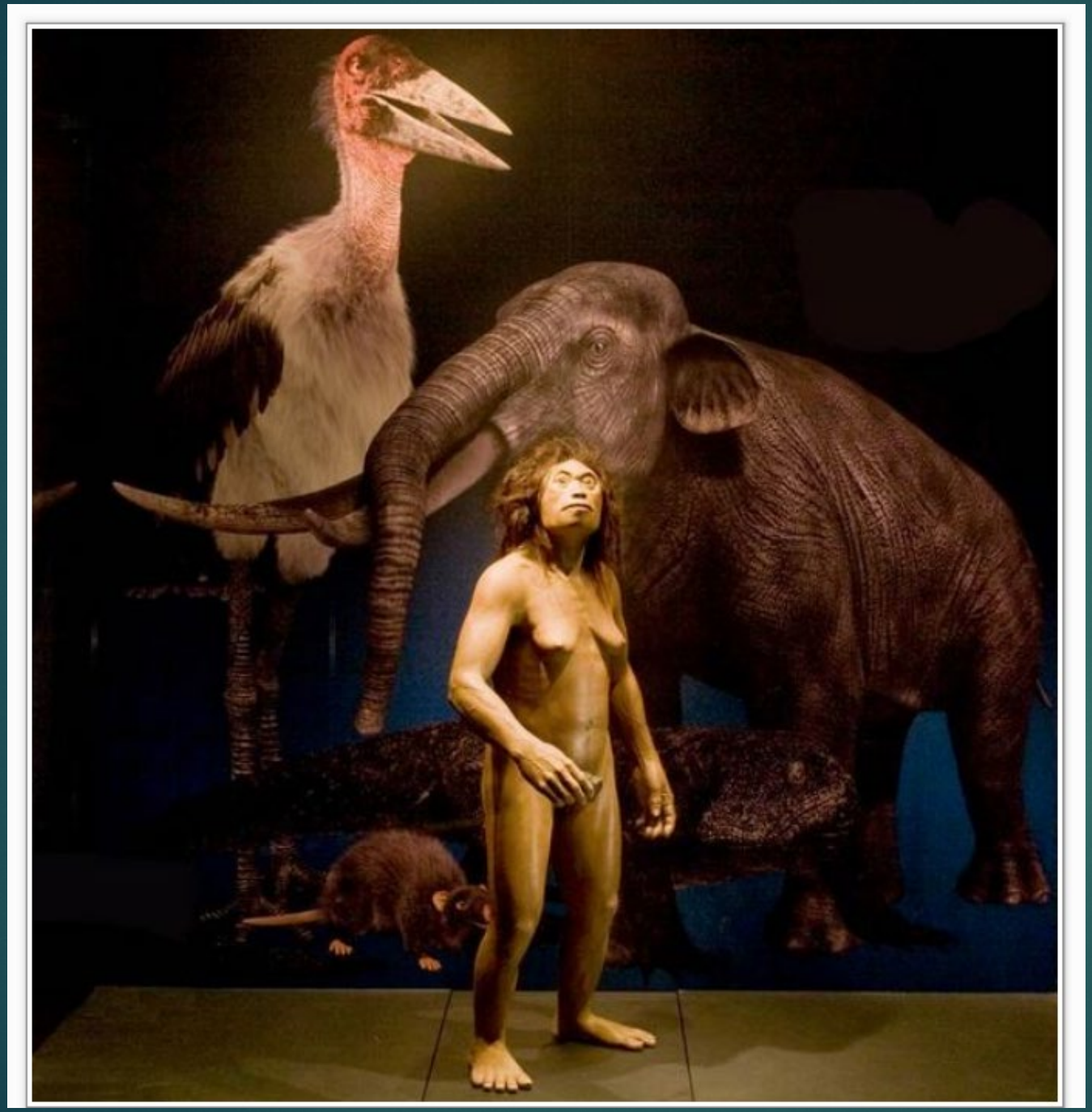
Liang Bua cave exterior

2003: Homo floresiensis, 3.5 feet tall, 700 to 50 Ka, island of Flores

3.5 feet tall



Killed Giant Rats and Komodo dragons on Flores

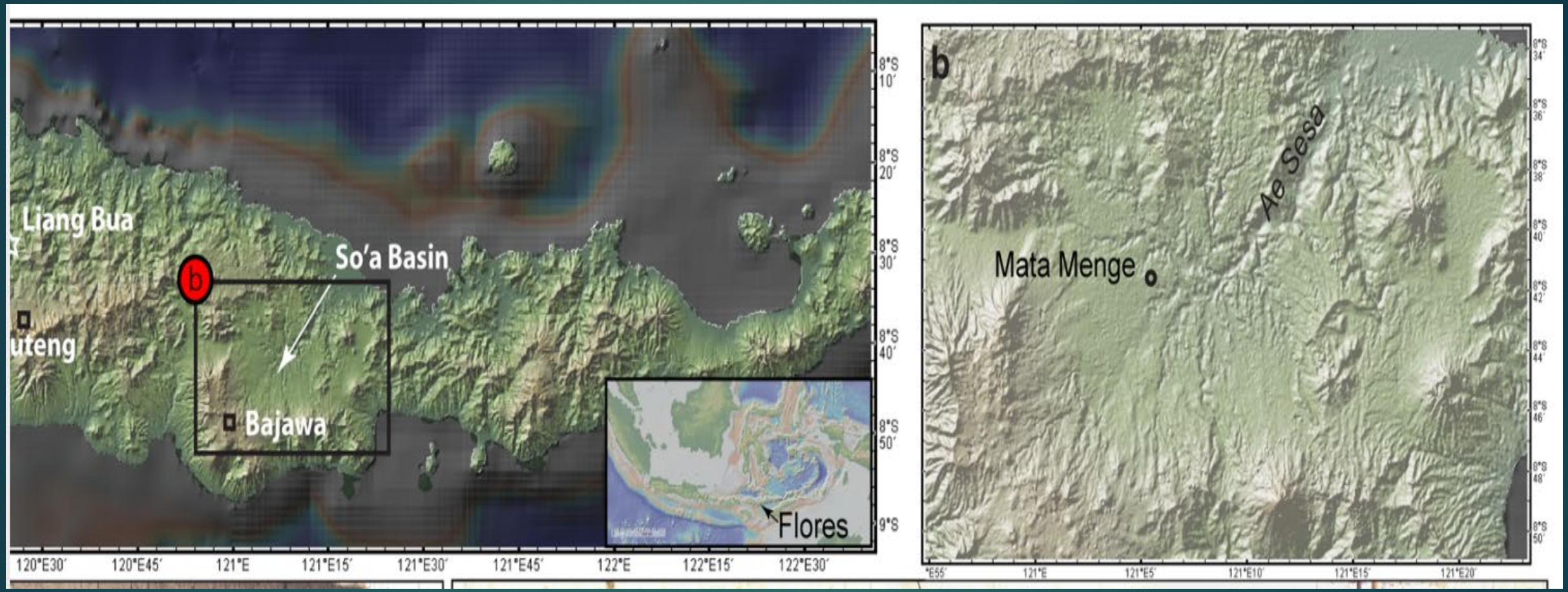


Hunted giant storks and dwarf elephants

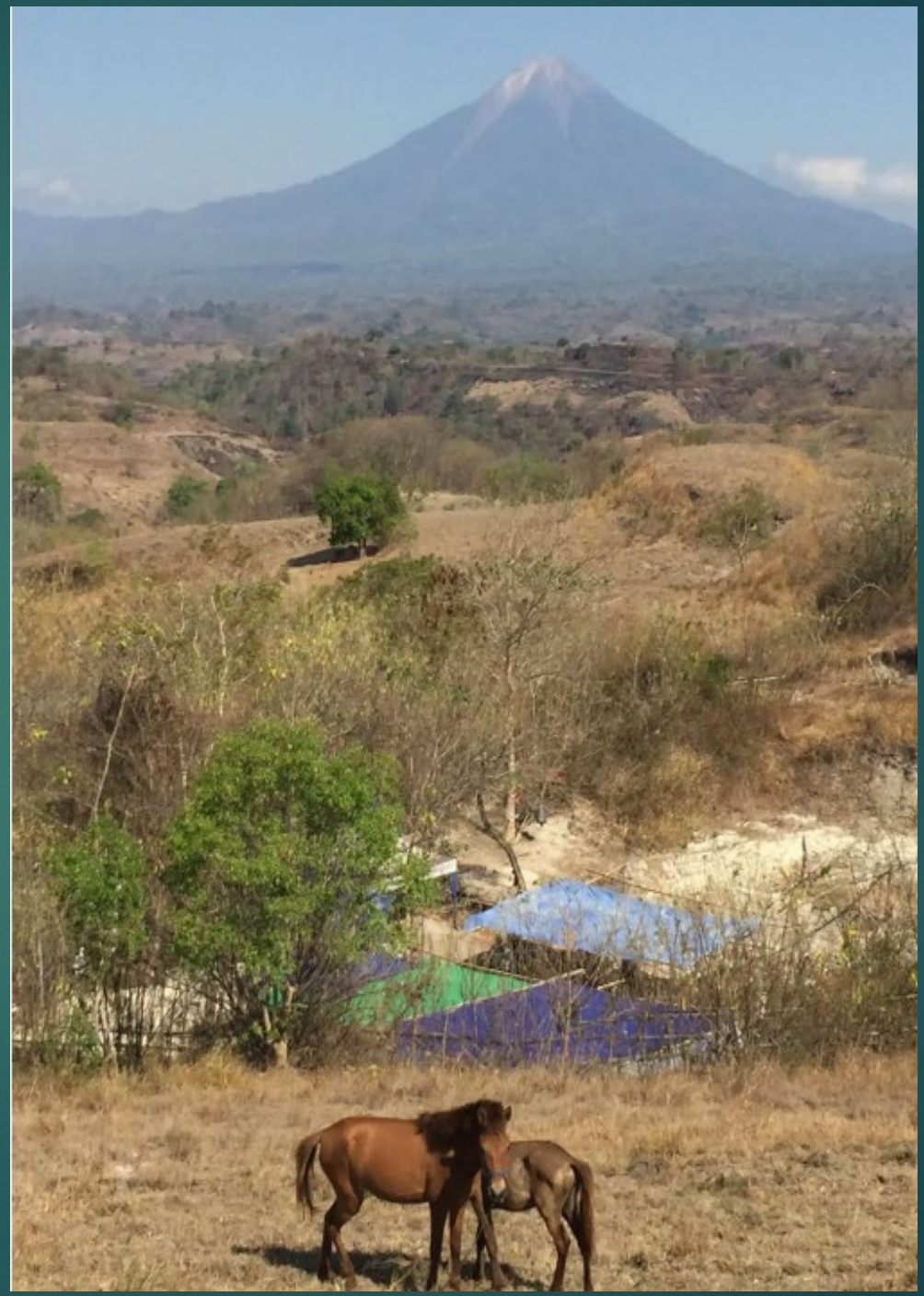
(Image credit: © National Museum of Nature and Science, Tokyo)

Liang Bua cave

Flores: Liang Bula and Mat Menge



Mata Menge, Flores site



Mata Menge excavation site

Mata Menge (700 Ka)

vs

Liang Bua (50 Ka) mandibles

Mata Menge site

- Other than Liang Bua, hominin fossils have only ever been found at a single location on Flores: the open-air site of Mata Menge 75 km to the east of the cave.
- This site previously yielded several hominin fossils (a jaw fragment and six teeth) excavated from a layer of sandstone laid down by a small stream around 700,000 years ago.
- Pre-dating the Liang Bua hominins by 650,000 years, the Mata Menge fossil remains have been shown to belong to at least three individuals with even slightly smaller jaws and teeth than Homo floresiensis, implying that small body size evolved early in the history of Flores hominins.

New study: shorter than Liang Bua hobbit

- New study reports the discovery of three additional hominin fossils from Mata Menge dating to 700,000 years ago. Most importantly, the new assemblage includes the first postcranial element, a distal shaft of an adult humerus (lower half of the upper arm bone).
- Digital microscopy of the microstructure indicates that the small humerus is from an adult individual. Based on the estimated length of the bone, the team was able to calculate the body height of this hominin to be about 100 cm/3.3 ft tall. This is around 6 cm shorter than the estimated body height of the 60,000-year-old Homo floresiensis skeleton from Liang Bua (~106 cm/3.5 ft, based on the femoral length).

Smallest arm bone in the human fossil record sheds light on the dawn of Homo floresiensis

When the arm bone fragment, measuring just 3½ inches, was originally bagged, it was first labeled a possible bone fragment from a crocodile.

The Mata Menge humerus fragment (MM9) (left) shown at the same scale as the humerus of Liang Bua

A very small hominin

- This 700,000-year-old adult humerus is not just shorter than that of Homo floresiensis, it is the smallest upper arm bone known from the hominin fossil rec
- Confirms our hypothesis that the ancestors of Homo floresiensis were extremely small in body size.
- More remarkable than its short stature was its minuscule brain, about one-third the size of a modern human's

Not descendants of H. habilis or A. afarensis

- The two additional hominin teeth from Mata Menge are also small in size, and one bears shape characteristics that are most consistent with the early Homo erectus of Java. This similarity does not support the hypothesis that Homo floresiensis evolved from an earlier and more primitive type of hominin, the likes of which have never been recovered from Indonesia, or indeed the wider region outside Africa.

- The Mata Menge human remains, which now total 10 fossil specimens, are from at least four individuals (including two children)n. All of them are very similar anatomically to the Liang Bua Homo floresiensis and can now be regarded as an older variant of this hominin. However, while a direct ancestor of the "Hobbit," this earlier form had a less specialized dentition (more primitive teeth) than its descendant at Liang Bua.

Dramatic body size reduction

- Further, it is evident from the tiny arm bone that extreme body size reduction occurred early in the history of the Flores hominins.

- Study supports the idea that *H. floresiensis*' ancestors evolved into a much smaller species just a few thousand years after arriving on the remote island of Flores

- "However, the new fossils strongly suggest that the 'Hobbit' story did indeed begin when a group of the early Asian hominins known as Homo erectus somehow became isolated on this remote Indonesian island, perhaps one million years ago, and underwent a dramatic body size reduction over time."

Early evolution of small body size in *Homo floresiensis*

- Previous investigations at Mata Menge, Flores Island, Indonesia, suggested that the early Middle Pleistocene ancestors of H. floresiensis had even smaller jaws and teeth.
- Report additional hominin fossils from the same deposits at Mata Menge. An adult humerus is estimated to be 9 − 16% shorter and thinner than the type specimen of H. floresiensis dated to ~60,000 years ago, and is smaller than any other Plio-Pleistocene adult hominin humeri hitherto reported.
- The newly recovered teeth are both exceptionally small; one of them bears closer morphological similarities to early Javanese H. erectus. The H. floresiensis lineage most likely evolved from early Asian H. erectus and was a long-lasting lineage on Flores with markedly diminutive body size since at least ~700,000 years ago.

The partial upper arm bone (humerus) found at Mata Menge.

Mata Menge

- Technologically simple stone artefacts (the oldest of which date back to at least 1.02 Ma),and, importantly, a fragmentary mandible and six isolated teeth of a small-sized hominin
- These hominin fossils were excavated from a sand-stone layer of fluvial origin (Layer II) of the upper fossil-bearing interval at the Mata Menge site, which is dated to between 0.65 and 0.773 Ma
- These fossils exhibit general morphological affinities to the type series of H. floresiensis from Liang Bua (0.1–0.06 Ma) and to early H. erectus from Java (1.1–0.8 Ma), but lack the unique molar specializations characterizing the former and were substantially smaller than the latter.
- New research shows that the species, which is an offshoot of *Homo erectus*, was 2.4 inches (6 cms) shorter, on average

Earlier origins debate

- Overall, the Mata Menge fossils suggest that they represent an ancestral segment of the Liang Bua H. floresiensis lineage, and that the Flores hominins are dwarfed descendants of large-bodied early Asian H. erectus. Some earlier cladistic/phylogenetic analyzes, however, support a direct evolutionary link between H. floresiensis and smaller-bodied basal Homo such as H. habilis or even Australopithecus.
- Notably, the Mata Menge mandible and teeth are slightly smaller than the type specimens of H. floresiensis from Liang Bua. This suggests that drastic dentognathic reduction had occurred on Flores by the early Middle Pleistocene epoch, more than 600,000 years before the earliest fossil evidence for H. floresiensis at Liang Bua. Until now, however, the lack of postcranial elements in the Mata Menge assemblage had limited our understanding of body size evolution on Flores.

Fast body size reduction

- New Mata Menge shaft morphology is more similar to small-bodied Homo (e.g., LB1 and H. naledi) than to Australopithecus (e.g., A.L. 288-1), and a molar crown (SOA-MM11) bears closer shape similarities to early Javanese H. erectus than to early African Homo.
- The increased Mata Menge fossil sample supports its classification to an early representative of H. floresiensis, which probably experienced drastic body size reduction from large-bodied Asian H. erectus sometime between ~1.0 and 0.7 Ma.
- The Mata Menge fossils we report here showed that the extremely small body size of *Homo floresiensis* evolved within the first 300,000 years of their history on the island … and then after that the small body size was maintained for more than 600,000 years.

New fossils from Mata Menge. A = 88 mm humerus; j-k = teeth

Humeral size & mandibular 3rd molar

- In all available dimensions of shaft diameter/circumference and length, new humerus is smaller than LB1 (H. floresiensis) and any other adult individuals of small-bodied fossil hominins (Australopithecus and H. naledi).
- Dental occlusal crown contour: Analysis shows that it clusters firmly with Sangiran H. erectus and marginally with H. ergaster, having a mesiodistally short crown. It is outside the range of variation exhibited by H. habilis sensu lato, which is primarily characterized by a mesiodistally elongated and distally tapered crown with a tendency for better developed hypoconulids and accessory cusps.
- Comparison of size with the Liang Bua H. floresiensis: Mata Menge fossils reported here or previously are smaller than the Liang Bua H. floresiensis remains (LB1 and LB6/1) by 1–21%.

Always small

- The observation that all four (or more) individuals are extremely diminutive supports the argument that small body size was not an idiosyncratic (individual) character but a population feature of the early Middle Pleistocene hominins of Flores.
- The markedly small deciduous teeth from at least two individuals, also indicate that the Mata Menge hominins had diminutive dental size at birth. Additionally, the strikingly small adult humerus (SOA-MM9) reported here demonstrates that this character was not limited to the dentognathic elements but also extended to upper arm size.
- On this note, it is worth highlighting that the two or more Mata Menge adult/adolescent individuals are consistently smaller than the two adults of Liang Bua H. floresiensis. This strongly suggests that by ~0.7 Ma, hominins on Flores were already as small as, or perhaps slightly smaller than, the late H. floresiensis.

Mata Menge fossils are H. floresiensis

- Now that a new arm bone and additional dental remains belonging to this assemblage display strong affinities with the Liang Bua remains, we can more confidently classify these early Middle Pleistocene hominins into H. floresiensis.
- This study also contributes to the debate over the origin and evolution of H. floresiensis. It was previously reported that the Mata Menge hominins now assigned to H. floresiensis were more similar to early Javanese H. erectus than to Australopithecus and H. habilis in mandibular body form and M1 (or M2) shape, a finding that runs contrary to hypotheses that assume a direct evolutionary link between H. floresiensis and pre-H. erectus hominins such as H. habilis.

Dwarfed lineage of Javanese H. erectus

- The present study indicates that the shape similarity between the Mata Menge fossils and early Javanese H. erectus also applies to M3,and that the Mata Menge molars lack the unique specialization seen in the Liang Bua H. floresiensis homologies (i.e., four-cusped, mesiodistally shortened and somewhat distorted molar crowns).
- Therefore, archaic H. floresiensis at Mata Menge probably represents the dwarfed lineage of early Javanese H. erectus at a stage prior to unique molar specializations.
- Alternatively, if H. habilis s.l. was ancestral to Mata Menge/ Liang Bua H. floresiensis, the latter would need to have experienced substantial molar size reduction of ~65–60% in mesiodistal and buccolingual crown diameters (from H. habilis means), and this accompanied by form changes comparable to the early Javanese H. erectus condition.

Who was their ancestor? Not H. habilis

- H. floresiensis as a direct lineal descendant of H. habilis s.l. is not supported.
- In contrast, molar size reduced from the Lower to Upper Sangiran dental assemblages without significant form changes, confirming that such local evolution could occur.
- Additionally, although the humeral shaft morphology of SOA-MM9 does not indicate an affinity with either H. erectus or H. habilis, its cross-sectional shape is most similar to that of dwarfed taxa of Homo (H. floresiensis and H. naledi) and unlike that of small-bodied Australopithecus individuals.

Teeth comparison: H. floresiensis similar to H. erectus

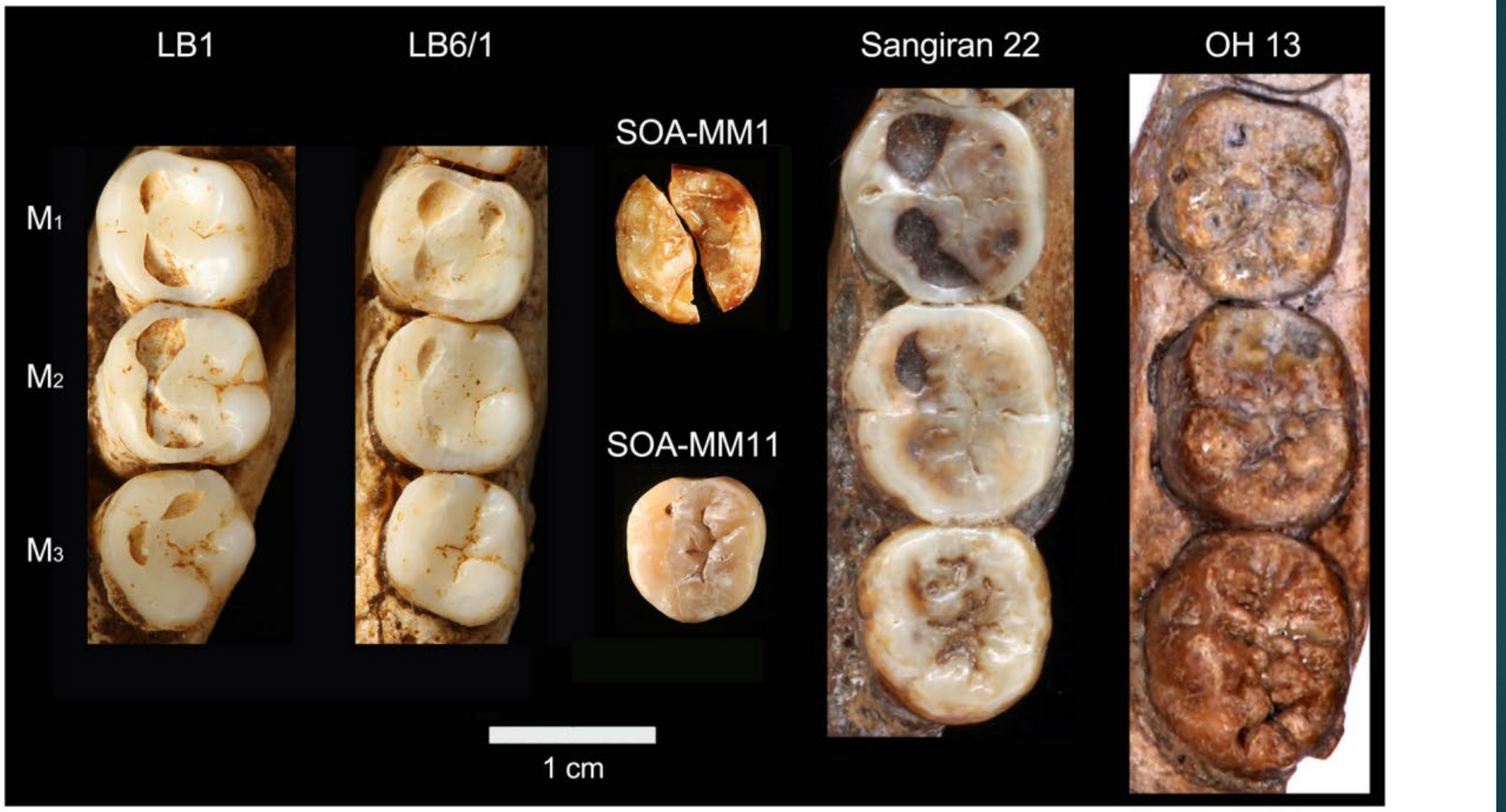


Fig. 8 | Mandibular molars of selected fossil *Homo* individuals. LB1 and LB6/1: Liang Bua *H. floresiensis*, Sangiran 22: early Javanese *H. erectus*, OH13: *H. habilis*.

New model of Flores

- Coupled with the recently revised arrival date for H. erectus on Java (~ 1.1 Ma, or at most younger than 1.3–1.5 Ma) and hominins on Flores (1.0–1.27 Ma), as well as the reported craniometric and odontometric analyzes which almost unanimously support strong affinities of H. floresiensis with H. erectus (particularly early H. erectus from Java), the following evolutionary model emerges.
- The earliest Flores hominins appeared on this Wallacean island ~1.0–1.27 Ma, probably unintentionally (i.e., through accidental 'rafting', perhaps on tsunami debris), and possibly as part of the initial colonization of the Sunda Shelf region by early H. erectus.
- The Flores hominins experienced substantial body size reduction soon after this event (within ~300,000 years), despite the presence of large-bodied predators such as ~3 meter-long Komodo monitors and crocodiles from the earliest paleontological record (~ 1.4 Ma) onwards.

Long term stability

- This implies that giant reptilians did not represent a serious predation threat for early H. floresiensis or its progenitors. This early evolutionary event was followed by long-term stability in hominin body size, possibly also in cultural adaptations (e.g., stone technology), and minor morphological specialization in the dentition.
- How the small brain size reported for the ~60,000 years old LB evolved still remains unknown. At present, however, the available fossil data imply that small body size had been a functional adaptation for these insular hominins during and slightly beyond the Middle Pleistocene and indeed potentially up until the arrival of H. sapiens on Flores around 50,000 years ago; an event that, we suspect, precipitated the demise of H. floresiensis.

Homo erectus lineage

- The researchers proposed that Homo erectus traveled 450 miles east from Java to Flores, arriving on the island about a million years ago. That's the age of the oldest stone tools found there.

- Once isolated on Flores, Homo erectus then shrank, reaching hobbit stature by 700,000 years ago

- Critique: Only Deborah Argue disagrees; she is the H. habilis lineage proponent. Thinks more data needed to prove new bones are indeed H. floresiensis.

*** How Early Humans Survived Cold Climates: A Genetic Perspective

- Gene alteration likely enhanced body heat generation among early humans in colder climates

- In Africa, our ancestors were shielded from the extreme cold of past ice ages, leading to adaptations suited for the continent's heat, such as the loss of thick body hair. However, as humans moved into colder regions, their survival depended on new adaptations.

- The exact mechanisms by which early humans adapted to cold climates remained unclear until recent studies provided insights into the genetic changes that facilitated this adaptation.

Fat mass and obesity-associated gene (FTO)

- Research has suggested that variations in the fat mass and obesity-associated gene (FTO) are linked to the body's ability to generate heat. These studies indicated that certain DNA variations within the FTO gene were associated with a reduced capacity for heat generation in specific human fat cells. In experiments with mice, the absence of these gene alterations, known as type C variants, led to enhanced heat production in brown fat tissue and some resistance to diet-induced obesity.
- Scientists hypothesized that such gene variants could have played a role in the adaptation of mammals, including humans, to cold environments. In their latest study, researchers analyzed the frequency of the C variant among diverse human ancestral groups. They found a significant inverse correlation between the frequency of the C variant and mean earth skin temperatures. This suggested that, the colder the location, the higher the frequency of this variant.

The Genetic Legacy of Cold Adaptation

- The shift in the frequency of the C variant in early human populations aligns with the migration routes of modern humans.

- As populations moved from Africa to Eurasia, there was a substantial increase in the frequency of the C variant. This change likely reflects the adaptation to varying levels of cold stress experienced during migration. Individuals with this gene variation had enhanced body heat generation in cold climates, providing a significant survival advantage.

- Yin, N., Zhang, D., & Wang, J. (2024). The *FTO* variant with enhanced UCP1 expression is linked to human migration out of Africa. *Life Metabolism*.

*** Tracing the Origins of Early Americans: Four Waves of Migration from Siberia

- Recent linguistic research suggests that Indigenous people entered North America in at least four distinct waves between 12,000 and 24,000 years ago.
- This new model aligns with archaeological, climatological, and genetic data, indicating that the populations in early North America were both dynamic and diverse.

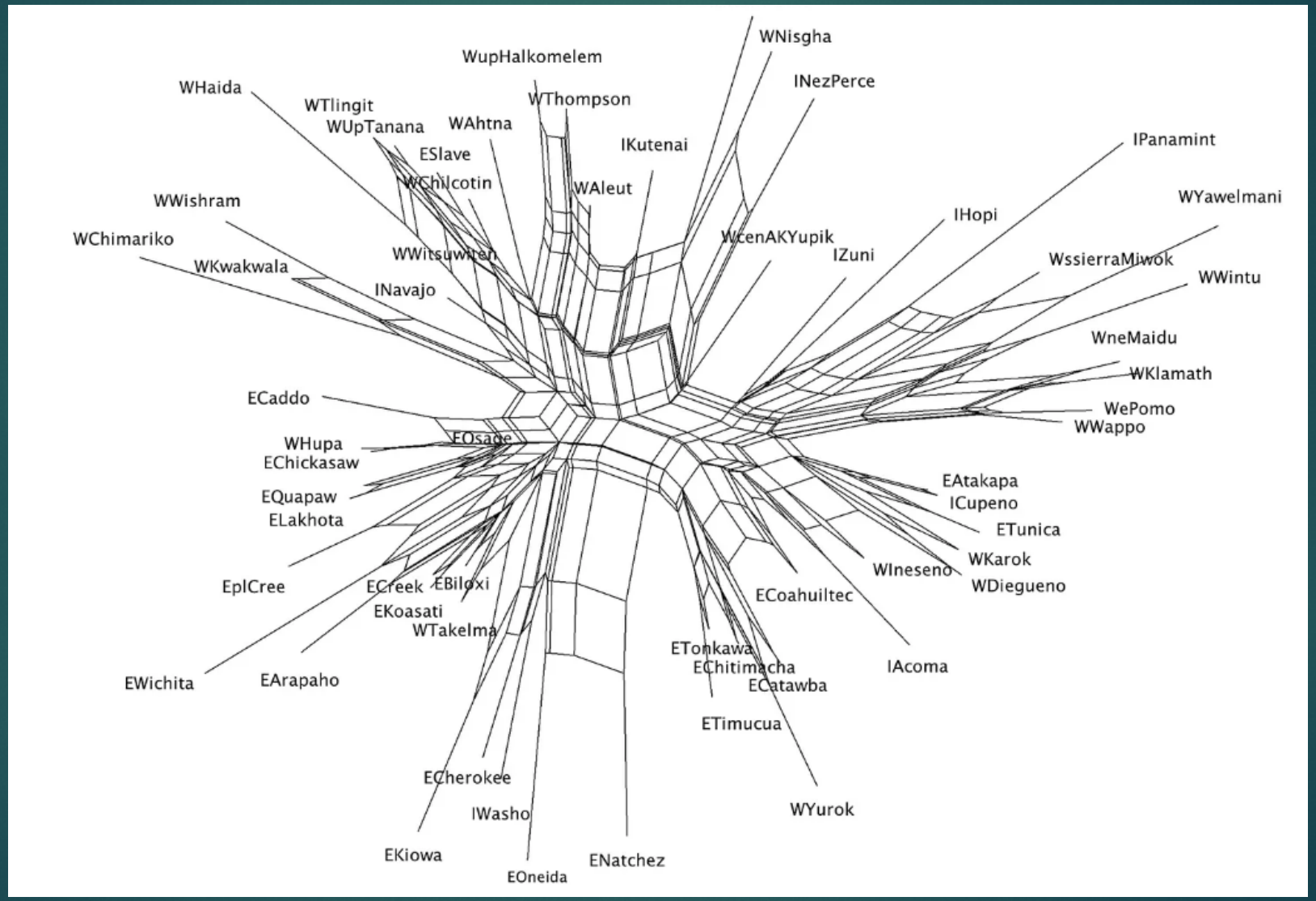
- The Americas are home to nearly half of the world's language families, many of which are now extinct. Historical linguistics allows for the analysis and comparison of living languages, offering insights into the groups that first populated the continent.

Founder effects identify languages of the earliest Americans

- Comprehensive analysis of 60 languages from across the U.S. and Canada. Her study revealed that these languages originated from two main language groups that entered North America in at least four distinct waves. Nichols examined 16 structural features of these languages, including syllable structure, noun gender, and consonant production.
- The languages were categorized into two main groups: an early group where the first-person pronoun contains an "n" sound and the second-person pronoun contains an "m" sound, and a later group where languages incorporate a sentence's worth of information into a single word.

Johanna Nichols, 2024

Native American Languages



Four waves of migration

- Nichols' linguistic analysis indicated that the migration into the Americas occurred in four distinct waves:

1. **First Wave (24,000 years ago):** This wave occurred during a period when massive glaciers covered much of North America. Nichols found no unique language features from this wave, suggesting a diverse set of people and languages entered North America at that time.
2. **Second Wave (15,000 years ago):** This wave brought languages with n-m pronouns.
3. **Third Wave (14,000 years ago):** This wave introduced languages with simple consonants.
4. **Fourth Wave (12,000 years ago):** This wave brought languages with complex consonants.

What dates?

- Historically, researchers believed that Indigenous people first arrived in the Americas via a land bridge from Siberia around 13,000 years ago. However, Nichols' linguistic data suggests that this timeline is insufficient for the development of the nearly 200 Indigenous American languages. Instead, she proposed that people first arrived closer to 35,000 years ago.
- Recent archaeological, geological, climatological, and genetic research supports the notion that several waves of people made their way into the Americas between 30,000 and 25,000 years ago. Adding linguistic studies to this research reinforces the idea that North America was populated much earlier than previously assumed.

4 migrations

- Nichols suggests that the people who migrated to North America likely left relatives in Asia, and it is possible that some of those languages still survive in Siberia.
- The linguistic evidence is consistent with two population strata defined by early coastal entries -24,000 and -15,000 years ago, then an inland entry stream beginning -14,000. and mixed coastal/inland -12,000. The dominant structural properties among the founder languages are still reflected in the modern linguistic populations. Structural profiles imply that two linguistically distinct and internally diverse ancient Siberian linguistic populations provided the founding American populations.

Coastal route, then later inland route

- The early stratum was coastal in origin and primarily maritime in subsistence and material culture, and entered during the first and second openings, when sea ice conditions permitted coastal canoe travel and entry south of the continental ice sheets.

- In the ~8000 years between the two openings, the languages of coastal eastern Siberia must have evolved and the language population must have lost members and acquired members, causing changes in frequencies of linguistic structural types there.

Complexity of language

- Though that initial sociolinguistic situation must have changed considerably over time, especially as languages spread out, it is suggestive that languages of the Pacific Northwest, from the Columbia to eastern Alaska—likely landfalls or entry points for all four openings—exhibit notably complex morphology and phonology compared to the rest of the hemisphere, and complexity levels in the Americas are high overall relative to world averages.
- Both the *n*-*m* pronouns of the early stratum and the polysynthesis of the later stratum have what can be called click distributions): features that are very rare worldwide but well-installed and stable in a large cluster of languages in one place (so called from the click consonants of southern African languages, which exhibit such a distribution in its most clear-cut form: absolutely unique to Africa).

*** C3 vs C4 dates and types

- From the mid-Oligocene, roughly 30 million years ago, to the mid-to-late Miocene, about 5 million years ago, carbon dioxide concentrations in the atmosphere fell by a roughly a third.
- This same period saw the emergence of a new form of photosynthesis in a subset of plants, the C4 pathway.
- Present in a subset of plants, the C4 pathway supplemented the earlier C3 photosynthetic pathway, meaning those species now reaped energy from the sun using two different strategies.
- Water availability may have been the critical factor behind the emergence of C4 plants.
- Then later, about 5 to 8 million years ago, there's a large expansion of C4 grasslands. That's because carbon dioxide was getting lower and lower. Carbon dioxide and light intensity were actually the limiting factors favoring C4 at that time."

**** 4 major 2024 papers on H. naledi = 260 slides

- 1 - What we know and do not know after the first decade of Homo naledi -- Paul Pettitt & Bernard Wood
- 2 - Preprints, press releases and fossils in space: What is happening in South African human evolution research? -- By Robyn Pickering and Dipuo Kgotleng, 2024
- 3 - No Sedimentological Evidence for Deliberate Burial by Homo naledi – A Case Study Highlighting the Need for Best Practices in Geochemical Studies Within Archaeology and Paleoanthropology – K. Foecke
- 4 - Evidence for deliberate burial of the dead by Homo naledi -- Lee R Berger…J. Hawks, et al., Aug 12 2024, BioRx preprint = 160 pages

*** What we know and do not know after the first decade of Homo naledi -- Paul Pettitt & Bernard Wood, 2024 – 20 slides

- It has been just over 10 years since the first fossils attributed to Homo naledi were recovered from the Rising Star Cave system in South Africa's Cradle of Humankind. The hominin fossil evidence for H. naledi displays a distinctive combination of primitive and derived morphology, yet for a time-averaged fossil sample it is remarkable for its relatively low level of variation.
- Thus—unusually for paleoanthropology—there has been little pushback against the decision to recognize a single novel taxon for all of the material recovered from the Rising Star Cave system.
- However, almost everything else claimed about H. naledi—its age, burial context and behavior—has been controversial.

Lee Berger

- Lee Berger had been instrumental in in the recovery of australopiths from Gladysvale and from Malapa, also within the Cradle, and when cavers told him about a new potential fossil site in the Rising Star Cave system, he probably had in mind more of the same.

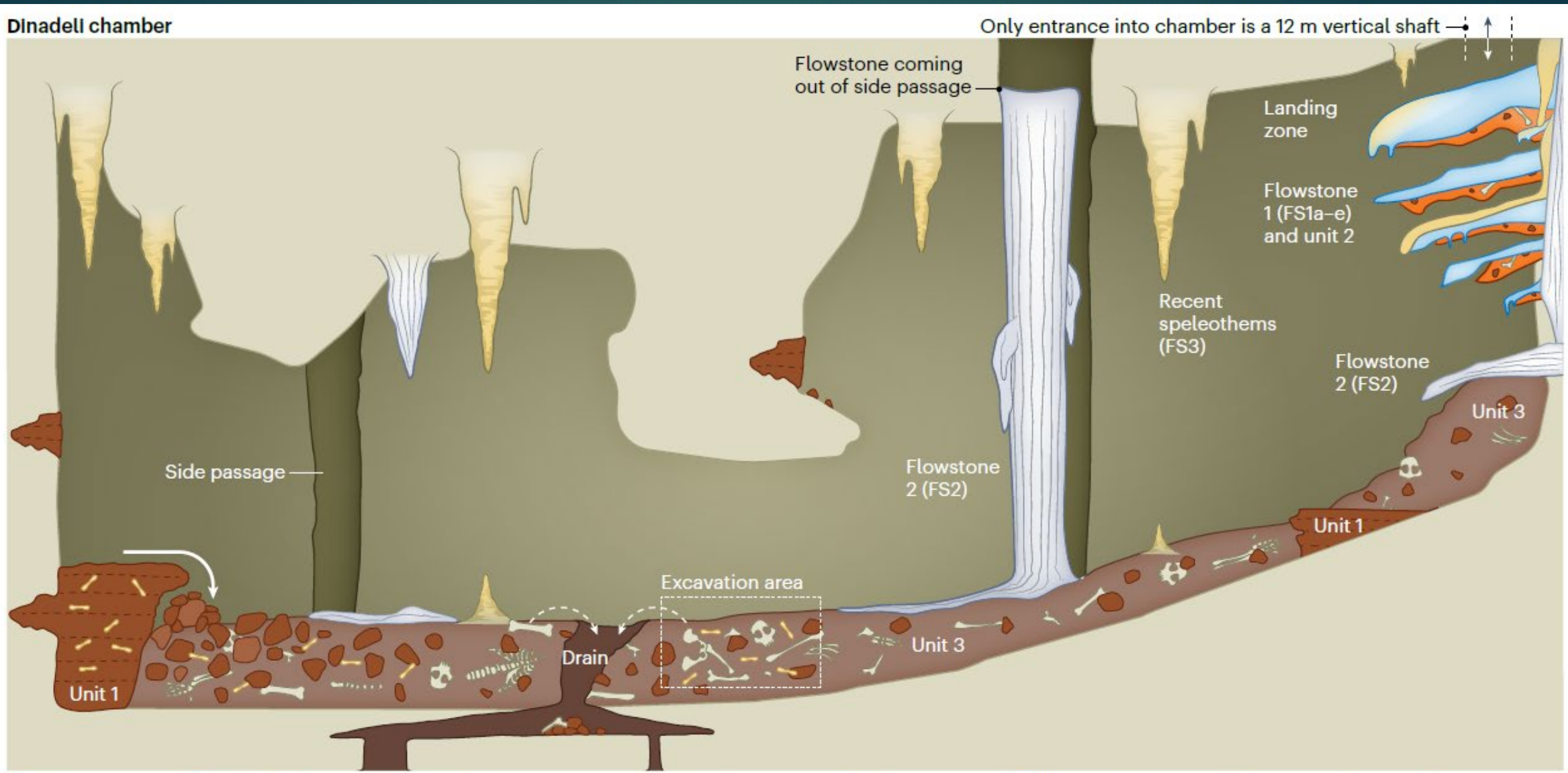
- But, when researchers investigated, they were surprised to find barely fossilized hominin remains preserved in soft mud-like sediments, not hard breccia, and although they shared some features with the australopiths, in many other ways they were evidently very different.

1,550 fossils in Dinaledi Chamber

- The majority of the H. naledi material—1,550 reported fossils from a minimum of 15 individuals (bone and tooth fragments has been recovered from the Dinaledi Chamber, with additional fossils from the Hill Antechamber and locality U.W. 110.

- The rest of the evidence—131 fossils from at least three, and probably four, individuals—comes from the nearby, but separate, Lesedi Chamber.

- Additional hominin discoveries have been reported from the Dinaledi subsystem. and from elsewhere in the system, but at the time of writing no details of these have been published.


Dinadell chamber
Only entrance into chamber is a 12 m vertical shaft
Flowstone coming out of side passage
Landing zone
Flowstone 1 (FS1a–e) and unit 2
Recent speleothems (FS3)
Flowstone 2 (FS2)
Unit 3
Side passage
Flowstone 2 (FS2)
Unit 1
Excavation area
Drain
Unit 3
Unit 1
Unit 1: laminated maroon mudstone
Unit 2: older mud clast breccias
Unit 3: cave floor sediments; youngest mud clast breccias
Hominin fossils
Micro-mammal fossils
Flowstone 1 (FS1a–e) and unit 2
Flowstone 2 (FS2)
Recent speleothems (FS3)

Dinaledi Chamber

- Fig. 1 | Summary diagram showing the general nature of a section through the sediments in the approximate center of the Rising Star Cave system's Dinaledi Chamber from which many of the H. naledi fossils derive.
- The location of the H. naledi fossils in the upper part of subunit 3b are shown represented by white bone symbols. The age of the lower part of unit 3 suggests a maximum age of ~900 kyr for the H. naledi fossils in subunit 3b. A minimum age of ~250 kyr for them is provided by U–Th-dated flowstones (shown in blue) overlying unit 3b, and the direct ESR dates on the fossils themselves of ~200–300 ka.
- If OSL dates for the sediments and averaged US-ESR measurements for the fossils are omitted due to unreliability (as discussed by Dirks et al.), H. naledi could be considerably older than 300 kyr old.

Depositional history

- The Rising Star Cave system as currently understood consists of at least 4,000 linear meters of passageways, plus other spaces of differing sizes and shapes, all within the Malmani subgroup dolomites.
- Currently there are four known entrances to the system, three open and one sealed.
- The Dinaledi subsystem, which is 30 m below surface and >70 m in a straight line from the nearest current opening, is connected to the rest of the Rising Star Cave system by the Chute.

Depositional history

- The initial report by the project's geologists suggested that sediment accumulation within the Dinaledi subsystem was the net result of multiple cycles of sediments entering—and flowstones forming—in the cave followed by sediment removal and dissolution, with some of the residual sediment finding its way into the Dinaledi Chamber.

- Most of the hominin evidence in the latter derives from the unit 3 sediments, and the same authors suggest that the Dinaledi Chamber was relatively isolated when unit 3 was deposited, with little or no sediment input from elsewhere in the subsystem.

Was Dinaledi isolated?

- They were also emphatic that the adjacent Dragon's Back Chamber is unlikely to have been the source of the hominin fossils in the Dinaledi Chamber.

- All this being said, it is possible, as others have suggested, that another entrance—now sealed—was how the sediments and hominin remains entered the Dinaledi subsystem.

- Karstic caves are dynamic systems, with the potential that substantially sized blocks could have fallen from the roof and blocked one, or more of any former entrances, located either to the south or to the west of he Dinaledi chamber

Difference from Cradle of Humanity fossils

- The high density of the H. naledi fossils in the Dinaledi Chamber, with almost no associated non-hominin fauna, contrasts with the sedimentary context of other hominin-bearing cave systems in the Cradle of Humankind, where hominins are but one component of a rich, but taphonomically degraded, mammalian faunal record that typically accumulated in debris cones subsequently brecciated by flowstone.

Difference from Cradle of Humanity fossils

- As suggested by the Rising Star project geologists, because its hominin fossils are mostly contained in unconsolidated reworked muddy sediments, with clear evidence of more than one episode of primary deposition, caution is called for when interpreting both the stratigraphy and the age of the fossils.

- Skeletal part representation of H. naledi and lack of associated non-hominin remains do not rule out natural accumulation.

Some things cannot be ruled out.

- The question is not whether periodic low-energy water transport occurred—it clearly did—but whether it moved hominin remains around within the cave's subsystems. [Berger denies this]

- The extent and pattern of bone breakage inflicted on the hominin fossils is inconsistent with minimal transport, but it could be explained if the hominin skeletal remains had entered the cave from another entrance. It is premature to assume that the location of the hominin remains is reliable evidence that corpses were dragged underground to this favored depositional location. Ingress via a now-sealed entrance, followed by natural deposition, cannot be ruled out.

How old is H. naledi?

- The initial paper addressing the geological and taphonomic context of H. naledi devoted a single five-line paragraph to the age of the fossils.
- The authors explained that because of the complex stratigraphy they were reluctant to ‘speculate’ on the age of the deposit, suggesting instead that they were working on developing dating methods that could ‘circumvent this problem’.
- Subsequent efforts to address the stratigraphic context and the dating of the H. naledi fossils concluded they are relatively recent.

Dating methods

- The sediments in subunit 3b—where all of the hominin fossils in the Dinaledi Chamber were recovered—were dated using optically stimulated luminescence (OSL), the overlying flowstones were dated using U–Th and paleomagnetism, and three H. naledi teeth were dated using U-series and electron spin resonance (US-ESR) methods.

Minimum age issue

- The minimum date for the capping flowstones is 242 ± 5 kyr before present, and the researchers' best estimate of the age of H. naledi is the maximum US-ESR age of 253 (+82/−70) kyr,

- A more recent study suggesting the age of the H. naledi remains is between 335 kyr and 241 kyr.

Age issue

- But, given that many of these dates are minimum ages, both OSL and US-ESR can be unreliable, and dates for the formation of flowstones in the chamber suggest ages ranging from 500 kyr old to older than 780 kyr, the age of H. naledi is still a work in progress.

- The potential uncertainty about its age affects our understanding of the evolutionary position of H. naledi.

The nature and relationships of H. naledi

- The fossil record of H. naledi is informative about regions of the body—especially the spine, limbs, hands and feet—that are usually not well represented in the fossil records of the more established taxa sampled at southern African cave sites.

- The overall bauplan of H. naledi is a distinctive combination of primitive (small brain and small body mass) and more derived (reduced body mass dimorphism and elongated lower limbs) features.

Features

- The cranium resembles early Homo/Homo ergaster but with an even smaller endocranial volume (approximately >550 cubic centimeters).
- The dentition, both permanent and deciduous, is a mix of modern human-like primitive and unusual features.
- The hand morphology is mostly derived in the direction of modern humans, and the pelvis and hip joint are relatively primitive, as are the curved foot phalanges, but the femoral morphology is unique among early hominins

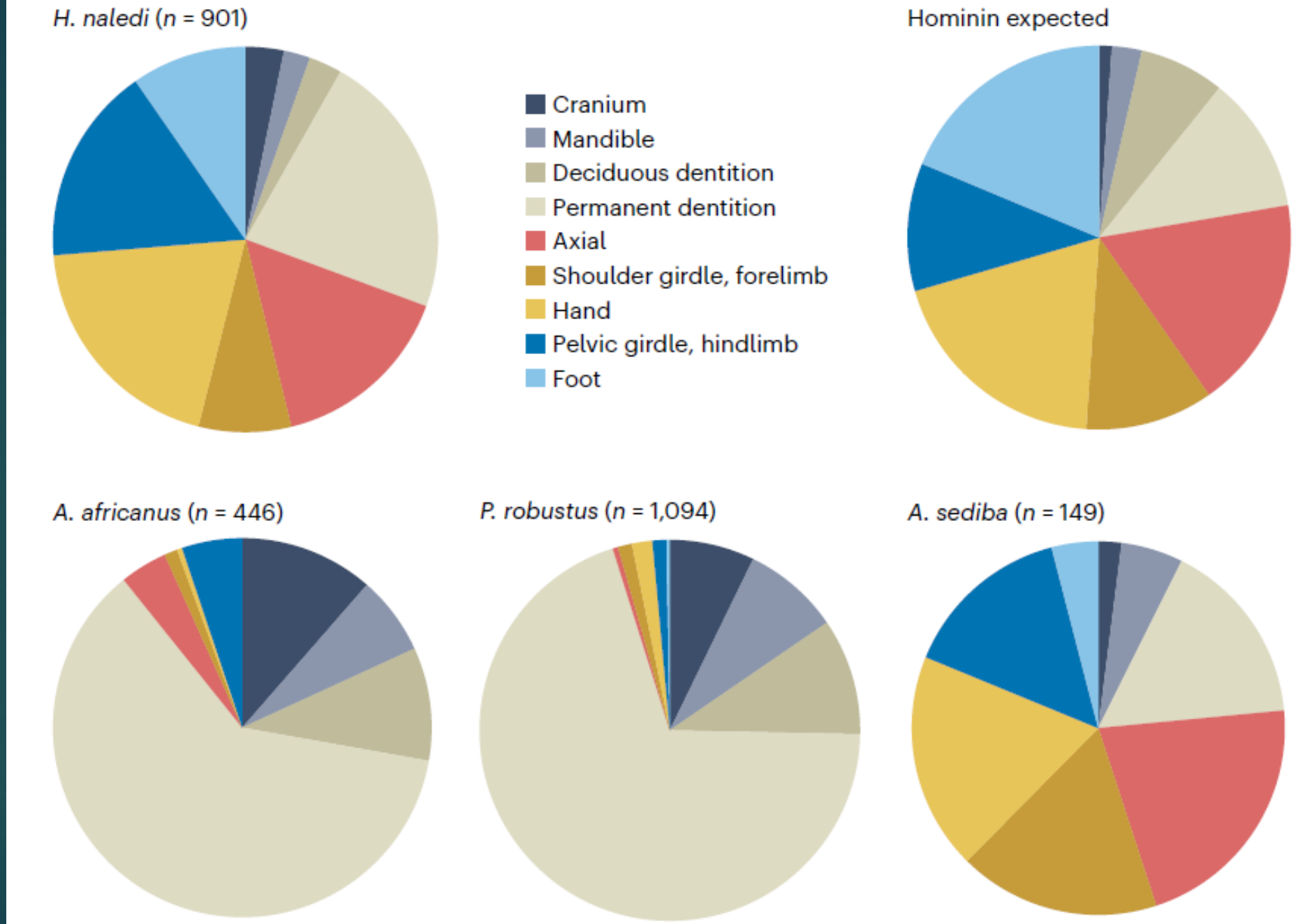

H. naledi (n = 901)
Hominin expected
Cranium
Mandible
Deciduous dentition
Permanent dentition
Axial
Shoulder girdle, forelimb
Hand
Pelvic girdle, hindlimb
Foot
A. africanus (n = 446)
P. robustus (n = 1,094)
A. sediba (n = 149)

Fig. 2 above |

- Published fossil evidence for southern Africa early hominin taxa assigned to nine color-coded regions of the skeleton. Total element (n) counts for each taxon are given in parentheses. The size of each slice of the pie charts reflects the relative representation of that region.
- For reference, the pie chart for a perfectly preserved skeleton is on the top right (also known as ‘hominin expected’).

- Note the similarities between the regional representations of H. naledi and Australopithecus sediba and how they both differ from the pie charts for Australopithecus africanus and Paranthropus robustus, which for taphonomic reasons are dominated by dental evidence (

Homo?

- The geological age of a species should not determine what genus it is assigned to, and there is legitimate debate about whether a creature with so many primitive features should be included in Homo.

- Given the mix of primitive and derived features both within and among anatomical regions, when Dembo et al. used craniodental evidence to reconstruct the age and relationships of H. naledi it was not entirely surprising that their suggested date of ~900 kyr ago (ka) had a wide error range or that taxa as different as Australopithecus sediba and modern humans were equally likely to be the closest relative of H. naledi.

Berger claims

- There is no obvious precursor to H. naledi and no evidence of any descendant taxon.

- Berger and colleagues contend that this small-brained hominin used controlled fire to illuminate a long and difficult-to-negotiate subterranean route through which it dragged corpses of its congeners in order to bury them in a chamber decorated with engravings.

The cognitive world of H. naledi

- With respect to fire, the authors admit to uncertainty about the mode and intensity of any fire used by H. naledi in the Dinaledi subsystem, so for now we must assume the use of fire is purely speculative.

- Arguments in favor of the deliberate burial of at least one individual rely on what is interpreted as sediment disturbance plus a statistically insignificant distinction between sediments within and without the assumed ‘grave’

Deliberate Burial?

- The authors also point to the very limited evidence of skeletal articulation, but this also occurs when any corpse decays, whether it is deliberately buried or not.

- The lack of any clear grave cutting and the presence within and around the ‘grave’ of remains from other individuals further weaken the ‘deliberate burial’ hypothesis, in our opinion.

Burial

- Berger interpreted linear marks on a natural stone pillar between the Hill Antechamber and the Dinaledi Chamber as ‘crosshatched etchings’ of a deliberate (that is, engraved) nature. Marks like this, which are made when tectonic activity causes sharp rocks in breccia to score the cave wall, are visible in nearby caves.

- Berger also argues one individual was buried holding a stone tool; however, sediments in the cave are littered with exfoliated limestone, and others have contended that a more parsimonious explanation is that the ‘artefact’ is a spall from the roof of the cave that is fortuitously ‘associated’ with this individual.

Where do things stand with *H. naledi* after a decade of discovery and analysis?

- For several decades now, any increase in our understanding of human evolution from the Cradle of Humankind has come from discoveries of australopiths at well-established sites such as Kromdraai, Sterkfontein and Swartkrans.
- Lee Berger should be commended for his success at locating an important new source of evidence and for taking on the considerable logistical challenge of recovering the evidence of H. naledi from deep underground.
- He has also offered opportunities to early-career researchers to take part in the description and analysis of the fossil evidence, and he has worked hard to disseminate casts of the fossils from the Rising Star cave system.

Genus Homo?

- The morphology of H. naledi is a puzzling combination of primitive and derived features. Presently, the implications of the fossil evidence have been assessed anatomically region by region, but a much more challenging task will be combining the regional evidence into a series of hypotheses about where, and how, H. naledi fits within existing, or modified, human evolutionary narratives.
- It remains to be seen whether after integrating all of this information it still makes sense to keep H. naledi in the genus Homo, and researchers need to explain why the H. naledi sample manifests so little morphological variation.

Importance of dating

- Despite arguments from Berger et al. to the contrary, the geological age of H. naledi does influence its interpretation.. Reliable dates are not needed for deciding whether H. naledi is a good species, but they are needed for working out how H. naledi relates to pre-existing hominin species.
- If it is between 1 and 2 million years old, its unique mix of primitive and derived features could help us to understand the sequence in which regions of the skeleton evolved, but if it is between 300 and 200 kyr old, H. naledi probably represents a local relict population whose combination of features owes as much to genetic isolation as it does to the influence of deeper human evolutionary history.

Extraordinary claims need extraordinary evidence

- More controversial are the ways in which the researchers have approached interpreting the various lines of contextual evidence.

- Best scientific practice considers the relative likelihood of a series of alternative explanations for each observation, and extraordinary claims require extraordinary evidence to support them.

Extraordinary claims need extraordinary evidence

- The presence in nearby caves of ‘crosshatched etchings’ identical to the ones the Rising Star researchers claim could only be created with a hard, sharp tool is perhaps the most obvious example of such an extraordinary claim.

- The preference for explanations that infer the behavior of H. naledi in relation to that of modern humans is an example of what Butterfield referred to as ‘presentism’—the tendency of historians to reconstruct the past by reference to the present.

- We need to look at the world of H. naledi for its own sake, without constantly comparing it to our world

Pre-prints vs peer review

- This brings us to the way the results of research related to the Rising Star Cave system have been communicated to scientists and to the public.
- Traditionally, major discoveries at hominin fossil sites are published in high-impact journals that are extensively peer-reviewed. Subsequently, detailed analyses of the hominin fossils are communicated via papers in peer-reviewed specialist journals. Peer review does not eliminate controversy, but it does place controls on a tendency to over-interpret evidence.
- The principal researchers involved with the Rising Star research decided to publish the results of their research as unreviewed preprints or in journals eschewing traditional models of peer review before publication.

Severe criticism and need for more research

- Science assumes researchers will work hard at the task of being their own critics, and it is not surprising that the recent post-publication peer reviews have been harshly critical of many of the claims made by Berger and his fellow principal researchers.

- The publication strategy of the Rising Star Cave system team, with its emphasis on controversial interpretations and ensuing media attention, has had the unfortunate effect of deflecting attention from the real scientific importance of H. naledi.

H. Naledi research 2023

- Behind the headlines is a hominin taxon with a hitherto unknown combination of primitive and derived morphology, which possibly lived alongside the earliest members of our own species. It fully deserves our considered attention. After 10 years there is much still to learn. We hope that, in the next decade, research will focus on the painstaking work involved in trying to understand the real place of H. naledi in human evolutionary history

- In November 2023, a paper by a group including Herries and María Martinón-Torres of (CENIEH), who helped develop the x-ray fluorescence-based technique, argued the Berger team hadn't ruled out the possibility that the bones might have landed in the cave by natural means, such as washing in with flooding water.