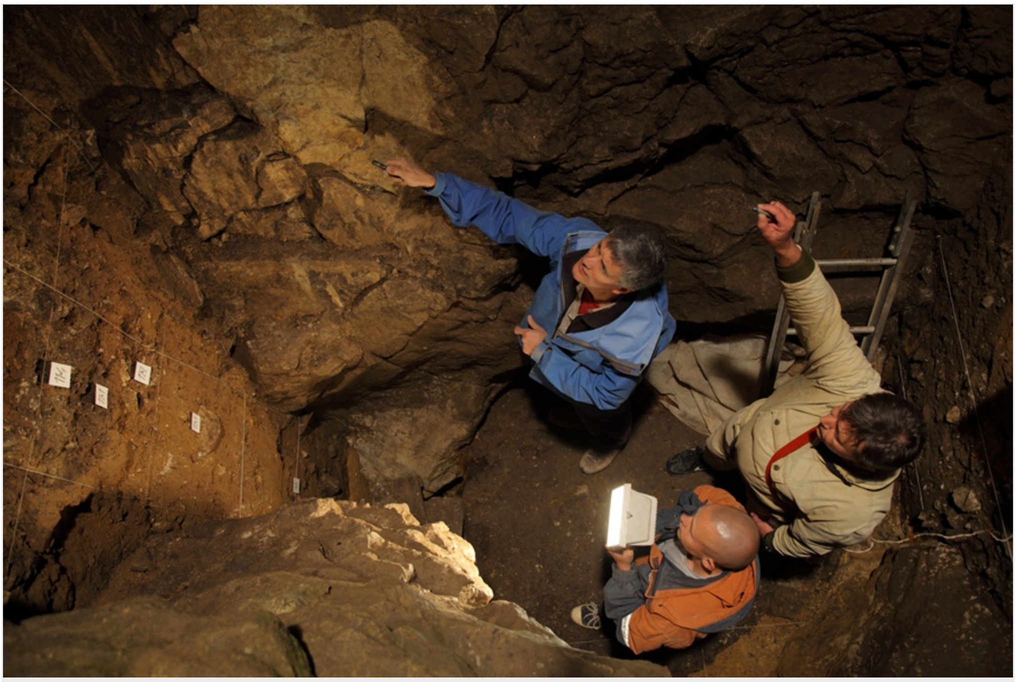
NATURE | NEWS

Ancient-human genomes plucked from cave dirt

For the first time, researchers have identified DNA of human relatives without the need to find their bones, opening new window into the past.

Ewen Callaway

27 April 2017



IAET SB RAS/Sergei Zelensky

Researchers plan the sampling of sediments in Siberia's Denisova cave.

Bones and teeth aren't the only ways to learn about extinct human relatives. For the first time, researchers have recovered ancient-human DNA without having obvious remains — just dirt from the caves the hominins lived in. The technique opens up a new way to probe prehistory.

From sediments in European and Asian caves, a team led by geneticist Viviane Slon and molecular biologist Matthias Meyer, both at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, sequenced genomes of cell structures called mitochondria from Neanderthals and another hominin group, the Denisovans. Their work is published in *Science*[1].

"It's exciting to see that you can end up with a whole pile of ancient-human DNA from just dirt," says Michael Bunce, an evolutionary biologist at Curtin University in Perth, Australia.

Slon and Meyer are not the first to decode ancient dirt. Palaeogeneticist Eske Willerslev of the Natural History Museum of Denmark in Copenhagen pioneered the approach in 2003, to find out about the plants and animals that populated prehistoric environments[2, 3]. Using the technique, he and his team revealed that Greenland was once richly forested[4]. But Slon and Meyer are the first to use the technique on hominin DNA.

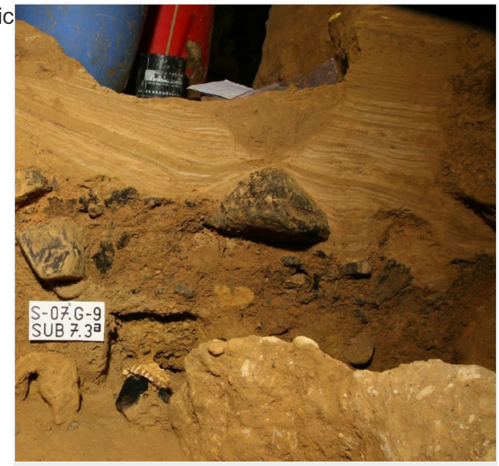
Dirt detectives

Isolating the genetic material of ancient peoples from dirt isn't easy. The DNA is exceedingly rare in the soil compared with that from plants, animals, fungi and microbes. It is also easy to mix it up with DNA from human excavators, for instance.

To improve the odds, Slon and Meyer's team collected sediments from sites at which tools or the remains of Neanderthals or Denisovans had previously been found. They looked at seven caves, including two in southern Siberia.

The team analysed the sediment samples with techniques that 'fish out' mammalian mitochondrial DNA, which is more abundant in cells than the DNA in the nucleus. To make sure that they weren't looking at modern genetic short sequences with chemical damage typical of ancient DNA.

The team recovered nine ancient-hominin mitochondrial genomes of varying completeness, from four of the sites. Neanderthal DNA was present in all four caves. Sequences of Denisovans, however, turned up only in a chamber of the southern Siberian cave where remains of the enigmatic group were first identified.



J. Fortea

The Galería del Osario ('tunnel of bones') site in Spain, where Neandertal DNA was retrieved from sediment.

But when?

Determining when these individuals lived is tricky. DNA attached to dirt can be picked up by water, then seep through the soil of archaeological sites and end up in a geological layer containing much older material — potentially confounding efforts to date it. So the researchers tried to demonstrate that the DNA they recovered hadn't been displaced into older layers. In Siberia's Chagyrskaya Cave, the researchers found abundant animal DNA in geological layers that contained animal bones and stone tools and none in older layers that lacked any sign of human or animal presence. That means it's likely that hominin DNA didn't move through layers either, they suggest.

But Robin Allaby, an evolutionary geneticist at the University of Warwick in Coventry, UK, isn't convinced. He thinks that the large amount of DNA recovered from some sites is evidence that lots of different material might have mixed and settled in a particular layer. "You can identify the hominins, but dating them becomes a bit of an issue," he says.

Johannes Krause/Max Planck Institute for Evolutionary Anthropology

Entrance to the Vindija Cave in Croatia, another site from which researchers isolated ancient-human DNA from dirt.

The exact source of the DNA is also unclear. Bodily fluids, faecal matter, hair and bone are all possibilities, says Slon. Whatever the source, the discovery of hominin DNA in soil should mean that the many archaeological sites that show signs of hominin habitation but lack obvious remains can now be probed genetically. For example, Slon's team identified Neanderthal DNA in soil from the Trou Al'Wesse cave in Belgium, where archaeologists have found tools probably made by Neanderthals, but have never recovered bones.

Underwater settlements

Researchers have high hopes for dirt DNA. Allaby's team is sequencing sea-floor sediments off the coast of England, in search of suspected ancient settlements that might now be submerged. Cool, constant ocean temperatures are ideal for preserving DNA, and Allaby thinks genetic material found under water could reveal details of human migrations out of Africa and into Australasia and the

Americas.

Mikkel Winther Pedersen, a molecular palaeoecologist at the University of Cambridge, UK, and his colleagues last year decoded animal DNA from the soil of archaeological sites in Greenland, documenting bowhead whale hunting 4,000 years ago[5].

Pedersen hopes the latest study will change how field archaeologists excavate sites. “Save the dirt,” he advises, “even though you don’t necessarily want to use it.” There may be a Neanderthal genome lurking in it, after all.

Nature | doi:10.1038/nature.2017.21910

References

1. Slon, V. *et al*. *Science* http://dx.doi.org/10.1126/science.aam9695 (2017).
2. Willerslev, E. *et al*. *Science* **300**, 791–795 (2003).
3. Pedersen, M. W. *et al*. *Nature* **537**, 45–49 (2016).
4. Willerslev, E. *et al*. *Science* **317**, 111–114 (2007).
5. Seersholm, F. V. *et al*. *Nature Commun.* **7**, 13389 (2016).