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# When were Denisovans and Neanderthals present in Eurasia?

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ABSTRACT

*Denisova Cave is an archaeological site in southern Siberia. Russian archaeologists have excavated it for over 30 years. It is the only site in the world we know to have been occupied by three different kinds of humans: Denisovans, Neanderthals*

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Denisova Cave is an archaeological site in southern Siberia. Russian archaeologists have excavated it for over 30 years. It is the only site in the world we know to have been occupied by three different kinds of humans: Denisovans, Neanderthals, and us. Denisova came to worldwide attention in 2010, when scientists from the Max Planck Institute in Germany sequenced the genome from a tiny finger bone found in the site. The bone did not belong to a Neanderthal, nor our anatomically modern human ancestors. Instead, it came from a group of humans not previously identified in the palaeoanthropological record. They were called Denisovans, after the site. The genetic data also revealed that, like Neanderthals and us, some groups of living humans in Melanesia, Papua New Guinea, and Australia inherit some genetic ancestry with Denisovans.

One area of uncertainty at Denisova has been the question of when these various groups were present at the site. Because the human fossil remains are so small (a few centimeters at most), it is challenging to date them with scientific methods directly. Over the last five years, our team of international researchers has been defining when Neanderthals and Denisovans were present and the environmental conditions they faced before they disappeared. Dating is crucial in archaeology to allow us to provide a proper framework for who was at the site when, and for how long.

To resolve this, we obtained fifty radiocarbon ages from the site, mostly in the upper parts of the cave. We dated samples of bone and teeth, as well as charcoal fragments from fires and humanly-made ornaments and bone spear points. Other researchers from Australia, led by Bert Roberts and Zenobia Jacobs, used a technique called optical dating, which allows us to date single grains of minerals in the sediments. They obtained more than 100 age estimates from the parts of the cave, which are too old for radiocarbon dating, which reaches its limit at 50,000 years ago.

To determine the most likely ages of the human fossils, our team developed a new Bayesian statistical approach. This approach makes it possible to use a range of different kinds of information to calculate a site chronology using statistical simulation methods. We included several lines of chronometric evidence. These included the different archaeological layers of the deposits (assuming that the deepest archaeological layers are older than younger ones on top of them). We calculated genetic ages for Denisovan and Neanderthal fossils based on the number of mutations in the mitochondrial genomes. We also incorporated several optical ages from the sediments and radiocarbon dates from bones and charcoal. All of this information enabled us to build a Bayesian model and obtain estimates for each of the fossil human bones that sit within the Denisova sediment sequence.

We discovered that the cave was occupied by Denisovans from at least 200,000 years ago. We think it is likely that humans were there before this because there are some stone tools in lower deposits dating perhaps as early as 300,000 years ago. We found that Neanderthals were present at the site periodically between 200,000 and 100,000 years ago. Most of the evidence for Neanderthals sits within a period called the last interglacial. This period dates to about 120,000 years ago. Then, the climate was much warmer, and conditions in the cave were similar to today. Denisovans remained at the site later, however, through much colder periods. Around 50,000 years ago, we think they disappeared from the site.

They were replaced by modern humans like us, who were present in other parts of Asia by this time. We do not know precisely when, however, because no fossil or genetic traces of modern humans have yet been found. Instead, we find so-called personal ornaments (tooth pendants) dating to between 43,000 and 49,000 years ago. These are the earliest dates for these artifacts in northern Eurasia. Frustratingly, we do not confidently know who might have made them at the site. In many parts of Europe, however, they are associated with modern humans, so it may be that they represent our earliest human ancestors. New research using DNA extracted from sediment might yield evidence for their presence. We would then be able to put a more robust date on their arrival into the Altai region and Denisova Cave.

New research is now focused on other sites in other regions of eastern Eurasia, to attempt to find more human remains belonging to the Denisovans. We hope this will shed light on their distribution across the region from around 250,000 years ago and what happened when modern humans met them.