Eruption of the Laacher See volcano redated

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13,000-year-old tree trunk from the volcanic deposits of the Laacher See eruption in the vicinity of Miesenheim, Germany. Credit: Olaf Jöris

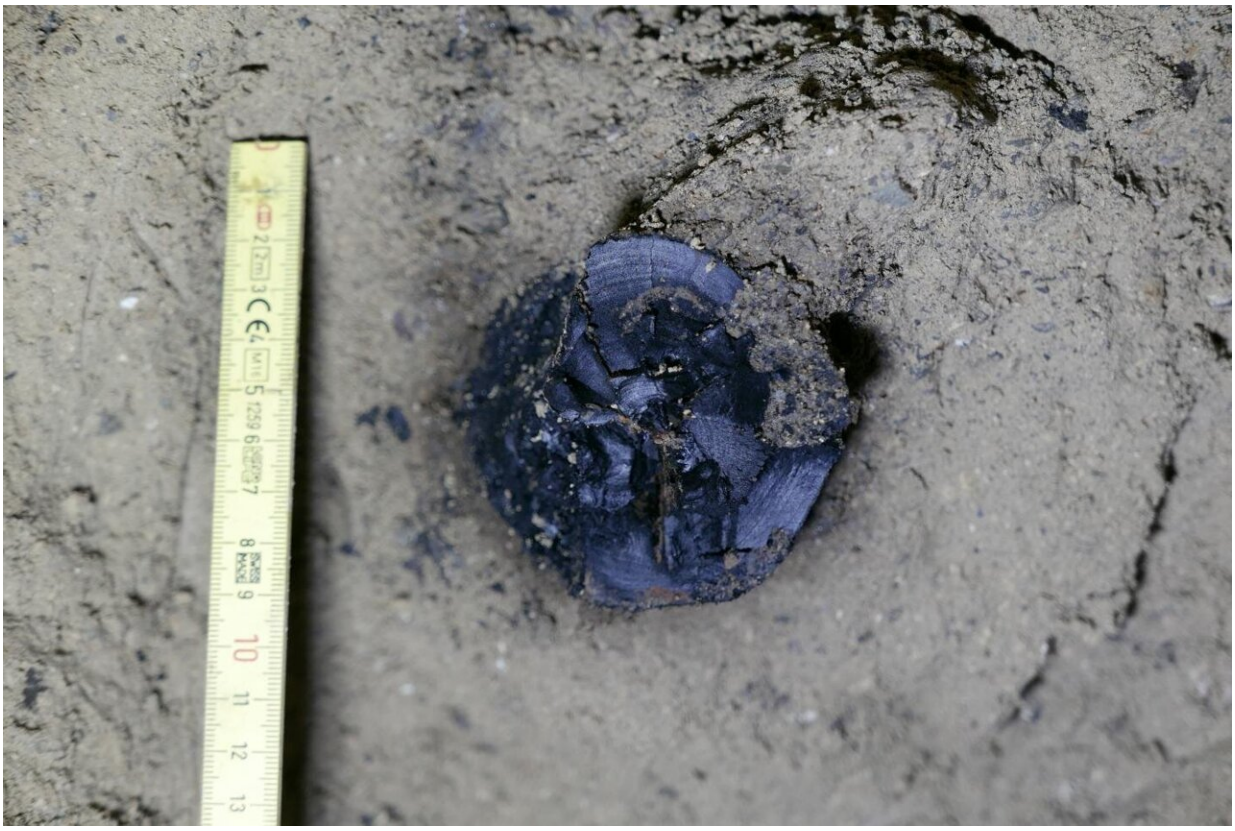
The eruption of the Laacher See volcano in the Eifel, a low mountain range in western Germany, is one of Central Europe's largest eruptions over the past 100,000 years. The eruption ejected around 20 cubic kilometers of tephra and the eruption column is believed to have reached

at least 20 kilometers in height, comparable to the Pinatubo eruption in the Philippines in 1991. Technical advances in combination with tree remains buried in the course of the eruption now enabled an international research team to accurately date the event. Accordingly, the eruption of the Laacher See volcano occurred 13,077 years ago and thus 126 years earlier than previously assumed. This sheds new light on the climate history of the entire North Atlantic and European region and requires an adaptation of the European climate archives. "We can now precisely date a drop in temperature at the end of the last glacial period, so that the information coincides with that observed from the Greenland Ice Sheet cores," said Dr. Frederick Reinig, a dendrochronologist at Johannes Gutenberg University in Mainz (JGU). An international research team with experts in archeology, climatology, ecology, radiocarbon dating, and volcanology was involved in this study. The research results were published in the journal *Nature*.

Charred remains of birch and poplar wood have been preserved to this day

The eruption of the Laacher See volcano was a natural disaster that affected large parts of Europe. The ash rain reached as far as northern Italy in the south and Saint Petersburg in the Northeast. In the immediate vicinity and the neighboring Rhine Valley, mighty deposits of ash and pumice formed, which buried all life beneath them. "During the eruption, pyroclastic flows buried the local vegetation around the Laacher See volcano. The trees were partially charred within the ash deposits and have been preserved to this day," explained Reinig, describing the eruption process that took place over several weeks in late spring to early summer and which now enables scientists to precisely date the event. "These wooden contemporary witnesses are very rare, and they are difficult to recover," said Reinig, first author of the study.

"The regional effects of the volcanic eruption have been well studied. What we have been missing so far is the certainty of when exactly this happened," emphasized Professor Ulf Büntgen, co-author of the *Nature* publication from the University of Cambridge. This was now determined based on samples from buried birch and poplar trees.



A charred tree trunk in the deposits of the Laacher See volcanic eruption: the individual annual rings of the sample were decisive for the exact dating of the eruption. Credit: Olaf Jöris

The analysis of tree rings reveals the precise date of the eruption

The volcanic sediments not only preserved the wood for over 13,000

years but also allowed to identify the individual tree rings. "The tree rings enable us to exactly determine the age of the samples," said Professor Jan Esper from Mainz University. In a joint initiative of the Federal Research Institute for Forests, Snow and Landscape WSL in Birmensdorf, Switzerland, together with the Archaeological Research Center and Museum for Human Behavioral Evolution MONREPOS in Neuwied, both newly discovered samples and older finds were analyzed. For this purpose, the Laboratory for Ion Beam Physics at ETH Zurich carried out radiocarbon measurements on 157 individual tree rings of the examined trees. Calibration of these results against a Swiss reference chronology then resulted in the precise dating. "The constant advances in radiocarbon measurement technology and the calibration methods used, as well as the careful handling of the sensitive samples, were the key to establish this dating with an uncertainty of less than ten years," said Lukas Wacker from ETH Zurich.

Tree rings reveal much more than the age of a tree. For example, they allow conclusions to be drawn about the respective growing conditions and thus enable indirect climatic insight. Credit: Jan Esper

Revised dating of the volcanic eruption has consequences for the synchronization of European climate archives and the understanding of large-scale climate dynamics

According to the description in *Nature*, the eruption of the Laacher See volcano took place 13,006 years before 1950, with an uncertainty of nine years. That is 126 years earlier than the generally accepted dating based on sediments in the Meerfelder Maar from the Eifel region in Germany.

This difference has far-reaching consequences for the synchronization of European climate archives and the understanding of North Atlantic and European climate history. Laacher See eruption ashes were widespread over large areas of Central and Northern Europe as a result of the volcanic eruption and represent an important time marker for paleoenvironmental archives. Due to the new dating, the European archives now have to be temporally adapted. At the same time, a previously existing temporal difference to the data from the Greenland ice cores was closed.

This means that the massive cooling at the beginning of the Younger Dryas—i.e., the last Ice Age intermezzo lasting around 1,300 years before the currently prevailing warm phase, the Holocene—also occurred in Central Europe 130 years earlier, around 12,870 years ago respectively. This is in line with the onset of the cooling in the North Atlantic region identified in ice cores from Greenland. During the Younger Dryas period, temperatures in Central Europe fell by up to 5

degrees Celsius. This strong cooling did not take place time transgressively, as previously thought, but rather synchronously over the entire North Atlantic and Central European region," said Frederick Reinig. The results of the interdisciplinary research team not only set a precise date for the eruption of the Laacher See in the Eifel. The revised age of the ash deposits and the associated shift in the European climate archives now sheds new light on the climate history of the entire North Atlantic region.

More information: Frederick Reinig et al, Precise date for the Laacher See eruption synchronizes the Younger Dryas, *Nature* (2021). DOI: 10.1038/s41586-021-03608-x

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