Tree rings pinpoint eruption of Icelandic volcano to half a century before human settlement

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Drumbabót forest in Iceland. Credit: Ulf Büntgen

An international group of researchers has dated a large volcanic eruption in Iceland to within a few months. The eruption, which is the oldest volcanic eruption to be precisely dated at high northern latitudes, occurred shortly before the first permanent human settlements were established, when parts of the now mostly treeless island were still covered with forest.

The team, which included volcanologists, climatologists, geographers and historians among others, used a combination of scientific and historical evidence to pinpoint the eruption date of the Katla volcano between late 822 CE and early 823 CE, decades before the earliest settlers arrived. Their results are reported in the journal *Geology*.

In a similar way to how fossils can be used to understand the development and evolution of life on Earth, different types of environmental evidence can be used to understand what the Earth's climate was like in the past and why. The 'fingerprints' contained in tree rings and ice cores help scientists to estimate past climatic conditions and extend our understanding of the interaction between humans and the environment hundreds and thousands of years back in time.

"In our work, we're trying to reconstruct past natural temperature and precipitation variability from tree rings – trying to reveal when it was cold and wet or warm and dry for instance," said Professor Ulf Büntgen of Cambridge's Department of Geography, the paper's lead author. "We're also interested in detecting and understanding key drivers of the Earth's climate dynamics and their possible linkages with changes in human history."

Credit: University of Cambridge

Currently, Iceland is for the most part treeless. However, before the first permanent settlers arrived in the late 9th century, it was most likely covered by extensive woodland. Early settlers harvested most of the trees they found on the island to establish an agricultural-based society, and the trees never recovered.

In 2003, a spring flood of the Thverá River exposed hundreds of birch trees which had been buried for centuries beneath layers of volcanic sediment. The so-called Drumbabót forest is the best-preserved prehistoric forest in Iceland, and had been buried by an eruption of the nearby Katla volcano, Iceland's most active volcanic system.

Volcanic eruptions are often responsible for an abrupt period of cooling, but only with a precise date of eruption can researchers definitively account for the variability in climate. Büntgen, who uses the information locked within tree rings to reconstruct past climate conditions, used the trees exposed by the 2003 flood to pinpoint when this particular eruption took place.

The team behind the current work have previously confirmed that in 775 CE, a large solar flare caused a spike in radiocarbon levels in the Earth's atmosphere, which would be stored in the wood of trees that were alive at the time. By measuring the radiocarbon levels in one of the Drumbabót trees, Büntgen and his colleagues were able to pinpoint the year 775 in the tree rings, and measure outward to the bark to count the number of years to the Katla eruption, when the tree died. The outermost tree ring had completely formed and a new one had not yet started, meaning that the eruption occurred after autumn 822 and before spring 823, before the next year's growth had begun. Iceland was not settled until around 870, so this particular forest was destroyed almost half a century before humans arrived.

Credit: University of Cambridge

The unique tree ring results were then linked with those of co-authors Professors Christine Lane and Clive Oppenheimer, also from Cambridge's Department of Geography. Lane and Oppenheimer used independent lines of ash (tephra) and ice core evidence to detect fingerprints of the Katla eruption.

In addition to the scientific results, the team also involved historians who analysed written documentary evidence from Europe and Asia, and found that there was a severe cold spell consistent with the timing of the reconstructed Katla eruption.

"It was a happy coincidence that we were able to use all these different archives and techniques to date this eruption," said Büntgen. "Data and methods we are using are constantly getting better, and by building more links with the humanities, we can see the real effects volcanoes have on human society."

More information: Büntgen et al. 'Multi-proxy dating of Iceland's major pre-settlement Katla eruption to 822-823 CE.' *Geology* (2017). DOI: 10.1130/G39269.1

Provided by University of Cambridge

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