Laser technology uncovers medieval secrets locked in Alpine ice core

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The ice core drilling site, under the dome tent on Colle Gnifetti, Swiss-Italian Alps. Credit: Antiquity and Dr N.E. Spaulding, Climate Change Institute, University of Maine

A new study has found ground-breaking evidence from an ice core in the Swiss-Italian Alps that proves the 7th century switch from gold to silver currencies in western Europe actually occurred a quarter of a century earlier than previously thought.

The findings, from the University of Nottingham and which are published in the journal *Antiquity*, will have major implications on the history of the European monetary system, and what we thought we knew about trade and the economy during this period.

The long-standing dating of all events and archaeological remains linked to the old dating of the first silver coinage will also have to change in light of the new study.

During the second half of the 7th century AD the coin-using regions of North West Europe switched from gold to silver currency. This change was a significant point in history and resulted in major social and economic transformations which saw increased long-distance trade and the emergence of major ports and trading centres, such as London and continental counterparts around the Channel and southern North Sea coast.

Until now, experts have reported this switch to be between 675 AD and 680 AD – but using new high precision technologies, a team of climate scientists, volcanologists, archaeologists and historians working on the 'Historical Ice Core Project' (HICP), have pinpointed definitively that the switch actually happened in 660 AD.

The HICP research is led by Professor Michael McCormick, Harvard University and Professor Paul Mayewski, Climate Change Institute (CCI), University, University of Maine, with the University of Nottingham and the University of Heidelberg, funded by the Arcadia Charitable fund.

The establishment of the chronology was made possible using ultra-high resolution laser analysis of elements on the 72m-deep ice core from Colle Gnifetti in the Swiss-Italian Alps, drilled in 2013. The laser-based chronology was further refined by linkage to markers of volcanic eruptions, from tephra and other known events. This included the tephra (volcanic glass) from the 536 mega-eruption.

Analysis of the 536 tephra in this study suggests, for the first time, that the mega-eruption occurred on Iceland, with major climate implications for northwest Europe especially. A unique atmospheric modelling programme developed at CCI, Climate Re-analyzer, also provides a unique insight on wind directions and origins of the lead pollution (the by-product of silver-mining/smelting) that was deposited in the Alps.

Professor Christopher Loveluck (lead-author of the Antiquity article), from the Department of Classics and Archaeology at the University of Nottingham, said: "We found huge lead pollution peaks in the ice, a by-product of large-scale silver mining and bullion production in the mid-7th century, in AD 640 and 660. The existing gold coinage started to be debased with silver in 640 and was replaced by a new silver coinage in 660, almost simultaneously in France and southeast England."

The team used the unique atmospheric modelling programme, and weather data from NASA and the National Oceanographic and Atmospheric Administration (NOAA) to learn which direction the lead was carried from, with the evidence indicating the mines at Melle in western France, the largest known silver source for Western Europe in the eighth and ninth centuries AD.

The new study shows that its paramount role probably began in the period from 640-660. The lead was released into the atmosphere during the smelting process and carried over the Alps, where it was deposited and frozen in the ice.

Professor Loveluck said: "For the first time, we have combined a series of research methods and technologies to definitively pinpoint when this fundamental economic change happened and where the lead was coming from. Previously, we have been unable to work this out, but by combining new laser ice chronological methods with new atmospheric modelling linked to the archaeological pollution and numismatic records and historical sources, we were able to get a clear picture of what was happening during this period, at a level of chronological precision never before possible. This is a truly interdisciplinary project, combining skills from historians, climate scientists, archaeologists and volcano experts and will literally change history."

The discovery of volcanic tephra from the 536 mega-eruption in the

Colle Gnifetti core, and its sourcing to Iceland, when fixing the chronology of the study, also has a profound impact on assessing very rapid climate change in Britain and Northern and Western Europe in the mid-sixth century, now referred to as the 'Late Antique Little Ice Age'. The tephra particles from the 536 eruption were thought previously to have come from a volcano in California, but after an expert analysis by the tephra team, led by Professor Andrei Kurbatov (CCI) they were actually found to match an Icelandic source.

Professor Loveluck said: "Iceland is a lot closer to Britain and North West Europe than California which means that the impact of this eruption at the time on climate in these areas would have been much greater than previously thought. It would have made places very cold very quickly and would have been most felt in Britain and places in North Western Europe. The consequences for these areas would have been immediate, with an increased likelihood of famine and ill health due to poor crop yields."

More information: C.P. Loveluck et al. Alpine ice-core evidence for the transformation of the European monetary system, AD 640–670, *Antiquity* (2018). DOI: 10.15184/aqy.2018.110

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