Comprehensive record of volcanic eruptions in the Holocene (11,000 years) from the WAIS Divide, Antarctica ice core (2021)

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Abstract

A comprehensive record (WHV2020) of explosive volcanic eruptions in the last 11,000 years is reconstructed from the West Antarctica Ice Sheet Divide deep ice core (WDC). The chronological list of 426 large volcanic eruptions in the Southern Hemisphere and the low latitudes during the Holocene are of the highest quality of all volcanic records from ice cores, owing to the high-resolution chemical measurement of the ice core and the exceptionally accurate WDC timescale. No apparent trend is found in the frequency (number of eruptions per millennium) of volcanic eruptions, and the number of eruptions in the most recent millennium (1,000–2,000 CE) is only slightly higher than the average in the last 11 millennia. The atmospheric aerosol mass loading of climate-impacting sulfur, estimated from measured volcanic sulfate deposition, is dominated by explosive eruptions with extraordinarily high sulfur mass loading. Signals of three major volcanic eruptions are detected in the second half of the 17th century (1700–1600) BCE when the Thera volcano in the eastern Mediterranean was suspected to have erupted; the fact that these signals are synchronous with three volcanic eruptions detected in Greenland ice cores suggests that these are likely eruptions in the low latitudes and none should be attributed exclusively to Thera. A number of eruptions with very high sulfur mass loading took place shortly before and during an early Holocene climatic episode, the so-called 8.2 ka event, and are speculated to have contributed to the initiation and magnitude of the cold event.

Plain Language Summary

A complete record of large volcanic eruptions during the last 11,000 years has been produced from a detailed chemical analysis of a 3,400-m long ice core from Antarctica. The record is a chronological list of 426 explosive volcanic eruptions with the quantity of emitted volcanic materials that can impact the global climate. A number of very large eruptions some 8,200 years ago may have triggered and/or enhanced an abrupt cold episode in Earth's climate history. This record does not provide conclusive evidence that the Thera eruption occurred in the 17th century BCE.

Student Summary

What we know: Volcanoes affect the earth's climate. During big volcanic eruptions, volcanoes release sulfur and chemicals that can alter how much sunlight enters the earth's atmosphere.
Why it's important: Not only can these eruptions lead to climate change, but they also mean that certain chemicals land on glaciers. Measuring these chemicals in an ice core allows scientists to learn about both the age of the ice and the volcanic eruption at the same time.
How the research was done: In this project, we used a 2-mile-long ice core from West Antarctica to learn about the history of volcanic eruptions during the last 11,000 years. We did this by measuring how much sulfur was in the ice. Whenever there was a huge amount of sulfur, this usually means that a large volcano erupted at that time.
What the evidence shows: We identified 426 volcanic eruptions, all of which will be useful for other scientists studying volcanoes, glaciers and the earth's climate. Most exciting are eruptions from 3,700 and 8,200 years ago that may have caused rapid climate changes at those times.