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Unlocking eruption source parameters of ancient volcanic eruptions using ice cores

Volcanic eruptions have been identified as a primary driver of climate variability. Yet, the observational record of the timing of volcanic eruptions, their locations, magnitudes of sulphate aerosol injection and atmospheric life-cycle, however, is often incomplete, with gaps in the knowledge of past volcanic activity increasing dramatically before the Modern (pre-1800) era. This shortage in observational data strongly limits our understanding of the sensitivity of the Earth system to volcanism and the vulnerability of social and economic systems to the climate impact of past and future eruptions.

The polar ice-sheets are a unique archive of Earth's volcanic past as they preserve the volcanic fallout products (volatiles, ash) from eruptions often located 1000s of kilometers away with unprecedented resolution and dating precision. Previous work has used continuous records of total acid-, sulfate- and/or sulfur concentrations to estimate the radiative forcing from volcanic eruptions. These records alone, however, contain limited information about the actual source locations of the individual eruptions. Distinct differences in the composition of metals from hotspot volcanoes -- like those found in Iceland -- and arc volcanoes, which are associated with subducting tectonic plates, may provide a pathway to disentangle the volcanic signals preserved in the ice-sheets by using their geochemical "fingerprint".

Using specific historic and ancient eruptions I will discuss the potential and limitations of combining state-of-the-art aerosol and geochemical records from ice-cores and other archives to advance our understanding of the timing and location of past eruptions and their consequences to climate and human societies.

This painting depicts the Holuhraun lava field in Iceland, where magma originating from the Bárðarbunga volcano spewed out of eruptive fissures from August 2014 to February 2015. (Brandur Bjarnason Karlsson)