Abstract ID : **98**

Deciphering the sources and climate impact potential of pre-historic volcanic eruptions from Iceland using the Greenland ice cores: a case study from the 8th century

Content

Preliminary analysis of six Greenland ice cores has revealed a prolonged period of elevated background sulphur emissions between 750 and 770 CE. This occurs in a period coined the 'Medieval Quiet Period'; a period previously considered to be volcanically quiescent and climatically stable (Bradley et al., 2016). This period of elevated sulphur coincides with several severe winters as recorded by European speleothems (Affolter et al., 2019; Fohlmeister et al., 2012) and numerous historical documents (Newfield, 2013). However, uncertainties persist over the nature of these emissions. Predominantly whether they were the product of a single eruption or several consecutive eruptions, the total duration and magnitude of this event, and the responsible volcanic centre(s). This has ultimately hindered robust climate impact assessments.

To resolve these uncertainties, we adopted a multi-parameter approach across several Greenland ice cores. We (1) robustly determined the total duration of these events using the annually resolved high-resolution ice core chronologies; (2) undertook targeted sampling for cryptotephra geochemical analysis to pinpoint the source volcano; (3) utilised halogen (F-) and trace metals as distinct ice-core proxies for Icelandic eruptions; and (4) conducted high-resolution sulphur isotope analysis to confirm the volcanic origin of these events and constrain plume heights of the eruption (tropospheric vs stratospheric).

Through the adoption and application of the above methods, it has been possible to better characterise this period of elevated volcanic sulphur emissions and thereby provide the eruption source parameters required to robustly assess the impacts of such events on the climate system. This multi-parameter geochemical toolkit is transferable to both other regions (i.e. Antarctica) and other time periods (i.e. Holocene, Last Glacial). Ultimately, it may allow us to reconstruct past volcanic eruptions and decipher their footprint on the past climate system.

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Track Classification: Holocene and last 2000 year climate forcings and variability