A new multi-parameter toolkit to unlock records of past volcanism

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BACKGROUND: Explosive volcanic eruptions can have profound environmental and societal consequences. In the UK and Europe, we are at greatest risk from explosive Icelandic eruptions, and while future Laki-style fissure eruptions pose the most severe health hazards (Schmidt et al. 2011), the 2010 eruption of Eyjafjallajökull demonstrated that even relatively minor eruptions have widespread consequences (disrupting the travel for millions of people and costing the global economy £3 billion).

To improve volcanic crisis preparedness in the UK and globally it is essential to build up detailed records of past eruptions. The frontier of this research lies in finding new ways to exploit the polar ice core records which undoubtedly preserve the finest records of large volcanic events over the last few 100,000 years.

Although ice cores provide exceptional inventories of past volcanism, scientists still face major challenges decoding these records. For the vast majority of ice core volcanic deposits, we have no constraints on eruption location, tectonic setting or style, and in fact >90 % of these events are still to be linked to a known source volcano (Sigl et al. 2015).

Fortunately, over the last few years a number of exciting geochemical methods (which are being developed at St Andrews) have been shown to overcome these challenges and provide a new and timely opportunity to fully exploit the ice core archive. These diverse methods are shown in Figure 1 and include:

1) **Isotope geochemistry**: multiple sulphur isotopes (measured using state-of-the-art MC-ICP-MS methods, Burke et al., 2019) provide the most promising approach for determining whether or not a volcanic plume reached the stratosphere.

2) **High-resolution glaciochemistry**: new records of sulphate, halogen and particle concentrations have only recently been used to study volcanic events, and by probing the precise timing and longevity of these signals it is possible to gather key information about eruption style and proximity (Koffman et al. 2017; McConnell et al. 2017).

3) **Tephrochronology**: recent geochemical compilations demonstrate that ice core tephra chemistry can be used as an all-purpose tool for deciphering tectonic setting and fingerprinting source volcanoes (Jensen et al. 2014).

![Fig. 1: The thrust of this project is to develop state-of-the-art tools to reveal the source and climate-changing potential of past volcanic events](image-url)
**RESEARCH PROJECT:** This studentship will focus on carefully calibrating these techniques for well-known volcanic events that can be identified in ice core horizons. They shall focus on the last 2000 years of Greenlandic ice cores which have well-resolved chronological frameworks and can be compared to key climate proxies (e.g. tree rings). The ultimate goal of this project is to extend this analysis to major unknown volcanic eruptions and reveal the likely source of massive 'mystery' eruptions.

Since Icelandic volcanoes are a major contributor to Northern Hemisphere ice core records, as well as the main volcanic hazard to the UK and Europe, one of the key goals of the project will be to constrain typical sulphate and tephra deposition for a wide variety of Icelandic volcanic styles. In the initial phase of the project the student will undertake a field campaign in Iceland to sample tephra from major fissure eruptions, e.g. Laki, as well as spectrum of major Plinian eruptions, e.g. Hekla, Öraefajökull and Askja. This will allow us to make robust geochemical correlations with the ice core archives and relate the proximal volcanological records to the distal ice core archives.

![Fig. 2: Fire fountains of the 2014 Holuhraun fissure. The initial phase of this study will examine major fissure eruptions and Plinian events in Iceland. The proximal volcanic deposits will be carefully linked to new ice core analysis to unravel the characteristic geochemical fingerprint of major Icelandic volcanic events. Photo by Einar Gudmann (CC BY 2.0)](image)

The new multi-parameter approach developed in this project has the potential to transform our understanding of the volcanic record. We expect the results to be of wide interest to volcanologists, climate scientists, historians and policy makers, ensuring that society is better equipped to manage risk, response and recovery to future volcanic events in the UK and Europe.

**RESEARCH ENVIRONEMENT:** The student will be based in the School of Earth and Environmental Sciences at St Andrews ([http://earthsci.st-andrews.ac.uk/](http://earthsci.st-andrews.ac.uk/)), which has recently invested over £1.3M on new analytical facilities for geochemistry. They will work with experts in volcanology and isotope geochemistry (e.g. Hutchison et al. 2019; Burke et al. 2019) and will also gain significant new expertise in climate science and atmospheric chemistry, as well as transferable skills such as scientific writing, statistics and data analysis, and problem-solving.

The student will join a burgeoning volcanology group at the St Andrews and will benefit from interactions with this vibrant and supportive team. They form valuable research links with our collaborators in in the UK, Europe and US and will also present their work at major international conferences (e.g. AGU Fall meeting) which will provide excellent opportunities for networking and career development.

Open to UK and EU students with an excellent BSc/MSci geoscience background. Laboratory and field work experience is advantageous. General information about eligibility, studying at the University of St Andrews, and the online application form can be found at [http://www.st-andrews.ac.uk/study/pg/apply/](http://www.st-andrews.ac.uk/study/pg/apply/).

On the application please note the project title, St Leonards as the funder, and Will Hutchison as the supervisor. The deadline is 24th January 2020 and interviews are expected to take place mid-February.

For specific questions about the project please email Will Hutchison ([wh39@st-andrews.ac.uk](mailto:wh39@st-andrews.ac.uk))