PhD topic: Linking volcanic sulfur emissions with deep Earth sulfur cycles: constraints from Galápagos volcanoes

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Importance of the research concerned

Volcanic emissions constitute a significant source of atmospheric sulfur dioxide (SO_2). One of the world's most volcanically active regions is the Galápagos and observations from space have shown that recent SO_2 emissions (9000 kg) represent a considerable amount of the global volcanic SO_2 atmospheric flux (Carn et al., 2018). These emissions are associated with effusive eruptions from volcanoes in the west of the archipelago (Sierra Negra and Fernandina) but little is known about the source of the sulfur and the role that it places in the magmatic systems that underlie Galápagos volcanoes. The main melt source for the volcanism is an underlying mantle plume and previous investigations have shown that this contains both recycled and primordial components, which exhibit systematic spatial variations in their contributions to melts erupted at Galápagos volcanoes. Additionally, the Pacific Oceanic crust beneath Galápagos is rich in sulfides (Gibson et al., 2016) but it is unclear if these crystallised from ascending Galápagos magmas or are fossil hydrothermal sulfides associated with large circulation systems at the nearby Galápagos Spreading Centre.

Figure 1. Galapagos volcanoes support important and diverse ecosystems.

Brief summary

The main goal of the project is to place improved constraints on the origin of the prodigious amounts of sulfur emitted by Galápagos volcanoes. In order to do this rigorously, a detailed systematic petrographic and geochemical study is required to examine how sulfur (S) is concentrated in Galápagos basalts (e.g. by crystal fractionation and magma chamber replenishment) prior to their eruption. The only recently published work on the S content of the underlying mantle is based on the compositions of basaltic glasses on the adjacent Galápagos Spreading Centre (Ding and Dasgupta, 2017) but these are in an area that is outside the main region of plume influence. These analyses provide important information on the S composition of the depleted Pacific mantle but there remains a large gap in our knowledge as to the S contents of the primary magmas that 'feed' Galápagos volcanoes.

What's involved?

In order to improve constraints on the role that S plays in magmatic systems beneath Galápagos detailed petrographic and geochemical investigations of Galápagos lavas and xenoliths from a series of volcanoes is required. To place constraints on depths of sulfur saturation, geochemical analyses will be undertaken on glass preserved in olivine- and plagioclase-hosted melt inclusions and also magmatic sulfides (Longpré et al., 2017; Beaudry et al., 2018). This will involve the determination of major, chalcophile (Ag, Cu, S, Se, Sn) and siderophile elements (Co, Mo and Ni) in samples that equilibrated at different pressure intervals in the thickened Galápagos crust. This will allow robust constraints to be placed on both the origin and behavior of S content in the mantle that is supplying melt to Galápagos volcanoes.

Training and development of new skills

The student will be provided with training in the study of sulfides and melt inclusions by QemSCAN, and their analysis by electron microprobe, laser-ablation inductively-coupled-plasma mass spectrometry, ion probe and raman spectroscopy. Additional training in data analysis (python), writing and presentation skills will be provided via the Cambridge DTP.

Equality Diversity & Inclusion

The project supervisor and the University of Cambridge actively support equality, diversity and inclusion and encourage applications from all sections of society. The University holds an institutional Athena-SWAN silver award and the Department of Earth Sciences is a bronze award holder.

How to Apply

You can find out about applying for this project on the Department of Earth Sciences page.
Please contact sally@esc.cam.ac.uk direct if you are interested in applying for this project.

References

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