Tracing mechanisms of sulphur release with Cu and Zn isotopes in historical Icelandic flood lavas

C.R. GALLAGHER*[1,2], P.S. SAVAGE[3], G.M. NOWELL[1], B.F. HOUGHTON[4], T. THORDARSON[2] AND K.W. BURTON[1]

[1] Dept. Earth Sciences, Durham University, UK
[2] Inst. of Earth Sciences, The University of Iceland, Iceland
[3] SEES, University of St. Andrews, UK
[4] SOEST, The University of Hawaii at Manoa, HA, USA
*Corresponding author: catherine.gallagher@durham.ac.uk

Historic flood lava eruptions are valuable analogues for large flood basalt events, which induce global climatic pertubations through atmospheric volatile loading. This study compares the timing and mechanisms of atmospheric sulphur (S) loading, and the Cu and Zn isotope signatures imparted during the two most recent flood lava eruptions in Iceland which are (1) The 2014–15 Holuhraun eruption which created a lava field of 1.45 ± 0.04 km^3 releasing 9.6Mt SO_2. This eruption yielded an un-paralleled dataset, making it an ideal test case for characterisation of isotopic variations. (2) The 1783–84 CE Laki eruption which produced 14.7 km^3 of lava and 0.4 km^3 of tephra, as activity propagated along a 27km long fissure. In total it released 120Mt of SO_2, producing a significant hemisphere-wide climatic impact.

This study utilises samples from coeval tephras and lavas to track changes in syn-eruptive and syn-emplacement degassing. Textural analysis is used to compare and contrast eruption dynamics, and the modulating role of shallow conduit processes. Glass chemistry constrains the degree of degassing, and the mechanism of S release was identified using a combination of chalcophile isotope proxies and volatile trace elements. The mechanism of volatile release controls the type(s) of sulphur released into the atmosphere, which have different residence times and climatic impacts. For both eruptions Zn and Cu isotopes display resolvable temporal trends reflecting an increasing degree of volatile S loss throughout vent activity.

The Holuhraun lavas give a complimentary dataset with both isotope systems displaying temporal and elemental trends. The Laki eruption is complicated by different portions of the fissure being active at separate stages. Therefore, the Laki lavas cannot be analysed as a whole for either isotope system, but when emplacement-related samples are grouped both systems display temporal and elemental trends. These results highlight the value of fully characterising spatial and temporal isotope variations to resolve the mechanisms of volatile release.