A chalcophile element perspective on mantle heterogeneity under Iceland

CALLUM D.J. REEKIE[1*], FRANCES E. JENNER[2], ERIK H. HAURI[3], EMMA S. BULLOCK[4], SÆMUNDUR A. HALLDÓRSSON[5] & HELEN M. WILLIAMS[1]

[1]Department of Earth Sciences, University of Cambridge, Cambridge, CB2 3EQ, UK (*cdjr2@cam.ac.uk).
[2]School of Environment, Earth and Ecosystem Sciences, The Open University, Milton Keynes, MK7 6AA, UK.
[3]Department of Terrestrial Magnetism, Carnegie Institution for Science, Washington DC, 20015, USA.
[4]Geophysical Laboratory, Carnegie Institution for Science, Washington DC, 20015, USA.
[5]Institute of Earth Sciences, University of Iceland, Reykjavík, 101, Iceland.

The distribution of sulfur (S) in the Earth's mantle has important implications for the mobility and inventory of economically-important chalcophile and siderophile elements (CSE) in mantle-derived melts. While the effects of magmatic differentiation processes on the S and CSE budgets of these melts are well-constrained [1], our understanding of the effects of lithological and chemical heterogeneity in their mantle source remains limited. For example, it is not known to what extent recycled crust, which is potenitally CSE-rich [2], influences the distribution of CSE between the Earth's mantle and crust.

To address this question, we assess the compositional variability of plume-related basalts from Iceland and the Reykjanes Ridge, which are derived from a heterogeneous mantle source [3]. We find that the variability of CSE in Icelandic basalts cannot be accounted for by crustal differentiation of a common parental melt. Instead, we find strong correlations between highly-chalcophile element (e.g., Cu and Ag) contents and incompatible trace element ratios (e.g., Ba/Nb and Zr/Nb). This suggests that the CSE variability in Icelandic basalts is controlled by mixing of melts derived from depleted, S-poor and enriched, S-rich mantle domains. Importantly, S-rich (and hence, sulfide-rich) mantle domains likely retain CSE during partial melting, leading to CSE-depleted melts.

Our results demonstrate an important link between mantle heterogeneity and the distribution of CSE between the Earth's mantle and crust, which might have important implications for the formation of magmatic ore deposits.

[1] Reekie *et al*. (2019) *Nat*. *Comms*. **10**, 82. [2] Jenner (2017) *Nat*. *Geosci*. **10**, 524-529. [3] Shorttle and Maclennan (2011) *G*[3] **12**, Q11008.