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Heavy halogens as tracers of recycled oceanic lithosphere

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Heavy halogens are incompatible and fluid-mobile elements concentrated in oceanic lithosphere by serpentinisation. Subduction returns oceanic lithosphere to the mantle, recycling it into the upper mantle and to the deep mantle where it may be returned to the surface in deep seated mantle-plumes [1]. Halogens therefore make potentially excellent tracers of recycled oceanic lithosphere in the mantle.

The Icelandic mantle is chemically and lithologically heterogeneous and is proposed to contain at least 5 % recycled oceanic lithosphere [2]. To investigate if halogens can be used to trace the presence of recycled oceanic lithosphere in the mantle we analyse heavy halogens (Cl, Br, I) for a suite of basaltic glass samples from the Reykjanes Ridge. Initial study of the samples by SIMS reveals a sharp increase in F and Cl concentrations of Reykjanes Ridge glasses on the approach to Iceland. We compliment this data with heavy halogens measured by the halogen technique [3] using the Argus VI noble gas mass spectrometer, a more sensitive technique for measuring halogens. Heavy halogens have also been measured in 73 subglacially erupted basaltic glass samples from across Iceland's active neovolcanic zones and flank zones. We use the new results to investigate variation in the concentration of the heavy halogens and halogen ratios along the Reykjanes Ridge, south-west of Iceland, and on mainland Iceland. From this we discuss the use of halogens for tracing recycled oceanic lithosphere in the mantle.

Glasses from Iceland display two orders of magnitude variation in concentration of halogens. The highest halogen content and high halogen/K ratios are observed in the flank zones and NVZ, suggesting a higher concentration of recycled halogens in their mantle source. Lower halogen content and halogen/K ratios present in EVZ and WVZ glasses are spatially associated with high $^{3}He/^{4}He$ and low $^{207}Pb/^{206}Pb$ signatures, suggesting that Iceland's plume-like mantle source is relatively halogen-poor.

[1] Hoffman and White (1982), *EPSL*, 57, 421-436

[2] Shorttle et al. (2014), *EPSL*, 395, 24-40

[3] Ruzié-Hamilton et al (2016), *Chemical Geology*, 437, 77-87