Noble gases and halogens in the Oman ophiolite

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Recent studies suggest that subduction recycling circulates seawater derived noble gases and halogens throughout the Earth's mantle [1-4]. Serpentinites and secondary peridotites have been identified as a key carriers of these volatiles to the mantle [4], however, the role of the oceanic crust remains poorly constrained. This study reports the first ever complete transect of noble gases and halogens through a fossil oceanic crustal section extending from low temperature alteration in basalt lavas to high temperature alteration of gabbros and serpentinisation of peridotites in the crustal root zone.

The heavy halogen (Cl, Br, I) and noble gas (Ar, Kr, Xe) contents and isotopic signatures of representative vein and whole rock background alteration samples were measured by noble gas mass spectrometry. Following sample irradiation, noble gases were extracted by in vacuo crushing and/or heating. In addition, He and Ne isotopes were measured on a high resolution Helix Mc *Plus* multi-collector mass spectrometer for a subset of un-irradiated samples.

Fluids throughout the altered crust are dominated by heavy noble gases derived from seawater/atmosphere, with the preservation of a minor mantle component indicated by elevated $^{40}Ar/^{36}Ar$ up to ~380 (seawater = 296). Preliminary Ne isotope data support the presesence of a mantle component in parts of the hydrothermal system with a maximum $^{20}Ne/^{22}Ne$ ratio of 11.5 measured in hydrothermal quartz. In contrast, halogen elemental ratios are consistent with hydrothermal fluids derived from evolved seawater with an added sedimentary component. Heating experiments show strong I enrichment of up to ~650 ppb (~10 times seawater) associated with low temperature alteration and zoisite-epidote veins. Amphibole alteration defines a large spread in Br/Cl and I/Cl ratios with distinctive low ratios and high Cl content (~1600 ppm) in the lower-most crustal gabbros. Further work is underway to investigate the causes of variation in: 1) amphibole Cl content; 2) I enrichment; and 3) the factors enabling preservation of mantle Ne isotope signatures.

[1] Holland & Ballentine (2006), Nature 441, 186-191. [2] Kobayashi et al. (2017), *EPSL*. [3] Sumino et al. (2010), *EPSL*. [4] Kendrick et al. (2011), Nat. Geosci. 4, 807-812.