Halogens, barium and uranium in mantle fluid inclusions

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A sensitive technique to measure halogens at ng/g levels is by irradiating samples and measuring Ar, Kr and Xe [1, 2]. Absolute rare gas amounts are converted to absolute halogen amounts via the SY scapolite monitor [2]. Kr-Xe systematics also yield Ba and U concentrations. We combined irradiation with stepheating on carbonate-sulfate-rich fluid inclusions (FI)-bearing xenoliths from El Hierro, Canarias: a spinel lherzolite and a dunite [4].

Three components are recognized in the rare gas release. Atmospheric surface contamination affects all steps to 1000 °C. FI decrepitation by laboratory heating is mostly observed above 1200 °C [3], corresponding to the release of ^{80,82}Kr and ^{128}Xe in the 1200 and 1400 °C steps. Halogen-derived rare gases are closely associated to Ba-derived ^{131}Xe; this is explained by the high affinity of Ba for CO_2-rich fluids. Daughter minerals in multiphase FI were identified by Raman microspectroscopy [4]. Calculated whole-rock concentrations: [Br] = 3-21 ng/g, [U]= 25-95 ng/g; [Ba] = 2-15 μg/g. The molar Br/Cl and I/Cl ratios in the lherzolite and dunite FI are identical, 9 E-4 resp. 2 E-4. This sets the halogens in our FI apart from MORB [2].

The third component is ^{238}U-derived (retained radiogenic) ^{134,136}Xe and ^{235}U-derived ^{86}Kr released in a spike at 1000 °C, decoupled from FI. This requires a different carrier than FI, e.g. ilmenite; given the ppb U concentration, the modal abundance of the U-bearing phase needs to be a few ppm, undetectable by petrographic observation. Retention of radiogenic Xe in a HFSE mineral at mantle conditions is not unexpected, given its large atomic radius.

[1] Jeffery & Reynolds (1961) *JGR* **66**, 3582 [2] Kendrick (2012) *Chem Geol* **292**, 116 [3] Roedder (1965) *Am Min* **50**, 1746 [4] Oglialoro et al (2015) AGU abs V21C-3046