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The distribution of halogens in Shergottite meteorites: implications for martian mantle abundances

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Volatile elements (such as halogens) have a strong influence on the physical and chemical evolution of planetary bodies, and their measurement in meteorites can provide information into volatile distribution and transport processes. Insights into the halogen composition (Cl, Br and I) of the martian interior can be gained from shergottite meteorites, whose parental magmas were formed by partial melting of the martian mantle. Previous studies (based on a limited dataset) indicated that depleted shergottites have halogen abundances similar to the Bulk Silicate Earth (BSE), whereas enriched shergottites have higher abundances and elevated I/Cl values [1]. However, these data were obtained on bulk samples and therefore subject to uncertainties arising from the effects of alteration (martian and/or terrestrial), magmatic processes (mineral-specific fractionation or crustal contamination), and impact-related shock effects that possibly led to volatile re-distribution or loss.

This study extends the number of shergottites investigated (including enriched, intermediate and depleted types) and, in particular, considers mineral separates (olivine, clinopyroxene and feldspar). Halogens (Cl, Br and I) were determined using neutron irradiation noble gas mass spectrometry. Stepped heating extraction was used in an attempt to assess and mitigate against the effects of any secondary processes on the primary halogen compositions. Using this approach, the aim was to establish whether halogens are heterogeneously distributed in the shergottite mantle source regions

Our results show high I/Cl ratios (10^{-2} to 10^{-1}) at low temperature, which decrease to stable ratios (10^{-4} to 10^{-2}) at higher temperature releases. Conversely, the Br/Cl ratios are consistent (10^{-3} to 10^{-2}) across the different stepped temperature releases. By discarding the low T releases, likely affected by alteration (shock or weathering) [2], the Br/Cl and I/Cl of the depleted and enriched shergottites are similar, and different from bulk measurements of Clay et al [1]. This has important implications for constraining the martian mantle halogen abundances.

[1] Clay, Joy, O'Driscoll, Busemann, Ruzié-Hamilton, Burgess, Fellowes, Joachim-Mrosko, Pernet-Fisher, Strekopytov & Ballentine (2020) *Am. Mineral.* 105, 289-306.

[2] Heumann, Gall & Weiss (1987) *GCA* 51, 2541-2547.