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The halogen composition of Shergottite meteorites

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Martian meteorites provide important clues for understanding Mars' mantle evolution and its volatile budget. Based on volatile/non-volatile element ratios and cosmochemical constraints, the martian interior is considered to be 2-3 times more enriched in chlorine relative to the terrestrial mantle [1, 2]. However, reported abundances of Cl in shergottites are relatively low and within the range determined for MORB [3]. The abundances of heavier halogens Br and I in shergottites are less certain, however the large range in volatility and incompatibility of halogens in silicates means that ratios of Br/Cl and I/Cl may be good indicators both of primary accretionary materials and secondary processes (e.g. melting/fractional crystallisation, degassing and crustal contamination). Based on the few analyses available [3, 4 this study], there is a factor 1000 variation in I/Cl values, extending from ~10^{-5}, similar to the comparatively uniform I/Cl of the Earth's mantle, to >10^{-2} far in excess of chondritic values. The origin of this variation is unknown, possible causes may include heterogeneous halogen distribution in the Martian mantle, core-mantle fractionation of iodine, preferential outgassing of chlorine, shock processes or contamination with Martian and/or terrestrial alteration products. To gain further insight into the reasons for these variations, and increase the database of heavy halogen measurements, we are analysing the whole rock and separated minerals in several shergottites using the noble gas neutron irradiation mass spectrometry technique [5]. We have complemented these measurements with noble gas isotope (Ar, Kr, Xe) determinations on unirradiated aliquots of companion samples, this enables correction of trapped and spallation-derived components. Both sets of data were obtained on noble gases extracted by step heating using a CO_2 laser and analysed using a ThermoFisher Scientific ARGUS VI mass spectrometer.

[1] Dreibus G. & Wänke H. 1987, Icarus 71, 225–240; [2] Taylor G. J. 2013. Chemie der Erde 73, 401–420; [3] Filiberto et al. 2016 MAPS 51, 2023-2035; [4] Clay et al. 2020, Am. Min. 105, in press [5] Ruzié-Hamilton et al. 2016 Chem. Geol. 437, 77-87.