

Resolving magmatic halogen signatures in nakhlite meteorites

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Constraining halogen (Cl, Br, I) contents on Mars provides critical insights into fluid circulation and interactions between the mantle, crust and atmosphere. Nakhlites, a group of magmatic Martian meteorites, exhibit aqueous alteration products and evaporation assemblages, making them ideal for investigating such processes. Miller Range (MIL) 03346, a Nakhlite recovered from Antarctica, was previously analysed using bulk extraction [1] and stepwise heating [2] on whole-rock samples, yielding conflicting halogen concentration results.

To resolve these discrepancies, we analysed the halogen content of MIL 03346 through CO₂ laser stepwise heating and mineral separation (olivine and feldspar). Our bulk Cl (141 ppm), Br (233 ppb) and I (685 ppb) concentrations are relatively high and align more closely with those reported in [1]. Similar to [2], which also employed step-heating, the majority of iodine (85%) is released at low temperatures, while Cl and Br exhibit minor variations across heating steps.

Consequently, only the I/Cl ratio evolves significantly, decreasing from 5.5×10^{-2} to 2.9×10^{-4} in whole-rock sample, and from 8.0×10^{-3} to 1.3×10^{-5} in olivine separates. Previous studies suggest that surficial iodine contamination can occur in meteorites exposed on Antarctic ice sheets [3]. Stepwise heating effectively identifies such contamination, allowing exclusion of low-temperature steps in estimating the Martian halogen budget.

Our results indicate a halogen evolution pattern similar to [2] but with distinct initial and final I/Cl values. We propose that the lowest I/Cl ratio obtained in the final whole-rock heating step (2.9×10^{-4}) represents an upper limit for Martian magmatic component, prior to terrestrial and/or martian weathering and contamination.

[1] Dreibus et al. (2006) *37th Annual Lunar and Planetary Science Conference*, 1180

[2] Cartwright et al. (2013) *GCS 105*, 255-293

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