

HYDROGEN ISOTOPE SIGNATURES AND WATER ABUNDANCES IN NOMINALLY ANHYDROUS MINERALS FROM THE SHERGOTTITE Y-984028

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Introduction: Water and other volatiles play a significant role in partial melting in the source region of primary magmas. On Earth, water degassing at shallow depths is the main source of energy for volcanic eruptions. Nominally anhydrous minerals contain trace or minor amounts of water, and constitute the main water reservoir in the Earth's mantle and perhaps in the Martian interior. Water in nominally anhydrous minerals also has a profound effect on the rates of high-pressure phase transitions in planetary interiors. In this investigation, we report on volatile abundances and H isotope signatures of the nominally anhydrous minerals Y984028, an Antarctic lherzolitic shergottite.

Experimental: A small chip of Y984028 was mounted in indium metal to avoid contamination from epoxy, and polished with alumina to avoid contamination from carbon-based abrasives. The water abundances were measured with a Cameca 6F ion probe using standard SIMS techniques. Routine detection limits measured on synthetic forsterite are 2-4 ppm. Glass standards with appropriate water concentrations were used. SIMS operating conditions for H isotopic measurements were 15 kV Cs⁺ primary beam of ~ 2 nA, 5 kV secondary accelerating voltage, a 50 eV energy window, a mass resolution of ~ 400 and an electron flood gun for charge compensation.

Results: The δD values for both pyroxene and olivine are low by Martian meteorite standards, and some of them lie within the terrestrial δD range (-350 to +100‰). The lowest water content of olivine is 23 ppm and its δD is 262‰. The water abundances of pyroxene are 12 to 15 ppm and the δD values range from 403 to 522‰. Olivine and pyroxene with high water contents have higher contents of CO₂, F, and Cl, which possibly were introduced during aqueous alteration. Our measurements of water abundances in olivine and pyroxene from Y984028 are low compared to their terrestrial analogues.

Discussion: The low δD values of the nominally anhydrous minerals suggest that their parent magma was D depleted by vapor-melt equilibrium isotope fractionation during degassing prior to crystallization. A second possibility is that there was impact-driven devolatilization, especially if partial melting occurred. A third possibility is that water was depleted in the source region of the parent magma.