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EVIDENCE FOR A HETEROGENEOUS DISTRIBUTION OF WATER IN THE MARTIAN INTERIOR

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The abundance and distribution of H_2O within the terrestrial planets, as well as its timing of delivery, is a topic of vital importance for understanding the chemical and physical evolution of planets and their potential for hosting habitable environments. Analysis of planetary materials from Mars, the Moon, and the eucrite parent body (i.e., asteroid 4Vesta) have confirmed the presence of H_2O within their interiors. Moreover, H and N isotopic data from these planetary materials suggests H_2O was delivered to the inner solar system very early from a common source, similar in composition to the carbonaceous chondrites. Despite the ubiquity of H_2O in the inner Solar System, the only destination with any prospects for past or present habitable environments at this time, outside of the Earth, is Mars. Although the presence of H_2O within the martian interior has been confirmed, very little is known regarding its abundance and distribution within the martian interior and how the martian water inventory has changed over time. By combining new analyses of martian apatites within a large number of martian meteorite types with previously published volatile data and recently determined mineral-melt partition coefficients for apatite, we report new insights into the abundance and distribution of volatiles in the martian crust and mantle. Using the subset of samples that did not exhibit crustal contamination, we determined that the enriched shergottite mantle source has 36-73 ppm H_2O and the depleted shergottite mantle source has 14-23 ppm H_2O. This result is consistent with other observed geochemical differences between enriched and depleted shergottites and supports the idea that there are at least two geochemically distinct reservoirs in the martian mantle. We also estimated the H_2O content of the martian crust using the revised mantle H_2O abundances and known crust-mantle distributions of incompatible lithophile elements. We determined that the bulk martian crust has approximately 1400 ppm H_2O, which is likely distributed toward the martian surface. This crustal water abundance would equate to a global equivalent layer (GEL) of water at a depth of ~229 m, which can account for at least some of the surface features on Mars attributed to flowing water and may be sufficient to support the past presence of a shallow sea on Mars' surface.