The abundance and isotopic composition of water in howardite-eucrite-diogenite meteorites

Conference or Workshop Item

THE ABUNDANCE AND ISOTOPIC COMPOSITION OF WATER IN HOWARDITE-EUCRITE-DIOGENITE METEORITES.

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Introduction: Volatile elements play a fundamental role in planetary formation and evolution through their influence on melting, silicate melt viscosity, magma crystallization and eruption processes [1]. The Howardite-Eucrite-Diogenite (HED) suite of meteorites represents the largest suite of crustal rocks available from a differentiated basaltic asteroid and account for between 2-3% of all meteorites collected globally [2].

Apatite is a widely distributed mineral, albeit in trace amounts, in planetary materials which acts as a recorder of volatile abundances in magmas and magmatic source regions [3] and is the most common volatile-bearing phase in lunar rocks [4, 5] and eucrites [3]. We are currently undertaking a detailed study of apatite in HED meteorites using Secondary Ion Mass Spectrometry (SIMS) techniques to better constrain the volatile inventory and evolutionary history of their putative parent body, 4 Vesta [6, 7].

Methods: We used the Cameca NanoSIMS 50L at the Open University to measure OH abundances and D/H ratios in apatite grains from two Eucrites (DaG 945, DaG 844) using the protocol described in [8]. In total, 13 measurements were made on 10 different apatite grains. As the cosmic ray exposure (CRE) ages for these samples are unknown, the measured D/H ratios were corrected for spallation processes using a CRE age of 38 Ma - the oldest cluster of CRE ages for HED meteorites [9]. This correction had little effect on the final D/H ratio.

Results: Apatite H_2O abundances range from ~50 to ~222 ppm in DaG 945 and ~1080 to ~3446 ppm in DaG 844, with weighted average δD values of 17 ± 160 ‰ and -88 ± 72 ‰ (2σ), respectively.

Discussion: Our results are within error of and extend the range of data reported by [10]. DaG 945 contains less water and is believed to have undergone granulitic metamorphism and at least some partial melting [11], which could explain the low water contents measured in apatite in this sample. The average δD values of these two samples are also similar to the δD values of carbonaceous chondrites, the Earth and the Moon, and are consistent with a common source of water.

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