

**VOLATILE ABUNDANCES AND H ISOTOPE SIGNATURE OF MELT INCLUSIONS AND NOMINALLY ANHYDROUS MINERALS IN SHERGOTTITES;** N.Z. Boctor<sup>1</sup>, C.M.O.D'Alexander<sup>1</sup>,  
<sup>1</sup>Carnegie Institution of Washington, 5251 Broad Branch Rd., NW, Washington, DC 20015, USA.

**Introduction:** Volatile elements are of great geochemical importance because they influence a wide range of geological processes. Water and other volatiles play a significant role in partial melting processes. Water degassing at shallow depths is the main source of energy for volcanic eruptions. Nominally anhydrous minerals contain trace or minor amounts of OH and constitute the main H reservoir in the Earth's mantle and perhaps the Martian interior. Water in nominally anhydrous minerals has a profound effect on the rates of high-pressure phase transitions in planetary interiors. We studied the volatile abundances and H isotope signatures in nominally anhydrous minerals, glasses, and melt inclusions in the chassignites, nakhlites, and ALH 84001 [1, 2]. We are extending our investigation to the more challenging group of Martian meteorites, the shergottites [3], which unlike the nakhlites which are the least affected by impact metamorphism, show a wide range of shock effects from mild deformation to vitrification, shock melting, and high-pressure phase transitions [4].

**Experimental:** Small chips of Martian meteorites (EETA 79001, ALHA 77005, Shergotty, and Zagami) were mounted in indium metal to avoid contamination from epoxy and polished by alumina to avoid contamination from carbon-based abrasives.

The abundances of H<sub>2</sub>O, CO<sub>2</sub>, F, S, and Cl were measured with a Cameca 6F ion microprobe using the techniques described by [5]. A charge compensated Cs<sup>+</sup> primary beam was used, and the negatively charged secondary ions were collected. Routine detection limits measured by this method measured on synthetic forsterite were H<sub>2</sub>O 2-4 ppm, CO<sub>2</sub> <3 ppm, and F, Cl, and S <1 ppm. Glass standards with appropriate concentrations for all the analyzed volatile elements were used. SIMS operating conditions for H isotopic measurements were 15 Kv Cs<sup>+</sup> primary beam of 2nA, 5Kv secondary accelerating voltage, a 50eV energy window, a mass resolution of 400 and an electron flood gun for charge compensation.

**Results:** Water abundance in cpx varies from one meteorite to another and ranges between 7 and 66 ppm for ALH 77005, 26 and 204 for EETA 79001. Zagami cpx has a higher water abundance (454 to 714 ppm). Shergotty cpx was highly fractured and unsuitable for analyses. Although additional analysis of cpx in other shergottites are needed, water abundances in the analyzed shergottites are lower than those in cpx from terrestrial mantle derived pyroxenes, which range between 130 and 970 ppm and also lower than the most

primitive MORB (370 to 1220 ppm) [6]. Olivine in ALHA 77005 has water abundance of 14 to 205 ppm. The most hydrous naturally occurring mantle-derived olivine contains 240 ppm [7]. Water abundance in the melt inclusions in ALH 77005 ranges from 74 and 163 ppm, and  $\delta D$  for melt inclusions lies between +28 to +375‰. The  $\delta D$  for the host olivine ranges between -47 to 746‰ with most of the olivine showing an extraterrestrial H signature.

**Discussion.** The low volatile abundance in nominally anhydrous minerals relative to terrestrial analogs suggests that either their parent melts degassed or volatiles were depleted in the source regions of magma generation. Devolatilization by impact would also lead to loss of volatiles, especially if partial melting occurs [8, 9]. Vesiculation of the feldspathic glass in ALHA 77005 and EETA 79001 suggest that volatile loss has occurred.

Although some of the melt inclusions and nominally anhydrous minerals show an extraterrestrial hydrogen signature, they generally show a modest D enrichment by Martian meteorite standards. The majority of Martian nominally anhydrous minerals with the exception of those who interacted with a Martian water reservoir that equilibrated with the Martian atmosphere also have low  $\delta D$ . If this low D/H signature is a primary magmatic signature and not due to terrestrial contamination, then the parent magma was D depleted. The low D/H ratio of the parent magma may be attributed to degassing, which decreases the  $\delta D$  values of the melt as a result of vapor-melt equilibrium isotope fractionation.

In the majority of meteorites we studied, there is no significant correlation between  $\delta D$  and H<sub>2</sub>O. Given the low water contents, contamination and devolatilization by impact may be complicating the interpretation of the H isotope data.

**References:** [1] N.Z. Boctor et al. (2005) LPSC abstract, 1751. [2] N.Z. Boctor et al. (2006) LPSC abstract, 1412. [3] Boctor et al. (2007) LPSC abstract, 1801. [4] N.Z. Boctor et al. (2003) *Geochim. Cosmochim. Acta*, 67, 3971-3989. [5] E. Hauri et al. (2002) *Chem. Geol.*, 183, 99-114. [6] A.E. Saal et al. (2002) *Nature* 419, 451-455. [7] D.R. Bell and G. R. Rossman. (2003) *J. Geophys. Res.*, B1205. [8] J.A. Tyburczy et al. (1986) *Earth Planet. Sci. Lett.*, 201-207. [9] J.A. Tyburczy et al. (2001) *Earth Planet. Sci. Lett.*, 23-30.