Experimental partitioning of REE using a primitive Martian basalt composition

A. BLINOVA AND C.D.K. HERD

Dept. of Earth and Atmospheric Sciences, 1-26 ESB, University of Alberta, Edmonton, AB, T6G 2E3, Canada (blinova@ualberta.ca, herd@ualberta.ca)

Yamato 980459 (Y98) is an olivine shergottite (basalt). Its bulk composition has characteristics that make Y98 a unique sample of a highly reduced primitive magma in a sample suite of Martian meteorites (Misawa 2003; Mikouchi *et al.* 2004) and a prime candidate for investigating partitioning of rare-earth elements (REE) for the Martian mantle. We present the first results from the experimental determination of REE crystal/melt partitioning (D_{REE}) in olivine and orthopyroxene under conditions of basaltic melt generation in the Martian mantle (10-20 kbar and 1350-1650ºC) using Y98 composition. The results have implications for understanding the Martian mantle differentiation.

We have doped Y98 composition with oxides of La, Nd, Sm, Eu, Gd and Yb to cover the range of REE. Temperature/pressure experiments were conducted using the end-loaded Boyd-England type piston cylinder apparatus at the University of Alberta. LA-ICPMS was used for determination of REE concentrations in doped samples.

Present models of Martian Magma Ocean (MMO) crystallization and basalt generation utilize D values from previously published values that are largely based on one atmosphere experiments, and/or compilation of phenocryst-matrix studies, and/or theoretical studies (e.g. McKay 1986; McKenzie and O'Nions 1991). We present the first experimentally determined D_{REE} on the composition of the most primitive Martian meteorite at high pressure conditions similar to that of the Martian basaltic sources. In addition, we introduce the three-stage petrological model using D values from this study and involving Nakhlites as an intremediate stage to explain the variations in isotopic and trace element composition observed in shergottites (e.g. lower time-integrated $^{147}Sm/^{144}Nd$ ratios of mantle sources vs. higher measured ratios in the Martian basalts; Borg et al 1997, 2003).

This project is funded by the Alberta Ingenuity Masters Scholarship and Natural Sciences and Engineering Research Council (NSERC) Masters Scholarship to AB and NSERC Discovery Grant 261740-03 to CDKH.

Biogenic element reduction in fulgurites

K.M. BLOCK* AND M. PASEK

Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, USA (*correspondence: kblock@lpl.arizona.edu)

Fulgurites, glassy products of lightning as it travels through the ground, fusing soil, sand, or rock, can provide sources of reduced biogenic elements in the terrestrial environment ([1, 2] and others). Iron silicides and graphite formed by reduction of organic material in the soil have been observed in fulgurite glass [1]. We also report the first occurrence of the reduced phosphorus species phosphite in fulgurites. This is also the first reported occurrence of phosphite in a natural, terrestrial sample.

As the ground material is rapidly heated, resultant boiling produces voids and vesicles surrounding the path of the lightning through which volatiles may easily escape. Electrolysis may drive the loss of oxygen, and subsequent reduction, in the melt [1, 3]. If, during heating of formation, the system reaches a temperature at which the liquid cannot equilibrate with the vapor in a range where silicon metal is present, the Si metal may be retained and observed in the final cooled fulgurite. The range at which Si metal is present is heavily dependent on carbon content— the more carbon available to act as an oxygen scavenger, the greater the temperature range [2]. Atmospheric nitrogen has also been suggested as an oxygen scavenger due to the observation of NO_x molecule production from lightning strikes [4], however availability of N_2 gas in soil may not be sufficient to provide a significant source of oxygen acceptors.

Using the Cameca SX50 electron microprobe to obtain backscattered electron images and point analyses, we examine the presence and distribution of reduced phases in fulgurites resulting from lightning strikes in a variety of environments including beach sand, desert sand, clay, and rock. We will present the results of these analyses with respect to the processes of biogenic element reduction during fulgurite formation.

[1] Essene & Fisher (1986) *Science* **234,** 189-193. [2] Wasserman, Melosh, & Lauretta (2002) *LPSC* **XXXIII,** 1308. [3] Wasserman & Melosh (2001) *LPSC* **XXXII,** 2037. [4] Desch, Borucki, Russell & Bar-Nun (2002) *Reports on Progress in Physics* **65**, 955-997.