

LIGHT LITHOPHILE ABUNDANCES AND ISOTOPIC RATIOS IN SHERGOTTITES. R.C.F. Lentz¹, H.Y. McSween, Jr.¹ and M. Fayek², ¹Dept. of Earth and Planetary Sciences, Univ. of Tennessee, Knoxville, TN 37996; rrlentz@utk.edu, ²Analytical Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831.

Introduction: Light lithophile element abundances have previously been analyzed in the Martian shergottites with an aim towards establishing whether the basaltic parent magmas contained any water [1]. Measured depletions in B and Li between pyroxene cores and rims in both Shergotty and Zagami were interpreted as marking a loss of magmatic water between the time of core crystallization at depth and rim formation at the surface, post-eruption [1]. Here we present data that 1) verifies our previous results and 2) tests our original interpretation further using B isotopic analyses.

Boron isotopic ratios are affected by the presence of water because of a link between the coordination state of B and its phase state. B bound in silicate minerals is tetrahedrally coordinated, while in hydrous fluids, B favors the trigonal state, particularly under conditions of increased acidity. Furthermore, ¹¹B favors the trigonal state [2]. Therefore, when a melt is in contact with a hydrous fluid, B will preferentially move from the melt into the fluid [e.g. 3] and be isotopically fractionated in the process. The fluid becomes isotopically heavy while the melt becomes B-depleted and isotopically lighter. Thus, we propose to establish whether there is any shift in isotopic composition from the cores to rims of the shergottite pyroxenes which would be expected from water interaction.

Samples and Methods: To confirm our previous results, we acquired a different sample of Shergotty (UNM 409) to measure Li, Be, and B abundances in more pyroxene cores and rims. In addition, we analyzed a section of QUE 94201 (.46) for comparison of bulk abundances. QUE has been interpreted as the most mantle-like (or unenriched) martian meteorite in the collection, so we were curious to see what its lithophile abundance would suggest about the mantle source contents. All samples and standards were cleaned in a 1% mannitol solution before carbon coating to remove surface B contamination [1].

All measurements were performed on the Camecims 4f ion probe at Oak Ridge National Lab. Element abundances were measured using a 12.5V, 3 nA primary beam of O⁻ ions with a mass resolution of ~500. Preliminary B isotopic measurements were made with a 12.5 V, 15 nA O⁻ primary beam with a mass resolution of ~1500. Natural minerals and glasses were used for standards.

Results: Lithophile element abundances in the new Shergotty sample show the same behaviors as we found previously (Fig. 1). Core-rim pairs show increases in Be abundance, but decreases in B and Li abundances towards the rims. Amount of depletion varies between grains, but is typically 60-75% for B and 55-80% for Li. QUE 94201 displays quite different results for lithophile abundances (Fig. 2). What difference there is between cores and rims is essentially in the noise of the data. More striking, though, is the fact that the abundances of all three lithophile elements is substantially less than in Shergotty (Figs 1, 2).

Preliminary B isotopic analyses show that pyroxene rims are isotopically lighter than the cores by about 5 per mil. In addition, maskelynite is about 12 per mil lighter than the pyroxene rims. These results compare well to ¹¹B measurements reported by [4] for pyroxene and maskelynite in Shergotty and Zagami. We plan to conduct more analyses on this sample of Shergotty (UNM 409) as well as on our original Shergotty sample (USNM 321-2) to verify these trends.

Discussion: The depletion in B and Li concentrations in pyroxenes from the new section of Shergotty agree with previous results. In fact, some grains exhibit even greater depletions than we originally found, particularly in Li. The variability in the amount of depletion is most likely an artifact of analyzing closer or further from the true core of a grain, depending on where the thin section surface cuts the grain. But despite the variability, there is a substantial depletion in the soluble elements concurrent with magma evolution.

The preliminary isotopic measurements support our original hypothesis. A hydrous component gradually exsolved from the magma, incorporating ¹¹B and Li in the process, and becoming isotopically heavier than the melt. The melt then became increasingly depleted, but isotopically lighter, in B. Later growth of pyroxene rims and interstitial plagioclase reflect these changes in the source magma composition. Without a hydrous component involved, it would be difficult to explain such substantial fractionation of the B isotopes.

An interesting addition to the story comes from the low and homogeneous concentrations of Li, Be, and B in QUE 94201. Previous studies [e.g. 5-7] have shown that QUE and Shergotty define two ends of a mixing line for several characteristics (*f*O₂, \square Nd, initial Sr ratios, light REE and trace element abundances, etc.), with Shergotty's enrichment reflecting either an en-

riched mantle source or a component of crustal contamination. Our results suggest a relative abundance of the light lithophiles is another characteristic of the "enriched component". [5] suggested that the higher oxidation state of Shergotty and Zagami may be attributable to a hydrous component. Linking a hydrous component to the other enriched characteristics agrees well with our interpretations. The parent magma of QUE, then, was never enriched with light lithophiles nor this hydrous component, resulting in a relatively depleted and drier magma. Further insight might be gained on water in other Martian magmas by analysis of the light lithophiles in other shergottite meteorites.

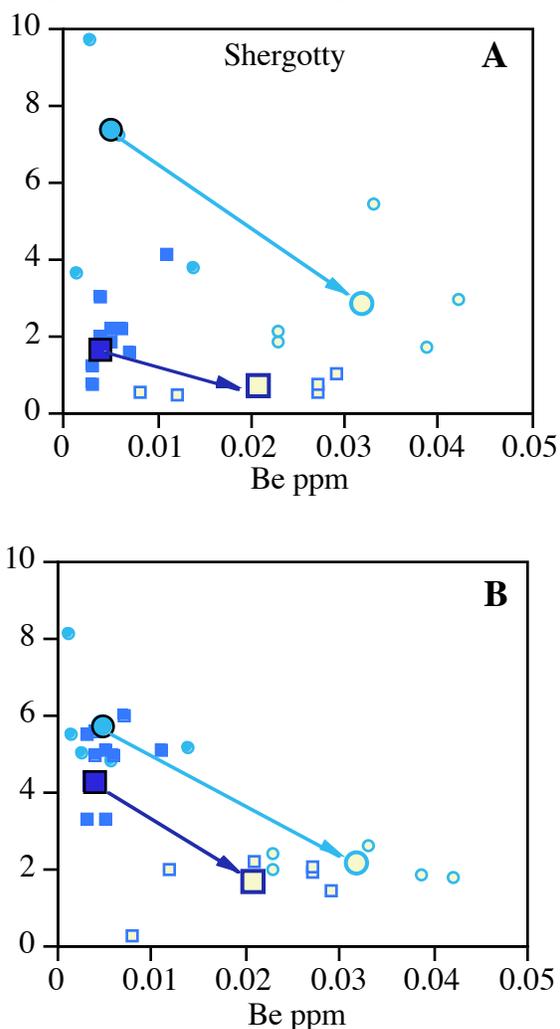


Figure 1: Light lithophiles in Shergotty. Graphs show beryllium vs. boron (A) and lithium (B) in pyroxene cores (solid symbols) and rims (open symbols) for our first study (circles) and the current analyses (squares). Note clear depletions in Li and B with concurrent increase in Be.

References: [1] Lentz R.C.F. et al. (2001) *GCA* 65, 4551-4565. [2] Benton L.D. et al. (2001) *EPSL*. 187, 273-282. [3] Hervig R.L. and Moore G. (2003) *Eos Trans. AGU* 84(46) *Fall suppl.*, Abst.# V51K-02. [4] Chaussidon M. and Robert F. (1999) *LPSC XXX* Abst. # 1592. [5] Borg L.E. (2002) *Unmixing the SNCs Workshop, LPI*, Abst. #6004 [6] Jones J.H. (1989) *Proc. 19th LPSC* 465-474. [7] Herd C.D.K. et al (2002) *GCA* 66, 2025-2036.

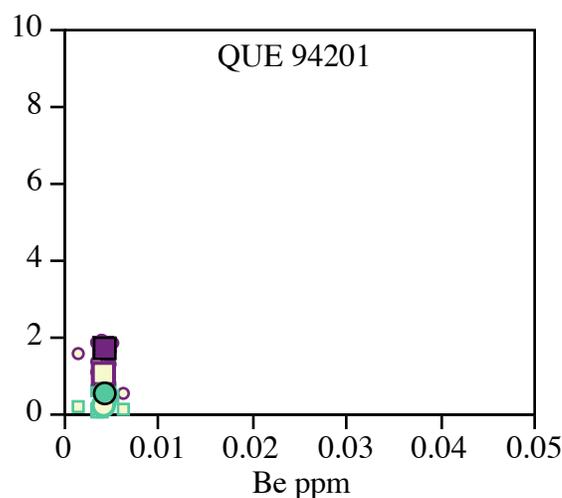


Figure 2: Light lithophiles in QUE 94201, the most primitive shergottite. Both B (circles) and Li (squares) show minimal depletions from cores (solid symbols) to rims (open symbols). Overall, all three elements have remarkably low abundances.