NEW INVESTIGATIONS OF LITHIUM ABUNDANCES IN SHERGOTTITE PYROXENES AND OLIVINES: POTENTIAL EVIDENCE FOR MARTIAN MAGMATIC WATER. A. Udry[1] and H. Y. McSween Jr.[1], [1]Planetary Geosciences Institute, Dept. of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996, USA.

Introduction: Recent studies have used soluble light lithophile element (LLE: Li, Be, B) and Li isotope zoning patterns in pyroxene and olivine as a means to trace degassing of water from shergottite parental magmas [e.g., 1-7]. Li, Be, and B are incompatible in olivine, pyroxene, and plagioclase during crystallization in dry systems [8]. Li and B are soluble in H_2O-rich fluids, whereas Be is insoluble. As a result, magmatic crystallization is predicted to cause core to rim LLE enrichment in these minerals. If magma degassing occurred during the formation of these martian meteorites, we expect to observe preferential depletion of soluble elements (i.e., Li and B) in the mineral rims and a LLE composition plateau in maskelynite indicating that no LLE diffusion occurred. LLE and Fe-Mg zoning are coupled as both are controlled by magma ascent. However, there is currently no consensus regarding degassing effects on LLE in martian meteorites and several authors have postulated that zoning of LLEs may instead be due to post-crystallization solid-state diffusion [e.g., 5-7].

Shergottites are characterized based on properties such as crystallization ages, magma source regions (which can be enriched or depleted), major and trace element compositions, and mineral modes. By targeting geochemically distinct shergottites, we attempt to determine the extent of degassing and initial magmatic water conditions in the different shergottite parental magmas. For example, if enriched shergottites show evidence for degassing and depleted shergottites do not, it would signify that the source of incompatible element enrichment (mantle or crust) contains more water than the depleted mantle source.

Samples used in this study: In this study, we selected three martian meteorites that span both the shergottite compositional range and age range. We also opted for shergottites that are only moderately shocked, and that have pyroxene and olivine grains that are adequately large (up to 2 mm) for SIMS analyses.

- Shergotty is a 165 ± 1 Ma enriched basaltic shergottite [9] with a water-rich parent magma prior to apparent degassing [10]. Pyroxenes in basaltic shergottites underwent two-stages of crystallization: the cores crystallized at depth, separated by a halt in nucleation, and followed by formation of Fe-rich rims during or after eruption. The multiple-stage pyroxene growth was thought to have been accompanied by magma devolatilization [1,2].

- QUE (Queen Alexandra Range) 94201 is a depleted basaltic shergottite that represents a liquid composition with an eruption age of 327 ± 10 Ma [11]. Similarly to Shergotty, it exhibited a high water content before degassing [10].

- LAR (Larkman Nunatak) 06319 is an enriched oxidized olivine-phyric shergottite with a crystallization age of 193 ± 20 Ma [12]. It is analogous to QUE in that it represents a near-primary melt composition with very limited crystal accumulation [13]. It consists of olivine megacrysts, groundmass pyroxenes and olivines, and maskelynite.

Methods: Li and Ti abundances were measured on a Cameca IMS-6f ion microprobe at Arizona State University (ASU). Ion microprobe analyses were conducted with a 3 nA O- beam with a spot diameter of 50 to 60 μm. The counts at the masses of interest, i.e., $^{7}Li^{+}$, $^{47}Ti^{+}$, and $^{30}Si^{+}$,were integrated for 2, 1, and 5 seconds, respectively, for each cycle and each measurement consisted of 50 cycles.

Results and Discussion: For the three meteorites, Li pyroxene abundances decrease from the core to the rim : from 5.9 to 1.3 ppm for Shergotty, from 1.6 to 0.5 ppm for QUE 94201, and from 4.1 to 0.7 ppm for LAR 06319 (Fig. 1). In addition, we compared Li to Ti due to the fact that both these elements have similar compatibilities in pyroxene and olivine. Li decreases with Ti increasing (Fig. 2). Notably, these element trends show the opposite direction of what would be predicted by typical magmatic chemical zoning. In order to investigate subsolidus diffusional processes, Li concentrations were measured in maskelynite located adjacent to the pyroxene and olivine grains, however no systematic variations were observed. Thus, we conclude that post-crystallization diffusion of Li probably did not take place and that water degassing occurred in the parental magmas of all three martian meteorites.

Additionally, cumulus olivines were measured in LAR 06319. They show increase in Li as Ti contents increase and Li enrichment from core to rim (from 1.4 to 8.5 ppm) indicating incompatible behavior during magmatic fractionation (Fig. 2b). Similar to basaltic shergottites, a multiple-stage growth history has been previously suggested for the olivine-phyric shergottites [14]: (1) formation of cumulus olivines; (2) a final magma entrainment of cumulus olivines, followed by the crystallization of groundmass olivine and pyroxene during magma ascent, and subsequent eruption. The cumulus olivines formed prior to magma ascent and hence, before degassing. This explains the normal fractionation trend of Li in olivines and so why degassing is not reflected (inverse Li trend) in this phase. According to these preliminary results, we suggest that Li abundance zoning in pyroxenes and olivine is a good proxy for magmatic water degassing and confirms conclusions from [1-3].

To better understand magmatic water degassing in shergottites, further analyses of Li, Be, and B abundances as well as Li isotopes are required. Future SIMS work is planned for these three shergottites and Tissint, a depleted olivine-phyric shergottite.

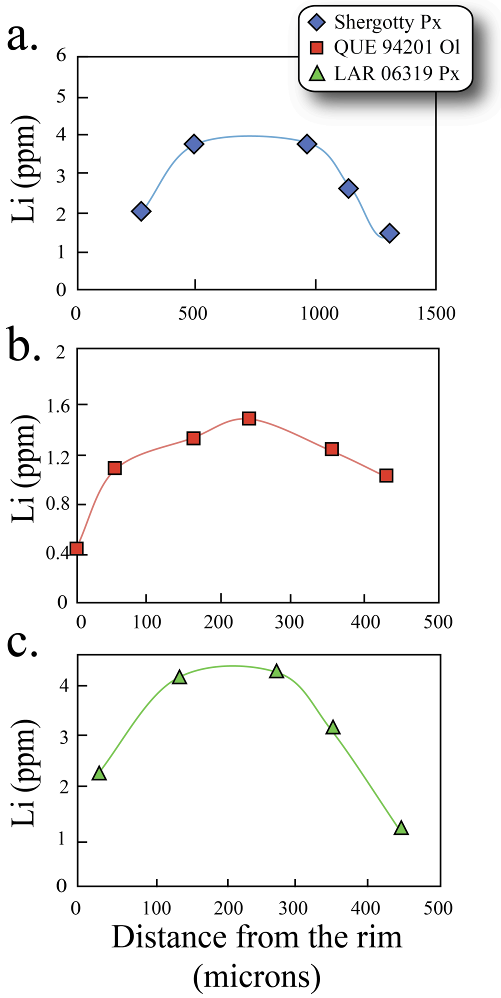

Fig. 2. Profile of Li abundances (ppm) as a function of distance from the rim in representative pyroxenes in a) Shergotty, b) QUE 94201, and c) LAR 06319.

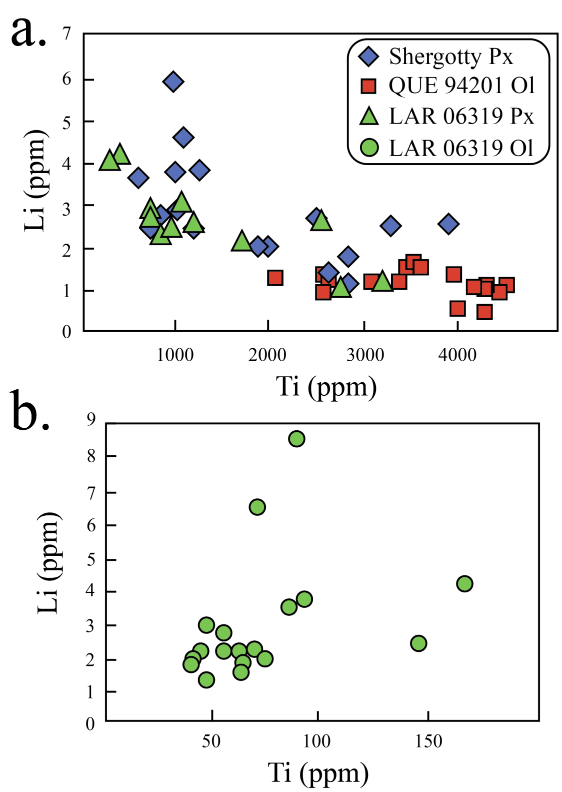

Fig. 1. Plot of Li abundances (ppm) vs Ti abundances (ppm) in a) pyroxenes of Shergotty, QUE 94201, and LAR 06319 and b) olivines of LAR 06319. High Ti content corresponds to rim compositions as Ti is a non-soluble incompatible element.

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