

**IN-SITU MINERAL TRACE-ELEMENT ANALYSIS OF DUAL-LITHOLOGY SHERGOTTITE EETA 79001.** Michael J. Mellin<sup>1</sup>, Lawrence A. Taylor<sup>1</sup>, Marc D. Norman<sup>2</sup>, Allan D. Patchen<sup>1</sup>, and Darren W. Schnare<sup>1</sup>. Planetary Geosciences Institute, Dept. of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37996, USA ([mmellin@utk.edu](mailto:mmellin@utk.edu)). <sup>2</sup>Australian National University, Canberra ACT 0200, Australia.

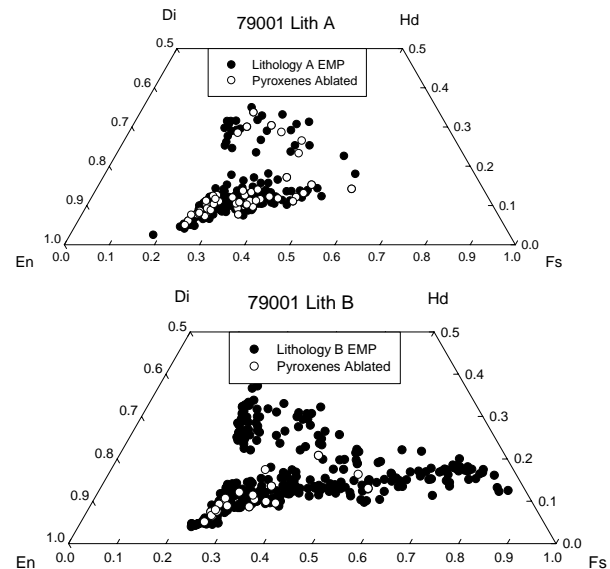
**Introduction:** ETTA79001 is a shergottite composed of two lithologies (termed A and B) that is separated by a linear and gradational contact [1]. Lithology A is an olivine phyric shergottite and lithology B is basaltic shergottite [2]. Despite the extensive studies on this meteorite, there is still general disagreement on the petrogenetic relationship of these two lithologies.

Some suggest the lithologies may be related by assimilation, partial melting, or fractionation from a similar parent magma [3,4]. Others suggest these lithologies cannot be related. For example, Wooden et al. [5] states that Rb-Sr isotopic systematics of shergottites (including EETA 79001) indicate these rocks cannot be derived from the same source. Also, mixing-model calculations by Mittlefehldt et al. [6] suggest lithology A may be an impact melt that incorporated lithology B as a clast.

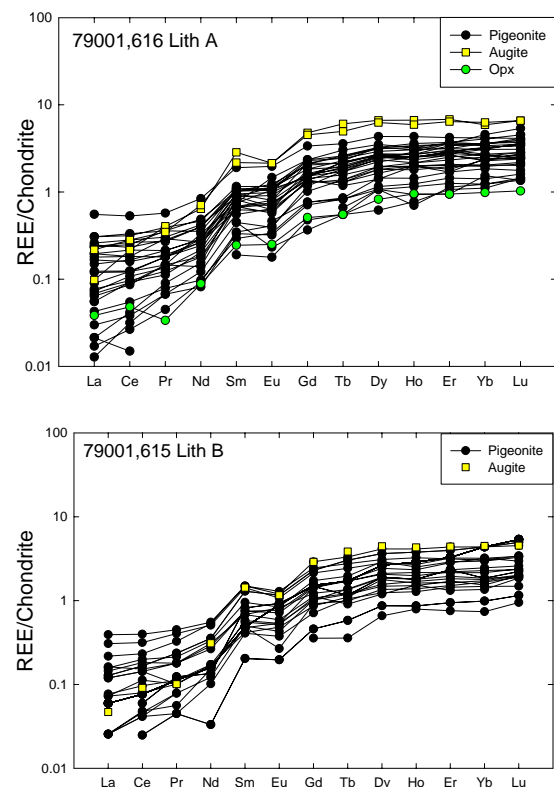
The objective of this study is to investigate the in-situ mineral trace element chemistry on minerals of both lithologies to determine their petrogenetic relationship, if any. New in-situ mineral chemistry for lithologies A and B is summarized in this report.

**Methods:** Polished thick sections 79001,616 and 79001,615 (lithologies A and B respectively) were used for this study. The in-situ mineral trace-element chemistry was obtained by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) at the Australian National University.

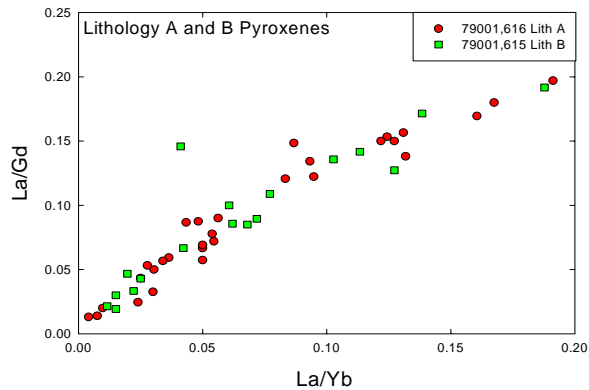
**Results:** Pyroxene major-element compositions (by Electron Microprobe (EMP)) are plotted in Figure 1, with the compositions of pyroxenes analyzed for their trace-element compositions by LA-ICP-MS (open circles). Ablated pyroxenes cover the range of pyroxene compositions in Lithology A. The Fe-rich pyroxenes in lithology B have not been analyzed by laser ablation due to their generally small size (< 24 microns, the minimum ablation spot size). The results of pyroxene REE analyses are shown in Figure 2. Both lithologies show sub-parallel REE patterns with light-REE depletions, typical of shergottites. All pyroxene analyses of both samples show slight Eu depletions. The pyroxene REE compositions for both lithologies are similar in abundance and pattern. La/Gd versus La/Yb show that the REE slopes for both lithologies are also similar (Figure 2).



**Figure 1.** Pyroxene Quadrilaterals



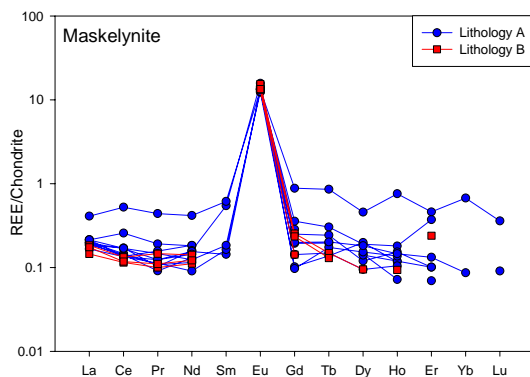
**Figure 2.** REE compositions of pyroxenes



**Figure 3.** Lithology A and B La/Gd versus La/Yb plot

Maskelynite REE compositions for both lithologies are shown in Figure 4. These patterns show typical +Eu anomalies. As expected from studies of REE behaviors [7], REE contents increase with decreasing An content of the maskelynite. Most trace-elements for olivines are below detection limits. Olivines, found only in lithology A, have trace-element correlations with V and Cr, consistent with melt evolution. Detectable trace elements found in olivines range between 251 – 2370 ppm Cr, 248 – 493 ppm Ni, and 6.45 - 11.1 ppm Sc.

Chromites show no detectable concentrations of REE. Instead, they contain detectable amounts of Sr (0.11 - 0.63 ppm), Zr (3.14 - 4.29 ppm), Y (0.07 - 0.09 ppm), Nb (3.31 to 4.14) and Ta (<0.16).

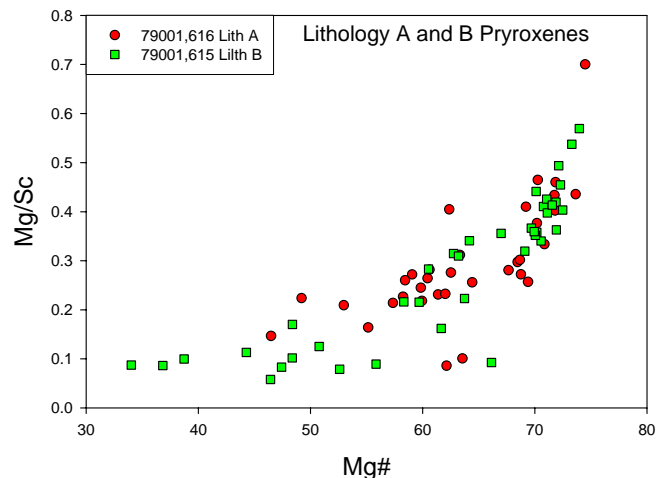


**Figure 4.** Maskelynite REE compositions for lithologies A and B.

#### Discussion:

Pyroxenes from both lithologies, of similar major-element compositions (for example  $Wo_{12}En_{60}$ ), have REE-compositions that, within error, are almost identical to each other. The pyroxene REE slopes and patterns for both lithologies are quite similar (Fig 2, 3), indicating a common source. These pyroxenes have undergone similar crystallization histories as

indicated by their identical trends on a plot of Mg/Sc vs Mg# (Fig. 5). Petrogenetic modeling, using partition coefficients and the REE-data from these pyroxenes, would indicate that, based on trace-element chemistry, the two lithologies have a common source origin. Lithology A is the more primitive of the two, containing olivine and chromite. Lithology B is then a later product in the melt-evolution sequence of these Martian Basalts.



**Figure 5.** Mg/Sc versus Mg# plot.

|            | D values* | Px (Lith A)** | Px (Lith B)** | Melt (Lith A)** | Melt (Lith B)** |
|------------|-----------|---------------|---------------|-----------------|-----------------|
| La         | 0.002     | 0.18          | 0.14          | 89.5            | 72.4            |
| Ce         | 0.004     | 0.18          | 0.18          | 45.6            | 45.6            |
| Nd         | 0.019     | 0.29          | 0.31          | 15.1            | 16.3            |
| Sm         | 0.031     | 0.67          | 0.68          | 21.5            | 21.9            |
| Eu         | 0.016     | 0.71          | 0.82          | 44.6            | 51.3            |
| Gd         | 0.043     | 7.71          | 6.61          | 179.4           | 153.8           |
| Yb         | 0.130     | 2.03          | 1.85          | 15.6            | 14.2            |
| Lu         | 0.130     | 2.18          | 1.93          | 16.8            | 14.9            |
| Wo Content |           | 11            | 10            |                 |                 |

\*from McKay et al (1986) [8]; \*\*values normalized to CI chondrite

**Conclusion:** The pyroxene mineral trace-element compositions of both lithologies A and B in the dual-lithology Shergotite EETA 79001 are identical, including similar patterns. Indeed, these data combined with the similarities in major-element chemistry of the minerals, strongly supports a distinct petrogenetic relationship between these two lithologies.

**References:** [1] Meyer C. (2003) *The Mars Meteorite Compendium*. JSC #27672, IX1-IX26; [2] Goodrich C.A. (2003) *GCA*, 67, No. 19, 3735–3771; [3] McSween H.Y. and Jarosewich E. (1983) *GCA* 47, No. 8, 1501-1513; [4] Wadhwa M., McSween H.Y., and Crozaz G. (1994) *GCA*, 58, 4213-4229; [5] Wooden et. al (1982) *PLPSC*. XIII, 879–880; [6] Mittlefehldt et al. (1997) *LPSC XXVII* Abstract #1739; [7] Jones J.H. (1995) *A handbook of physical constants*, American Geophysical Union, 74-104; [8] McKay G., Wagstaff, J. and Yang, S.R. (1986) *GCA* 50, 927-937