RARE EARTH ELEMENT GEOCHEMISTRY OF THE SHERGOTTITES LAR 12095, 12240 AND 12011.

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Introduction: The 2012 ANSMET expedition recovered 3 new olivine-phyric shergottites: LAR 12095, LAR 12240 and LAR 12011. Preliminary petrographic and geochemical investigations suggested that LAR 12095 is paired with LAR 12240, while LAR 12011 is paired with another previously recovered shergottite LAR 06319 ([1] and references therein). Here we report rare earth element (REE) abundances in individual minerals from each of the three meteorites to determine their petrogenesis, parent magma compositions and relationships to other shergottites.

Results and Discussion: REE were measured in phosphate, olivine, maskelynite, and pyroxenes of LAR 12095, 12240, and 12011 using the Cameca IMS-6f ion microprobe at Arizona State University. Olivines in all 3 samples have low REE abundances (with LREE present below the detection limit) and strongly LREE-depleted patterns. Maskelynites show REE patterns with large positive Eu anomalies typical of plagioclase. The phosphates are predominently merrillite and they dominate the whole rock REE budget. The low- and high-Ca pyroxenes in these 3 shergottites show a range in REE and other trace element abundances, with LREE-depleted patterns and negative Eu anomalies.

The REE abundances and patterns measured in various phases, along with trace element zonation patterns in the pyroxenes, confirm that 1) LAR 12095 and 12240 are paired with each other and are most similar to the depleted olivine-phyric shergottite DAG 476 [2], and 2) LAR 12011 is most likely paired with previously recovered, relatively LREE-enriched, olivine-phyric shergottite LAR 06319 [3,4].

Using a method similar to that utilized by [5], and the fO_2 versus D_{Eu}/D_{Sm} calibration determined for low-Ca pyroxenes by [6], we used the REE compositions of the low-Ca pyroxene cores to estimate the magmatic redox conditions of these shergottites. For these calculations we assume that the REE patterns of the LAR 12095/12240 and LAR 12011 parent melts are approximated by the whole rock REE patterns for DaG 476 and LAR 06319, respectively. These calculations show that LAR 12095/12240 has a magmatic fO_2 of ΔIW-0.5 (+0.6/-0.4), while LAR 12011 has a magmatic fO_2 of ΔIW+1.1 (+1.2/-0.9). As such, the paired shergottites LAR 12095 and 12240 have magmatic redox conditions close to (or slightly lower than) the IW buffer, while the magmatic redox state of LAR 12011 is more oxidized and similar to that of LAR 06319 [2]. This result suggests that the olivine-pyric shergottites originated from source reservoirs with different redox conditions on Mars.

References: [1] Balta J.B. et al. 2015. Abstract #2294. 46th LPSC. [2] Wadhwa M. et al. 2001. *Meteoritics & Planetary Science* 36:195-208. [3] Balta J. B. et al. 2013. *Meteoritics & Planetary Science* 48:1359–1382. [4] Basu Sarbadhikari A. et al. 2009. *Geochimica et Cosmochimica Acta* 73: 2190-2214. [5] Wadhwa M. 2001. *Science* 291:1527-1529. [6] McCanta M.C. et al. 2004. *Geochimica et Cosmochimica Acta* 68:1943-1952.