RARE-EARTH-ELEMENT ABUNDANCES OF CLASTS AND MATRIX IN THE LAMONT MESOSIDERITE: COMPLEX SPATIAL VARIATIONS.

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Boesenberg et al. [1] suggested that the silicate assemblage in the Lamont (3B) mesosiderite, including both large olivine and orthopyroxene clasts (broken megacrysts) and a mafic matrix, could represent a monotonic igneous fractionation sequence from a single source. A companion abstract [2] reports the results of a detailed study of the textures and major- and minor-element zoning patterns in pyroxene clasts from Lamont, which suggests that this picture may be oversimplified. In particular, FeO reduction in melts and chemical interactions between clasts and surrounding matrix melt were also important processes [2]. To obtain further constraints on the petrologic evolution of Lamont and its pyroxene clasts, we determined rare-earth-element (REE) abundances in the cores, rims, and overgrowths of 7 orthopyroxene (opx) clasts and in pyroxene and plagioclase (plag) grains from the matrix.

Matrix-- We analyzed two plag grains and one grain each of fine-grained (<100 µm) opx and pigeonite (pig) from the matrix (Fig. 1). The matrix opx and pig have unusually high and uniform REE abundances (~0.3-4 x CI-chondrites) with no Eu anomalies; plagioclase also has a relatively flat pattern (La/Yb_N ~2-5) and a large positive Eu anomaly (Fig. 1). Assuming plausible D-values [3-5], unrealistically high LREE abundances are calculated for the pyroxene source melts (e.g., La_N ~500-3000). This is much higher than for the plagioclase source melts (e.g., La_N ~6). In contrast, HREE abundances for the parental melts for matrix plag and pyroxene overlap, albeit over a large range (e.g., Yb_N ~6-30). These results suggest that *the REE (especially LREE) abundances for matrix pyroxenes do not reflect equilibrium mineral/melt partitioning.*

Clast P– This small opx clast has a complex major-element zoning pattern, featuring a core region (200 µm across; $Wo_{3.5}En_{65.7}$) surrounded by a more magnesian ($Wo_{3.4}En_{72.5}$) inner rim (50 µm wide), followed by a return to a more ferrous ($Wo_{4.5}En_{68.2}$) outer rim (<10 µm). The magnesian rim probably formed by the interaction of the clast with a surrounding melt that was relatively aluminous and reduced [2]. REE abundances of the core and magnesian rim are nearly identical (Fig. 2). *Most likely, the magnesian rim of clast P did not experience REE exchange with the surrounding melt, despite an apparent Al-Fe-Mg exchange.*

Clast O– This clast also has a complex major-element zoning pattern that probably reflects interaction between the clast and a surrounding, relatively FeO-poor melt [2]. The core (400-800 µm across; $Wo_{1.8}En_{70.2}$) is surrounded by a magnesian inner rim (60 µm wide; $Wo_{1.6}En_{75.4}$), followed by a thin (<20 µm), more ferrous outer rim ($Wo_{3.7}En_{68.7}$). REE data for the clast (Fig. 3) reveal unusually low abundances of the HREE relative to Sm in the core, and a more HREE-enriched pattern for the magnesian rim similar to that of the rim and core of clast P (Fig. 2). Most likely, *the rim of clast O experienced REE-equilibration with the matrix melt, whereas the core was unaffected. Moreover, the different HREE abundances in the cores of clasts O and P (Fig. 2,3) suggest that they were derived from different source regions.*

Clast H1-- Clast H1 contains a 500 x 700 µm-diameter opx core (average $Wo_{1.0}En_{78.9}$) surrounded by a wide (up to 200 µm) overgrowth containing both opx ($Wo_{3.2}En_{63.5}$) and pig ($Wo_{8.1}En_{58.4}$). The overgrowth probably crystallized from a melt that was more chemically evolved and had lower FeO/MnO than the core [2]. Opx in the core and an opx-pig intergrowth in one portion of the overgrowth have relatively flat and high REE abundances, with no Eu anomalies evident (Fig. 4). Opx in another portion of the overgrowth has a completely different LREE-depleted pattern with a negative Eu anomaly (Fig. 4). *The data for clast H1 demonstrate that locally extreme variations in REE abundances can occur over a small scale.* The flat REE patterns for portions of H1 resemble matrix opx and pig

(Fig. 1), and, like them, probably do not reflect equilibrium igneous partitioning. The LREE-depleted pattern obtained for one portion of H1 is similar to the LREE-depleted patterns of clasts P and O (Fig. 2,3), and probably was produced by igneous crystallization from the matrix melt.

Discussion– The REE signatures for pyroxenes from Lamont fall into two overall types. Type 1 is characterized by LREE-depleted patterns ($\mathrm{La/Yb}_N$ ~.01-.17) and by absolute REE abundances roughly similar to that in opx from diogenites [6,7]. This type of signature was found in opx from most clast cores and locally within rims and overgrowths. *Type 1 signatures may reasonably be interpreted in terms of igneous partitioning. Their inferred source melts are LREE-enriched ($\mathrm{La/Yb}_N$ ~ 1-20), and are totally unlike the parent melts inferred previously for most large basalt and gabbro clasts in mesosiderites* [e.g., 8,9]. For Type 1 signatures, there is no correlation between Mg# and REE abundances, suggesting that processes other than igneous fractionation alone (such as FeO-reduction) were important.

Compared to Type 1, Type 2 REE signatures are characterized by flatter REE patterns and higher REE abundances. This type of signature was found in the matrix, locally within clast rims and overgrowths, and in the core of one opx clast. It probably does not reflect equilibrium pyroxene/melt partitioning, as unrealistically high REE abundances and LREE-enrichments would be required for the melts. Instead, *Type 2 signatures may indicate the presence of undetected, REE-enriched inclusions in the analyzed volumes (trapped melt?), high-temperature disequilibrium, metamorphic re-equilibration, or cryptic alteration.*

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