

PETROGENESIS OF THE LAMONT MESOSIDERITE: EVIDENCE FROM PETROGRAPHY AND PYROXENE CLAST ZONING SYSTEMATICS.

Alex Ruzicka¹, Joseph S. Boesenberg², Gregory A. Snyder¹, Martin Prinz², and Lawrence A. Taylor¹. ¹Planetary Geosciences Institute, Dept. Geological Sciences, University of Tennessee, Knoxville, TN, 37996. ²Dept. Earth and Planetary Sciences, American Museum of Natural History, New York, NY, 10024.

The Lamont (3B) mesosiderite is notable for containing relatively abundant large (cm-sized) olivine (Fo₉₃₋₆₆) and orthopyroxene (Wo₁₋₅En₈₃₋₅₃) clasts (broken megacrysts) in a mafic, possibly igneous matrix [1]. Boesenberg et al. [1] suggested that the silicate assemblage of Lamont could represent a single fractional crystallization sequence. We have studied in more detail the zoning patterns of a group of representative, relatively small (≤ 4 -mm-diameter) orthopyroxene (opx) clasts to further elucidate how these clasts and Lamont may have formed. This abstract reports petrographic and EMP data; a companion abstract [2] discusses trace-element (REE) SIMS data for the same sample (AMNH 4914-1). We define *rims* on opx clasts as marginal areas of the clasts that are chemically but not crystallographically distinct from the clast cores, and *overgrowths* as crystallographically distinct marginal zones. Data are summarized in Table 1.

Matrix-- The matrix in Lamont consists chiefly of FeNi-metal and plagioclase (An₈₉₋₉₆) that encloses low-Ca pyroxene (Wo₁₋₁₁En₈₁₋₅₃) [1]. Observations with backscattered electrons (BSE) show that the smallest (<100 μ m) opx and pigeonite (pig) grains have subhedral margins; a few euhedral opx grains were also observed. These textures, and evidence from pyroxene zoning of the clasts (see below), support the suggestion [1] that *the matrix of Lamont is primarily igneous*, and are consistent with the conclusion of Hewins [3] that the matrix of Type 3B mesosiderites such as Lamont were melted.

Normally-zoned clasts H, L, N- These opx clasts (0.4-4 mm across) have chemically uniform cores, and opx rims that have (1) higher Wo, Al₂O₃ and TiO₂, (2) lower Mg#, and (3) relatively constant Fe/Mn, compared to the clast cores (Table 1). These trends are consistent with normal igneous fractionation. *Clasts H, L, and N either experienced chemical exchange with more*

Table 1. Zoning data for selected orthopyroxene clasts in Lamont (AMNH 4914-1). All analyses are for opx, except for pigeonite (pig), which occurs in clast rims and overgrowths. Ovg. = overgrowth; in. = inner; ou. = outer.

Clast	Mg# (at)	Wo, En (mol%)	Al ₂ O ₃ (wt%)	TiO ₂ (wt%)	Fe/Mn (wt)
J1 core	0.67	3.1, 65.3	0.81	0.12	27.3
J1 rim in.	0.76	2.9, 74.2	1.35	0.09	25.0
J1 pig	0.62	10.1, 55.4	0.89	0.28	25.1
P core	0.68	3.5, 65.7	0.50	0.11	27.3
P rim in.	0.75	3.4, 72.5	1.78	0.10	25.8
P rim ou.	0.71	4.5, 68.2	1.51	0.15	28.6
O core	0.72	1.8, 70.2	0.38	0.08	29.3
O rim in.	0.77	1.6, 75.4	0.45	<0.03	25.9
O rim ou.	0.71	3.7, 68.7	1.39	0.15	25.4
H core	0.76	1.6, 75.0	0.39	0.06	32.5
H rim/ ovrg.	0.62	2.3, 60.8	1.00	0.21	31.6
H pig	0.63	7.8, 57.9	0.70	0.19	27.7
L core	0.76	1.8, 74.6	0.48	0.05	30.2
L rim	0.62	3.4, 60.0	1.26	0.32	30.7
K*	0.77	1.6, 75.9	0.59	0.08	31.3
H1 core	0.80	2.0, 78.9	0.47	0.04	32.3
H1 ovrg.	0.66	3.2, 63.5	0.82	0.24	27.9
H1 pig	0.64	8.1, 58.4	0.98	0.22	24.5
N core	0.82	1.5, 80.6	0.39	0.06	27
N rim	0.67	4.4, 63.7	1.07	0.21	27
N pig	0.65	7.1, 60.5	1.25	0.17	26

* various opx clasts within clast-laden melt rock K.

evolved melt-matrix or, less likely, retain primary igneous zoning.

Normally-zoned clast H1— This opx clast (500-700 μ m)

LAMONT MESOSIDERITE: A. Ruzicka et al.

across) has a well-formed overgrowth that contains opx and pig. As with clasts H, L, and N, opx and pig in the overgrowth have lower Mg# and higher Wo, Al₂O₃, and TiO₂ abundances than the core, consistent with the crystallization of the overgrowth from a melt more chemically evolved than that which produced the core. Unlike the previous clasts, Fe/Mn is lower in opx (and pig) from the overgrowth than in the core, suggesting that *the overgrowth on H1 may have crystallized from a relatively reduced (low FeO/MnO) melt*. Also unlike other pyroxene clasts, H1 contains diffuse ferrous zones that extend from the overgrowth and cross-cut the core of the object. These probably represent zones of chemical exchange between the core and overgrowth.

Complexly-zoned clasts P, O, J1 – These opx clasts (200-800 μm across) have chemically uniform cores that are surrounded by a discontinuous inner, relatively magnesian opx rim and an outer, less magnesian rim of opx or pig. The inner, magnesian rims have higher Mg# and lower Fe/Mn than the cores, which suggests they were produced by FeO reduction of the clast cores as they interacted with their environment. The outer rims have the highest Al₂O₃, TiO₂, and Wo contents, which is consistent with their having equilibrated with a more evolved melt composition. *Clasts P, O, and J1 probably reacted with relatively evolved matrix melt that was undergoing FeO reduction. Their complex zoning patterns could have been produced by an interplay between reduction and igneous fractionation in the melt-matrix.*

Melt-rock clast K– The largest clast (>1.5 cm across) in 4914-1 is an orthopyroxene-rich, non-porous microbreccia that has a well-defined contact with the host. Clast K is composed almost entirely of opx mineral clasts (<400 μm across) that contain, and are surrounded by, numerous tiny (<10 μm) troilite inclusions. Troilite veinlets locally cross-cut the opx clasts. Orthopyroxene is chemically uniform throughout the object and shows no significant chemical zonation at the contact with the host. The clast also lacks the coarse metal of the host. Clast K is interpreted to be a clast-laden melt-rock that formed by brecciation and impact-melting of an orthopyroxenite precursor. Troilite was mobilized during

the formation of the clast. The sharp margins of the clast, the lack of zoning near the clast margin, and the absence of coarse metal suggest that *clast K was agglomerated in Lamont at a relatively late stage, after metal-silicate mixing had occurred and the melt-matrix had formed.*

Implications– Our data suggest that the chemical evolution of pyroxene clasts in Lamont was more complex than suggested by Boesenberg et al. [1]. Although igneous fractionation was important, FeO reduction also affected the rim and overgrowth compositions. Moreover, even the core compositions of the clasts, which are relatively uniform and do not appear to have significantly interacted with the matrix, lack the chemical trends expected for simple monotonic fractionation. In Table 1, the data are arranged in order of increasing Mg# in the cores of the clasts. For fractional crystallization, one would expect an anti-correlation between Mg# and the abundance of incompatible minor elements such as Ti or the abundance of Wo or Al₂O₃, but this is not observed (Table 1). This suggests that *the pyroxene clasts were not derived from a single system undergoing fractional crystallization alone*. However, Al and Ti contents in the cores are correlated with one another (e.g., they are lowest in clasts O, H, and N, and highest in clast J1; Table 1), as would be expected if both elements behaved as incompatible elements during magmatic fractionation. Conceivably, the clast cores were also affected by FeO reduction, analogous to that experienced at the margins of some clasts, explaining why Mg# is uncorrelated with other chemical parameters. *Thus, the orthopyroxene clasts in Lamont may have sampled igneous systems that experienced similar magmatic fractionation but variable degrees of FeO reduction. Such reduction would have had to occur prior to the reduction event that affected clast margins, and hence, prior to the brecciation that formed the clasts.*

References: [1] Boesenberg J.S. et al. (1997) LPSC XXVII, 125-126. [2] Ruzicka A. et al., This Vol. [3] Hewins R.H. (1984) PLPSC 15, C289-C297.