NAKHLITE AND CHASSIGNITE PARENTAL MELT COMPOSITIONS COMPARED.

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Introduction: With 29 samples sharing overlapping crystallization (1340 ± 40 Ma) and ejection (11 ± 1.5 Ma) ages, the nakhlite and chassignite meteorites comprise the largest single origin suite of igneous rocks from Mars [1]. Nakhlites and chassignites originate from a single mantle source [1,2]. However, the spatial and magmatic relationships between the two types of samples are weakly constrained. Here we investigate the parental melt compositions of nakhlites and chassignites by analyzing major, minor, and trace element abundances present in melt inclusions found in cumular olivine (nakhlites, chassignites) and pyroxene (nakhlite) for nakhlites Northwest Africa (NWA) 10645, Caleta el Cobre (CeC) 022, Governador Valadares, Miller Range (MIL) 090032, MIL 090030, and chassignites Chassigny and NWA 2737. Systematic comparison of the parental trapped liquids (PTLs) calculated from melt inclusions found in these meteorites has the potential to nakhlite-chassignite petrogenetic relationships.

Methods: We used an electron probe microanalyzer (EPMA) using methods described in [3] to analyze the major and minor element abundances in melt-inclusion hosted phases. Backscattered electron images were used to mode-normalize melt inclusion compositions with *ImageJ* software. To correct for post-crystallization homogenization in olivine-hosted melt inclusions, we used PETROLOG3 [4], and Rhyolite-MELTS [5] for pyroxene-hosted inclusions in nakhlites. Fractional crystallization modeling was conducted using Rhyolite-MELTS for the corrected PTLs [5]. Trace element abundances were obtained with a laser ablation inductively coupled mass spectrometer (LA-ICP-MS) using methods similar to [6].

Results: Melt inclusions in nakhlites contain phase assemblages that range from polycrystalline (pyroxene, glass, oxides) to primarily holohyaline. Melt inclusions in chassignites are mineralogically complex, containing glass, low-Ca pyroxene, high-Ca pyroxene, amphibole, apatite, and oxides.

Nakhlite and chassignite PTL compositions overlap one another in Al_2O_3, but chassignite-hosted PTLs are more primitive (Fig. 1). Fractionation models of chassignite PTLs do not replicate nakhlite mineralogy. Melt inclusion rare earth element (REE) compositions in the nakhlites and chassignites are typically parallel to the bulk host rock, with some exceptions. Ratios of La/Lu_{CI} in some samples vary widely (Fig. 2), and thus melt inclusions likely retain heterogeneities imparted from the parent melt or during crystallization. Ratios of Zr/Y and Nb/Y behave similarly to La/Lu_{CI}, with most PTL values falling close to the bulk rock, with a spread in values seen in sample NWA 10645 (Zr/Y = 1.02–3.66, Nb/Y = 0.02–1.29).

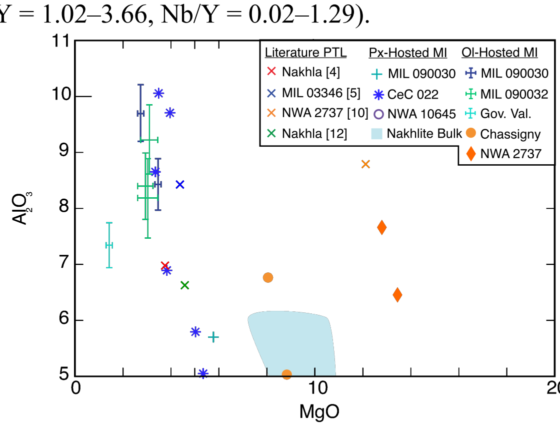

Fig. 1: MgO versus Al_2O_3 diagram for calculated PTL compositions in nakhlite and chassignite melt inclusions.

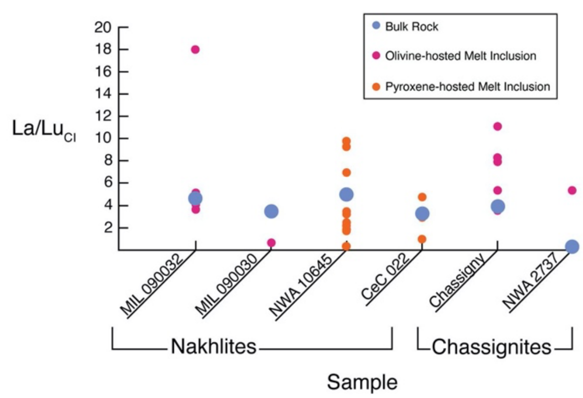

Fig. 2: Nakhlite and chassignite melt inclusion and bulk La/Lu normalized to CI chondritic values [6].

Discussion: The range in PTL compositions between nahlite and chassignite cumulus phases imply that they arise from different parental melts. Parallel REE compositions between melt inclusions and bulk rock imply a single source for all samples and a closed-crystallization sytem. Documented heterogeneity in a single-origin igneous suite indicates that it may arise from multiple generations of magma in a single volcanic complex.

References: [1] Udry, A., and Day, J. M. D. (2018) *GCA*, 238, 292-315. [2] McCubbin, F., et al. (2013) *MAPS*, 48, 819-853. [3] Sonzogni, Y. and Treiman, A. (2015) *MAPS*, 50, 1880-1895. [4] Danyushevsky, L. V. and Plechov, P. (2011) *Geochem Geophys Geosys*, 12, No. 7. [5] Gualda, G.A.R., et al. (2012) *Journal of Petrology*, 53, 875-890. [6] Basu Sarbadhikari, A. B., et al. (2011) *GCA*, 75, 6803-6820. [7] McDonough and Sun (1995) *Chemical Geology*, 120, 223-253.