TRACE ELEMENT ANALYSIS OF OLIVINE AND PYROXENE-HOSTED MELT INCLUSIONS IN THE NORTHWEST AFRICA 13669 NAKHLITE.

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Introduction: Nakhlites make up ~8% of the total number of martian meteorites and are clinopyroxene-rich cumulate-like rocks from Mars linked by shared crystallization ages (1340 ± 40 Ma) and cosmic ray exposure ages (11 ± 1.5 Ma) [1–2]. Given their shared ages and similar textures and mineralogy, the nakhlites are the largest coherent suite of igneous rocks from a common provenance on any planetary body besides the Moon and Earth [2]. As such, nakhlites are important for understanding relatively recent magmatic and volcanic processes on Mars, as well as the evolution of martian volcanic plumbing systems.

One method of interrogating the relationship between cumulate rocks is studying parental melt compositions using melt inclusions (MI), or small pockets of melt entrapped while a crystal is growing [e.g., 3]. Here we present trace element compositions derived from olivine and pyroxene-hosted MI to assess the petrogenesis of Northwest Africa (NWA) 13669, a recently found nakhlite, and its relation to other nakhlites.

Methods: Trace element analyses were conducted *in situ* on one olivine-hosted and four pyroxene-hosted MI using a NWR 193 nm laser ablation system coupled to an iCAP Qc quadrupole ICP-MS at UNLV. A spot size of 50 µm was used to measure the bulk composition of all MI phases, and the laser was operated at 15 Hz with a photon fluence of ~3 J/s maintained throughout the analyses. Standardization was done using the NIST 610 and BHVO-2 glass and LA-ICP-MS data was reduced using *iolite 4* [4]. All analyses were corrected for host phase contributions.

Results: Trace element abundances in MI are more enriched (>10 × CI) in rare earth elements (REE) than the whole rock but broadly parallel the whole rock REE pattern of NWA 13669 and the whole rock REE patterns of other nakhlites (Fig. 1a). Northwest Africa 13669 MI exhibit a notable light REE enrichment [(La/Lu)CI = 3.7–7.6] and pyroxene-hosted inclusions have varying degrees of REE enrichment (Fig. 1a). Trace elements in the one olivine-hosted melt inclusion measured are often below detection limits, likely due to dilution from the olivine host during ablation.

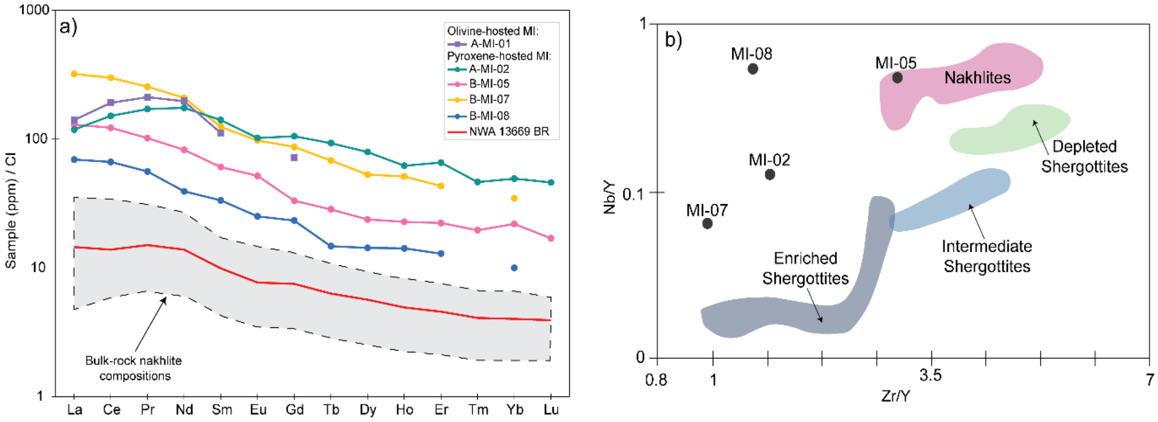

Figure 1. a) CI-normalized [8] REE abundances in NWA 13669 MI and NWA 13669 whole rock. Grey envelope indicates bulk nakhlite compositions [2]. b) Zr/Y and Nb/Y diagram with NWA 13669 MI data with bulk nakhlites and shergottites ranges (envelopes). Adapted from [9].

Discussion: Whole rock [5] and MI trace element compositions suggest NWA 13669 sampled a single depleted mantle source common to all nakhlites. Ratios of trace elements (e.g., Zr/Y, Nb/Y) are variable between different MI (Fig. 1b). Scatter has also been observed in a previous nakhlite study [6] and likely indicates post-entrapment processes, such as re-equilibration between the host phase and MI. Re-equilibration, when combined with multiple parental melt compositions across the nakhlite suite, suggests magma generation was long-lived and the cumulus nakhlite phases underwent magma storage [6]. Trace element scatter also indicates the parental melt responsible for NWA 13669 likely underwent storage/ponding before entrainment and emplacement, likely within a crystal mush. Magma storage within a crystal mush would have allowed diffusive re-equilibration to occur between MI and their host phases, consistent with the current understanding of terrestrial magma chamber dynamics [e.g., 7]. Re-equilibration in a crystal mush can also account for the homogeneity of NWA 13669 pyroxene and olivine compositions [5].

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