MAGMA EVOLUTION OF POIKILITIC SHERGOTTITE NORTHWEST AFRICA 7397 FROM ITS OLIVINE-HOSTED MELT INCLUSIONS. J. Ferdous[1], A.D. Brandon[1] and A.H. Peslier[2]. [1]University of Houston, Houston TX 77204, USA, jferdous@uh.edu, [2]Jacobs, NASA-Johnson Space Center, Mail Code X13, Houston TX 77058, USA.

Introduction: The compositional analyses of olivine-hosted melt inclusions (MI) is one potential monitor of the processes that have affected the evolution of shergottite magmas as they migrate towards the surface. However, trapped magma can differentiate during host mineral crystallization by slow cooling and can re-equilibrate with the host mineral after entrapment. To overcome these complications, correction for post-entrapment re-equilibration and assessment of equilibrium with the earliest crystallized phases is necessary. Several studies have adopted the procedure to determine source magmas for MIs and their progressive differentiation [1, 2, 3 and references therein].

In this study, the olivine-hosted MIs of Northwest Africa (NWA) 7397 are examined. This stone is a permafic shergottite. It is one of the three known incompatible trace element enriched poikilitic shergottites along with Robert Massif (RBT) 04261/04262 and Grove Mountain (GRV) 020090 [4]. As with the other poikilitic shergottites, NWA 7397 is comprised of 2 lithologies. The first lithology is poikilitic and consists of pyroxene, olivine and chromite. The second lithology is non-poikilitic and consists of olivine, Ca-poor and Ca-rich pyroxenes, maskelynite with minor spinel, phosphate, sulfide and Fe-oxide. The mineral modal distribution is 50:30:10:8:2 for olivine, Ca-poor pyroxene, Ca-rich pyroxene, maskelynite and minor phases, respectively. Detailed petrography of NWA 7397 is described in [4].

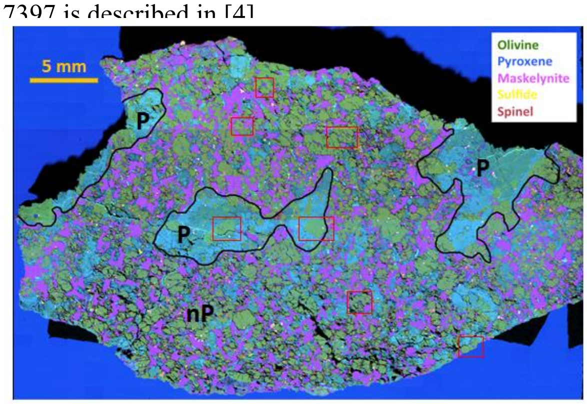

Figure 1: EDX-image of thick section of NWA 7397, showing the MI locations highlighted in the red outlined areas. P= poikilitic region, nP= non-poikilitic region.

Analytical Techniques: A 4 cm x 2 cm thick section of NWA 7397 was studied by EDX- elemental maps and back-scattered electron (BSE) images to find the MIs using a JEOL-SEM 7600F at NASA-JSC. Seven potential MIs were selected of which 2 MI are from the poikilitic lithology and 5 are from non-poikilitic lithology (Fig. 1). Major and minor oxide compositions of host olivines and MIs were analyzed using a Cameca SX-100 electron microprobe at NASA-JSC. The modal composition (in wt.%) for each MI was calculated from measured composition and estimated area proportion by ImageJ software. The compositions were then corrected for post-entrapment Fe-Mg re-equilibration using the PETROLOG3 software [5].

Results: Olivines of the poikilitic and non-poikilitic lithologies contain rounded to subrounded MIs. Melt inclusions of poikilitic olivine are smaller (60-126 µm in dia.) than those of non-poikilitic olivine (170-275 µm). The host olivines are compositionally homogeneous and no zonation is observed. Forsterite contents (Fo) of MI-hosted olivine is Fo_{62-63} in the poikilitic lithology and Fo_{58-60} in the non-poikilitic lithology. Daughter phases of the poikilitic MI are Ca-poor (<10%) and Ca-rich (>10%) pyroxenes and of the non-poikilitic MI are Ca-poor and Ca-rich pyroxenes with compositionally variable glass (Ca-rich, Ca-poor, Si-rich). Molar Mg# [Mg# = 100 x molar Mg/(Mg+Fe)] of poikilitic MI pyroxene range is 66-69 whereas Mg# of non-poikilitic MI pyroxene range is 53-68. These values of Mg# are lower than their respective primary pyroxene Mg#s of both poikilitic and non-poikilitic regions of 72-74 and 67-74. The contents of Al_2O_3 and TiO_2 of MI pyroxenes are 3-10% and 0.4-2.5%, respectively. These values are higher than the primary pyroxenes of 0.5-1.6% and 0.1-0.3%, respectively [4]. These relationships between MI and primary pyroxene compositions are similar to those found in LAR 06319 [2]. Molar Mg# of non-poikilitic MI-glass ranges from 15 to 46, and does not have any gradational pattern. A wide range of Na_2O content from 0.87-6.62% is present in the MI-glass, consistent with the observed ranges in Na_2O glass content in the olivine-phyric shergottites LAR 06319, SaU 005, EETA 79001 [1,2]. This variation is interpreted as resulting from shock causing late stage volatile loss [1,2].

Discussion: The calculated present bulk composition (PBC) was obtained for each MI, where Mg# of poikilitic MI is ~68 and of non-poikilitic MI range is 13-54. Melt inclusion data of RBT 04262 [6] were also considered for comparison where compositions were calculated following the similar procedure as NWA 7397. Molar Mg# of calculated PBC are plotted against SiO_2, Al_2O_3 and CaO, respectively, for both of these enriched poikilitic shergottites (Figs. 2a-c). The PBCs show increasing SiO_2, Al_2O_3 and CaO-contents with decreasing Mg# from poikilitic MIs to non-poikilitic MIs of NWA 7397. In contrast, PBCs of RBT 04262 MIs do not follow any gradational trend from poikilitic to non-poikilitic MIs.

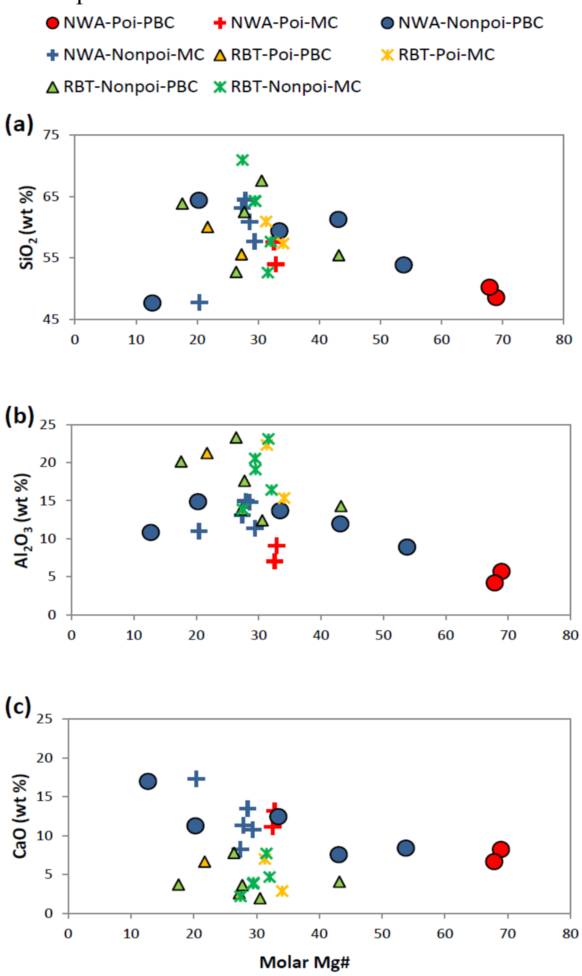

Figure 2: Molar Mg# vs. (a) SiO_2, (b) Al_2O_3 and (c) CaO contents of MIs before and after the post-entrapment corrections.

Since the Mg#s of all the MI-PBCs are not in equilibrium with their host olivine, a Fe-Mg re-equilibration post-entrapment correction is implemented in each MI to obtain trapped magma compositions (MC). All the MCs of both NWA 7397 and RBT 04262 MIs have a narrow range of Mg# from 27-34, except one MI of NWA 7397 of Mg# 20 (Fig. 2). This may indicate that corresponding magmas were trapped at the early stages of differentiation as MIs and started crystallizing at the same time. One MI of NWA 7397, with Mg#20, may form from a later stage melt in the parent magmatic system. The poikilitic MCs of NWA 7397 are distinct from all the non-poikilitic MCs of both NWA 7397 and RBT 04262 and also from poikilitic MCs of RBT 04262 (Fig. 2). Additionally, Al_2O_3 and CaO contents are distinct between the two shergottite MIs (Fig. 2b,c). For example, the MIs of NWA 7397 contain >8 % CaO and higher than all the RBT 04262 MIs. Based on narrow range of Mg# and apparent Al_2O_3, CaO and alkali-contents, it can be said that magmas of non-poikilitic MIs of NWA 7397 and of both poikilitic and non-poikilitic MIs of RBT 04262 trapped in an analogous condition preceded by the poikilitic MIs of NWA 7397.

The MCs of NWA 7397, RBT 04262, LAR 06319 [2] and Tissint [3], are compared with the bulk composition of regolith breccia NWA 7034 [7], average compositions of Martian mantle, Gusev crater, Bounce rock [8] and Pathfinder rock [9] in a total alkali and silica (TAS)-diagram in Fig. 3. The compostions of MI-MCs of LAR 06319 and Tissint plot near those of the Gusev and Bounce rocks at low SiO_2 and alkali contents. The compostions of MI-MCs of NWA 7397 and RBT 04262 are scattered and have broadly higher SiO_2 and alkali contents and are analogous to that of Pathfinder rock.

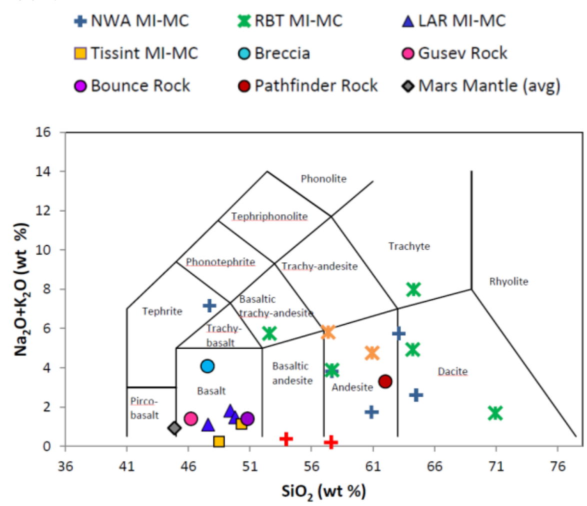

Figure 3: TAS-diagram.

Conclusion: The calculated MI-MCs of NWA 7397 and RBT 04262 have higher SiO_2 and distinct alkali-contents and are not within the range of other shergottites' MI-MCs and Mars rocks (except Pathfinder rock) which may expose a new way of explaining the shergottite magma evolution. Additional work will include trace element analyses of the melt inclusions and subsequent crystallization modeling.

References: [1] Goodrich (2003) *GCA, 67,* 3735-3771. [2] Basu Sarbadhikari et al. (2011) *GCA, 75,* 6803-6820. [3] Basu Sarbadhikari et al. (2016) *MAPS,* 1-7. [4] Howarth et al. (2014) *MAPS, 49,* 1812-1830. [5] Danyushevsky & Plechov (2011) *Geochem. Geophy. Geosyst., 12,* Q07021. [6] Potter et al. (2015) *LPSC XLVI,* Abstr. #2945. [7] Agee et al. (2013) *Science, 339,* 780-785. [8] Filiberto & Dasgupta (2011) *EPSL, 304,* 527-537. [9] Dreibus et al. (1998) *MSM LXI,* Abstr. #5067.