Source and parental melts of a poikilitic shergottite suite: implications for martian magmatism

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Project Summary

Driving Research Question: Is there a petrological link between the poikilitic shergottites and other shergottite sub groups?

Why should we care? Determining petrological relationships between the different shergottite subgroups will help constrain the heterogeneity of the martian mantle and crust.

What did we do? We conducted melt inclusion analyses on a suite of poikiltic shergottites including Northwest Africa (NWA) 11043, NWA 10618, NWA 11065, NWA 7755, and Allan Hills (ALHA) 77005 to calculate their parental trapped liquid (PTL) compositions.

What did we find out? Though compositionally not as primitive, the poikilitic shergottite PTL compostions are similar to that of the olivine-phyric PTL compositions suggesting a potential relationship.

What is Next: We will conduct isotopic analyses to determine the crystalization ages and source compositions of the suite.

Methods

Electron microprobe analysis:
-Inclusions: 15 kV accelerating voltage, 10 nA beam current
-Beam size was dependent on phase size [1]
-For phases too small to measure, a larger beam (10 µm) was used to obtain a bulk analysis, and then each phase was determined through averaging of the results [2]

Melt inclusion rehomigenization:
-All inclusions are olivine-hosted
-Use PETROLOG3 [2]
  -Corrects requilibration for PTL composition [3]
  -Required FeO_T value used from Combs et al., 2019 [4]

Results: Melt Inclusions

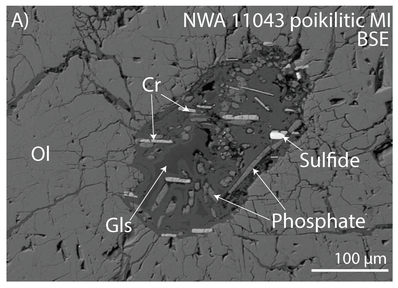
Olivine hosted melt inclusions:

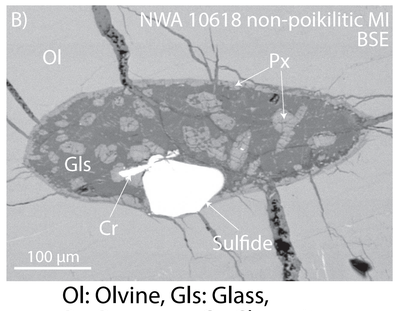
-Present in both poikilitic and non-poikilitic textures

-Melt inclusions are characterized as pockets of melt trapped inside a host crystal [5]

-Inclusions are variable in size, shape, and mineral phase content

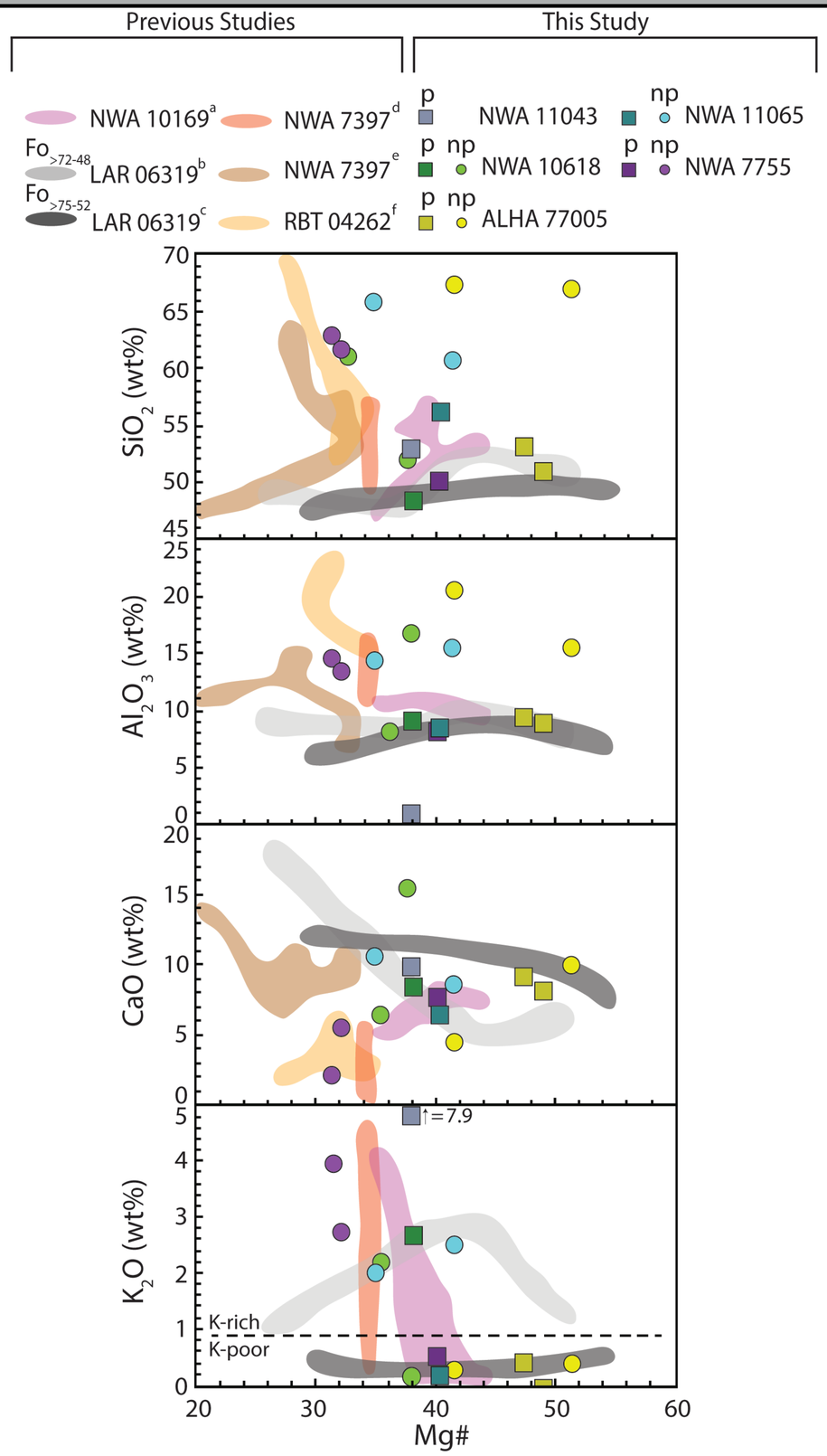
-Total Inclusions Analyzed: NWA 11043 (1), NWA 10618 (3), NWA 11065 (3), NWA 7755 (3), ALHA 77005 (4)





Ol: Olvine, Gls: Glass,
Px: Pyroxene, Cr: Chromite

Results: Parental Trapped Liquid Compositions



The enriched poikilitic shergottite compositions are represented by RBT 04262 [6], NWA 7397 [7,8], NWA 10169 [4], NWA 10618 and NWA 7755 . The enriched olivine-phyric shergottite composition is represented by LAR 06319 [9,10]. The intermediate poikilitic shergottite compositions are represented by NWA 11065, NWA 11043, and ALHA 77005. p = poikiltic np= non-poikiltic

Results and Discussion

Poikilitic shergottites and olivine-phyric shergottites may share a petrological link such as a common magmatic system

-Similar petrogenesis and magmatic history likely occurred for NWA 10618, NWA 7755, NWA 11065, NWA 10169, NWA 7397, RBT 04626, and LAR 06319

-The PTL compositions of NWA 7755, NWA 11065, NWA 11065, NWA 11043, and NWA 10618 are more similar to the PTL composition of NWA 10619 [4] and LAR 06319 [9,10] based on K_2O, CaO, and Al_2O_3 and SiO_2 oxide wt% than other enriched shergottites

-Poikilitic shergottite PTL compositions are not as primitive, and cover a smaller range than olivine-phyric PTL compositions, but fall within the olvine-phyric PTL ranges

-ALHA 77005 is more primitive than that of the other poikilitic shergottites suggesting it formed/emplaced differently than other poikilitic shergottites

Poikilitic shergottites may go through a common magmatic process resulting in addition of K-rich metasomatized material during melt evolution

-Based on varability of K_2O/Na_2O ratio between samples

-Evident in this study (NWA 10618, NWA 11065, and NWA 7755) and previous studies (NWA 7397 [7,8] and NWA 10169 [4])

No significant PTL compositions were calculated for NWA 11043

-No data was succesfully collected for NWA 11043 non-poikilitic melt inclusions, due to terresterial alteration

-K_2O (7.9 wt%) is high and Al_2O_3 (0.39 wt%) is low, likely due to terresterial alteration

Future Work

-Conduct melt inclusion analyses and determine PTL composition for the newly recovered intermediate poikilitic shergottite NWA 12241

-Attempt to run successful melt inclusion analyses on NWA 11043 using less contaminated melt inclusions

-Investigate poikilitic shergottite sources and crystallization ages in NWA 11043 and NWA 10618

-$^{176}Lu/^{177}Hf$ and $^{147}Sm/^{143}Nd$ isotopic systems will be used for analyses to determine differences in ages and isotopic compositions

-Trace element analyses of parental melt compositions

-Compare crystallization ages and source compositions of this study to previous studies to help create a petrological link

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