PETROGENESIS OF THE DAR AL GANI (DAG) OLIVINE-PHYRIC SHERGOTTITES AND IMPLICATIONS FOR VOLCANISM ON MARS.

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Abstract: The last two decades have seen a significant increase in the rate of recovery of Martian meteorites allowing for the potential of studies to evaluate suites of igneous rocks rather than individual samples. As the number of Martian meteorites recovered increases and more isotopic and geochemical data become available, more stringent constraints can be placed on Martian volcanic systems and ejection sites. One proposed cogenetic relationship is represented by a group of at least 11 depleted olivine-phyric shergottites, including Dar al Gani (DaG) 476, that have ejection ages of 1.1 ± 0.2 Ma and share similar mantle source compositions [1, 2, 3]. The igneous crystallization ages of these 11 depleted shergottites range between 348 Ma and 2.4 Ga [3], spanning almost half of Mars' magmatic history. This ejection paired group allows for more comprehensive studies of cogenetic magma systems. Long-lived volcanoes (e.g., Alba Mons, Biblis Tholus, Jovis Tholus, Uranis Mons and Hecates Tholus) are well known on Mars and this group of depleted shergottites likely originate from one of them [4], providing geological context. A sample with a geological context has great value, aiding in better understanding of geological processes and planetary evolution thus creating a link between Martian meteorite petrology and data collected from remote exploration missions.

This study investigates six of the seven depleted olivine-phyric shergottites found in the Dar al Gani meteorite field of the Libyan Sahara (DaG 476, 670, 735, 876, 975, 1037), which have previously been assumed to be launch paired based on their ejection age association. The motivation behind this work is to evaluate their pairing, based initially primarily on geographic association, and secondly to constrain the petrogenetic relationship between the DaG olivine-phyric shergottites and then use this to understand part of the volcanic history related to the 1.1 Ma ejection site on Mars. We have begun a campaign to collect EPMA data for all phases in these samples, and *in situ* LA-MC-ICP-MS $^{87}Sr/^{86}Sr$ isotopes of maskelynite and bulk-rock geochemistry for a subset of samples where we were able to get additional material (DaG 476, 670, 735, 1037) for destructive analyses. Here we present our preliminary data and interpretations in combination with previously reported data.

All the DaG shergottites obtained for this study are characterised by porphyritic textures comprising of zoned olivine and pyroxene phenocrysts (grain sizes ~ 1.5 to 2.6 mm) set in a finer groundmass of later crystallizing olivine and pyroxene laths (up to 0.7 mm in length) with interstitial maskelynite as well as accessory chromite, Fe-Ti oxides, sulfides, merrillite, and apatite. To date, we have measured the olivine composition in DaG 1037, which has a range of Fo_{75-61} comparable to previously reported data for DaG 476 (Fo_{76-58} [6]). Estimated crystallisation pressures using Ti vs. Al (pfu) in pyroxenes from DaG 1037 are also comparable to DaG 476 [6]), implying crystallisation close to the crust-mantle boundary. *In situ* $^{87}Sr/^{86}Sr$ isotope analyses of maskelynite in DaG 670 have an average of 0.70170 ± 0.00049 and are indistinguishable from previously reported data for DaG 476 ($^{87}Sr/^{86}Sr$ = 0.70125) and other depleted shergottites [1]. Bulk-rock data collected for DaG 670 and 735 are characterized by depleted LREE profiles in chondrite-normalised plots, consistent with classification as depleted shergottites. Furthermore, DaG 670 and 735 have Mg#'s of 68.8 and 61.0, and previously reported data for DaG 476 has an Mg# of 66.5. In all three cases, the most primitive olivine compositions (reported in the Meteoritical Bulletin database for meteorite classification) are not in equilibrium with the bulk-rock Mg#, indicating accumulation of olivine. This initial characterization suggests the olivine-phyric DaG shergottites may be paired as well as launch paired and the importance of this finding will be discussed.

References:

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