CONSTRAINING FORMATION AND EMPLACEMENT PROCESSES OF POIKILITIC SHERGOTTITES USING QUANTITATIVE TEXTURAL ANALYSES

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Introduction: Martian meteorites are the only tangible material available for laboratory-based study of our planetary neighbor, Mars. Thus, it is important to thoroughly analyze martian meteorite samples to robustly constrain the geological processes operating during Mars' history. Shergottites, the most prevalent type of martian meteorite, are mafic to ultramafic igneous rocks. Three distinct petrographic groups make up the shergottites: olivine-phyric, basaltic, and poikilitic [1]. The shergottite groups have also been categorized on the basis of their light rare earth element (LREE) concentrations into enriched, intermediate, and depleted [1-3]. Here we investigate the petrogenetic relationships amongst the enriched and intermediate poikilitic shergottites. Poikilitic shergottites are gabbroic intrusive rocks that likely represent an important lithology of the martian crust, as the surface of Mars is largely basaltic in composition [4]. It has previously been suggested that the poikilitic shergottites may have originated from a common igneous body on Mars [5]. However, although the enriched and intermediate poikilitic shergottites share textural and mineralogical similarities, the enriched poikilitic shergottites exhibit comparable ejection and crystallization ages to some basaltic and olivine-phyric enriched shergottites [2-6]. In addition, early models suggesting a common igneous body for these meteorites were based on intermediate shergottites only, as enriched end-members for this group were only identified in 2010 [7].

In this study, we investigate quantitative textural analyses of various enriched and intermediate poikilitic shergottites to constrain their emplacement within the martian crust and understand their links and relationships with other enriched shergottite groups.

Methods: Crystal size distribution (CSD) and spatial distribution pattern (SDP) textural analyses are well-established and useful tools to assess the crystallization histories and spatial associations of the analyzed crystal populations [8-10]. These analyses allow for constraints to be placed on the emplacement processes of igneous rocks, such as magma residence time, crystal accumulation, and textural coarsening. CSD analyses have been applied to the earliest crystallizing phase, olivine, in four enriched poikilitic shergottites (Northwest Africa – NWA 4468, NWA 10169, NWA 7397, NWA 10618). In addition, we will also present CSD and SDP analyses of two intermediate poikilitic shergottites, Allan Hills (ALHA) 77005 and Lewis Cliff (LEW) 88516.

To produce CSDs and SDPs for the olivine populations within the analyzed enriched and intermediate poikilitic shergottites, olivine grain boundaries were traced by hand using reflected and transmitted light mosaic images. The grain dimensions were measured using *ImageJ* software, which were then put into *CSDslice* software [9]. *CSDslice* software is a database that is used to obtain the best-fit 3D shape ratio (long-, intermediate-, and short- axis ratio) of the 2D measured grain population. The best-fit 3D shape was then entered into *CSDcorrections* software to generate the CSD plots. The R-value, used for SDP analyses, was obtained using *Big-R* software available in *CSDcorrections* software [10].

Results and Discussion: If the enriched poikilitic shergottites all crystallized from a similar igneous intrusion on Mars, then our preliminary results of the CSD analyses imply that NWA 10618 crystallized at a lower cooling rate than NWA 10619, NWA 7397, and NWA 4468. Additionally, NWA 7397 and NWA 4468 crystallized at similar conditions, and likely are the shallowest of the four enriched poikilitic shergottites if all the enriched poikilitic shergottites crystallized in a single magmatic intrusion. These interpretations are based on the slopes of the CSD profiles, which are related to growth rates and magma residence times. In a single igneous body, we would expect the samples at the base of the body to exhibit the longest residence time, and therefore the shallowest slope. The textural analyses results for the intermediate poikilitic shergottites will be presented at the conference.

Future Work: The work here are preliminary results of a more expansive study to fully characterize the petrogenetic relationships amongst the entire suite of poikilitic shergottites. Future work will include CSD and SDP on additional enriched and intermediate poikilitic shergottites, as well as analysis of more thin sections from each sample.

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