MG-RICH CLASTS IN AN APOLLO IMPACT MELT BRECCIA PROVIDE EVIDENCE FOR MG-SUITE VOLCANISM ON THE MOON.
A. C. Stadermann¹, J. J. Barnes¹, T. M. Erickson¹, T. C. Prissel¹, and Z. D. Michels⁴; ¹Lunar and Planetary Laboratory, University of Arizona, ²Jacobs JETS at NASA Johnson Space Center, ³Astromaterials Research and Exploration Science at NASA Johnson Space Center, ⁴Department of Geosciences, University of Arizona.

Introduction: The lunar magnesian (Mg-)suite is a broad lithological group of ancient (~4.1–4.5 Ga) Mg-rich plutonic rocks (Mg# > 78; Mg# = molar Mg/[Mg + Fe] × 100) that were emplaced at depths of 10–50 km [1–6]. We focus here on the Mg-Al-spinel-bearing lithology of the Mg-suite, spinel troctolite, which consists predominantly of olivine and plagioclase, but also contains minor spinel and pyroxene. A variety of intrusive models exist to explain the petrogenesis of the Mg-suite lithologies [6–10] in light of limited evidence for extrusive-textured spinel troctolites [11–13]. However, magmatic ascent models applied to new crustal densities determined by GRAIL suggest Mg-suite extrusive volcanism was possible [14]. Here, we present findings on two polished thin sections of Apollo impact melt breccia 68815 which contains Mg-rich, spinel-bearing clasts with fine-grained textures, unlike most other spinel troctolites on the Moon. The sections in this study are 68815.17 and 68815.148, and consist of lithic and mineral clasts embedded in a glassy to devitrified impact melt matrix. We investigate these troctolite-like clasts to determine if they are Mg-suite volcanic products or relatively rapidly cooled, crystalline impact melt.

Methods: We used optical and electron microscopy to characterize the samples in this study petrologically, geochemically, and mineralogically. We used a Keyence VHX7000 Digital Microscope to create plane-polarized, cross-polarized, and reflected light image mosaics of the two thin sections. A Cameca SX100 electron probe microanalyzer was used to obtain elemental X-ray maps of the thin sections, along with quantitative spot analyses of phases of interest. To obtain backscattered electron images, energy dispersive X-ray spectroscopy maps, and electron backscatter diffraction (EBSD) maps of regions of interest, we used a Hitachi S-4800 scanning electron microscope (SEM) and a JEOL 7900F field emission SEM. The EBSD data were processed using AZtecCrystal. Crystallization modeling and 1-bar liquidus temperatures were calculated using MAGFOX and MAGPOX software [15, 16].

Results and Discussion: The clasts within 68815.17 and 148 were divided into two groups: Alpha and Beta. Clasts within the Alpha group share similar petrographic textures and geochemistry, while Beta clasts are dissimilar to the Alpha Clasts and to each other. We also identified eight spinel mineral clasts within the impact melt.

Alpha Clasts. The six Alpha clasts are all characterized by skeletal spinifex-textured olivine, fine grained plagioclase, with minor pyroxene and euhedral spinel. The Alpha clasts likely originate from the same parent lithology or rock. The EBSD maps of the Alpha clast 148a2 reveal that the olivine dendrites are elongated along the a-axis of the olivine, consistent with spinifex texture in terrestrial komatiites [17]. The chemistry of olivine, plagioclase, and spinel in the Alpha clasts are consistent with spinel troctolites, and with geochemical trends from our crystallization models. All of these data are consistent with an endogenous (volcanic) origin for the Alpha clasts. Modeling suggests that the Alpha clasts are linear mixtures of an Mg-suite parent melt [10] and ferroan anorthosite, consistent with an Mg-suite melt assimilating anorthositic crustal material.

Beta Clasts. The three Beta clasts have varying mineral chemistry and textures, revealing they likely did not originate from a single homogenous melt. The Beta clasts are more likely to be of impact melt origin than the Alpha clasts. One Beta clast contains a xenocryst, and the others have inconsistencies between spinel and olivine Mg#s.

Conclusions: We conclude that the Alpha clasts are consistent with volcanic origin, whereas the Beta clasts contain more indicators of impact origin. These findings need further analyses to be confirmed, specifically with trace element and isotopic analyses. If the endogenous nature of the Alpha clasts is confirmed, it would extend the known compositional diversity of lunar volcanism, consistent with models of ancient Mg-suite eruptions.