PETROGENESIS OF LUNAR BASALTIC METEORITE DOMINION (DOM) RANGE 18666. S. M. Ireland[1], C. L. McLeod[1], A. J. Gawronska[1], M. P. Loocke[2], B. J. Shaulis[3]. [1]Miami University, Dept. of Geology & Environmental Earth Science, Oxford, Ohio 45056, USA (irelans@miamioh.edu), [2]Louisiana State University, Dept. Of Geology and Geophysics, E235 Howe Russell Kniffen, Baton Rouge, LA 70803, USA, [3]University of Arkansas, Trace Element and Radiogenic Isotope Laboratory (TRAIL), Fayetteville, Arkansas, 72701, USA.

Introduction: Insights into the geological evolution of the Moon can be gleaned from lunar meteorites found on Earth [1]. This particular sample suite is uniquely insightful as it represents a random sampling of the lunar surface and can thus broaden our current understanding of lunar geology beyond what is provided by the relatively spatially limited Apollo suites.

In this work, we seek to characterize the mineralogies, textures, and chemistries of a brecciated lunar meteorite retrieved from the Dominion Range (DOM), Antarctica, during the 2018 Antarctic Search for Meteorites (ANSMET) expedition: sample DOM 18666 (figure 1). Previous work has classified this sample as basaltic in nature [2].

Methodology: Initial phase identification and textural observations were conducted via Polarized Light Microscopy (PLM). This was followed by mineral and clast spectral analysis, and elemental mapping, conducted using a Zeiss Supra 35 Variable Pressure Field Emission Gun-Scanning Electron Microscope (VP FEG-SEM) at the Center for Advanced Microscopy and Imaging (CAMI) at Miami University. Elemental data were collected on a Bruker Xflash 5010 Energy Dispersive X-ray Spectroscopy Detector. Element maps provided the spatial context for subsequent *in situ* mineral major element analyses using the JEOL JXA-8230 Electron Probe Microanalyzer (EPMA) at Louisiana State University. To complement thin section study, a 19.970 mm^3 rock chip of DOM 18666 was analyzed via X-ray computed tomography (XCT). Textural features associated with clast and mineral fabrics in 3D will thus be evaluated [3].

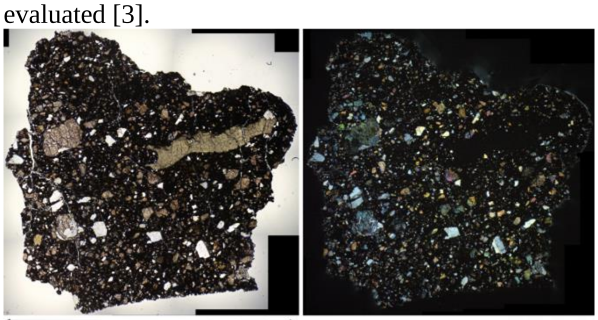

Figure 1: DOM 18666 in plane polarized light (left panel) and cross polarized light (right panel).

Results: From petrographic study and SEM-EDS analyses, DOM 18666 can be classified as clast-poor (<5%). Individual mineral fragments are common: Ca-rich plagioclase, clinopyroxene, minor olivine, and trace ilmenite. Sulfides and phosphates were also identified as trace phases, with the largest grains measuring 7 µm and 30 µm, respectively. Several fractures in mineral grains and clasts extend into the matrix providing evidence of shock (figure 3). The majority of clasts identified are gabbroic in nature (figure 3a,b) (~200 mm), and consist of Ca-rich plagioclase with clinopyroxene). The largest gabbroic clast present is just over 1000 µm across. Additional findings include a SiO_2 polymorph (likely cristobalite) coexisting with Ca-rich plagioclase in one clast (700 µm across). Symplectite textures are also present (Figure 2).

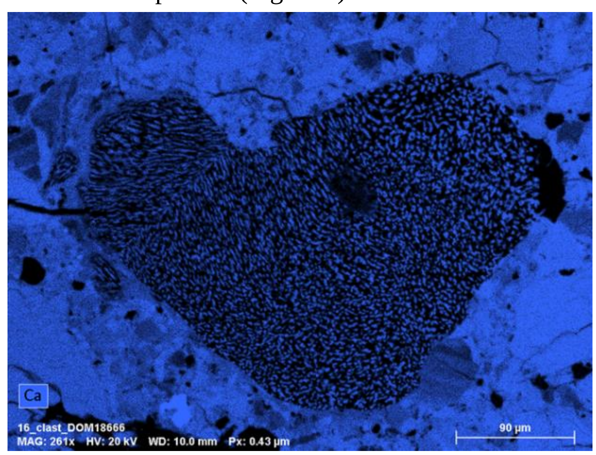

Figure 2: Ca elemental map of a symplectite.

Trace ilmenites (<1% of sample) have been identified as inclusions in mineral grains, clasts, and in the glassy matrix. Several crystalline spherules are also present, characterizing DOM 18666 as a basaltic regolith breccia [4]. These petrographic features are summarized in Figure 3. Preliminary analyses of volumetric mineralogy collected via XCT are consistent with PLM and SEM-EDS observations.

The majority of feldspars analyzed, both as individual grains and as part of lithic clasts, are anorthitic in composition (84% of total spot analyses, >An90), and several analyses are consistent with alkali feldspar compositions (>Or89). The majority of clinopyroxenes analyzed range from augite to pigeonite along with minor hedenbergite and rare enstatite (figure 4). 66% of olivine spot analyses exhibit compositions ranging from $Fa_{85.4}$ to $Fa_{99.2}$. This includes analyses from individual olivine mineral grains (up to 350 μm), and olivine in clasts. Phosphate grains were confirmed to be fluorapatites. EPMA analysis of symplectites revealed them to be composed of three phases: quartz, fayalite, and hedenbergite.

Discussion: Clinopyroxene compositions of DOM 18666 and other DOM suite basaltic breccias are consistent (Figure 4, [5]), which supports the classification of the DOM lunar basaltic breccias from the 2018-2019 ANSMET expedition as a meteorite clan. The compositions of plagioclase feldspar in DOM 18666 overlap many of the signatures seen in Apollo basalts [6]. In contrast, however, olivines are significantly more fayalitic than those in sampled Apollo basalts. This indicates that DOM 18666 likely originated outside of the Apollo landing sites. The presence of 3-phase symplectites and cross-cutting fractures (e.g., Figure 3c) are interpreted as being shock-related.

The relatively low abundance of ilmenites, and presence of spherules, indicate that DOM 18666 is a low titanium regolith basaltic breccia. Upcoming work will focus on the acquisition of trace element compositions of major silicate phases via Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) at the Trace Element and Radiogenic Isotope Laboratory (TRAIL) at the University of Arkansas. This work will continue to evaluate the petrogenesis and lithological diversity of DOM 18666. Data will be compared to the previous studies of this particular DOM suite of meteorites as well as Apollo samples.

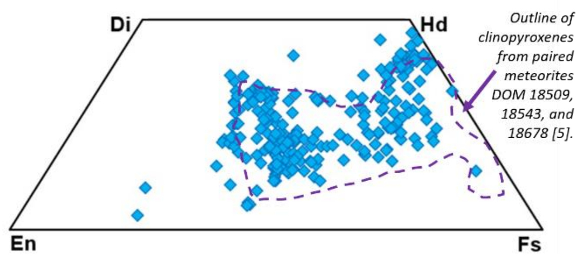

Figure 4: Summary of DOM 18666 clinopyroxene compositions. As shown, Augite and pigeonite dominate with very minor hedenbergite and potential rarer enstatite.

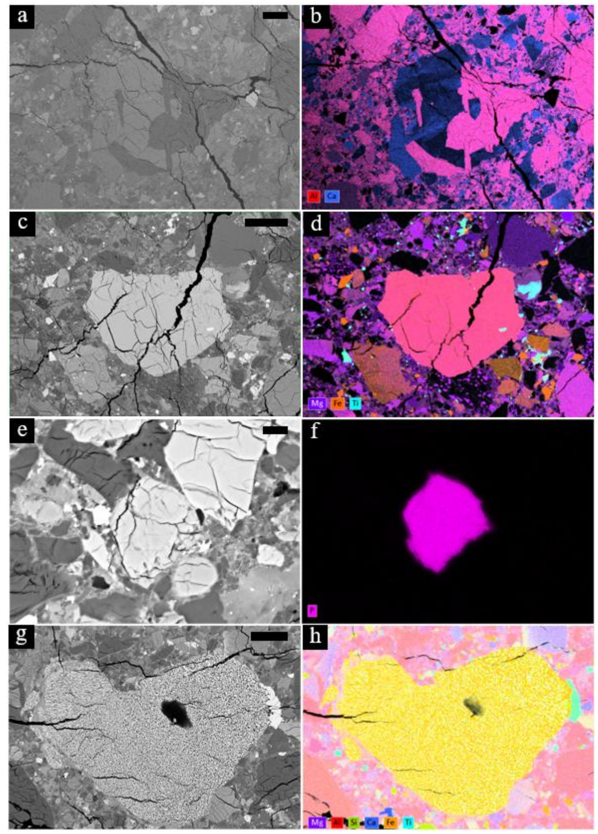

Figure 3: Back-scattered electron (BSE) images (**a**, **b**, **c**, **d**) with scale bars of 200 μm, 100 μm, 10 μm, and 50 μm, respectively, and elemental maps (**b**, **d**, **f**, **h**) of various lithic clasts and individual mineral grains identified in DOM 18666.

Acknowledgments: The authors would like to thank Matthew Duley, Microscopy Specialist at CAMI, for his assistance with the use of the Zeiss Supra 35 VP SEM instrument that has facilitated this research to date. We also extend thanks to the ANSMET team and program for the collection and return of this exciting new suite of lunar samples.

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