VOLCANIC HISTORIES OF LUNAR BASALTS REVEALED VIA 3D VISUALIZATION

Z. E. Wilbur[1], J. J. Barnes[1], S. A. Eckley[2,3], R. A. Zeigler[4]
[1] Lunar and Planetary Laboratory, University of Arizona, USA,[2] Jacobs- JETS, NASA Johnson Space Center, [3] University of Texas, Austin, [4] ARES, NASA Johnson Space Center

Introduction: Amidst the evolving field of lunar volatiles, there are debates regarding the abundances, distribution, and origin of volatiles in or on the Moon [e.g., 1]. Volatile elements and halogens (e.g., H, H_2O, CO_2, S, Cl, F) critically influence magma properties, dynamics, ascent, and eruptive processes. Basalts can record both the initial volatile composition of their parental melts, as well as subsequent volatile loss or addition (e.g., due to assimilation or degassing). Many lunar basaltic samples contain vesicles and vugs, which are important testaments to the gas-rich volcanic activity that occurred on the Moon. Coupling studies of degassing signatures, which are indirectly recorded in vesicles, with quantitative analyses of the volatiles within minerals can provide new insights to the chemical and physical evolution of lunar magmas.

We investigate the magmatic, volcanic, and alteration histories of a suite of low-titanium and high-titanium lunar basalts using a novel combination of 2D analysis of textures, modal mineralogy, chemistry, and volatile abundances of rock thin sections, with 3D analysis of whole rock textures, modal mineralogy, and vug abundances and morphology. This work should elucidate the potential differences in eruptive characteristics between low-Ti and high-Ti lunar basalts.

Samples: We are studying five low-Ti Apollo 15 basalts collected from the basaltic plain adjacent to Hadley Rille. Samples 15555 and 15556 are vesicular, olivine normative basalts; 15495 and 15499 are vuggy, porphyritic pigeonite basalts; and 15608 is an unusual basalt, which has not been previously investigated in detail. Additionally, we compare these low-Ti basalts to four high-Ti Apollo 17 basalts collected from Camelot Crater and the Central Valley: 75035 and 75055 (Type A basalts); 70215 (Type B); and 70035 (Type U) [e.g., 2].

Methods: To date, X-ray-elemental maps, backscattered-electron maps, and mineral chemical analyses of thin sections were acquired using the University of Arizona's Cameca SX100 electron microprobe and the NASA Johnson Space Center's (JSC) JEOL 7900F Scanning Electron Microscope. Mineral modal abundances were determined in 2D using thresholding [3] and quantified using *ImageJ*. These 2D abundances are compared to 3D XCT scans. For 3D analysis, XCT datasets were acquired using the NASA JSC Nikon XTH 320 instrument. The 3D modal mineralogy and vesiculation textures were determined through visualization and segmentation using Dragonfly™ and Blob3D software, respectively.

Discussion: The 2D modal mineralogies calculated in this work agree with past studies that utilized point counting techniques [4,5]. These 2D modes will be compared to 3D values from XCT scans to evaluate sample heterogeneity. The analyses of apatite chemistry confirm the presence of fluorapatite, and the compositions overlap literature data reported for other Apollo 15 and 17 basalts [e.g., 1]. Pyroxene compositions indicate that basalt pairs 15555/15556 and 75035/75055, each likely derive from a similar parental magma [6]. However, 70215 was likely derived from a distinct parental magma [6]. Future chemical analyses will better constrain the origins of the remaining Apollo 15 and 17 basalts, and when coupled with XCT data, will elucidate the eruption sequences for the the low-Ti and high-Ti basalts. At the meeting we will present our chemical characterization, discuss our comparison of 2D and 3D data, and inform on the eruption sequences of the studied basalts.

References: [1] McCubbin F.M. et al (2015) *Am. Min.,* 100, 1668-1707 [2] Hallis L.J (2014) *GCA*, 134, 289-316. [3] McCubbin F.M. et al. (2021) *GCA*, 314, 270-293. [4] Longhi J. (1972) *GCA*, 1, 447-469. [5] Dymek R.F. (1975) *Proc. Lunar Sci. Conf.* 6th, 49-77. [6] Papike J. J. et al. (1977) *Reviews of Lunar Sciences, Collected Reprint Series (Ed.).*

Acknowledgements: We thank CAPTEM for their sample request review and JSC curation for allocation of the samples for this project. This work is partially funded by NASA Grant 80NSSC19K0803 and FINESST Grant 80NSSC21K0516.