

ONGOING PREPARATIONS FOR A MISSION TO A LUNAR PIT. L. Kerber¹, K. Uckert¹, R.G. Sellar¹, N. Moore², I.A. Nesnas¹, B. Denevi³ ¹Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA (kerber@jpl.nasa.gov) ²Pomona College, Claremont, CA 91711. ³JHU/APL, Laurel, MD

Introduction: Mare pits [1-3] have attracted attention as a site of interest for lunar exploration both due to their access to subsurface voids [4-5] and their ability to serve as natural drill holes, exposing both the regolith/bedrock transition and sequences of bedrock lavas [6].

The stratigraphy exposed by the pits is interesting for several reasons: First, it provides a cross-sectional view of lunar lavas that reveals whether they were emplaced as cooling-limited compound flow-fields, thick, inflated flows, or turbulent flows [7]. Having a sequence of multiple lavas permits an estimation of their rates of effusion through time, which can be used to test hypotheses regarding the mode of their ascent through the lunar crust [7]. Second, measuring the chemical composition of lavas in context makes it possible to understand which lavas are most likely to represent primary magmas [8], and what fractionation, mixing, and assimilation processes may have affected the magmas as they ascended [9]. Unraveling these influences improves our understanding of the Moon's composition at depth. Third, the ability to study the composition of the regolith and the underlying bedrock in the same location is helpful for understanding both how the regolith was formed and the representativeness of the regolith in locations where bedrock exposure is not available [10].

However, in order to make progress on the goals above, data collected by a prospective mission to a lunar pit must be of sufficient quality to enable meaningful interpretation. In this ongoing work we compare the data (images, mineralogy, and elemental chemistry) taken by candidate mission payload instruments with data taken using traditional laboratory methods to assess the suitability of the instruments for this specific use.

Imagery: Two GoPro 9 cameras mounted on a two-wheeled, non-actuated rover prototype (based on the Axel Rover [11]) are used to capture imagery while descending down a vertical cliff of lava layers. Several transects capture the variability in morphology in cliffs exposing low-flux, compound pahoehoe flows, while others are taken of high flux continental flood basalt flows. The resulting strip of imagery (and topography) is compared against a 3-D model created using a UAV.



Spectral Data: Spectral information is taken in the visible and short-wave infrared region using a laboratory hyperspectral imaging spectrometer and a multispectral microscopic imager (MMI; [12]). The mineralogy derived from these imagers is compared with modal mineralogy derived from analysis of petrographic thin sections.

Elemental Chemistry: Elemental chemistry is measured using the Mars2020 PIXL [13] instrument breadboard, which measures a grid of 100 um spots. This information is used to simulate what an Alpha Particle X-Ray (APXS) instrument would see if it was integrating on the same sample footprint. These measurements are compared with the compositions derived from a laboratory XRF measurement.

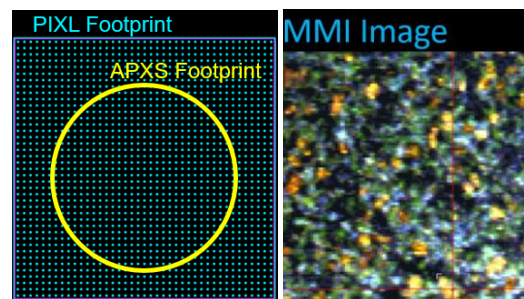


Figure 1. Left: Reconstructed wall topography from stitched together GoPro images. Center: APXS instrument footprint superimposed on a PIXL grid. Right: MMI false color image.

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References: [1] Haruyama, J., et al. (2009) GRL 36, L21206. [2] Robinson, M.S. et al. (2012) PSS 69, 18–27. [3] Wagner, R.V., Robinson, M.S. (2014) Icarus 237, 52–60. [4] Hörz, F. (1985) Lunar Bases & Space Act. of the 21st Cent., pp. 405–412. [5] Haruyama, J. et al. (2012) Moon. [6] Nesnas, I., et al. (2012) J. of Field Robotics 29, 663– 685. [7] Head, J. W., Wilson, L. (2017). Icarus, 283, 176-223. [8] Basaltic Volcanism Study Project (1981) *Basaltic Volcanism on the Terrestrial Planets*. Pergamon Press, Inc., New York. 1286 pp. [9] Moore, N.E. et al. (2020). *Geochemistry, Geophysics, Geosystems*, 21(8), e2020GC008910. [10] Li, L., & Mustard, J. F. (2005). *JGR*, 110(E11). [11] Nesnas, I., et al. (2012) *J. of Field Robotics* 29, 663– 685. [12] Farmer, et al., (2011). AGU [13] Allwood et al. (2015). In 2015 IEEE Aerospace Conference (pp. 1-13). IEEE. [14] VanBommel et al. (2021). LPSC (No. 2548, p. 1688).