A TALE OF TWO MOZARTS: INVESTIGATION OF LUNAR PYROCLASTIC DEPOSITS NEAR LACUS MOZART.

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Introduction: Lunar Pyroclastic Deposits (LPDs) are the surface materials left from explosive volcanic eruptions on the Moon. The identification of LPDs is generally based on composition, albedo, and/or physical changes in the regolith structure [1]. With notable exceptions, LPDs are typically basaltic in composition and often exhibit a stronger glass signature than most lunar materials [1, 2]. They tend to have a low relative albedo and mantle (i.e., blanket) the underlying topography, which produces a smoother texture than typical lunar surfaces [1, 2].

In this study, we use new datasets to re-evaluate a pyroclastic deposit named Mozart identified in [3] as a "dark mantled valley" and the complex volcanism of the surrounding area. Here, we describe our study of the Mozart LPD (#1 in Fig. 1) and new potential pyroclastic features identified near Lacus Mozart: vents along Mozart rille. These vents are of high interest as they appear to be directly related to Mozart rille and their relationship to the rille (i.e., the interconnectivity of explosive and effusive volcanism) has important implications for eruption dynamics of volcanism in the Montes Apenninus region.

Description of Study Region: Lacus Mozart (located at approximately 24.5°N, 0.5°E) is an isolated mare deposit that lies between the second and third rings of the Imbrium basin (#2 in Fig. 1, [8]) and contains several volcanic features. Mozart LPD, as identified in literature, is located within a valley bound to the northwest by Lacus Mozart and to the southeast by an unnamed slope within Montes Apenninus [3]. Northwest of Lacus Mozart is a rille (Mozart rille) with along-rille depressions, some identified as volcanic vents and others as collapse features (identified as craters in Fig. 1 and Table 1; [8]). The source vent of Mozart rille is hypothesized to be Kathleen crater, the rille then flowing to the west towards Ann crater, Michael crater, and terminating or losing enough topographic contrast to be distinguished from Lacus Mozart at Patricia crater [8]. It should be noted that the use of the term "crater" here is non-genetic, and not indicative of an impact structure.

Methods: We use data from the 85-band global mode Moon Mineralogy Mapper (M^3, [6]) to map the lunar surface and evaluate spectra to compare the composition of the features within the Lacus Mozart region and surrounding area (23°N to 27°N and -1.2°E to 2°E, Fig. 1). The calibrated products downloaded from the Planetary Data System were processed following the methods of [7] for spectral characterization, including suppression of the continuum due to factors including space weathering and smoothing the continuum to better evaluate spectral variations. We create spectral parameter maps of targeted indicator minerals (e.g. orthopyroxene and iron-bearing glass) and specific regions of the spectrum where iron has characteristic absorption features (i.e. 1 µm and 2 µm). These parameter maps include band depth, band center, or area under the curve at a band location.

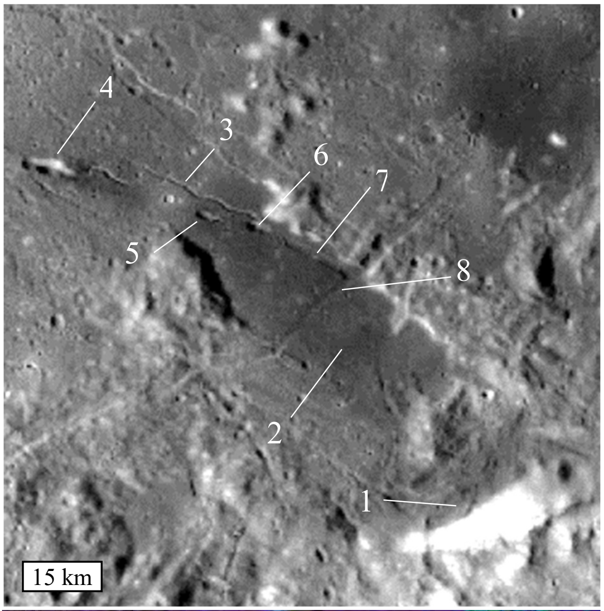
We then used ENVI to analyze spectra from Regions of Interest covering the LPD identified in literature [3], and regions identified in Table 1. Spectral parameter maps of targeted minerals were created individually and were overlaid on a Lunar Reconnaissance Orbiter Wide Angle Camera (LRO WAC) basemap in ArcMap (see Fig. 2 for glass band parameter map). Further characterization of spectra of the Mozart LPD, Mozart rille, and Lacus Mozart are reported here.

No.	Feature and identifier	Feature type
1	Mozart LPD [3]	Pyroclastic deposit
2	Lacus Mozart	Mare deposit
3	Mozart rille	Sinuous rille
4	Kathleen crater	Rille source vent
5	Ann crater	Pyroclastic vent
6	Michael crater	Pyroclastic vent
7	Patricia crater	Pyroclastic vent
8	Rima Bradley	Linear rille

Table 1: Features identified in Figures 1 and 2.

M^3 Results: Mozart LPD was originally identified as a "dark mantled valley" (#1 in Fig. 1 and 2, [3]) and prior studies indicate TiO_2 results similar to those of Rimae Fresnel and Rima Hadley pyroclastic materials [4]. Areas with the lowest albedo have the highest FeO contents, which would be consistent with an LPD. We find that the Mozart LPD has a very weak glass signature in the M^3 glass band parameter map (Fig. 2) and did not contain definitive characteristic indicators of basaltic pyroclastic material (e.g., strong 1 µm and/or 2 µm absorption features) or a significantly low albedo relative to other materials in the area.

Spectral analysis of Kathleen crater depression (which appears to be the "cobra head" or source vent of Mozart rille) is consistent with an LPD: it exhibits strong glass parameter values compared to surrounding materials (particularly on the eastern rim, in the direction of travel of Mozart rille, see Fig. 2) and contains characteristic 1 µm and 2 µm absorption features expected of pyroclastic deposits of basaltic composition. Ann crater and Michael crater also exhibit areas with strong glass parameter values surrounding the depressions, particularly in the direction of travel down-flow of the crater within Mozart rille.



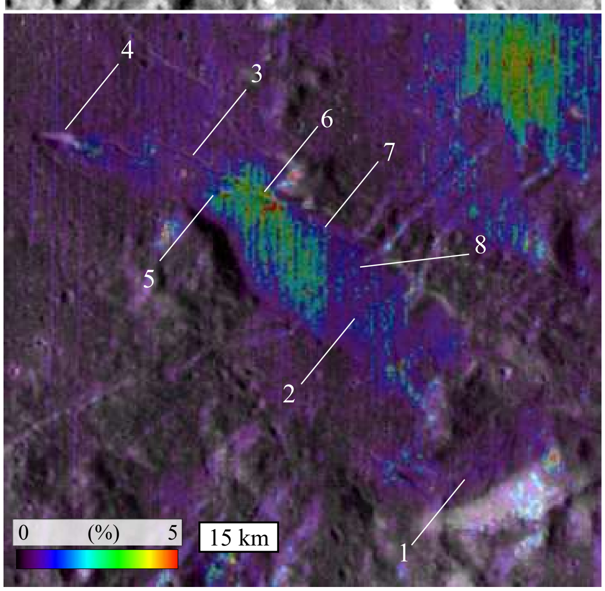


Fig. 1 (top): LRO WAC [5] mosaic of Lacus Mozart and associated features.
Fig. 2 (bottom): Glass parameter map mosaic (percent is glass band depth %) from M^3 overlaid on LRO WAC mosaic.
Labeled features are identified in Table 1

Additionally, a region of strong glass parameter values within Lacus Mozart, south of Mozart rille, is potentially indicative of a larger pyroclastic deposit that has not been previously identified. This area could be sourced from Patricia crater due to its proximity to Patricia crater and the strong glass parameter values of the vents along Mozart rille, and Patricia being the longest crater. No central vent structure was identified within the boundary of the region with strong glass parameter values. Currently, it is unclear if this large region is a yet-unidentified pyroclastic deposit, a glassy region that expands the extent of another pyroclastic deposit (e.g. near Kathleen crater or the dark mantled valley identified as the Mozart LPD), or a glass or olivine-rich region of unknown origin.

Interpretations and Future Work: Our results indicate that the Mozart LPD should no longer be categorized as a pyroclastic deposit as it does not meet established criteria to be defined as an LPD. To further investigate this hypothesis, we are continuing our spectral evaluation of this area and investigating supplementary datasets (e. g., Kaguya derived mineral maps).

We have confirmed that the previously recognized volcanic vents near Lacus Mozart (i.e. #3, #4, #6, and #7 in Figs. 1 and 2) sourced explosive volcanic deposits in addition to the effusive rilles. The presence of possible glass signatures surrounding these vents supports these as pyroclastic deposits, and we are using M^3 data for the first time to analyze these deposits and the surrounding areas to characterize the mineralogy and determine the relationship between the explosive and effusive features.

We have identified a large possibly glass-rich area within Lacus Mozart that could potentially represent a previously unidentified LPD. Further characterization of mineral and band parameter maps, spectra, and topographic renderings of the glassy region within Lacus Mozart is ongoing to characterize its relationship with other features or identify the variability of the strength of mineral and glass signatures to correlate the glassy region with other features (e.g. Patricia crater or other topographic depressions).

References: [1] Gaddis, L.R. et al., (2003) *Icarus, 161*, 262-280. [2] Head, J.W., (1974) *PLPSC 5th, 207-222.* [3] Blewett & Hawke, (2001), *Met. & Planet. Science, 36,* 701-730. [4] Hawke, B.R., et al., (1979) *PLPSC 10th, 2995-3015*. [5] Speyerer, E. J. et al., (2011) *LPSC 42nd, Abs 2387.* [6] Pieters, C. et al., (2009) *Current Science, 96* (4) 500-505. [7] Horgan, B.N.H., et al., (2014) *Icarus, 234*, 132-154. [8] Coombs, C.R., et al., (1988), *PLPSC 18th,* 339-353.