REGOLITH HISTORY OF THE TAURUS-LITTROW LIGHT MANTLE DEPOSIT: IMPLICATIONS FOR CORE SAMPLES 72001/2 .

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Introduction: The light mantle deposit in the Taurus-Littrow Valley is a unique geologic feature on the lunar surface, potentially representing multiple geologic events that led to its formation [1-5]. The ongoing study of the Station 3 core sample (73001/2) [6] by the Apollo Next Generation Sample Analysis Program (ANGSA) enables a modern study of a ~51 cm section of the light mantle deposit including the evolution of the regolith since its emplacement [7] in multiple events [2]. Using remotely sensed data, specifically data that highlight variations in regolith properties, of the Taurus-Littrow Valley we interpret the regolith history of the valley. In a companion abstract, compositional variations within the South Massif and the implications for the origin of samples are explored [8]. Collectively, remote sensing data of the Apollo 17 landing region provides critical geologic context for interpreting the history of samples collected during the mission. This geologic context serves as critial guides for the application of remote sensing data towards interpreting future landing sites, particularly those in complex geologic environments.

Remote Sensing Data: The enormous volume of data collected by the Lunar Reconnaissance Orbiter and other contemporary missions enables unparalleled insight into the Moon's surface. Relevant to the interpretation of the regolith history of Station 3 (Figure 1), are datasets that reveal variations in regolith properties. In Figure 1 we walk through multiple datasets and what they reveal about the Light Mantle Deposit.

Lunar Reconnaissance Orbiter Camera - Narrow Angle Camera: Images from the LROC NAC, specifically those taken with low solar incidence angles, reveal albedo variations that highlight differences in composition and exposure history [9]. In Figure 1 (top frame), a perspective view of the South Massif and Light Mantle deposit reveals shows the higher albedo in the "young" light mantle (the setting for Station 3) and relatively lower albedo in the "old" light mantle [2] (the setting for LRV 2 sample 72140). Of particular note in this view are the streaks of high albedo material on the South Massif, some of which correspond to compositional differences noted by Moriarty et al. [8]. Also note that the origin of the "old" light mantle appears to be sourced from approximately the lower portion of the South Massif.

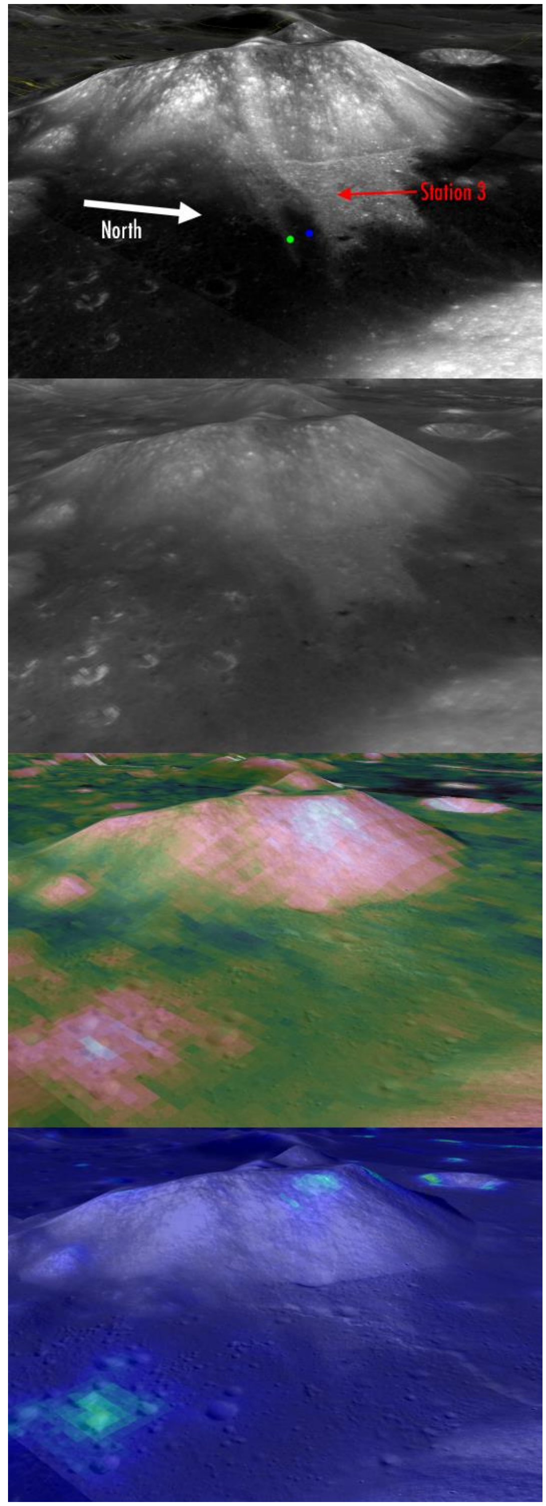

Figure 1. Multiple perspective views of the South Massif and Light Mantle deposits at the Apollo 17 landing region. Data are

from Lunar QuickMap. *Top Frame:* LROC NAC low incidence angle images with the locations of LRV-2 (green dot, 72140) and LRV-3 (blue dot, 72150) sample sites and Station 3. *Second Frame:* Kaguya Spectral Profiler Optical Maturity parameter. *Third Frame:* LRO Diviner derived h-parameter. *Bottom Frame:* LRO Diviner derived rock abundance.

Kaguya Optical Maturity Parameter: The mapping of variations in optical maturity [10, 11] is useful in identifying variations on exposure history particularly across geologic units of similar composition. In a companion abstract [7] maturity variations in 73001/2 are explored. Noting that within the core most maturity variations is due to regolith reworking of the upper few centimeters, across the region there are *at least* four distinct units that can be defined by maturity, presented from youngest to oldest surfaces. Some fraction of the core may contain fractional abundances of these units, with much of the core likely containing the "young" light mantle deposit.

Young Light Mantle: The young light mantle, as presented by Schmitt et al. [2] was triggered either by motion along the Lee-Lincoln Scarp or the emplacement of Tycho ejecta. This material has the lowest optical maturity of surfaces within the valley, beyond small arears around fresh craters. This material is likely best represented by the upper cm's of the core and surrounding surface regolith samples at Station 3. Lower (depths > ~5cm) in the core the maturity is approximately 2-3x higher than the uppermost portion of the core [7], likely due to space weathering of the surface over ~90 mya.

Old Light Mantle: The "old" light mantle deposit (sampled at the LRV 2 stop) represents an initial landslide unit, approximately 2x less mature in the orbital data. This reduction in optical maturity can be either due to it having been space weathered or the deposit being thinner than the "young" light mantle and having mixed more with floor material. Additional studies of the 72140 sample may aid in interpreting the origin of the landslide.

Shorty Crater Ejecta/Volcanic Glass: An additional albeit small unit is the ejecta around Shorty Crater and other small craters, including Victory Crater. These features may be indicative of volcanic glasses that have distinct spectral responses to space weathering. If this does indeed represent a signature of space weathering, this may be another method for identifying the distribution of volcanic glasses within the Taurus-Littrow valley.

Valley Floor Material: The mature regolith of the valley floor reflects the expected weathering patterns of the lunar regolith. This material can be identified within the Station 3 core as mare material and is certainly distinct from the light mantle and glassy material.

Diviner h-parameter: The Diviner instrument on LRO provides critical insight into the thermophysical properties of the regolith. The "h-parameter" provides insight into density variations in the upper few cm's [12]. The light mantle deposits do not present as having variations relative to the valley floor, beyond small areas that have thicker low-density surfaces (units in blue in Figure 1). This implies that the upper cm's regolith at Station 3 has matured similarly to the valley floor.

Diviner Rock Abundance: Perhaps not surprisingly the rockiest surfaces [13] associated with the light mantle are limited to steep surfaces at the South Massif and outside the deposit in the central cluster (Station 1). This strongly suggests that within the upper 10cm of the regolith the rock population (rocks >50 cm in diameter) is comparable to the rest of the valley floor.

Conclusions: Given the diversity of remote sensing datasets available for the Moon, we have an opportunity not only to revisit Apollo sites and our understanding of samples (particularly the "pristine" Apollo samples) to better interpret their geologic context and use that understanding to prepare for Artemis samples and *their* context. For example, the Apollo 17 Station 3 setting, with the light mantle deposit is potentially comparable to portions of the lunar south pole and the possible presence of distal ejecta from Tycho [14]. Certainly geologic relationships between multiple, overlapping ejecta deposits of craters [15] in the south pole presents a complex environment with which the lunar community will need to untangle. The interpretation of the Apollo 17 Station 3 core not only prepares us for such complex geologic relationships, it also points to the critical need for core samples from the south pole.

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