MODAL PETROLOGY OF THE <1mm FRACTION OF THE APOLLO 17 DOUBLE DRIVE TUBE 73001/2 AND COMPARISONS WITH NEARBY SAMPLES.
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Introduction: The double drive tube core sample (73001/73002), collected at Station 3 during the Apollo 17 mission, was taken within the light mantle deposit at the base of the South Massif of the Taurus-Littrow Valley. Orbital data suggest that this deposit represents multiple landslide events that were triggered by movement along the Lee-Lincoln scarp [e.g., 1] or impact events [e.g., 2,3]. Although numerous core and trench samples were collected during the Apollo program, including within the light mantle (landslide) deposit during the second EVA of Apollo 17, and numerous other landslide deposits have been identified on the lunar surface by orbital missions [e.g., 3], the Station 3 double drive tube is the only core to have penetrated a landslide deposit.

As part of the Apollo Next Generation Sample Analysis (ANGSA) program, double drive tube 73001/2 has been completely dissected and analysis of the samples is underway. Here, we present grain type distributions from sieved samples of <1mm material from 73002 (<20µm, 20-90µm, 90-150µm, 150-250µm, 250-500µm, and 500-1000µm). We compare the 90-150µm fraction from the core to those from nearby trench samples 73121 & 73141 (Station 2a trench), 73221-73281 (station 3 trench), and 71061 & 71501 (Station 1 mare soils). Examining these size fractions in 73001/2 will provide insight into: the evolution of regolith in a distinctly different environment than any other core sample taken from the Moon; landslide dynamics and triggers in a lunar environment; and highland lithologies from the South Massif, which would be otherwise inaccessible. Additional data will be presented at the Conference.

Methods: A total of 15 <1mm samples along the length of core 73002 and 10 samples from 73001 have been dry-sieved into the size fractions: <20µm, 20-90µm, 90-150µm, 150-250µm, 250-500µm and 500-1000µm. Each sample represents an average of a 0.5cm depth interval of the core, and a final sample, designated "Rind", represents the top 10cm of the outer portion of the core. Sieved fractions were weighed and mounted in epoxy on glass slides and polished to produce grain mounts at the University of New Mexico and Johnson Space Center. We are collecting backscattered electron maps and determining the modal petrology of each grain mount. Where possible, ≥300 grains are examined to produce modal petrology data using BSE maps and energy-dispersive analysis using the TESCAN Lyra3 scanning electron microscope at UNM equipped with an IXRF silicon drift energy-dispersive X-ray detector running Iridium Ultra software.

Results & Discussion: Multiple comparisons of clast distributions from both 73002 and nearby trenches are included in Figures 1-3.

Core stratigraphy: In Fig. 1, we show a progression of ten 90-150µm fractions going down the length of the core. The most significant change with increasing depth is a decrease in the concentration of agglutinates. The decrease is sharpest between the dark horizon at the top 5cm of the core and sloped transition to the grey lithology between 5 and 7cm. The transition continues below 7cm, but the rate is much reduced. There is an increase in both highland and basaltic lithic fragments as well as mineral and glass fragments below the upper, agglutinate-rich unit.

Comparison of size fractions: In Fig. 2 we show how the components of the regolith change with particle size within a single sample. We include every grain examined for each size fraction. Totals are as follows: <20µm = 1000 grains, 20-90µm = 1000 grains, 90-150µm = 2910 grains, 150-250µm = 1993 grains, 250-500µm = 424 grains, and 500-1000µm = 80 grains. Totals include all sections from 150-1000µm, 10 sections from 90-150 µm, and three sections each from <20µm and 20-90µm. There is a significant increase in the population of monomineralic grains with decreasing grain size, as most lunar rocks have grain sizes in this range or larger. The <20µm and 500-1000µm size fractions have the lowest agglutinate contents. In addition, there are only 2-4 agglutinates in the complete >4mm size fraction. This is due to fewer agglutinates forming larger than 500µm and those larger agglutinates which do form tending to be more fragile and break into smaller fragments. The final significant trend is an increase in the abundance of impact melt breccias, disproportionate to the decrease in concentration of monomineralics, as particle size increases. This is a result of the larger the size, the fewer breccias have been reduced to their individual components.

Comparisons to other Apollo 17 soil samples: The 73002 soils are significantly different from any other Apollo 17 regolith samples. Fig. 3 shows a suite of eight

90-150µm A-17 samples from [4]. Samples 73121 and 73141 were taken from the top and 15cm depths, respectively, of a trench dug at Station 2a in the light mantle, between the base of the South Massif and Station 3. Samples 73221-73281 are from a trench dug at Station 3 near the rim of a 12m crater. 73221 is described as a light-grey layer 1.5cm deep at the top of the trench, and 73241 is a darker layer which goes down 5cm below the surface mixed with the thin, upper layer. 73261 and 73281 are medium grey and white components, respectively of a mottled layer below 5cm. 73261 is described as "mixed". The final two samples, 71061 and 71501 are, respectively, a 5-6cm depth sample from a trench and a rake soil from Station 1, included as representative mare soils.

The 73002 soils have low concentrations of agglutinates compared to the surface soils. The highest concentration of agglutinates in the 90-150µm samples observed so far occurs at 2.0-2.5cm depth, with exactly 30% agglutinates, and the second being 3.0-3.5cm at 16.7% (Fig. 1). The only A-17 samples with agglutinate concentrations significantly lower than our dark-layer sample are 71061 and 73241 (Fig. 3), all samples from the core 70008 examined in [4], and those samples associated with the Station 4 orange glass deposit. The final major exception to the abundance of agglutinates found in A-17 samples is the drive tube 76001 [5], in which no fraction exceeds 10.2% agglutinates. Considering that: the 73001/2 drive tube is not anomalous (like the orange glass deposit); the majority of agglutinate-poor samples are in either cores or drive tubes; and that agglutinate formation is a surficial process, it is possible that the trench and rake sampling methods may have a tendency contaminate deeper samples with surface materials.

Our 73002 samples also have a much higher concentration of highland lithics than any sample examined by [4] and, intriguingly, is only approached by lithology A of drive tube 76001, in which 13.5% ANT fragments normalized to a matrix-free basis using optical point counting is reported [5]. This is not surprising, as 76001 sampled talus at the base of North Massif [5], while 73001/2 contains a relatively high concentration of lithologies from the highland slopes of South Massif. The lower concentration of highland lithics in other A-17 soils [4], in general, corresponds to the higher concentration of agglutinates, plus lower monomineralic, and in some cases (i.e. 73241) much higher breccia contents. Overall, none of the trench or rake samples examined previously from the light mantle of the TLV are representative of what we are observing in the double drive tube 73001/2.

References: [1] Schmitt H. (2017) *Icarus 298*, 2-33. [2] Arvidsson R. et al. (1976) *Proc. LSC* 7, 2817-2832. [3] Bickel V. et al. (2020) *Nature Communications*, *11*(1), 1-7. [4] Heiken G. and McKay D. (1974) *Proc. LPSC 5,* 843. [5] Papike J. J. and Wyszynski J. (1980) *Proc. LPSC 11*, 1609.

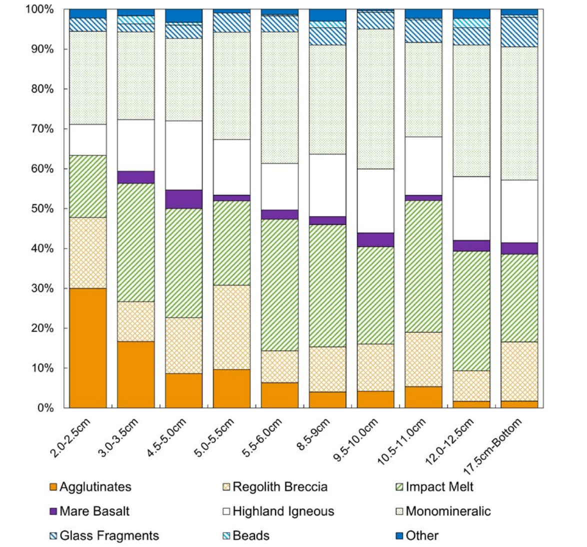

Figure 1: Clast distributions of all 90-150µm sections examined with representative depth ranges.

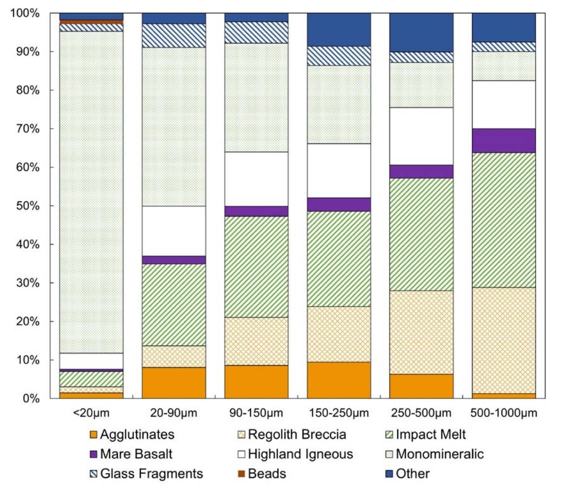

Figure 2: Bulk average clast distributions of all examined grains in each size fraction.

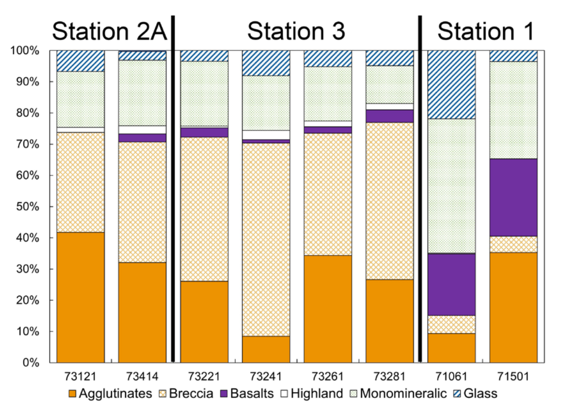

Figure 3: 90-150µm fractions of 8 soils from [4].