STRATIGRAPHY OF THE APOLLO 17 LANDSLIDE CORE 73002 FROM FMR MATURITY AND VNIR AND MÖSSBAUER SPECTROSCOPY.

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Introduction. A suite of samples from the Apollo missions to the Moon (1969-1973) were set aside and stored under controlled conditions to have unexamined lunar samples available decades later for analyses that take advantage of evolved sample handling techniques, maturation of then existing instrumentation, and development of new analytical techniques and instrumentation [e.g., 1]. One preserved sample is the Apollo 17 double drive tube core (73001/2) that was driven into the lunar surface on the landslide deposit at Station 3 on the South Massif in the Taurus-Littrow valley [2]. The deeper section (73001) was stored frozen in a Core Sample Vacuum Container (CSVC) to maximize preservation of lunar volatiles.

We report here, as a part of the Apollo Next Generation Sample Analysis (ANGSA) Initiative [1,3], stratigraphy for the upper core section (73002) with respect to maturity (ferromagnetic resonance (FMR) maturity index I_s/FeO [4-6]), visible-near-IR (VNIR) spectroscopy, and, for representative samples, grain-size analysis and Mössbauer spectroscopy. Stratigraphy provides data to model the dynamics of lunar landslide deposits and their post-emplacement evolution in comparison to impact-driven mixing on an airless body and stratigraphic context for volatile and (if any) organic behavior. Reported by [7] are preliminary results for multispectral imaging and hyperspectral scanning of the first dissection pass of 73002.

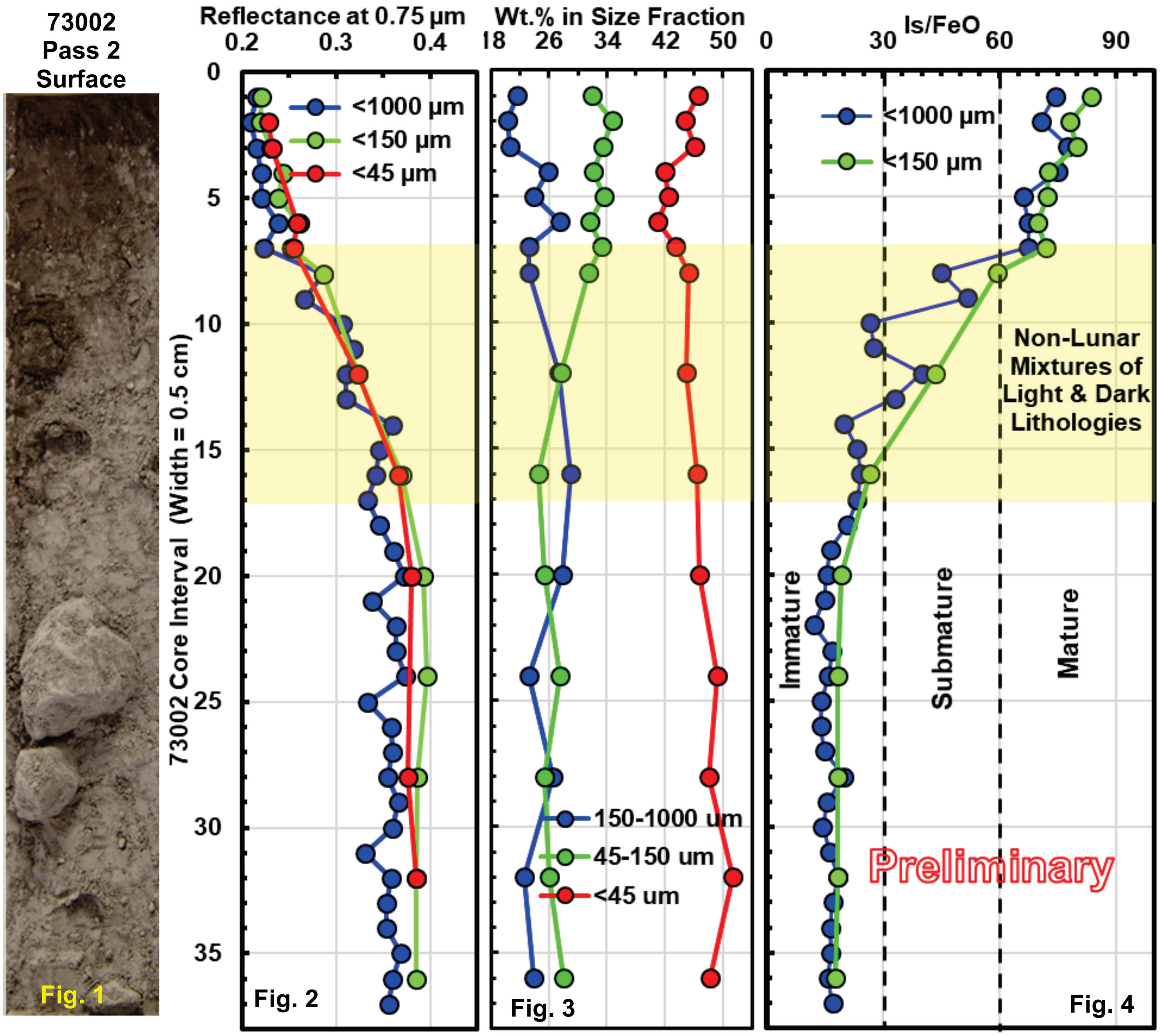
Samples and Methods. The sample allocation scheme was developed with the Apollo sample Curator to optimize science return and minimize allocation mass from the <1 mm size fraction (dry sieved) of regolith from 73002 dissection Pass 2. We analyzed 37 samples (~50 mg each) from contiguous segments (0.5 cm wide) for the length of core occupied by sample (13.5 cm) by FMR (for I_s) and VNIR. Afterwards, the 37 samples were transferred to Washington University in St. Louis for chemical analysis [8], including FeO to calculate I_s/FeO. For microbeam space weathering studies, samples from 15 representative core segments were allocated (~250 mg each) for grain-size distribution (<45, 45-150, and 150-1000 µm size fractions by dry sieving) with VNIR and FMR measurements completed and underway on <150 and <45 size fractions. Portions of the <45 µm fraction were provided for additional dry sieving (Purdue University) and microbeam analysis (Purdue and JSC) [8]. Samples (1-2 mg each) from the same 15 core segments were sent directly to University of Virginia and JSC for additional space weathering studies.

FMR spectra were recorded on a Bruker EMXnano electron paramagnetic resonance (EPR) spectrometer operating at a ~9.5 GHz over the field range 0 to ~0.6 T. The intensity of the resonance at g~2.1 from fine-grained metal, produced at the very lunar surface by micrometeorite impact (I_s), was calculated according to [1, 2] relative to a standard sample. Reflectance spectra (~0.4-2.5 µm) were obtained using an Muglight-configured ASD FieldSpec 3 spectrometer. Mössbauer spectra were acquired using MIMOS-II spectrometers equivalent to units onboard the Mars Exploration Rover (MER) mission [9]. Dry sieving of allocated <1 mm lunar samples was performed at 45 µm and 150 µm using Veco precision metal sieves. Instrumental analyses were non-destructive, non-contaminating, and made under ambient laboratory conditions.

Results and Discussion. A grey-scale image of the core surface before Pass 2 dissection is shown in Fig. 1. It shows the core dissection intervals can be roughly subdivided into three albedo units: (1) the upper 3 core intervals (~1.5 cm) have uniformly dark regolith across the full core width; (2) core intervals 4 through ~15 (2.0-7.5 cm) have both dark and light regolith; and (3) core intervals 15 through 37 have light regolith across the full core width. Because samples received for analysis are derived from the full width of each dissection interval, interpretation of data from the central albedo unit must take into account non-lunar mixing of dark and light lithologies.

The core albedo at 0.75 µm is shown in Fig 2. As expected from the core image (Fig. 1) and partial if not complete sample homogenization in each dissection interval, albedo is lowest near the surface (~0.23) and highest in the bottom half (~0.37) with an intermediate transition zone (yellow) whose albedo represents the relative proportions of high and low albedo material in each interval. A comparable albedo trend was observed by [8] for the Pass 1 core surface. The three size fractions (<1000 µm, <150 µm, and <45 µm) have overlapping albedo stratigraphy, presumably because high proportions of fine-grained material control the albedo. That this is the case is shown in Fig. 3 where the ~42 to 51 wt.% the total mass is present in the <45 µm size fraction. There was insufficient mass in the 150-1000 µm and 45-150 µm size fractions to obtain reliable VNIR spectra. The 45-150 um size fraction has consistently higher albedo than the 150-1000 µm size fraction in the upper 8 intervals (0-4 cm), implying the low albedo regolith is finer grained than the high albedo regolith

DRAFT LPSC53 ABSTRACT.



Stratigraphy for the I_s/FeO maturity index [6,7] is inverse that for the albedo stratigraphy (Figs. 2 and 4). Mature regolith corresponds to the low albedo unit at core top and vice versa for the high albedo unit at core bottom. Values of I_s/FeO for the intermediate albedo unit (yellow) are averages from mixing low and high albedo components during core dissection. The decrease in maturity from the surface to approximately interval 19 (~9.5 cm) interpreted as an in situ reworking depth implies a timescale of ~26 My years for its development [5]. Using the optical maturity (OMAT) profile from the Pass 1 surface, [7] placed the reworking depth at 14 implying an ~61 My timescale. Using our VNIR spectral data for Pass 2, we calculated its OMAT profile (not shown) and it gave the same reworking depth as the Is/FeO profile (~9.5 cm). Because the two profiles gave the same result for Pass 2, we speculate that the viewing conditions for Pass 1 measurements were sub-optimal.

Mössbauer spectra (not shown) for intervals 2 (mature, low albedo) and 32 (immature, high albedo) show that the iron of both is dominated by Fe^{2+} in pyroxene. Preliminary results indicate higher proportions of Fe^{2+}-bearing glass in interval 2 consistent with differences in maturity and concomitant formation of agglutinitic glass.

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