PRELIMINARY EXAMINATION PROCESS OF APOLLO CORE 73002 – INSIGHTS AND LESSONS LEARNED FROM ANGSA FOR FUTURE SAMPLE RETURN MISSIONS. J. Gross[1,2,3,4], C. Krysher[5], A. Mosie[6], R.A. Zeigler[1], F.M. McCubbin[1], C. Shearer[4,7], and the ANGSA Science Team[8] (jgross@eps.rutgers.edu). [1]ARES, NASA Johnson Space Center (JSC), Houston, TX 77058; [2]Dept. of Earth & Planetary Sciences, Rutgers University, Piscataway, NJ, 08854; [3]Dept. of Earth & Planetary Sciences, American Museum of Natural History, New York, NY 10024; [4]Lunar and Planetary Institute, Houston TX 77058; [5]HX5 - Jacobs JETS Contract, NASA JSC, Houston, TX 77058; [6]GeoControl Systems - Jacobs JETS Contract, NASA JSC, Houston, TX 77058; [7]Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131; [8]www.lpi.usra.edu/ANGSA/teams/

Introduction: Apollo Sample 73002 is part of a 2-foot long "drive tube" (73001/73002) of regolith that was collected near Lara Crater at the Apollo 17 site, Station 3. The double drive tube is believed to have penetrated a lunar landslide deposit that was transported from the slope of the South Massif into the Taurus-Littrow Valley [1]. As part of the ANGSA (Apollo Next Generation Sample Analyses) initiative, preparing a preliminary examination (PE) catalog of 73002 is a crucial first step for the early identification of material types such as rock fragments and potential stratigraphy within the core. PE of Apollo core 73002 is distinct from science activities; the main goal is to produce a sample catalog with a level of detail about sample characterization that is sufficient for the ANGSA PIs (and later the lunar sample community) to select and request the samples to conduct their individual, scientific studies.

Ultimately, the PE catalog of 73002 will help to establish a better understanding of the stratigraphy of the landslide deposit; the processes of the landslide, including the trigger(s) and possibly the total number of landslide events, as well as the role of volatiles in the event [1]. It will also aid in the careful preservation of the material for future studies [2].

Preliminary Examination: On November 5, 2019, sample 73002 was successfully opened and extruded after careful and diligent preparations [3]. Processing the core is a painstakingly diligent, albeit necessary, process aimed to maximize the scientific return of the sample. This process includes documentation of sample properties for the PE catalog and can be divided into two main stages, each revealing important information: processes prior to opening the core sample and processes after opening the core sample.

PE processes prior to opening the sample: Prior to opening the sample, the entire core tube was scanned using X-Ray Computed Tomography (XCT) to facilitate non-destructive, rapid detection of minerals, lithic clasts, and void spaces within the drive tube. The XCT data was crucial in helping us to identify and avoid potential pitfalls before, during, and after opening and extruding the core. Further, the data was used during the dissection process to anticipate when and where void spaces could be encountered, and thus identify regions where the core would be particularly friable, as well as where and when larger rock fragments and clasts would be encountered. Knowing ahead of time what to expect helped to circumvent problems and allowed us to take counter measures (e.g. video recording of loose intervals) to maximize sample integrity, and thus, minimize science loss. This decreased the pressure and stress-level of the processors immensely.

PE processes after opening the sample: Processing the core after opening and extruding happens in several stages: 1) The core is dissected in three passes: top part, middle part, lower part (Fig. 1). Each pass is subdivided into 0.5mm wide intervals (37 intervals total) with about ~1cm height. The leftover core after the 3rd pass is impregnated with epoxy and turned into thin sections.

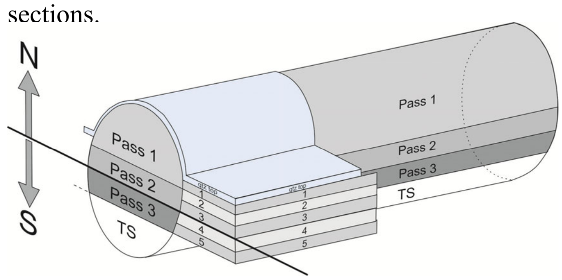

***Figure 1**: Sketch of 73002 core with locations of each pass. For pass 1 the quartz top (light blue) and the first plate (gray) was removed. Two more plates are removed for each subsequent pass. TS = Thin Section.*

Preliminary Examination Catalog: In its current state, the PE catalog is a living document and includes:

1) an image database core images taken during and after dissection of each interval. These images are taken at different angles and with different lighting conditions to capture the nature and morphology of clasts, rock fragments, cross section, plate level surface of the core, etc.;

2) an interval inventory database that includes all information pertaining each interval, from the weights of all size fractions present per interval per pass, dates, depth of each interval (Fig. 2), etc.;

3) a particle database of all ≥4mm clasts and rock fragments that were removed from the core during dissection. More than 80 of the 128 particles from pass 1 and 2 have been scanned. The particle database includes the XCT-dataset for each scanned particle, a

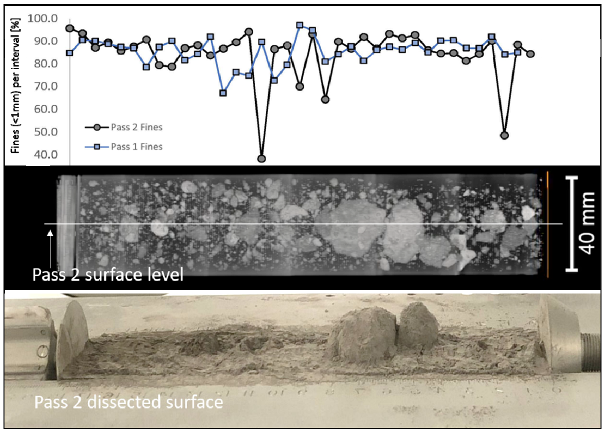

Figure 2: *The combination of digital image (bottom), XCT scan (middle), and relative % of fines per interval (top) can reveal important information about clast densities, stratigraphy, and compression within the core.*

preliminary classification of the lithology for each clast and rock fragment, as well as an initial description of each clast and rock fragment that was scanned;

4) the dissection notes and digitized sketches for each interval that capture the characteristics of the core such as color, texture, grain size, compactness, locations of clast and rock fragment, and other noteworthy information (Fig. 3).

Lessons learned: 1) Consistency is most important (Fig. 1,3). This includes consistency when taking notes (e.g. direction of the core - top vs bottom; N vs. S; plate level vs. surface, etc.); consistency when digitizing the sketches (Fig. 3), and consistency in taking images (angles, lighting condition, and amount of images taken) during the dissection processes (Fig. 2). This will prevent information loss and ultimately prevent science loss during the dissection process. 2) XCT scanning is a crucial step during all stages of PE. During extrusion of 73002, the core got compressed due to large void spaces that were present in the core where material fell out during collection on the lunar surface. The core compressed about 1.5cm from 20cm prior to extrusion down to 18.5cm after extrusion. It is unclear where the compression happened. However, with the XCT data of the core, in combination with the individually scanned particles, the interval database, and digitized sketches it is possible to reconstruct in which areas the compression most likely took place (Fig. 2). Furthermore, XCT data of the full core helped alleviate pressure and stress during the dissection process and allowed us to anticipate and circumvent potential problems prior to opening and extruding the core. XCT scanning of the individual particles has revealed a wealth of information about the mineralogy and textures in the particles in the core and has led to the unambiguous classification of many different rock types within the core [4]. This non-destructive method is an invaluable source of information for the science community and critical when allocating specific lithologies (e.g., basalts vs impact-melt breccias) for detailed analyses and targeted investigations. 3) Digitizing the dissection notes and sketches is very time consuming. 4) Including the ANGSA Science PIs to help during the dissection process is important but time consuming as it includes training on the equipment (camera and note taking) as well as daily pre- and de-briefs to ensure consistency. During pass 1, two ANGSA scientists per week were included in the dissection process, and it took 11 weeks to finish dissecting pass 1. Due to COVID-19 restrictions, ANGSA Science PIs could not be included during the dissection of pass 2. However, because of the increased consistency of just the core team present during the process, as well as lessons learned from pass 1, we were able to dissect pass 2 within three weeks.

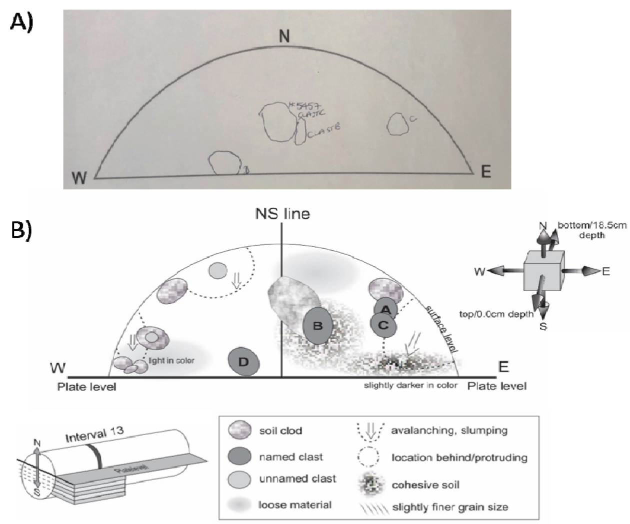

***Figure 3**: **A)** Sketch of an interval cross section with locations of clasts. **B)** Digitized sketch of the same interval taking into account the notes taken during processing to maximize the information per sketch.*

Conclusion: Processing Apollo core 73002 and other future ANGSA samples and creating an informative PE catalog are invaluable activates that yield critical information for the lunar community. This activity has also prepared us for future human exploration and sampling missions like OSIRIS REx and Artemis. Furthermore, these processes enable new scientific discoveries about the Moon and our solar system.

References: [1] Schmitt H. (2017) *Icarus 298*, 2-33. [2] McCubbin et al. (2019) *Space.Sci.Rev.* 215:48 [3] Krysher et al. (2020) *LPSC 51st,* #2989; [4] Zeigler et al. (2021) *LPSC 52nd this meeting.*