X-RAY COMPUTED TOMOGRAPHY DURING PRELIMINARY EXAMINATION OF APOLLO DRIVE TUBE 73001

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Introduction: Starting in 2019, the Apollo Next Generation Sample Analysis (ANGSA) Program has enabled consortium studies of specially curated Apollo samples that were previously unstudied (or under studied). This began with unsealed core tube 73002 [1,2] that is the upper part of a station 3 double drive tube. More recently the program extended to the study of a variety of frozen Apollo 17 samples [3], as well as the gas extraction [4] and dissection [5] of 73001, the lower half of the station 3 double drive tube, that was sealed under vacuum on the Moon. In this abstract we will examine the role of X-ray Computed Tomography (XCT) during the preliminary examination process for sealed core 73001, including: (1) engineering scans to aid in understanding the gas extraction process, whole-core scanning prior to opening to inform extrusion and dissection work, and (3) individual particle scanning to characterize rock fragment lithologies for follow on studies.

Methodology: Sample 73001 is a 33 cm long, 4 cm diameter regolith sample collected inside a drive tube (~1 mm aluminum walls). That drive tube was sealed inside a 0.5 mm thick stainless steel (SS) Core Sample Vacuum Container (CSVC). XCT scans for engineering purposes were done on the Nikon XTH 320 system at Johnson Space Center using the 225 kV multi-metal reflection source at 215 kV, 179 µA, and a 38.49 µm voxel size. Individual >4 mm particles separated from the core during processing (then triply sealed in Teflon bags) were also scanned at JSC using the 180 kV source at 90 kV, 33 µA, and a 2.98 – 10.65 µm voxel size. Whole-core scans were done at the University of Texas High-Resolution X-ray Computed Tomography Facility (UTCT) on the 225 kV reflection source on the North Star Imaging cabinet XCT system. These scans included: (1) a series of 9 overlapping super-resolution scans each covering a ~4 cm length of the tube at 190 kV, 180 µA, and a 12.9 µm voxel size and (2) a lower resolution continuous helical scan of the entire core at 190 kV, 180 µA, and a 51.8 µm voxel size.

Progress and Results: Before piercing and extracting the gas from sample 73001, an XCT scan of the bottom portion of the CSVC was used to confirm the location of the Teflon cap on the inner drive tube, to ensure it was not accidentally pierced during gas extraction. Similarly, after piercing, the bottom and top portions of the CSVC were scanned in order to capture engineering knowledge about the results of the piercing process, as well as the metal knife edge vacuum seal (SS into In-Ag alloy). Both scans will provide constraints on future work of this type, particularly for samples collected during the Artemis mission. Another finding from these "engineering" scans was that the device in the drive tube that immobilizes the regolith (the keeper) was not seated in the tube properly. This meant that (1) the drive tube could not be removed from the CSVC for the trip to UTCT, and (2) the procedure for opening and extruding the drive tube had to be modified. Had either of these things not been known prior to opening the CSVC, it could have led to an inability to XCT scan the whole core at high resolution and/or potential disruption of the core stratigraphy during extrusion. At UTCT, the entire length of the core was scanned at high resolution (12.9 microns per voxel). This scan serves multiple purposes: (1) A lower resolution (and uncorrected) version of these scans stitched together was used to help inform the processors of potential pitfalls during extrusion and dissection; and (2) the full resolution corrected data will serve as the permanent in situ record of the stratigraphy of the sample and will enable future researchers to perform a variety of analyses. So far, 92 of the 121 >4 mm particles separated during dissection pass 1 of sample 73001 have been individually scanned. These scans clearly show the lithology of each particle while keeping the particles in pristine condition. Because of the dust adhering to particle exteriors it would otherwise be impossible to determine lithologies in a non-contaminating way. Thus far the types of lithologies seen in sample 73001 (e.g., regolith breccias, impact-melt breccias, agglutinates, and basalts) are similar to those previously identified in sample 73002 [2]. By the time of the meeting, all particles from all 3 dissection passes will have been scanned and statistics on the different lithologies in 73001 compiled.

References: [1] Shearer et al. (2020) 51st *LPSC,* abstract 1181. [2] Zeigler et al. (2020) 51st *LPSC,* abstract 3023. [3] Kent et al. (2022) *This Volume*. [4] McDonald et al. (2022) European Lunar Symposium. [5] Gross et al (2022) *This volume*.