CHARACTERIZATION OF ROCK FRAGMENT 73002,1017C: AN UNUSUAL LITHOLOGY WITHIN THE APOLLO SAMPLE SUITE. C. J.-K. Yen[1], B. L. Jolliff[1], R. A. Zeigler[2], J. Gross[2,3,4,5], S. B. Simon[6], S. A. Eckley[7,8], C. K. Shearer[5,6], and The ANGSA Science Team[9]. [1]Dept. of Earth and Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 (yenc@wustl.edu); [2]ARES, NASA Johnson Space Center (JSC), Houston, TX 77058; [3]Dept. of Earth & Planetary Sciences, Rutgers University, Piscataway, NJ, 08854; [4]Dept. of Earth & Planetary Sciences, American Museum of Natural History, New York, NY 10024; [5]Lunar and Planetary Institute, Houston TX 77058; [6]Dept. of Earth and Planetary Science, Institute of Meteoritics, University of New Mexico, Albuquerque, New Mexico 87131; [7]Jackson School of Geosciences, University of Texas at Austin, Austin TX; [8]Jacobs Technology, Johnson Space Center, Houston, TX; [9]includes all members of the ANGSA Science Team, which includes members of the JSC curation team.

Introduction: The Apollo Next Generation Sample Analysis (ANGSA) initiative can be described as a technology handshake between Apollo and Artemis. New technology developed in the decades following the Apollo program can offer new insights into lunar samples, such as the preserved double drive tube 73001/73002 collected at Apollo 17 Station 3 [1,2]. This double drive tube collected soil from a ~100 Myr old avalanche deposit from the South Massif of the Taurus-Littrow Valley [3] and potentially sampled previously unknown lithologies that could yield new insights into lunar magmatic and thermal histories [1]. We surveyed the micro-X-ray computed tomography (μXCT) data collected on >4 mm rock fragments in 73002 and observed an unusual magmatic lithology represented by fragment 1017C.

Rock fragment 73002,1017C (Fig. 1) was located in the 2-2.5 cm depth interval beneath the surface, and weighs 0.050 g. Its lithology is consistent with a porphyritic basalt, comprised of a plagioclase or glass-rich groundmass and two types of mafic phenocrysts: (1) large darker zoned grains, and (2) smaller, brighter, unzoned grains. The sample does not show evidence of being a breccia. The unusual texture in ,1017C prompted a search through the Apollo 17 sample catalog, with a focus on samples collected at Stations 2-4 [4-6], and the lunar meteoritical bulletin database. Thus far, this exact texture has not been found in the existing lunar sample collection, however, two other 73002 fragments (,1121B and ,1125A) are potentially related to ,1017C.

Methods: All rock fragments in 73002 were scanned using μXCT by the Nikon XTH 320 at NASA's Johnson Space Center (JSC) [7-8]. μXCT data of ,1017C was collected with the following scan parameters: 180kV transmission target source, 110kv, 2.0 W, no filter, 2.00 s exposure, 2 frame average per projection, and 2521 projections, yielding 1571 slices with a voxel size of 2.91 μm. This process was non-destructive and yielded a 3D image set and demonstrated the benefits of this technology for non-invasive characterization of samples leading to more efficient and effective selection for consortium studies [9]. We analyzed the μXCT data in the software Dragonfly [10] to characterize and estimate the phenocryst sizes and modal volume proportions of phases (Fig. 2). To do so, we segmented the data into regions of interest (phases) using global grayscale thresholding and inspection of the histogram distribution [11].

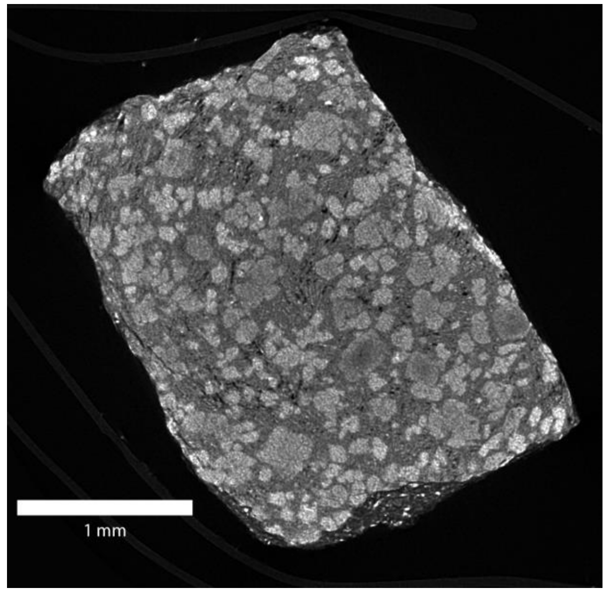

Figure 1. μXCT slice 895 of 73002,1017C showing the modestly vesicular, likely feldspathic matrix with roughly equigranular, mafic phenocrysts. Judging by the relative brightness of phenocryst grains, none are plagioclase. Any plagioclase present is in the fine-grained groundmass. The lack of significantly brighter grains reflects an absence of resolvable ilmenite grains.

Results and Discussion: We studied the μXCT data for ,1017C and characterized the fragment as a roughly 3×4×4 mm sample with a slightly vesicular, finely crystalline, plagioclase-rich to glassy matrix, and subhedral, roughly equigranular mafic phenocrysts. The grain sizes are <0.02 mm for the matrix, ~0.1-0.2 mm for the smaller, brighter phenocrysts, and ~0.4 mm for the larger, darker phenocrysts. Apparently bright grains occur near the edges of the sample (Fig. 1, 2), but these only occur along edges and are likely an artefact of the μXCT process (beam hardening). The sample is roughly

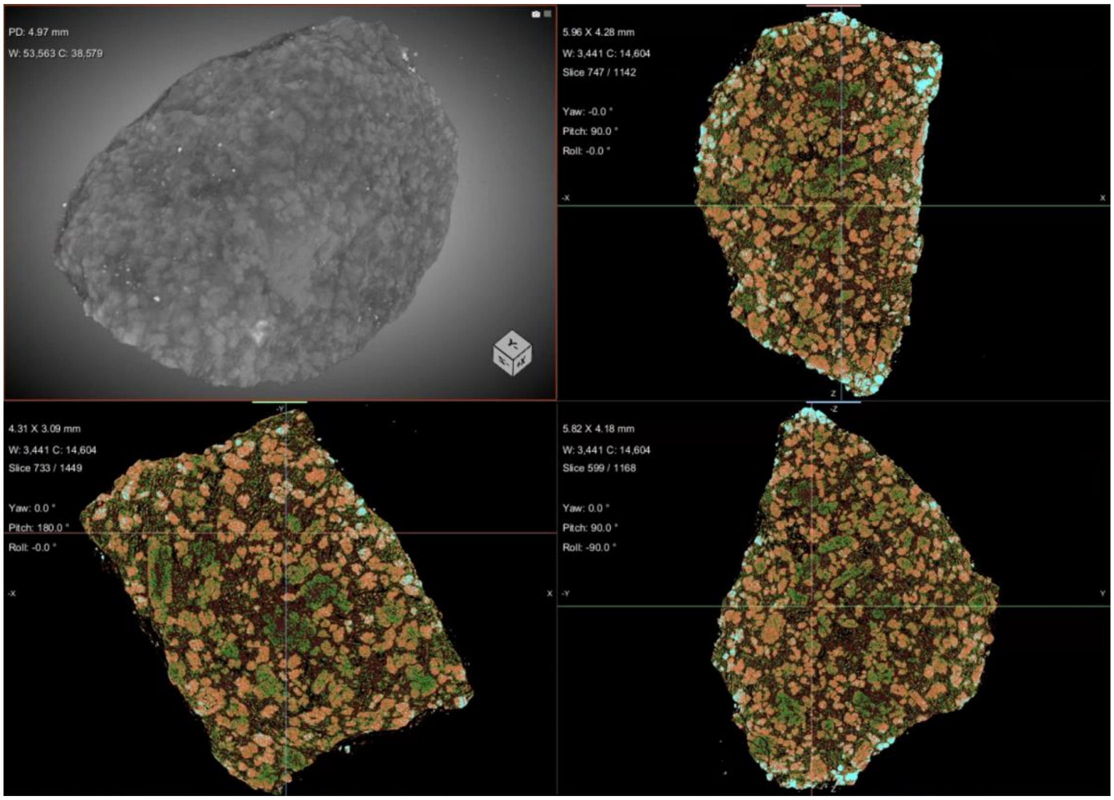

Figure 2. Analysis of all 1449 slices of the XCT data in Dragonfly [10], with the 3D view in top left and 2D orthogonal views in the other quadrants. The 2D views have been segmented into 4 regions of interest (phases): matrix (maroon), darker mafic phenocrysts (green), brighter mafic phenocrysts (orange), and brightest grains, possibly due to artefacts (cyan). Fields of view (x by y mm) noted in 2D views.

36:64 matrix:phenocryst by volume percent. Specifically, ,1017C is 36% feldspathic matrix (plagioclase or feldspathic glass), 23% coarser, darker phenocrysts, 37% finer, brighter phenocrysts, and 4% bright grains by volume. A subset of the data (35% of the volume) was used to estimate the air volume fraction, which yielded about 6% porosity. The phenocrysts are most likely olivine and pyroxenes, and show slight zoning, more so in the large grains. Sample ,1017C appears to lack x-ray bright phases such as metal, sulfides, and FeTiCr-oxides (e.g. ilmenite) that are typically seen in lunar basalts.

One limitation of μXCT data is that it does not provide precise quantitative chemical or mineralogical identification; we have instead relied on comparison to other Apollo samples of similar composition. Once thin sections of this sample are made, it will allow for precise compositional studies of this sample in 2D, which will help interpret the 3D data of the XCT scan. Two other fragments (,1121B and ,1125A) have similar suspect mineralogies, namely they appear to be fragments with pyroxene and olivine enclosed in plagioclase, albeit brecciated and without the vesicularity seen in ,1017C. Another unusual aspect of ,1017C that evades exact comparison is the exclusively mafic phenocryst population. Perhaps early olivine (coarser, darker grains) was replaced at the peritectic by pyroxene (finer, brighter grains), resulting in more ragged rims on the former (skeletal texture). In addition, olivine typically comes on the liquidus first, and thus olivine phenocrysts should be larger or at least comparable to pyroxene phenocrysts. The texture bears some resemblance to those of Apollo 12 and 15 pigeonite basalts, specifically the phenocryst and groundmass textures of ,1017C are perhaps comparable to those of basaltic fine 12070,891 [12,13]. Thus, preliminary examination and characterization of 73002,1017C reveals a rock fragment with an unusual lithology within the lunar sample suite that awaits further exciting study.

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