RESULTS FROM THE 1mm to 150µm FRACTION OF APOLLO 17 DRIVE TUBE 73002: MODAL PETROLOGY and NEW ROCK TYPES. S. B. Simon[1,2,3], M. J. Cato[2], C. K. Shearer[1,2,4], and the ANGSA Science Team[5]. [1]Institute of Meteoritics, Univ. of New Mexico, Albuquerque, NM 87131,[2]Dept. Earth and Planetary Sci., Univ. of New Mexico, [3]Field Museum of Natural History, Chicago, IL,[4]Lunar and Planetary Institute, Houston, TX, [5]all members of the ANGSA Science Team listed in https://www.lpi.usra.edu/ANGSA/teams/. (sbs8@unm.edu)

Introduction: As part of the Apollo Next Generation Sample Analysis (ANGSA) program, samples from previously unopened Apollo 17 double drive tube 73001/73002 are becoming available for study. The upper section, 73002, was extruded in late 2019. Dissection and sampling are being completed, and 73001 will be extruded in early 2022. This process includes sieving of the material into multiple size fractions. Here we report results from petrologic investigations of three size fractions (1000-500, 500-250, 250-150 µm) from seven depth intervals in 73002: "rind" (lunar surface); ,192 (1-1.5 cm depth); ,172 (5-5.5 cm); ,176 (9.5-10 cm); ,227 (15-15.5 cm); ,230 (16-16.5); and ,182 (17.5 to bottom of the column). Data for additional intervals will be presented at the Conference.

The double drive tube was collected at Station 3, within the "light mantle" deposit at the base of South Massif. 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]. It is expected to contain a variety of lithologies, including mare basalts from the valley floor and highland lithologies from the South Massif.

Methods: Bulk <1 mm soils were received at the University of New Mexico (UNM) and sieved into six size fractions, then mounted in epoxy and polished. Particles were identified and classified through backscattered electron imaging and energy-dispersive analysis (both qualitative and quantitative) with a TESCAN Lyra3 scanning electron microscope at UNM equipped with an IXRF silicon drift energy-dispersive X-ray detector running Iridium Ultra software.

Results: Petrographic observations and modal petrologies are summarized here.

1000-500 µm fraction. Only 53 particles fall into this size range. Nearly half (22, or 43.4%) are crystalline melt breccias (CMBs), rocks crystallized from impact melts, typically with coarse plagioclase clasts in a fine-grained matrix. The second-most common fragment type is regolith breccia (24.5%). The remaining particles are five anorthosites, a fragmental breccia, a feldspathic basalt, and an impact glass spherule.

500-250 µm fraction. This fraction has 235 particles. Here too CMBs and regolith breccias are the most abundant, but a wider variety of particles is observed, including agglutinates, Mg-suite rocks, mare basalts, and monomineralic fragments (Fig. 1).

250-150 µm fraction. There are currently 463 particles in the five sections for which data are available (the remaining two sections contain over 300 particles each). CMBs are most abundant in this size fraction as well, followed by monomineralics, igneous highland rock fragments, and regolith breccias. These are also important components of the 150-90 µm fraction of other light mantle soils [3].

To first order, the modal data indicate that the upper ~6 cm of 73002, with higher agglutinate, monomineralic and glass contents (Fig. 1), are more mature than the lower material, consistent with the observation, prior to sampling, that the upper material is darker in appearance than the lower material, the only easily visible transition in the column.

Summary of observed endogenous rock types. These range from rare to common and from highly fractionated felsites to basaltic and even ultramafic. Ilmenite-rich, high-Ti basalt fragments are present and multiple flow units and cooling histories are represented, as ilmenite ranges from acicular with armalcolite cores (Fig. 2a) to massive and blocky (Fig. 2b-d).

Mg-suite highland rocks, most types of which are found in 73002, are more abundant than mare basalts. They are classified based on their plagioclase:mafic, olivine:pyroxene, and orthopyroxene:clinopyroxene ratios [4], assuming the observed phase proportions are representative of their sources. Mg-suite members among the present samples range from anorthosites (most abundant) to gabbros, norites, and troctolites. Of the 31 anorthosite fragments, nine are ferroan anorthosites, identified based on their plagioclase compositions (An mol%) and the relatively low Mg#s (Mg/(Mg+Fe)) of their mafic silicates [5].

Examples of relatively common highland rocks are shown in Fig. 3a (anorthosite) and 3b (troctolitic anorthosite). Also shown in Fig. 3 are examples of rare, nonmare rock types. We found several coarse felsite fragments, dominated by silica, K-feldspar, and sodic plagioclase (Figs. 3c,d), one of which also contains finer-grained phosphate and zircon (high-albedo grains in Fig. 3c). Zircons in this and other samples provide targets for follow-on age-dating by NanoSIMS. An even more remarkable lithology, an unbrecciated, spinel-bearing dunite, is shown in Fig. 3e. This sample consists of sparse calcic plagioclase (An_{97}) and Mg-Al spinel

with ~8wt% Cr_2O_3 enclosed in forsteritic olivine (Fo_{94}). To our knowledge this lithology has not been previously reported among lunar samples. A possible mare impact melt (Fig. 3f) consists of skeletal ilmenite and lath-shaped olivine in a clinopyroxene host.

Discussion: Prior to the opening of 73002, only surface and trench soils from Station 3 of the Apollo 17 site had been studied. Drive tube 73001/2 penetrated the landslide deposit (the "light mantle") to previously unsampled depths; this soil column has great potential to contain previously unsampled rock types, and some evidence of that is seen here, with unusual felsites, spinel-bearing anorthosite, and an unbrecciated, spinel-bearing dunite found in a relatively small sample.

Despite the variety of mare basalts found (Fig. 2), the lithic fragment population in 73002 is dominated by highland lithologies, mainly Mg-suite members and impact melt rocks, probably derived from multiple horizons of the South Massif.

References: [1] Schmitt H. (2017) *Icarus 298*, 2-33. [2] Lucchitta B. et al. (1977) I*carus 30*, 80-96. [3] Heiken G. and McKay D. (1974) *Proc. 5th LSC*, 843-860. [4] Stöffler D. et al. (1980) *Proc. Conf. Lunar Highlands Crust*, 51-70. [5] Shearer C. et al. (2021) LPSC 52, abstract #1155.

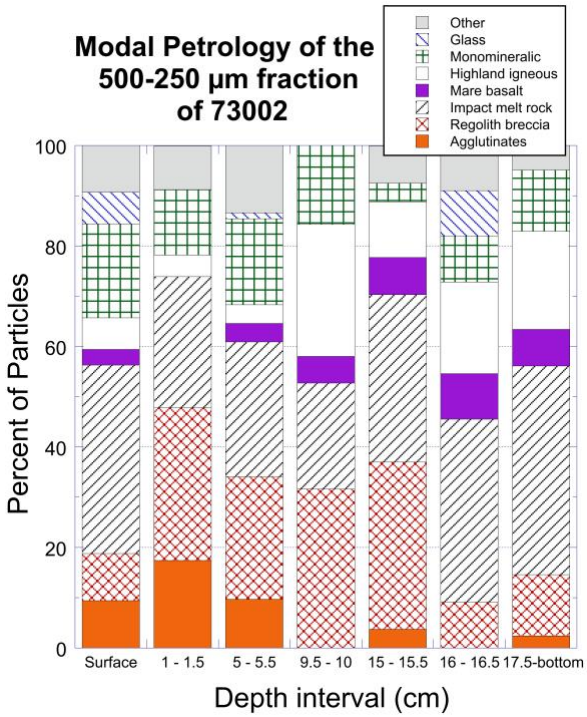

Fig. 1. Modal petrology of the 500-250 µm size fractions, determined by SEM/EDS, as a function of depth in 73002. Impact melt rocks are a significant component throughout the soil column.

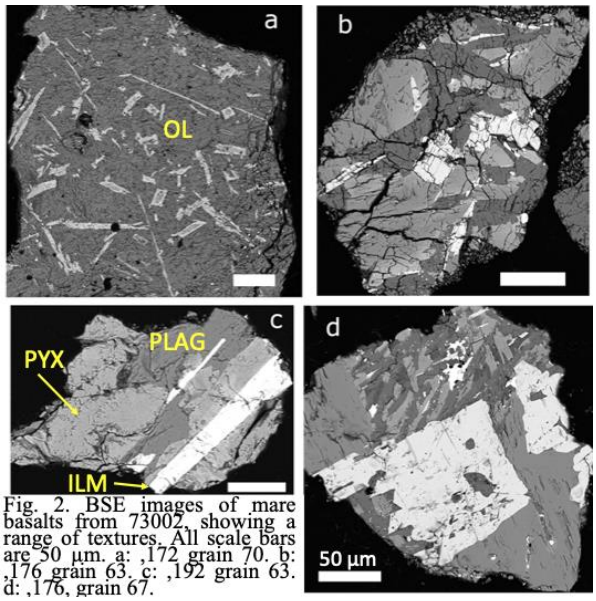

Fig. 2. BSE images of mare basalts from 73002, showing a range of textures. All scale bars are 50 µm. a: ,172 grain 70. b: ,176 grain 63. c: ,192 grain 63. d: ,176, grain 67.

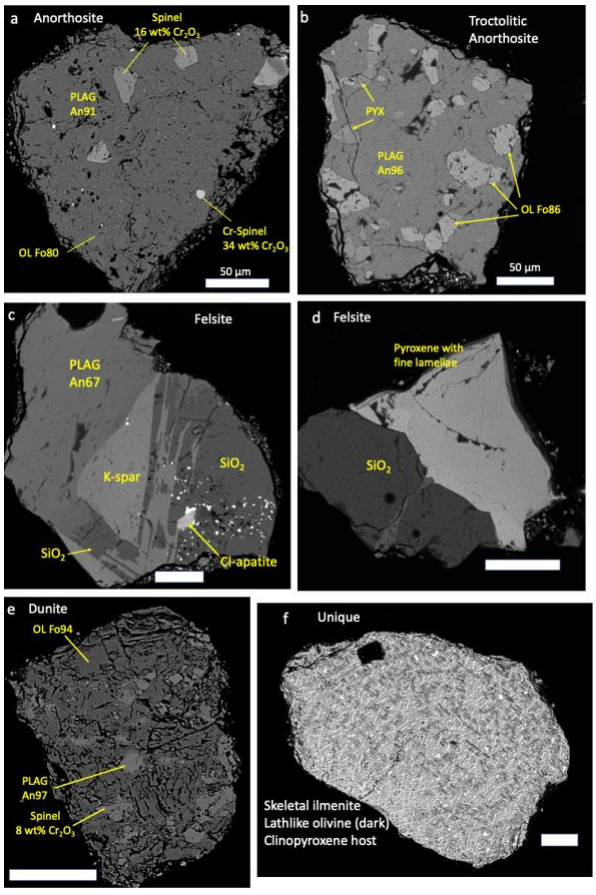

Fig. 3. BSE images of nonmare lithic fragments from 73002. Scale bars are 50 µm, all particles are in the 250-150 µm fraction except (f), 500-250µm. a) ,176 grain #50. b) ,182 grain #114. c) ,182 grain #46. High-albedo grains are zircons. d) ,182 grain #121. e) ,176 grain #26. f) ,227 grain #26.