IN SEARCH OF TYCHO EJECTA IN APOLLO 17 DOUBLE DRIVE TUBE 73001/2 USING CONTINUOUS CORE THIN SECTION QUANTITATIVE ANALYSIS. B. L. Jolliff[1,3], P. K. Carpenter[1,3], C. J.-K. Yen[1,3], M. D. Neuman[1,3], R. C. Ogliore[2,3], A. Minocha[2,3], and the ANGSA Science Team[4], [1]Department of Earth & Planetary Sciences, [2]Department of Physics, [3]The McDonnell Center for the Space Sciences, Washington University in St. Louis, MO 63130, and [4]www.lpi.usra.edu/ANGSA/teams/ (bjolliff@wustl.edu)

Introduction: The light mantle deposit at the base of South Massif, Apollo 17, may have been caused by ejecta from the formation of Tycho crater ~110 Myr ago [1,2]. Attempts to identify possible Tycho ejecta in Apollo 17 samples primarily focused on looking for materials exotic to the Apollo 17 site [e.g., 3]. Given currently available compositional and mineralogical remote sensing of Tycho crater and its proximal ejecta, plus LROC Narrow Angle Camera images showing what appears to be impact melt near the summit of South Massif and at the presumed top of the landslide slope, it may be possible to narrow the possibilities for Tycho material and search among glasses or fine-grained impact melt in the landslide deposit. The recently opened Station 3 double drive tube 73001/2 provides a new set of samples for this investigation. In the abstract we report initial efforts to search among glasses and fine-grained impact melt for exotic components that match the distinctive characteristics of Tycho ejecta.

Tycho Ejecta: As seen in the area of Tycho crater (Fig. 1), proximal ejecta have low FeO (4-5 wt.%), TiO_2 (<1 wt.%), and Th (<0.5 ppm) [4] (as a proxy for KREEP - potassium, rare earth elements, and phosphorus). Mineralogically, the continuous ejecta are rich in plagioclase (75-80 wt.%) and distinctively rich in high-Ca pyroxene (HCP) (7-15 wt.%), with 5-10 wt.% low-Ca pyroxene (LCP), and low (1-3 wt.%) olivine [5]. Accordingly, we searched for compositions with similarly low FeO, TiO_2, and K (which correlates with Th). We also compared normative mineralogy for glass compositions to search for those that would form from melt of target rocks rich in plagioclase and HCP, i.e., gabbroic anorthosite.

Searching the Continuous Core Thin Sections: Here we report on glass and impact-melt clast compositions in the continuous core thin sections to seek new candidates for Tycho impact melt, expected from remote sensing to be FeO-poor and of gabbroic anorthosite composition. We also collected data for glasses and impact melt that would represent typical Apollo 17 lithologies, for comparison.

Double drive tube 73001/2 was collected at station 3, located on the light mantle deposit at the base of South Massif [6]. In this work, we use the 73002 continuous core thin sections and quantitative EPMA mapping as described by [7,8]. We included glass fragments, vitrophyres, and very-fine-grained impact melt and impact-melt-breccia matrices using the "Q-tool" [7]. Examples are shown in Fig. 2. We retrieved the bulk compositions with oxide sums ranging from 97 to 101 wt.% for 45 clasts in four thin sections, 73002,6015-6018. These included glass compositions representing local regolith (glass fragments and agglutinitic glass), impact-melt components representing various impact-melt breccias, and FeO-poor, feldspathic compositions that potentially represent Tycho impact-melt components. Each composition represents an average of between 25 and 15,000 pixels (quantitative X-ray spot analyses [8]) and clast sizes range from ~80 μm to >1 mm.

Results and Discussion: In our data retrieval, we avoided mare lithic fragments and volcanic glasses, and single-mineral clasts or coarsely crystalline materials. The dataset is not intended to reflect relative proportions of different compositions, but instead to reflect the occurrence of specific components.

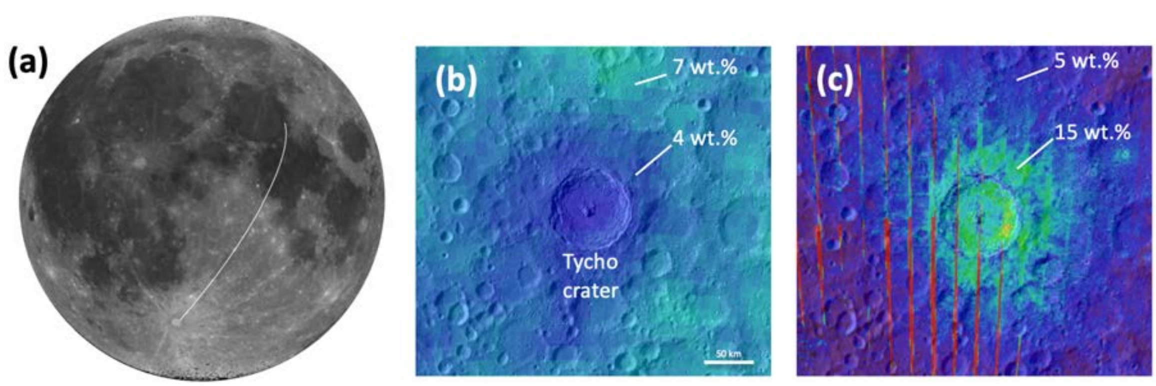

Figure 1. (a) Schematic trajectory of ejecta from Tycho crater to Taurus-Littrow Valley. (b) Lunar Prospector Gamma Ray Spectrometer (LP-GRS) FeO [4] overlay on LROC WAC basemap. (c) Clinopyroxene from SELENE spectral data [5] overlay on LROC WAC basemap (figures constructed using Lunar QuickMap, e.g., see https://bit.ly/3Gt2qBr for (c)).

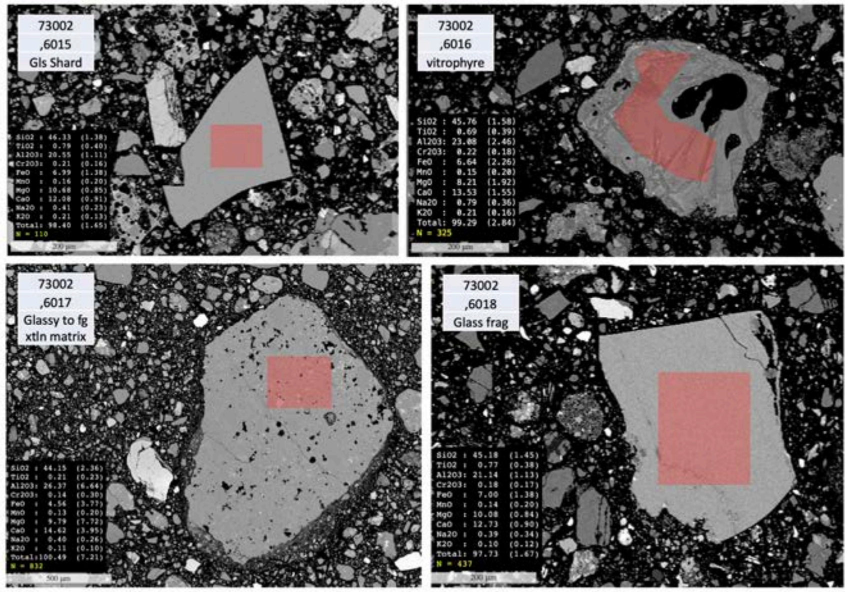

Figure 2. Examples of clasts in continuous core thin sections with compositional retrieval areas indicated by pink regions. All four represent relatively feldspathic compositions. Scale bars in lower left of frame.

Compositional plots such as FeO vs. TiO_2 (Fig. 3a) define distinct clusters of compositions. Apollo 17 mafic impact-melt breccias plot in the range of ~8-10 wt.% FeO and around 2 wt.% TiO_2. All of the ones in our selected set have an aphanitic matrix. Numerous compositions lie in the range 6-8 wt.% FeO and 0.5-1.2 wt.% TiO_2. These compositions cluster about the composition of Station 2A regolith clod 73131 [9], which we take to be an approximation of the mare-free composition of the regolith.

A third group has FeO values <6 wt.% and TiO_2 <0.6 wt.%. These materials may represent regolith and lithologic components formed prior to admixture with either mare components or impact-melt breccias that are characterized by enrichment in incompatible lithophile trace elements. We presume that the mafic impact-melt breccias derive from Serenitatis basin or possibly some other basin, thus the lithic components lacking these would represent pre-basin materials. These materials have predominantly noritic normative compositions (rich in LCP).

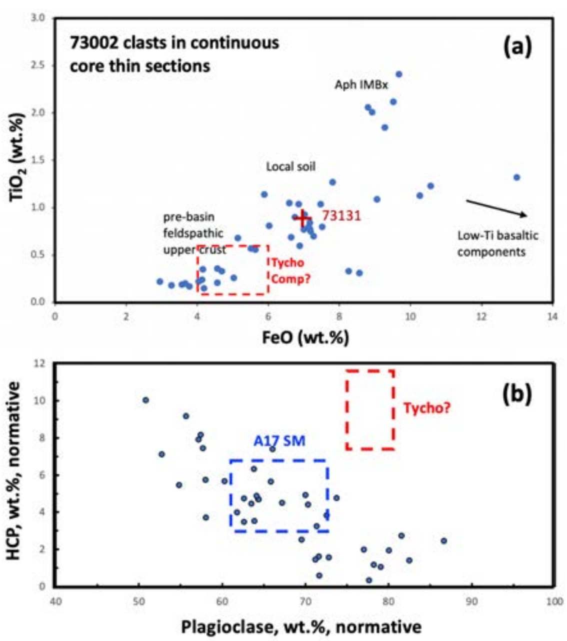

Figure 3. (a) Select set of compositions of clasts in continuous core thin sections, including agglutinate glass, glass fragments, vitrophyres, fine-grained impact melt, and aphanitic impact-melt breccia matrix. (b) Calculated normative plagioclase and HCP compositions of the samples in (a). SM: South Massif summit (remote sensing).

Tycho Material? Most of the compositions we encounter among the 73002 nonmare clast compositions are noritic (LCP >> HCP in the norm). We do find glassy components with very low FeO and TiO_2, and with very low incompatible element contents, judging by measured K_2O (~0.1 or less wt.%). However, the Apollo 17 array clearly is rich in LCP and poor in HCP (e.g., Fig. 3b), and relatively high in olivine content compared to what we expect for Tycho ejecta. We conclude that either we have not found a representative Tycho-derived melt clast, or the remote sensing about Tycho ejecta is misleading us. We will continue the search with 73001 as the data become available.

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