IDENTIFYING THE GEOLOGIC CONTEXT OF APOLLO 17 APHANITIC AND POIKILITIC IMPACT MELT BRECCIAS. Debra Hurwitz[1] and David A. Kring[1]; [1]Center for Lunar Science and Exploration, NASA Solar System Exploration Research Virtual Institute, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX, 77058, (hurwitz@lpi.usra.edu)

Introduction: The identification of the impact events that produced melt samples collected during the Apollo 17 mission to the Taurus Littrow valley remain controversial four decades later. Specifically, no consensus has yet been reached whether collected aphanitic and poikilitic samples were produced as a result of the Serenitatis impact [1-3], the Imbrium impact [4], a combination of both impact events [5], and/or as a result of another pre- or post-Serenitatis impact event [e.g., 6]. The uncertainty behind the source of collected samples engenders uncertainty in the implications of the measured sample ages and compositions. The current study uses high-resolution Lunar Reconnaissance Orbiter Narrow Angle Camera (LROC NAC) imagery and Lunar Orbiter Laser Altimetry (LOLA) topography data to investigate the geologic context and, thus, source(s) of aphanitic and poikilitic impact melt breccias.

Geology of Taurus Littrow valley: The Taurus Littrow valley is a graben oriented radially to the Serenitatis basin. The graben is bounded to the north and south by massifs, steep (~25°), relatively cohesive structures that rise to heights of 2000 and 2300 m, respectively, above the valley floor (Fig. 1). Astronauts Cernan and Schmitt observed "source-crops" of boulders on the upper one-half to two-thirds of both massifs and boulder tracks that connect these source-crops to boulders near the base of each massif [7]. The Sculptured Hills, as described by the astronauts on the surface, form a darker grey, hummocky unit that has been pockmarked with small craters and typically has more gradual though undulatory slopes (10°–30°). This unit lies atop the massifs or, in the vicinity of Station 8, drapes over the valley floor.

In some locations, both atop the massifs and on the valley floor, the terrain is covered with clusters of fresh superposed craters that are interpreted to have been emplaced ~100 Myr ago during the Tycho impact event [8]. Additional geologic units identified within the Taurus Littrow valley include mare basalts that cover the valley floor, a bright deposit that appears to have slumped from the South Massif, the Lincoln Scarp that crosses the valley, and Wessex Cleft, a saddle with darker deposits that lies between the North Massif and the Sculptured Hills unit to the east.

Impact melt samples were often collected from boulders at the base of massifs. As an example of their sources, we illustrate (dotted lines in Fig. 1b) the boulder tracks that lead to samples at Station 2 at the base of the South Massif (SM) and Station 6 at the base of the North Massif (NM).

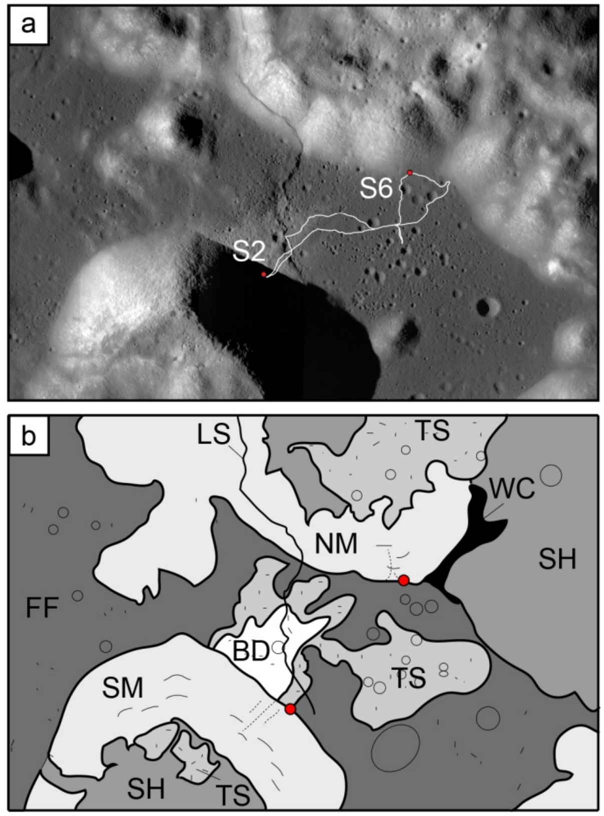

Fig. 1: Taurus Littrow valley shown in (a) LROC NAC images with the Apollo 17 traverse tracks noted, and (b) a preliminary geologic sketch map. Units include the North and South Massifs (NM, SM), the Sculptured Hills (SH), Tycho secondary crater clusters (TS), floor fill (FF), bright deposits (BD), the Lincoln Scarp (LS), and the Wessex Cleft (WC). Red dots note stations 2 (S2) and 6 (S6) where relevant samples were collected, and dotted lines above the red dots trace boulder tracks that lead to source outcrops on the massif walls. The scene is ~30 km across.

Relevant samples from Station 6: Multiple boulders can be traced to their uphill sources (Fig. 2). One of those boulders appears to have fragmented, producing a five-boulder cluster (red dot). Two representative samples are 76295, a blue-grey, nonvesicular impact melt breccia with an aphanitic matrix from Boulder 1, and sample 76315, a micropoikilitic impact melt breccia sampled from the "transitional zone" of Boulder 2. Sample 76295 contains a marbled texture of the tan and blue-grey breccias, while sample 76315 is a dark grey breccia with several lighter grey clasts. Both samples have

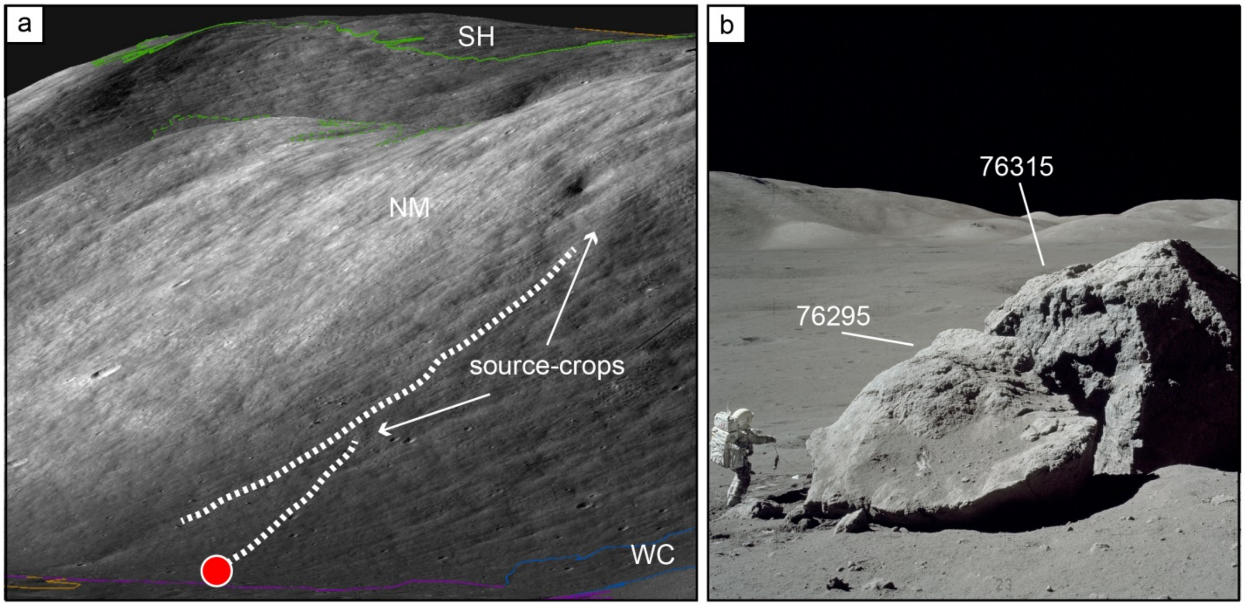

Fig. 2: (a) Perspective view of Station 6 using LROC NAC images overlain on Lunar Orbiter Laser Altimetry (LOLA) data. Samples were collected at the base of the North Massif (NM, red dot) from a boulder with a clear track from a "source-crop" about a third of the way up the massif (dashed line). The source outcrop is clearly within the NM unit and is not contaminated by Sculptured Hills (SH) or Wessex Cleft (WC) material. (b) Boulders 1 (left) and 2 (right) sampled by astronauts Cernan and Schmitt (shown, NASA photo AS17-140-21496). These boulders are interpreted to be fragments of a single boulder that rolled down the massif. Relevant samples for this study include 76295 (aphanitic melt breccia, Boulder 1) and 76315 (micropoikilitic melt breccia, Boulder 2).

similar petrography, with 50% plagioclase, 40% pyroxene (mostly low-Ca), and minor amounts of olivine, ilmenite, and other minerals [8,9]. The tan matrix of sample 76295 yielded an Ar-Ar age of 3.95 ± 0.04 Ga, and the blue-grey matrix of sample 76295 yielded an Ar-Ar age of 3.96 ± 0.04 Ga [10]. Similarly, sample 76315 yielded an Ar-Ar age of 3.900 ± 0.016 Ga [11]. The similarities in composition and age across the transitional zone suggests that both aphanitic and poikilitic breccias have the same source.

Results: A perspective view of Station 6 (Fig. 2) allows the boulders to be traced to their uphill sources that lie within the massif, not in the overlying Sculptured Hills formation. The source outcrop is not contaminated by either the darker Wessex Cleft (WC) material to the east or debris from the Sculptured Hills (SH) atop the North Massif (NM). Furthermore, there is no evidence of a fresh crater in the Sculptured Hills that could have redistributed SH material onto the slope of the NM. These high-resolution and topographically-draped images ease concerns [4] that the melts may be derived from the Sculptured Hills formation and, thus, potentially from the Imbrium basin.

Conclusions: The boulders sampled during the Apollo 17 mission originated from outcrops within massifs generally thought to have formed as a result of the Serenitatis impact event and blanketed by Serenitatis melt [e.g., 1]. If those samples were indeed produced by the Serenitatis impact event, then Serenitatis formed ~3.89 Ga in the midst of the lunar cataclysm. Three basins formed after Serenitatis and before Imbrium, which formed between 3.77 or 3.85 Ga [12], and eight basins formed prior to Serenitatis during the earlier part of the Nectarian. If, however, Serenitatis is stratigraphically older than Nectaris as has recently been suggested [4], then as many as 25 basins may have formed between Serenitatis and Imbrium, implying a much more intense basin-forming epoch than is currently recognized.

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