IDENTIFYING THE GEOLOGIC CONTEXT OF APOLLO 17 APHANITIC, OPHITIC, AND POIKILITIC IMPACT MELT BRECCIAS. Debra Hurwitz[1,2] and David A. Kring[1,2]; [1]Center for Lunar Science and Exploration, [2]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 remains controversial four decades later. To date, no consensus has been reached whether collected aphanitic, ophitic, 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]). This ambiguity exists, in part, because it remains uncertain whether samples are derived from the massifs or the overlying Sculptured Hills formation. The current study uses high-resolution Lunar Reconnaissance Orbiter Narrow Angle Camera (LROC NAC) imagery and Lunar Orbiter Laser Altimetry (LOLA) topography data to produce an updated geologic map (Fig. 1) and to determine whether boulders sampled at stations 2 and 6 originated from outcrops within the massifs or from a superposed unit. Images with varied solar azimuth angles (~90^o and ~270^o) were used to improve observations of source outcrops and their geologic context.

Landing Site Geology: The Taurus Littrow valley is a graben oriented radially to the Serenitatis basin. The graben is bounded to the north and south by massifs (NM, SM), steep (~25^o), cohesive structures that rise to heights of 2000 and 2300 m, respectively, above the valley floor. The origin of the massifs remains poorly understood. They may be constructed from pre-existing material uplifted and covered by ejecta during the Serenitatis impact, or they may be formed from material ejected during that basin-forming event (e.g., [1,7]).

Between the massifs, the valley floor has been flooded by mare basalts and locally deformed by the formation of the Lincoln Scarp. In some locations atop the massifs and on the valley floor, the terrain is covered with clusters of craters interpreted to be Tycho secondaries emplaced ~100 Myr ago [8]. A bright land slide deposit at the base of SM may also have been emplaced due to deposition of Tycho ejecta (e.g., [9]).

Another significant geologic unit is the Sculptured Hills (SH). Astronauts Cernan and Schmitt described this unit as a darker grey, hummocky unit with gradual though undulatory slopes (10^o–30^o) pockmarked with small craters [10]. This unit lies on top of the massifs or, near station 8, drapes over the valley floor. This unit is generally interpreted as Imbrium ejecta.

Astronauts' Perspective: Boulders were sampled at the base of SM and NM at stations 2 and 6, respectively. At the base of SM, boulders were observed to sit atop the bright landslide deposit. At the base of NM, a sampled boulder cluster lay at the base of a boulder track that connected to "source-crops" observed ~500 m above the valley floor [10]. These observations led to the interpretation that the boulders rolled downhill relatively recently (e.g., [10]), an interpretation that is supported by young exposure ages of ~35 Ma and ~20 Ma for stations 2 and 6 boulders, respectively (e.g., 11,12]).

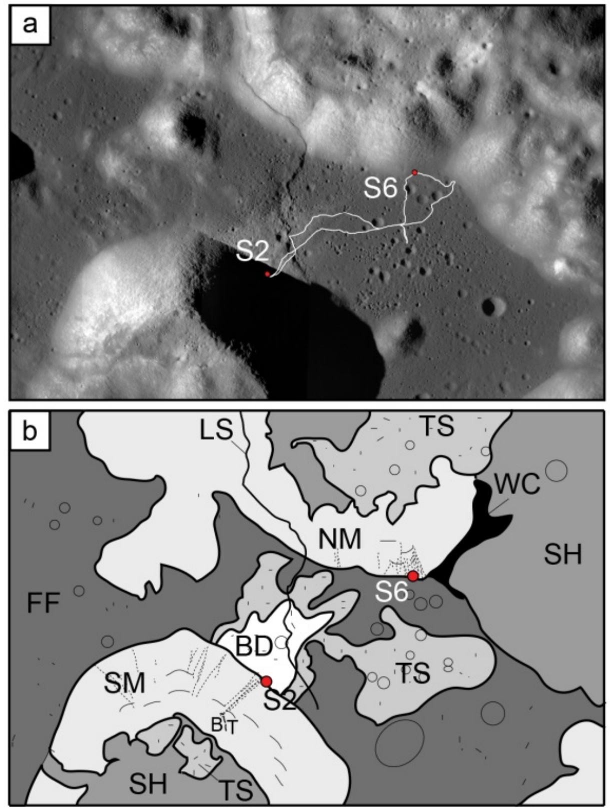

Fig. 1: Taurus Littrow valley shown in (a) LROC NAC images (azimuth ~ 90^o) with the Apollo 17 traverse and stations 2 (S2) and 6 (S6, red dots) noted, and (b) a geologic sketch map. Units include the North and South Massifs (NM, SM), the Sculptured Hills (SH), Tycho secondary craters (TS), floor fill (FF), bright deposits (BD), the Lincoln Scarp (LS), and the Wessex Cleft (WC), a dark saddle between NM and SH. Boulder tracks (dotted lines) lead to source outcrops (solid lines) on massif walls. Astronauts noted a contact between blue grey (B) and tan grey (T) breccia units on SM. The scene is ~30 km across.

New Results: LROC images were used to resolve 93 boulder tracks on both massifs and to further discern boulder source regions (e.g., dotted lines in Fig. 1b). The station 6 boulder has an associated track that directly connects the boulder to the source outcrop on the NM wall (Fig. 2). In contrast, the station 2 boulders

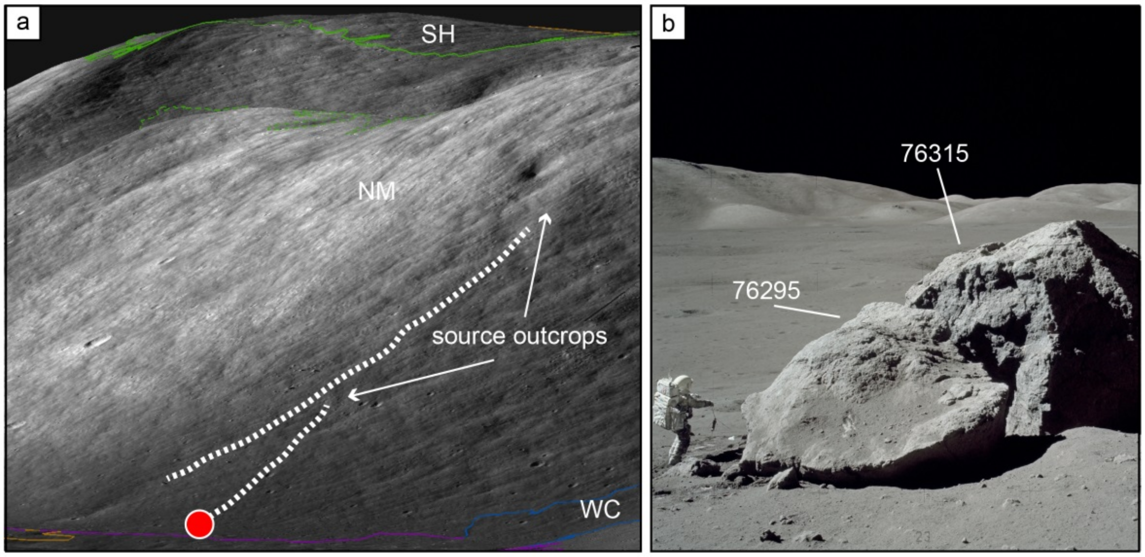

Fig. 2: (a) Perspective view of Station 6 using LROC NAC images overlain on LOLA data. Samples were collected at the base of the North Massif (NM, red dot) from a boulder with a clear track from a source outcrop. about a third of the way up the massif (dashed line). The source outcrop is clearly within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

do not have associated tracks, though source outcrops are inferred based on tracks that connect prominent outcrops with boulders located ~100 m west of the sampled boulders (Fig. 1b). To demonstrate our approach, station 6 is discussed in more detail.

A perspective view of station 6 (Fig. 2a) shows the boulder track connecting the sampled boulder (Fig. 2b) to its uphill source. The source outcrop lies on the NM wall and is not contaminated by Wessex Cleft (WC) material to the east or SH material atop the massif. Furthermore, there is no evidence of a fresh crater within SH redistributing that material onto the NM slope. High-resolution, topographically-draped images with ideal azimuth angles ease concerns [4] that sampled impact melts may be derived from SH and, thus, potentially from Imbrium.

Samples collected from the station 6 boulder contain the three dominant textural types of impact melt at the Apollo 17 site: poikilitic (76015, 76135, 76215, and 76315), ophitic (76255 and 76295), and aphanitic (76295). Two representative samples are 76295, a blue-grey, non-vesicular subophitic impact melt breccia with an aphanitic matrix sampled from block 1, and 76315, a micropoikilitic impact melt breccia sampled from the "transitional zone" of block 2 (Fig. 2b). Sample 76295 has a marbled texture of tan and blue-grey breccias, while 76315 is a dark grey breccia with several lighter grey clasts. Both samples have similar petrography, with 50% plag, 40% pyx (mostly low-Ca), and minor amounts of olivine, ilmenite, and other minerals [13]. The tan and blue-grey matrices of 76295 and sample 76315 all have similar Ar-Ar ages [12,14].

Conclusions: Observations of LROC NAC images verify that sampled Apollo 17 boulders originated from outcrops within massif walls that were uncontaminated by superposed Sculptured Hills material. These findings can be used with updated Ar-Ar ages of analyzed samples (e.g., [15]) and interpreted basin stratigraphic relationships to constrain the intensity of the lunar cataclysm epoch. For example, if Serenitatis is stratigraphically only slightly older than Imbrium and if updated Ar-Ar decay constants similarly affect interpretations of all analyzed sample ages, then ~11 basins formed between Nectaris and Imbrium within ~80 Ma (e.g., [14]). However, recent analyses suggest Serenitatis is stratigraphically much older than Imbrium [4], which may imply that as many as 25 basins formed during a much more intense lunar cataclysm.

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