EVIDENCE OF RECENT AND CONTINUOUS SLOPE DEFORMATION OF THE SOUTH MASSIF, TAURUS-LITTROW VALLEY, ON THE MOON.

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Introduction: Taurus-Littrow Valley, location of the Apollo 17 landing site, hosts recent, late-Copernican geomorphological landforms and tectonic structures, namely the Light Mantle avalanche deposit and the Lee-Lincoln lobate scarp. The Light Mantle deposit represents a unique case of a hypermobile avalanche on the Moon [1][2]. Suggested to have been triggered by the Tycho impact event 110 Ma, the Light Mantle has recently been interpreted as made of two distinct units, based on albedo variations [2][3]. The Lee-Lincoln lobate scarp is the surface expression of a recent thrust fault [4], which is considered to be the source of strong seismic shaking throughout Taurus-Littrow Valley [5][6], and potentially still active [7].

The Light Mantle deposit represents a geomorphological marker. Surface change superposed on the Light Mantle deposit, and on the slope from which it was generated (the NE-facing slope of the South Massif), must post-date the landslide event. As the absolute age of the deposit is known thanks to the Apollo 17 returned samples, such surface changes demonstrate that recent processes have occurred at this location during the last 70-110 Ma. For example, small scale grabens (10-20 m wide) associated with the Lee-Lincoln lobate scarp are found superposed on the young Light Mantle unit [4]. These troughs likely formed less than 50 Ma ago [8] and are thought to be generated by the flexural bending of the hanging wall [4][8].

Here we present evidence of slope deformation and surface changes that have occurred since the emplacement of the Light Mantle deposit (Fig.1).

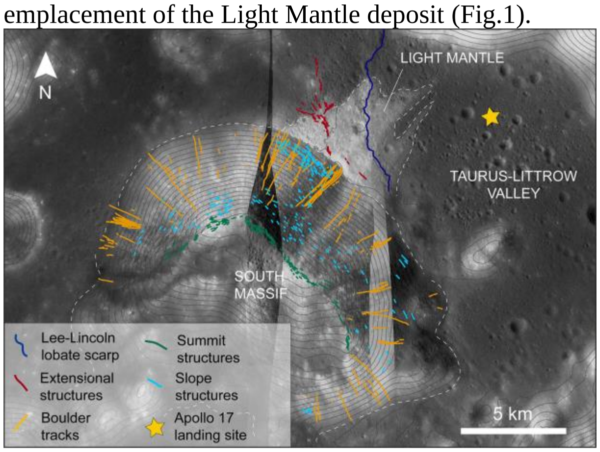

Figure 1. *Ortho-view of the South Massif and Taurus-Littrow Valley (NASA/PDS). Different types of surface features are mapped.*

Boulder Tracks and Regolith Disturbance: We identified 116 boulder fall events. We observed cross-cutting relationships at times, which provide evidence of subsequent episodes of boulder falls.

Regolith disturbance from downslope creep is thought to be the expression of recent seismic activity [7] or to be the product of continuous downslope creep under the effect of gravity (e.g., [9]). We observed widespread disturbed regolith on the slopes of the South Massif, in particular on the NE-facing slope, which corresponds to the slope from where the Light Mantle originated. The disturbed regolith appears in patches that are characterized by a crenulated pattern. These patches are reminiscent of terrestrial soil creep.

We observe regolith disturbance affecting boulder tracks, by means of attenuation and even obliteration of their morphological evidence. We also observe boulder tracks overlapping disturbed regolith. Such superposition relationships provide evidence of the concurrence of boulder falls and downslope creep (Fig. 2).

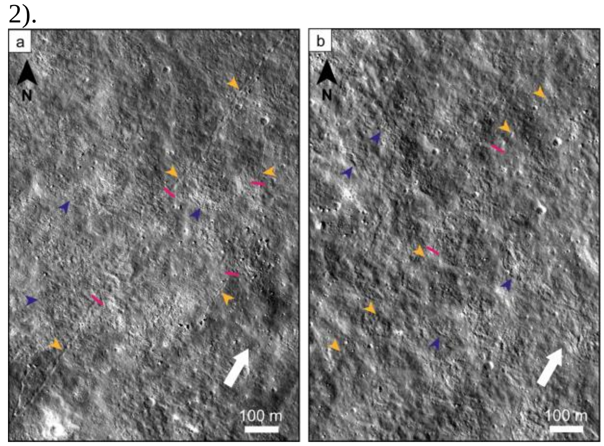

Figure 2. *Examples of superposition relationships between boulder tracks (some tracks are marked by the orange arrowheads; more tracks are present in the figure but not marked so to avoid over annotating the image) and regolith disturbance (some examples of the pattern are marked by the dark blue arrowheads). Two short pink lines are placed on the marked boulder tracks and show a section of the tracks where the tracks are attenuated or almost obliterated by the downslope creep that create the regolith disturbance pattern. White arrow shows the slope direction.*

Summit Structures: All along the South Massif summit we report the presence of linear structures parallel to the crest of the massif. At the summit of the NE-facing slope, we observe structures that resemble terrestrial crestal grabens (Fig. 3). In this location, the uphill-facing surfaces are about 1 m high. The origin of crestal graben is associated with gravitational slope deformation.

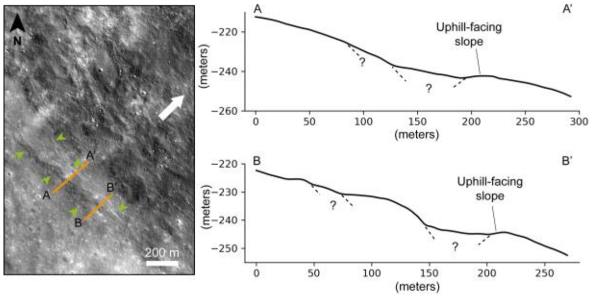

Figure 3. *Structures observed at the summit of the NE-facing slope of the South Massif resemble crestal grabens (light green arrowheads).*

Linear Slope Structures: The upper part of the South Massif slope is characterized by linear structures that are parallel to contour lines. Some of them produce slope benches, about 20 m long (in the downslope direction) and about 100-200 m wide (in the contour-parallel direction), which correspond to breaks in slope (Fig. 4a).

On the lower part of the NE-facing slope, the linear structures appear to have a longer extent than the ones on the upper part, in the order of several hundreds of meters (Fig. 4b). Moreover, the lower linear structures appear to be at an angle (~30º) with the contour lines.

Discussion and Conclusions: We mapped four types of surface structures found along the slopes of the South Massif and on the deposit of the Light Mantle in Taurus-Littrow Valley. We focused on the boulder tracks, regolith disturbance, summit structures, and linear slope structures that are found on the NE-facing slope of the South Massif. The overlapping relationships between the boulder tracks and regolith disturbance suggests that continuous slope deformation has been affecting the NE-facing slope. The presence of structures reminiscent of crestal grabens and small-scale slope benches on the upper part of the slope suggests the slope has undergone gravitational deformation. We suggest that the hundreds-of-meters-scale linear structures on the lower part of the slope may be the expression of backthrust faults that generally form in association with thrust faults.

We conclude that the NE-facing slope of the South Massif has been recently and continuously affected by slope deformation processes. We suggest that the stress field created by the Lee-Lincoln thrust fault could be one of the principal factors. We will search for present-day surface changes in this region to further investigate the possible active-state of the Lee-Lincoln scarp.

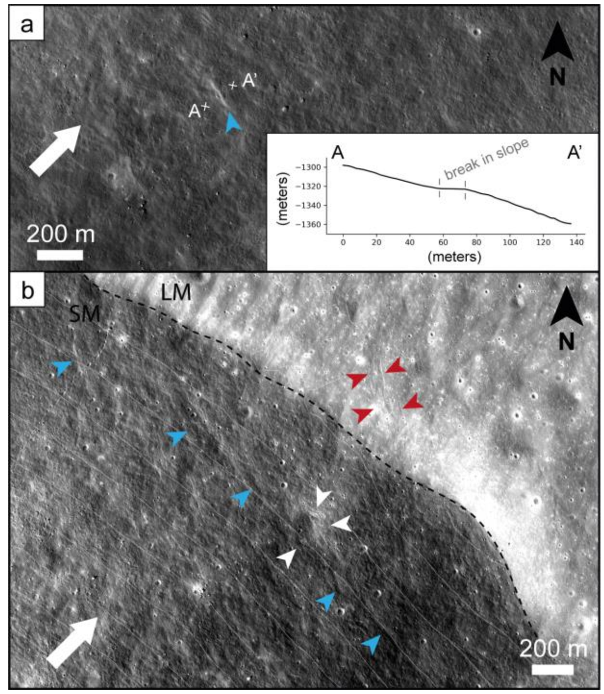

Figure 4. *(a) Example of small-scale slope bench that results in a break in slope. b) Linear slope structures observed at the base of the NE-facing slope of the South Massif (light blue arrowheads). The red arrowheads mark the small-scale grabens that are superposed over the young Light Mantle unit. The Lee-Lincoln lobate scarp is located about 2 km to the East (outside the frame of the image). Light grey lines represent 50 m contour lines.*

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