ORIGIN OF DEBRIS FLOW MATERIAL: ISMENIUS LACUS, MARS.

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Creep has produced distinctive landforms on some martian plains units (1,2), particularly in the fretted terrain and other areas near the highland/lowland boundary. Downslope movement is presumably enhanced by the presence of volatiles in the debris. A general softening of the appearance of the terrain and the accumulation of debris by creep have been used as indicators of subsurface volatiles (2). Although flow has undoubtedly shaped lobate debris aprons (LDA), lineated valley fill (LVF), and concentric crater fill (CCF), the origin of the creeping material and some details of the downslope movement are not well understood. Investigation of landforms in central Ismenius Lacus (MC-5) is underway to address these issues. The study site is in knobby terrain north of the highland/lowland boundary where knobs, associated LDA deposits, and a unit resembling LVF in the interknob area are common (Figure 1).

There are two possible origins of the debris: either they are material mass wasted from the knobs and not transported far (1,2,3) or they represent some sort of air-fall type deposit that has undergone slope failure and aeolian sculpting, perhaps similar to those in Electris and elsewhere (4,5,6). Several lines of evidence favors the latter interpretation. First, and most important, the LDA and LDF deposits are too voluminous to have been locally derived. The deposits tend to mantle older terrain, rather than have it as an obvious source area (Figure 1). Second, the knob material appears to be much more resistant to aeolian erosion than the LDA and LVF units; behavior more consistent with an air-fall depositional origin than a flow origin. In some locations the surface layer appears to have moved as a unit atop a failed basal zone (Figs. 1,2). Third, stratigraphic relationships indicative of repeated deposition rather than flow are visible in moats eroded at the knob/LDA boundary by the wind. The moat forms because the wind is concentrated on the erodible LDA as it deflects around the knob and the layering mantle is thin at that point. In some locations, multiple layering is present, similar to layering seen in concentric crater fill deposits. The latter probably represent wind eroded crater fill materials rather than rim material wasted into the crater (7). Similarly, the layers in the LDA that appears to drape over the older knob material (Figure 3) probably would not have survived during downslope flow and are more likely due to a large-scale, low-energy depositional episodes. Highest-resolution Viking photographs reveal an unconformable relationship between LDA and overlying LVF material was probably not locally derived and that it is more easily eroded than the older LDA deposit.

The general geologic history of the central Isemenius Lacus region is as follows. Ancient heavily cratered terrain was incompletely buried by volcanic flooding, flood deposits or lake deposits, leaving exposed knobs of underlying material. The region was then blanketed by volatile-rich, air fall deposits (see 4), either widespread pyroclastics, aeolian material, polar materials, or something else. The volatile-rich material is particularly susceptible to slope failures and aeolian sculpting; the upper few meters or more of the surface at the study side bears an indelible signature of aeolian gradation.

References

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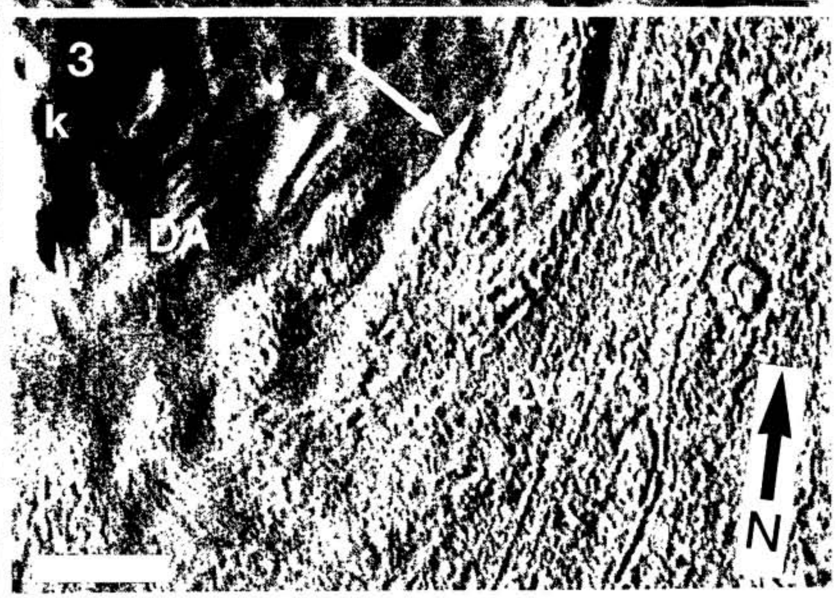

Captions

Figure 1. The morphology of lobate debris aprons reflect their flow origin by thier lobate shape, surface texture and deflection by obstacles (white arrow). Black arrows indicate places where a surface layer apparently slid downslope as a unit, presumable due to base failure. Erosional moats around knobs (black and white arrow) reveal structure more likely caused by air-fall than by mass-wasting. Final evidence for an air-fall origin of the surface layer is that it is too voluminous to have been locally derived, as seen where craters are partially mantled. Portion of Viking Oribiter frames 338 S29 and 338 S31. Scale bar is 10 km long.

Figure 2. Knobby terrain showing lobate debris aprons and erosional moats. Some interknob areas show the same ridged pattern as lineated valley fill. Some sort of slope failure has occurred on the lobate debris apron (arrow). It could be a regular slump or a rotational slump caused by failure of the base of the apron along the old crater surface. The box shows Figure 3. Portion of Viking Orbiter frame 338 S86. Scale bar is 10 km long.

Figure 3. High-resolution view (9.4 m/pxl) showing knobby material (k), multiply-layered lobate debris apron material (LDA) and lineated valley fill material (LVF). LDA and LDF appear to have been draped over the knob, then eroded. The edge of the LVF atop the LDA shows a wind-sculpted texture (arrow). Lateral flow in the LVF presumably caused size-sorting at its surface which now stands out due to differential aeolian erosion. Portion of Viking Orbiter frame 461 B09. Scale bar is 1 km long.