OCCURRENCE AND ORIGIN OF LOBATE MATERIALS IN THE HIGHLAND-LOWLAND BOUNDARY OF SOUTHERN UTOPIA PLANITIA, MARS. J. A. Skinner, Jr., R. L. Fergason, and K. L. Tanaka, Astrogeology Team, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001 (jskinner@usgs.gov).

Introduction: The southern Utopia Planitia highland-lowland boundary (HLB) contains a spatially broad and temporally successive sequence of materials interpreted as colluvial sequences associated with the backwasting of the HLB scarp [2-4]. Though secondary resurfacing processes such as lava and/or mud eruptions have been cited to account for the occurrence of local materials and landforms [2-5], their regional extents and evolutionary implications have yet to be fully documented and placed into the stratigraphic story. Herein, we use geomorphological and thermophysical details to expand more regional work presented by [2-5].

Geologic Setting: The southern Utopia HLB is located between the base of the Elysium volcanic rise and Isidis Planitia in the eastern equatorial region of Mars. Nepenthes Mensae forms the southern boundary of the HLB plain and is defined by knobs, mesas, and their intervening erosional plains. These features are progressively more dispersed and subdued toward the north where they are eventually onlapped by materials of Vastitas Borealis. The regional topography is dominated by the Amenthes Cavi, isolated and coalesced depression that bisect the region from east to west. Viking Orbiter-based geologic maps characterized the region as Hesperian- and Amazonian-age ridged and etched plains materials (units Hr and AHpe, respectively) [1]. Post-Viking geologic maps revamped these interpretations by postulating that the regional HLB was comprised of Early Hesperian colluvial remnants initially deposited through the degradation of highland knobs and mesas, then superposed by the collapsed and transported remnants of that colluvium. Volatile-assisted activities including liquefaction and mud volcanism were proposed as a likely mechanism for those subsequent features [4].

The materials of the southern Utopia HLB plain have a TES albedo range from 0.19 to 0.23 and there is generally negligible contrast across adjacent units and landforms [6]. Local dust proportions range from ~25 to 50% [7] and the TES dust cover index ranges from ~0.93 to 0.96 [8]. These values indicate that dust is of sufficient thickness to obscure chemical differences in the units described above, but not thick enough to dominate the thermophysical properties. As such, we must rely on detailed geomorphological and thermophysical observations to discern the formational history of these materials.

Geomorphology: We observe three closely-associated geologic units within the southern Utopia Planitia HLB that contain lobate materials. We describe these as they occur from south to north.

Scarp-adjacent lobes: These features reside between the knobs and plateaus that define the HLB scarp. The lobes are predominantly south-facing and each is defined by topographically-subdued, arcuate ridges that are <20 km in length and surround and ramp onto higher-standing knobs and mesas (Fig. 1). The scarp-adjacent lobes are most prevalent and continuous in the western part of the study area, though discontinuous lobes occur all along the southern Utopia HLB scarp. Shadow lengths and image incidence angles indicate that the scarp-adjacent lobes are perhaps only a few meters thick. THEMIS-derived thermal inertia (TI) values for the scarp-adjacent lobes range from 210 to 285 $Jm^{-2}K^{-1}s^{-1/2}$ while the adjacent plains materials range from 290 to 470 $Jm^{-2}K^{-1}s^{-1/2}$. These lobes form the southern margin of a smooth unit that extends 20 to 80 km to the north, where it grades into complexly-overlapping materials.

Complexly-overlapping materials: These materials are located directly south of Amenthes Cavi and consist of systems of rugged and smooth "facies". The complexly-overlapping materials overlap and grade with one another in complex fashion and abut low-relief mesas and their adjacent slope materials (Fig. 1B). Thick (tens of meters) lobes emanate from isolated and clustered cones and are traceable for several kilometers before grading into undulating plains. The complexly-overlapping materials are most commonly rugged at decameter scales, though these grade eastward into smoother materials. TI values for the complexly-overlapping materials range from 210 to 255 $Jm^{-2}K^{-1}s^{-1/2}$. The southern margin of these materials grades into the smooth unit associated with the scarp-adjacent flows (described above). The northern margin is apparently buried by smooth, fracture-sourced materials (described below).

Smooth, fracture-sourced materials: These features occur along the margins of the Amenthes Cavi as well as within the cavi floors. The margins of these materials are everywhere traceable to the terminations of narrow (<500 m wide) fractures that ring the cavi. Segmented and overlapping channels emanate from many of these fractures (Fig. 1C) and apparently are the source of the smooth materials. The margins of the smooth, fracture-sourced materials are most commonly identified by either by meter-scale, lobe-like abutments or an abrupt transition to more rugged surfaces. Where these materials infill the Amenthes Cavi, they commonly contain narrow (tens of meters) ridges that parallel the cavi walls. TI values for both the smooth, fracture-sourced materials and their source terrains range from 180 to 240 $Jm^{-2}K^{-1}s^{-1/2}$. These materials extend north for 100 to 200 km, forming a smooth plain [9].

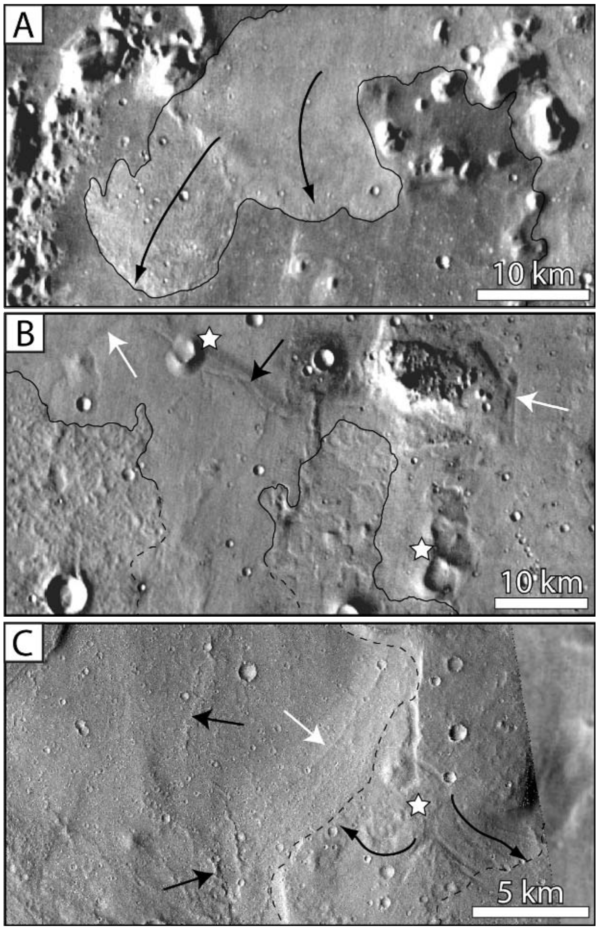

Figure 1. Lobate materials described herein. (A) Scarp-adjacent materials abut the knobs and plateaus of the HLB scarp. Lobes allude to directional flow (arrows). THEMIS daytime IR mosaic. (B) Complexly-overlapping materials source from isolated and clustered cones (stars) and form along fractures (black arrow). Smooth and rugged facies are observed (white arrow). THEMIS daytime IR mosaic. (C) Smooth, fracture-sourced materials emanate from narrow (<500 m) fractures (stars) and fill adjacent cavi floors. Note narrow linear (black arrow) and concentric (white arrow) ridges. CTX image P03_002280_1945_XN_ 14N240W.

Interpretations: Close association of the scarp-adjacent lobes with large (>10 km diameter) impact craters suggests that the lobes may have formed through impact-induced liquefaction. The thin character and abutment relationships with Nepenthes Mensae knobs and mesas of these lobate materials lead us to assert that they formed as ground-hugging debris flows mobilized from a pre-existing unit. TI values suggest the scarp-adjacent lobes are composed of weakly-indurated materials with minimal lithic blocks that overlie a more strongly indurated and/or more blocky unit with a potentially thinner dust cover. Though we have yet to define the margins of the pre-existing unit, we suggest that it gradationally buries the complexly-overlapping flows located to the north.

The complexly-overlapping materials are more expansive than previously realized [3-4]. We suggest that they constitute the bulk of the HLB surface south of the Amenthes Cavi. We interpret the gradational southern margin as burial by a younger deposit proximal to the HLB scarp, perhaps of aeolian or atmospheric fall-out origin. We agree with previous interpretations [2-5] that the complex lobes were emplaced, at least partly, through mud or silicate volcanism. It is currently unclear whether the rugged and smooth "facies" in complexly-overlapping flows are temporally equivalent. However, we assert that these materials are partly buried along their northern margins by smooth, fracture-sourced materials.

The smooth, fracture-sourced materials apparently formed as low-viscosity fluid emanations from around (and perhaps within) the Amenthes Cavi. We interpret that they post-date the complexly-overlapping flows and formed contemporaneously with the growth of the Amenthes Cavi through aquifer drainage, compaction, and subsidence. The smooth flows not only infill cavi floors but also appear to bury the northern margin of the complexly-overlapping materials. We suggest that these materials comprise the bulk of the smooth plain that underlies the VB margin in southern Utopia Planitia. The smooth facies of the complexly-overlapping flows may represent superposing smooth flows sourced from fractures.

Conclusions: We conclude that the described materials (1) formed through flow-related processes, likely associated with subsurface volatiles, and (2) constitute the bulk of the southern Utopia Planitia HLB. Pervasive colluvium associated with the degradation of the Nepenthes Mesae appears to be buried by the lobate materials described herein. The colluvium may currently be exposed only at the margins of isolated outliers of degraded highland knobs and mesas.

References. [1] Greeley, R. and Guest, J.E., (1987) *USGS I-1802 B*, 1:15M scale. [2] Tanaka, K.L. *et al.* (2005) *USGS SIM 2888,* 1:15M scale. [3] Tanaka, K. L. et al. (2003a) *JGR*, 108 (E4). [4] Tanaka, K.L. et al. (2003b) *JGR*, 108 (E12). [5] Skinner, J.A., Jr., and Tanaka, K.L. (2007) *Icarus*, 186, 41-59. [6] Christensen, P.R. et al. (2001) *JGR*, 106 (E10). [7] Bandfield, J.L. (2002) *JGR*, 107 (E9). [8] Ruff, S.W. and Christensen, P.R. (2002), *JGR*, 107 (E12). [9] Kreslavsky, M.A. and Head, J.W. III (2000), *JGR* 105.