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GEOLOGY OF THE SOUTHERN UTOPIA PLANITIA HIGHLAND-LOWLAND BOUNDARY PLAIN: FIRST YEAR RESULTS AND SECOND YEAR PLAN. J. A. Skinner, Jr., K. L. Tanaka, and T. M. Hare, Astrogeology Team, U. S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001 (jskinner@usgs.gov).

Introduction: The southern Utopia highland-lowland boundary (HLB) extends >1500 km westward from northern Nepenthes Mensae to the topographic saddle that separates Isidis and Utopia Planitiae. It contains bench-like platforms that contain depressions, pitted cones (some organized into arcuate chains and thumbprint terrain), isolated domes, lineated depressions, buried circular depressions, ring fractures, polygonal fractures, and other locally- to regionally-dispersed landforms [1]. The objective of our mapping project is to clarify the geologic evolution of the southern Utopia Planitia HLB by identifying the geologic, structural, and stratigraphic relationships of surface materials in MTMs 10237, 15237, 20237, 10242, 15242, 20242, 10247, 15247, and 20247.

Datasets and methods: The chief map base is a USGS-produced THEMIS daytime IR mosaic (100 m/px). We supplement this base with image and topography datasets, including the Viking MDIM 2.1 (231 m/px), MOLA DEM (463 m/px) (and ancillary products), MOC WA mosaic (231 m/px), and internet-hotlinked image footprints (*e.g.*, MOC NA, THEMIS VIS and IR, HiRISE, and CTX). We are applying "classical" and updated planetary mapping methods [1-4]. Because many of the materials that form the southern Utopia Planitia HLB are likely to be dispersed sedimentary sequences [1, 5-7], daytime and nighttime thermal data provide critical information for defining unit boundaries (where not covered by dust), particularly as such sequences may laterally grade into other materials [*e.g.*, 8].

Mapping bases are co-registered to one another and global datasets in ArcGIS®, which serves as our primary mapping environment. We have found that a maximum scale of 1:200,000 is adequate for units and landforms resolvable in the THEMIS base map resolution. We can confidently delineate and describe surface features >500 meters in diameter. We digitally stream vector linework into the GIS project using a WACOM® tablet. Vertex spacing for vector data is 250 meters. Lines are smoothed and line attributes (*e.g.*, contacts, linear structures) are committed on-the-fly. Unit polygons are periodically built from digitized contacts and iteratively revised, as necessary. Metadata for all vector information is being periodically inputted in order to (1) document mapping stages, and (2) ease production of the final map product.

Accomplishments: Proposed project runs January, 2007 to December, 2009. The project was awarded in April, 2007 and work commenced immediately. Year 1 (1/07 to 12/07) accomplishments included: (1) collation of relevant datasets (including construction of THEMIS daytime IR basemap by USGS cartography staff), (2) construction of GIS project with current data releases, (3) processing of HRSC and CTX images, (4) geologic and structure mapping, beginning with Amazonian units and superposed impact crater materials, (5) catalog of impact craters ≥ 1 kilometer in diameter, and (6) nomenclature updates (three impact crater names). A PGG-funded undergraduate student assisted on project goals during the summer 2007.

Year 2 accomplishments (to date) include the geologic delineation and characterization of the Amazonian-age VB unit margin, results and scientific perspectives of which were presented at LPSC 38 [8]. In addition, impact craters, structures, and Hesperian-age units have been delineated and described, providing first-cut geologic units and correlation of map units (COMU). The remainder of the project year will be committed to the completion of all geologic vector information (contacts, units, and tectonic and erosional structures) and compilation of the geologic history.

Results: Geologic mapping tasks are progressing well and are (generally) ahead of the proposed schedule. Based on the efforts to date, our most notable results include: (1) detailed characterization of the Vastitas Borealis (VB) unit margin, (2) mapping of overlapping sequences of Hesperian lobate materials, and (3) the delineation of impact crater ejecta facies and their temporal relationships. In the following sections, we briefly outline these results and provide interpretations on how they help gauge the regional geologic history.

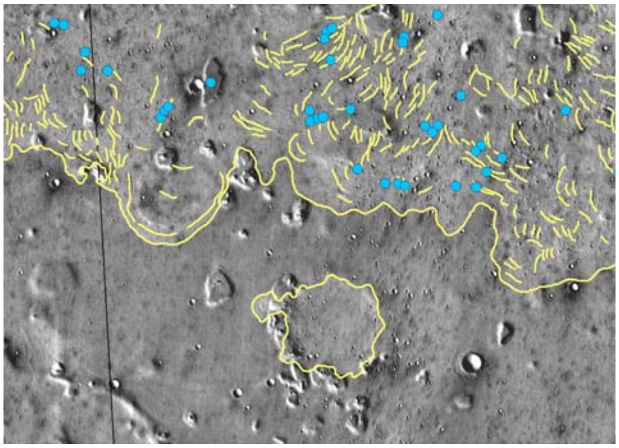

Figure 1. THEMIS base map showing the VB margin (continuous yellow line), arcuate ridges (short yellow lines), and pitted cones (blue dots). Note isolated occurrence of VB material located within an eroded crater south of the VB margin.

Amazonian VB unit margin. The regional VB margin is composed of overlapping, south-facing lobes (**Fig. 1**), often accompanied by km-long shallow troughs. The lobe-forming VB margin in southern Utopia Planitia is traceable for >2800 km and varies only slightly in elevation (–3569±318). The VB margin characteristically ramps onto (or terminates against) small knobs and plateaus. North of the VB margin, the unit contains a series of km-spaced, convex-southward arcuate ridges; these roughly parallel to the marginal lobes (**Fig. 1**). The ridges are composed of small (<80-m-wide) pitted cones and hummocks exist where the ridges intersect. We observe several subdued ridges south of the ABv$_m$/HBu$_2$ contact, though these are discontinuous and not clearly delineable.

Based on current mapping results, we suggest that the regional VB margin formed through the soft-sediment deformation related to seismicity [8] (and not by an ocean shoreline [*e.g.*, Parker et al., 1989]). We attribute characteristic landforms to shoaling effects of a seismic wave and the detachment and southward movement of surficial units. This hypothesis implicates major variation in the near subsurface (within the uppermost tens of meters), perhaps due to grain size, lithification, and/or water or ice content. Older surfaces may indicate higher stands of subsurface volatiles and/or different layers of liquefied lowland materials. We speculate that the source of the seismic energy was one or more lowland impacts, whereby lowland material was conducive to wave propagation.

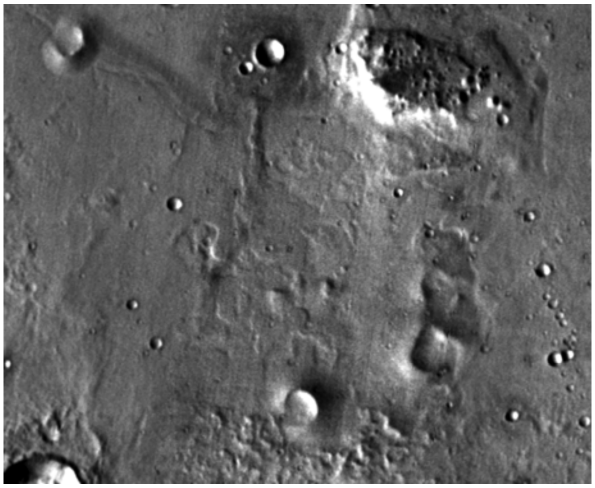

Figure 2. THEMIS base map showing lobate materials and the source constructs (pitted cones). Note cross-cutting relationships between the lobate materials within which the pitted cones are located.

Hesperian lobate plains. Our mapping shows that the Hesperian plains located between the VB margin (to the north) and the HLB scarp (to the south) are predominantly composed of discretely overlapping lobate materials with characteristic smooth and rugged surfaces (**Fig. 2**). Though texture alone is inadequate criteria to delineate geologic units [3], the cross-cutting relationships between these units are superb, perhaps indicative of discrepant viscosities of erupted material. Lobate flows are commonly traceable to isolated or coalesced pitted cones. Lobate materials are generally confined to the region between Amenthes Cavi and the higher-standing knobby plains located adjacent to the HLB scarp to the south. The formation of the lobate plains appears coincident with the formation of Amenthes Cavi; the depressions deform and are filled by lobate deposits.

We find evidence that the HLB plains in southern Utopia Planitia were both emplaced and deformed through volatile-related processes, perhaps akin to terrestrial soft sediment deformation [7]. This runs counter to previous interpretations, which defined these as volcanic materials [*e.g.*, 5]. We suggest the lobate flows were perhaps related to seismically- and/or tectonically-induced extrusion of fluidized regolith. We further suggest that Amenthes Cavi formed in tandem with the lobate plains, perhaps via compaction of underlying sequences and extrusion of pore-space fluids as breccia flows.

Impact crater materials. We have opted to abandon age-related impact crater units in favor of delineating impact facies, similar to those employed in lunar geologic maps [*e.g.*, 9]. This is particularly relevant to the study area, where crater ejecta morphologies are pervasively diagnostic of the ejection processes. We currently identify six mappable impact facies, as follows: (1) lobate ejecta, located distal to the crater, (2) hummocky ejecta, locate proximal to the crater, (3) interior wall material, (4) hummocky floor materials, (5) smooth floor materials, and (6) interior peaks. These materials will be divided by relative age. Facies can be applied (at least in part) to craters >20 km diameter. We currently differentiate secondary crater chains (polygons) and low-albedo ejecta material (points for crater <1 km diameter, stippled polygon for craters >1), as these provide insight into subsurface characteristics.

References: [1] Tanaka *et al.*, (2005) *USGS SIM 2888*, 1:15M scale. [2] Wilhelms, D.E., (1990) in *Planetary Mapping* (R. Greeley and R.M. Batson (eds.)), Cambridge U. Press. [3] Hansen, V.L. (2000) *EPSL*, *176*, 527-542. [4] Skinner and Tanaka (2003) *LPSC XXXIV*, abs. #2100. [5] Greeley, R. and Guest, J.E., (1987) *USGS I-1802-B*, 1:15M scale. [6] Tanaka, K.L. *et al.*, (2003a) *JGR*, *108*, (E4). [7] Skinner, J.A. Jr. *et al.*, (2007) *Icarus*, *186*, 41-59. [8] Skinner, J. A. Jr. *et al.*, (2008) *LPSC XXXIX*, abs. #2418. [9] Schmidt, H. H. *et al.*, (1967) *USGS I-515*, 1:1M scale. [10] Parker, T.J., *et al.*, (1989), *Icarus*, *82*, 111-145.