GEOMORPHIC AND STRATIGRAPHIC ANALYSIS OF LAYERED DEPOSITS IN TERBY CRATER, MARS.

S. A. Wilson[1] and A. D. Howard[1], [1]Department of Environmental Sciences, P.O. Box 400123, University of Virginia, Charlottesville, VA 22904-4123, sharonwilson@virginia.edu.

Introduction: Recently released, high-resolution images from the Mars Orbiter Camera (MOC) and the Thermal Emission Imaging System (THEMIS) reveal a myriad of intriguing landforms banked along the northern edge of Terby Crater located on the northern rim of Hellas (~28°S, 287°W). Landforms within this crater include north-trending troughs and ridges, a remarkable 2.5 km–thick sequence of exposed layers, mantled ramps that extend across and between layered sequences, fan-like structures, sinuous channels, collapse pits, a massive landslide and viscous flow features. The suite of diverse landforms in Terby and its immediate surroundings attest to a diversity of rock types and geologic processes, making this locality ideal for studying landform-climate relationships on Mars. In order to decipher the complicated geologic history of Terby Crater and the nature of the layered deposits, a generalized geomorphic map was created and the slope of the layered deposits was examined.

Data Analysis: A preliminary geographic map was generated using all currently released wide- and narrow-angle (NA) MOC images and THEMIS visible and infrared images. These data were obtained, processed and co-registered with Viking Orbiter 2.1 MDIM images and topographic information from the Mars Orbiter Laser Altimeter (MOLA) to generate rectified image mosaics of Terby Crater. Arc GIS (Geographic Information Systems) was used to delineate different geomorphic units within Terby.

In order to determine whether the layered deposits are level or sloping, marker beds were traced on MOC NA images that were co-registered with MOLA data (Figure 2). Using Surfer® software, the elevation along points of the marker beds were determined from raw MOLA track data. Using the elevation associated with each latitude/longitude pair, the slope of the layer was determined by fitting a trend surface (polynomial regression) in Surfer.

Geomorphic Map of Terby Crater: The deposits in Terby are mapped as late Noachian-aged etched material consisting of fine-grained and friable material that is indicative of dust, loess or tephra that may include interstitial ice [1]. The major geomorphic units in Terby Crater and its immediate surroundings include flat mesa tops, layered deposits, an undifferentiated rough unit, crater floor deposits, a moat deposit, mantled terrain, viscous flow features and fan deposits (Figure 1).

Flat Mesa Tops. Relatively planar, pitted, scoured and dust-covered surface of the south-sloping ridges capping the layered deposits. Abrupt scarp edges suggest a locally indurated caprock.

Layered Deposits. Sub-horizontal, repetitive and laterally continuous layers inferred to be sedimentary rock based on their cliff-forming nature and thermal signature. This unit extends from the northern crater rim to the moat-like depression roughly halfway into the crater interior. The layered deposits are best exposed on steep walls and on the floor of the crater in elongated mounds.

Undifferentiated Rough Unit. A hummocky, mottled and degraded unit that generally occurs on Terby crater walls.

Crater Floor Deposit. A relatively smooth and flat unit found on the southern half of the crater interior. THEMIS nighttime images indicate high thermal inertia.

Moat deposit. Smooth, flat and presumably dust-covered material occupying the moat-like depression at the southern end of the interior deposits.

Mantled Terrain. Smooth and dark unit that mantles layered deposits and occurs in depressions and draped on slopes. Low scarps at the margins of eroded mantled terrain suggests that it was slightly indurated. This mantle presumably covered most of the crater at one time and has been preferentially eroded by wind.

Viscous Flow Features. Intricate, south-trending, lobe-like flow features located on the floor of a small crater perched on the northeast rim of Terby Crater. Thin, east-west trending linear cracks are observed oriented perpendicular to the presumed direction of flow.

Fan Deposits. A striated, fan-like deposit with sinuous gullies on its surface. This deposit originates from a breached rim of the small crater containing the viscous flow features and splays out to the south forming distal lobes that are locally eroded at their base .

Layered Deposits in Terby Crater: As on Earth, sedimentary rocks on Mars preserve a record of past environments and the mode of deposition is often discernable by the nature of the layers. One of the major outstanding questions related to the nature of the layered deposits is their three-dimensional structure and whether they are level or sloping. The gradient of the west and east ridges are ~20 m/km and ~15 m/km toward the south, respectively, which is consistent with the overall gradient of Terby (~17 m/km, Figure 3).

The gradient of the layer traced in MOC NA image R05-00948 is ~29 m/km which is consistent given the potential errors associated with this technique (Figure 2). However, the benches, if projected southward, would extend well beyond the moat onto the Terby crater floor (Figure 3). This suggests either that benches predated the moat but originally steepened considerably near the margins of the moat (black line, Figure 3), or that the moat and crater floor deposits were created subsequently to extensive lateral erosion of the benches and associated layered deposits (blue line, Figure 3).

There are a variety of possible mechanisms by which sedimentary material can be produced, transported and deposited on Mars including aeolian [2-4], fluvial [2, 4-8] open-water lacustrine [9-15] and glacial processes [16]. Further insight into the nature and origin of the layered deposits in Terby will help narrow the processes responsible for the emplacement and subsequent modification of this deposit.

References: [1] Leonard G. J. and Tanaka K. L. (2001) *USGS Map I-2694*. [2] Greeley R. and Guest J. E. (1987) *USGS Map I-1802-B*. [3] Scott D. H. and Chapman M. G. (1995) *USGS Map* I-2397. [4] Edgett K. S. and Malin M. C. (2002) *GRL*, *29* (24), 2179. [5] Cabrol N. A. et al. (1999) *Icarus*, *139*, 235–245. [6] Malin M. C. and Edgett K. S. (2003) *Science*, *302*, 1931–1934. [7] Moore J. M. et al. (2003) *GRL*, *30*(24), 2292. [8] Aittola M. et al. (2003) *LPS XXXIV*, 1538. [9] McCauley, J. F. (1978) *USGS Map I-897*. [10] Nedell S. et al. (1987) *Icarus*, *70*, 409-441. [11] Edgett K. S. and Parker T. J (1997) *GRL 24*(22), 2897-2900. [12] Malin M. C. and Edgett K. S. (2000) *Science*, 290. [13] Moore J. M. and Wilhelms D. E. (2001) *Icarus*, *154*, 258–276. [14] Grant J. A. and Parker T. J. (2002) *JGR*, *107*(E9), 5066. [15] Christensen P. R. and Ruff S. W. (2004) *JGR*, *109*, E08003. [16] Raitala J. M. et al. (2004) *LPS XXXV*, 1134.

Figure Captions:

Figure 1. Geomorphic Map of Terby Crater. Flat Mesa Tops: dark green; Layered Deposits: yellow; Undifferentiated Rough Unit: light blue; Crater Floor Deposit: tan; Moat Deposit: dark blue; Mantled Terrain: pink; Viscous Flow Features: light green; Fan Deposit: orange; Heavy black line: Terby Crater Rim; Dashed red line: avalanche deposit. Solid red line depicts location of elevation profile in Figure 3.

Figure 2. Sedimentary layered deposits in Terby as shown in part of MOC NA image R05-00948. Slope of layer estimated from elevation points obtained from intersection of layer (red line) and available MOLA tracks (yellow lines). Image width is 3km. NASA/JPL/MSSS.

Figure 3. Elevation profile of MOLA track (red line in Figure 1). The blue and black lines represent two possible surfaces of the layered deposits.