GLACIATED TERRAIN IN GUSEV CRATER, MARS. Tracy K.P. Gregg[1] Jason R. Briner[1], and Kristen N. Paris[1] [1]Department of Geology, 876 Natural Sciences Complex, University at Buffalo, Buffalo, NY 14260-3050; tgregg@geology.buffalo.edu.

Introduction: Spirit rover [1] landed in Gusev crater on November 17, 2003, at 14.57°S, 175.48°W [2] and has continued to return valuable information about Martian history [e.g., 3, 4]. Gusev crater was chosen as a landing site largely because the geomorphology, as observed using Viking Orbiter and Mars Orbiter Camera (MOC) images [5] suggested that the crater once held a standing body of water. The interior of Gusev crater has been carefully studied using available data from the Thermal Emission Imaging Spectrometer (THEMIS) [6, 7, 8], and geomorphologic units identified. Recently, Greeley and others [9] identified fluid basalt flows covering most of the floor of Gusev crater, consistent with observations of basalts identified by Spirit [10]. They noted that the eastern boundaries of this lava flow unit could locally be identified by a topographic bench; Milam and others [8] commented on this "steep escarpment" but do not offer an explanation for its formation.

We concur with Greeley and others [9] that the floor of Gusev was flooded with fluid basalts; here we present evidence that the basalt flows were topographically contained by an ice-rich deposit—possibly crater ejecta—that has subsequently sublimed away, leaving a hummocky terrain similar to terrestrial deglaciated terrains.

Approach: We used all available MOC and THEMIS images for Gusev crater, although we have focused our investigations on the eastern quarter of the 160-km-diameter crater (Figure 1). In addition, general topographic assessments were made using the freeware Gridview [11] and the 128 pixels/degree gridded data for the region. Locally, we used shadow measurements on MOC and THEMIS visible images to obtain feature heights; the features we measured were too small to be resolved by MOLA.

Observations: As noted by Milam and others [8], the eastern boundary of the fluid lavas [9] found on the floor of Gusev crater is marked by a scarp; shadow measurements on MOC narrow-angle images indicate scarp heights of 20 – 60 m. This is intriguing because the flat floor of Gusev crater reveals no obvious lava flow margins or volcanic vents, suggesting that the lava had a low viscosity [cf. 9]. A low-viscosity lava should not generate a 20 – 60-m thick margin, unless there was a topographic barrier impeding flow advance.

The hummocky terrain shown in Figure 2 corresponds with units identified by Cabrol and others [5] and Milam and others [8]. Although these researchers used different data sets and presented distinct interpretations for this material, they all acknowledge its unique properties. It is found north, east, and south of Thira crater and corresponds closely with Cabrol et al.'s [5] unit "b" (Ma'adim terraces) and Milam et al.'s [8] units "ET" (etched terrain) and "HTI" (high thermal inertia). It is characterized in both MOC and THEMIS-vis images by irregular mesas, knobs and ridges 10s to 100s of meters across and >20 m tall. Typical mesa diameters increase with proximity to the rim of Thira crater (Figure 3). Dunes are common, and make it difficult to distinguish primary surface textures. This hummocky terrain also crops out as outliers completely surrounded the smooth lava flows to the west of Thira crater.

Terrestrial Analogs: The hummocky terrain observed in Gusev crater is morphologically similar to hummocky terrain found in a variety of glaciated settings in North America (Figure 4). The terrestrial morphology formed during glacial retreat: hummocks were created as the debris-rich snouts of ice sheets melted.

Terrestrial lava flows have been observed to pond and thicken against glacial ice [12]. Fluid pahoehoe lavas in Iceland have been observed to pond and thicken slightly against thick snow, similar to the thick flow margins observed on the floor of Gusev crater.

Interpretations and Conclusions: We believe that the hummocky terrain observed on the floor of Gusev crater was once a continuous ejecta blanket emplaced during the Thira impact. The ejecta blanket became enriched in volatiles, probably water, during or after emplacement. The water ice was present when lava flows crossed the floor of Gusev crater and ponded against the topographically higher ejecta. Later, the water ice sublimed (there is no evidence for meltwater in the available data), and aeolian processes continued to modify the ejecta blanket, generating the mesas and knobs we see today.

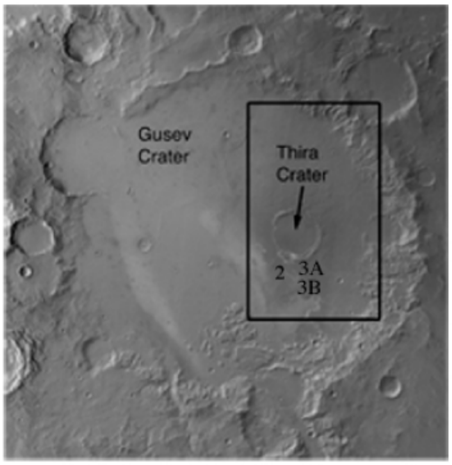

Figure 1. THEMIS daytime infrared image mosaic of Gusev crater (~160 km in diameter) and Thira crater (~20 km in diameter). Black rectangle outlines area of interest to this study; numbers mark approximate location of other figures. (ASU/NASA/JPL).

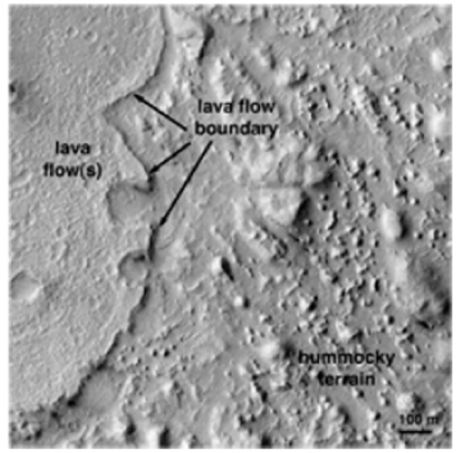

Figure 2. Contact of fluid lava flows in eastern Gusev crater with hummocky terrain. MOC image E05-00471, frame 05. Image courtesy of MSSS/JPL/NASA.

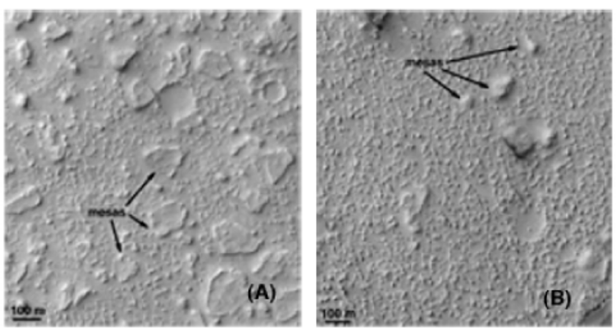

Figure 3. MOC narrow-angle images of hummocky terrain. Mesas tend to be larger closer to the rim of Thira crater. (A) is located ~1.5 km south of Thira crater rim (MOC image E03-01511 frame 7); (B) is located ~5 km south of Thira crater rim (MOC image E03-01511 frame 10). Courtesy of MSSS/NASA/JPL.

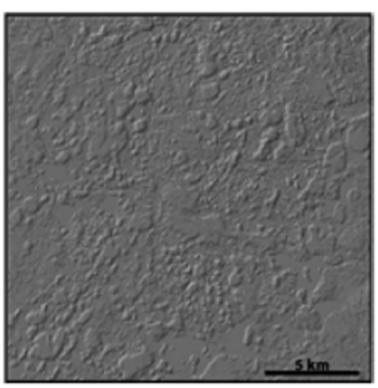

Figure 4. National Elevation Data shaded-relief image of hummocky moraine deposited by the Des Moines Lobe, MN, USA. Vertical resolution ~10 m. Located at 44 ° 31' N, 93° 19' W.

References: [1] Squyres, S., et al., Science 305:794-799, 2004. [2] Arvidson, R., et al., Science 305:821-824, 2004. [3] Greeley, R., et al., Science 305:810-813, 2004. [4] Crumpler, L.S. et al., Geology 33:809-812, 2005. [5] Cabrol, N., et al., Icarus 133:98-108, 1998. [6] Christensen et al., THEMIS. [7] Christensen, P.R. et al., Icarus 176:12-43, 2005. [8] Milam, K.A. et al., J. Geophys. Res. 108(E12):8078, 2003. [9] Greeley, R. et al. J. Geophys. Res. 110:E05008, 2005. [10] McSween, H.Y. et al., Science 305:842-845, 2005. [11] Roarke, J., http://denali.gsfc.nasa.gov/gridview/, 2003 [12] Lescinsky, D., and Sisson, T.W., Geology 26:351-355, 1998.