GEOLOGIC MAPPING OF GUSEV CRATER, MARS. David A. Crown, Frank C. Chuang, and James W. Rice, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719, crown@psi.edu.

Introduction: Gusev crater is a ~160 km diameter impact crater located at 14.53°S, 175.52°E along the southern highland-northern lowland dichotomy boundary on Mars. The geologic history of Gusev crater is complex, with features attributed to a variety of geologic processes and spanning much of Martian history [e.g., 1-3]. The geologic diversity of the Gusev crater region has been further revealed through in situ exploration of the Columbia Hills and surrounding volcanic plains by the MER Spirit rover [e.g., 4].

We have initiated a new geologic mapping investigation of Gusev crater, designed to produce a 1:250K-scale, formal geologic map focused on the geologic evolution of the Gusev rim and floor. An existing USGS map that includes Gusev crater was mapped at 1:500K based on Viking mission data [5]. Other studies have produced maps of Gusev based on geomorphic, thermophysical, and topographic characteristics [e.g., 3, 6-9]. Here, we present preliminary GIS mapping results of Gusev; our study will utilize the full suite of high-resolution imaging, topographic, and compositional datasets available for Gusev from multiple Mars missions.

Gusev Crater Floor: Gusev floor materials have been attributed to aeolian deposits overlying lava flows [10]; mass-wasting and channel deposits [11]; fluvio-lacustrine deposits [5-6]; and basaltic lava flows [7, 12-13]. Although Spirit confirmed the presence of basalt, questions remain regarding the overall geologic evolution of Gusev.

Figure 1 shows our preliminary geologic map of Gusev floor materials. Using 5-6 m/pixel CTX images, we have identified eight geologic units, including: two volcanic plains (rvp1, rvp2), debris flow (Mf), dissected plateau (dpl), mesas (Gm), hills (h), crater (c), and crater terrace (Gt). The volcanic plains units exhibit smooth to hummocky surfaces with wrinkle ridges. Some debris flow margins consist of lobes that locally embay parts of the volcanic plains and other high-standing features (i.e., mesas, crater rims). Current research focuses on contacts between floor units and the crater rim, and examines potential contributions of rim materials to the crater floor.

Gusev Crater Rim: The morphologic characteristics of Gusev's rim and interior walls vary based on section [see Fig. 1]. The E-SE section is characterized by multiple headscarps with down-dropped surfaces and large mass-wasting deposits, some with semi-lobate terminations [Fig. 2]. The E-NE section walls appear incised with multiple sinuous, gully-like canyons. Below the termini of two canyons are possible sedimentary deposits, one with a fan-shaped appearance [Fig. 3]. This particular deposit appears to have a narrow linear neck extending towards the canyon terminus. However, there are no sinuous channel-like or inverted-relief features within either of the deposits that would suggest fluvial deposition. The N-NW section has been heavily modified such that most of the rim structure is no longer intact. The W-SW section appears to have an intact rim structure, but the walls appear subdued compared to the E-SE and E-NE sections. A series of impact craters that formed after Gusev are observed along Gusev's rim in the N-NW and W-SW sections.

Gusev Topography: To assess the modification of interior crater walls, MOLA topographic profiles were examined across the E-SE and E-NE sections [see Fig. 1]. Two profiles in the E-SE section yielded slopes of 5.1°-5.6° (rim headscarp to deposit terminus), and two in the E-NE section (rim headscarp to base of the wall) yielded slopes of 5.4°-5.8° [Fig. 4]. The slightly shallower E-SE slopes are likely due to the advancement of mass-wasted wall materials onto the crater floor. Topographic profiles across the entire crater (rim to rim) indicate a relatively flat floor with a maximum of ±100 m elevation difference [see Fig. 4]. As indicated earlier, the N-NW section of the crater has been significantly modified and this is reflected in the topographic profiles. The maximum relief here (relative to the crater floor) is ~600 m whereas the opposite wall has ~2550 m of relief.

Future Work: In addition to continued geologic mapping, we will systematically document cross-cutting, stratigraphic, and embayment relationships across the map area. These will be combined with compilation and analyses of crater size-frequency distributions to investigate relative and absolute ages and derive the geologic history of Gusev crater.

References: [1] Greeley R (2003) Sixth Int. Conf. on Mars, Abstract 3286. [2] Golombek MP et al. (2003) JGR 111, 8072. [3] Milam KA et al. (2003) JGR 108, 8078. [4] Squyres SW et al. (2006) JGR 111, E02S11. [5] Kuzmin RO et al. (2000) USGS Geol. Surv. Misc Invest. Ser. Map I-2666. [6] Cabrol N et al. (2003) JGR 108, 8076. [7] Greeley R et al., (2005) JGR 110, E05008. [8] Martinez-Alonso S et al. (2005) JGR 110, E01003. [9] van Kan Parker M et al. (2010) EPSL 294, 411-423. [10] Scott D.H. et al. (1978) USGS Geol. Surv. Misc Invest. Ser. Map I-1111. [11] Greeley R and Guest JE (1987) USGS Geol. Surv. Misc Invest. Ser. Map I-1802B [12] McSween HY et al. (2004) Science 305, 842-845. [13] Hamilton VE and Ruff SW (2012) Icarus 218, 917-949.

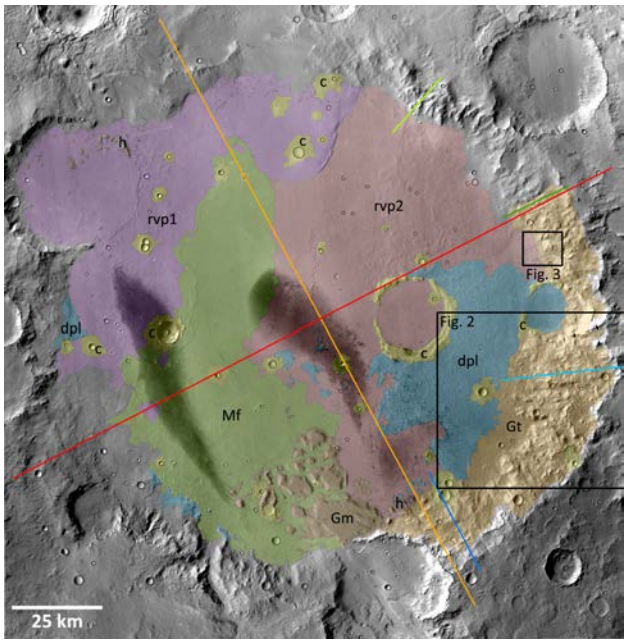
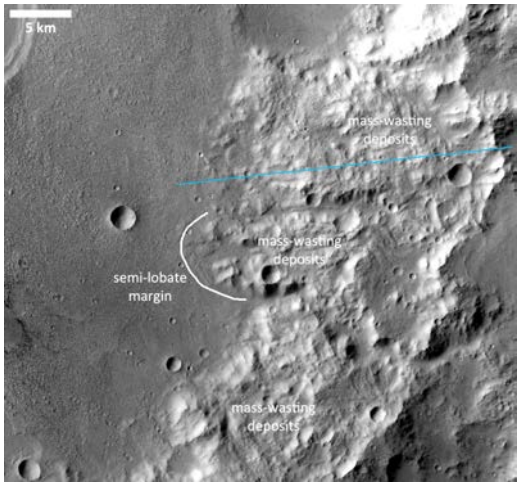
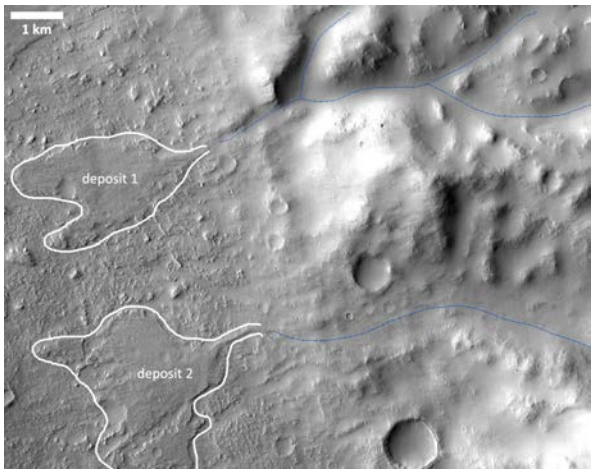


Figure 1 (left). Gusev crater with preliminary geologic map of floor units: ridged volcanic plains 1 (rvp1), ridged volcanic plains 2 (rvp2), Ma'adim debris flow (Mf), dissected plateau (dpl), Gusev mesas (Gm), hills (h), crater (c), and Gusev terrace (Gt). Locations of Figures 2 and 3 highlighted by black boxes. Select MOLA topographic profiles over the rim and interior walls are located in the E-SE sections (dark & light blue lines) and E-NE sections (dark & light green lines) of the crater. Rim-to-rim topographic profiles are shown by orange and red lines. See Figure 4 for profile plots. Background: CTX global mosaic (Cal Tech Murray Lab).

Figure 2 (below left). Portion of CTX image mosaic of the E-SE section of Gusev crater with multiple mass-wasting deposits, some with semi-lobate margins that extend onto the crater floor. Topographic profiles across this section are shown in Figure 4.





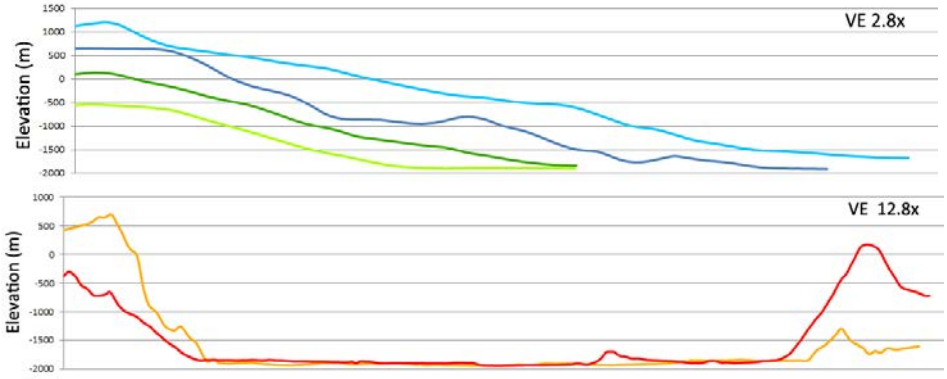


Figure 3 (above). Portion of CTX image mosaic of the E-NE section of Gusev crater with possible sedimentary deposits (deposits 1 & 2) below the termini of gully-like canyons. Deposit 2 has an upslope narrow linear neck.

Figure 4. (top) MOLA topographic profiles of the E-SE (dark & light blue) and E-NE (dark & light green) sections of Gusev rim and interior walls. E-SE section walls have slightly shallower slopes and extend further than E-NE section walls. **(bottom)** MOLA topographic profiles from rim to rim across Gusev crater (orange & red). Note the flat floor and low relief in the N-NW section compared to the opposite wall (orange profile).