GEOLOGIC MAPPING OF GUSEV CRATER, MARS: GUSEV RIM AND FLOOR CHARACTERISTICS.

David A. Crown[1], Frank C. Chuang[1], James W. Rice[1], Steven W. Ruff[2], and Stephen P. Scheidt[1,3,4], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719 (crown@psi.edu), [2]Arizona State University, Tempe, AZ 85287, [3]Howard University, Washington, DC 20059, [4]Center for Research & Exploration in Space Science and Technology, Greenbelt, MD 20771.

Introduction: The geologic complexity of Gusev crater (~160 km diameter; 14.53°S, 175.52°E) and its surroundings have been revealed through orbital remote sensing coupled with in situ exploration of the Columbia Hills and adjacent volcanic plains by the MER Spirit rover [e.g., 1-4]. Gusev crater's geologic history has been attributed to the combined effects of a variety of geologic processes that span much of Martian history. 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 (Figures 1-3). This mapping investigation will be informed by terrestrial analogues studies of volcanic embayment relationships at a series of sites in the western U.S. [5].

The existing USGS map that includes Gusev crater was produced at 1:500K based on Viking mission data [6]. Other studies have mapped Gusev based on geomorphic, thermophysical, and topographic characteristics [e.g., 3, 7-10]. Here, we present preliminary mapping results of Gusev. Our GIS-based study utilizes the full suite of high-resolution imaging, topographic, and compositional datasets available for Gusev from multiple Mars missions.

Gusev Crater Rim: Previous studies of Gusev have noted the significant modification of the crater since its formation. The morphologic characteristics of Gusev's rim and interior walls vary around its perimeter. The southern rim has been modified by New Plymouth crater and later breached by the northern extent of Ma'adim Vallis. The eastern rim generally has higher relief than the western rim. For example, the N-NW rim has a maximum relief of ~600 m, whereas the opposite wall has ~2550 m of relief. Much of the western rim has been heavily modified by impact craters, and large portions are either poorly defined or completely lacking. Topographic profiles across the entire crater (rim to rim) indicate a relatively flat floor with a maximum of ±100 m elevation difference.

Gusev's E-NE rim has dissected slopes with multiple canyon-like valleys and possible sedimentary alluvial deposits. The E-SE rim has large terrace deposits that are not observed elsewhere within Gusev. Topographic profiles from rim to floor in eastern Gusev indicate longer lengths and slightly shallower slopes (5.1-5.6°) for E-SE rim slopes compared to E-NE rim slopes (5.4-5.8°). The shallower slopes are consistent with mass-wasting deposits extending onto the crater floor.

Gusev Crater Floor: Gusev floor materials have been attributed to aeolian deposits overlying lava flows [11]; mass-wasting and channel deposits [12]; fluvio-lacustrine deposits [6-7]; and basaltic lava flows [8, 13-15]. 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 ridged volcanic plains, Ma'adim debris flow, dissected plateau, Gusev mesas, Gusev terrace deposits, hills, and crater materials. The volcanic plains units exhibit smooth to hummocky surfaces with wrinkle ridges. Some debris flow margins consist of lobes that extend across volcanic plains and surround topographic highs on the crater floor. Current analyses focus on widespread Gusev floor materials (i.e., volcanic and other flows) and their embayment relationships with Gusev rim materials and local relief.

Future Work: As part of our geologic mapping investigation, we are systematically documenting cross-cutting, stratigraphic, and unit contact relationships across the map area. These relative age constraints will be combined with compilation and analyses of crater size-frequency distributions to fully investigate relative and absolute ages and derive an updated geologic history of Gusev crater.

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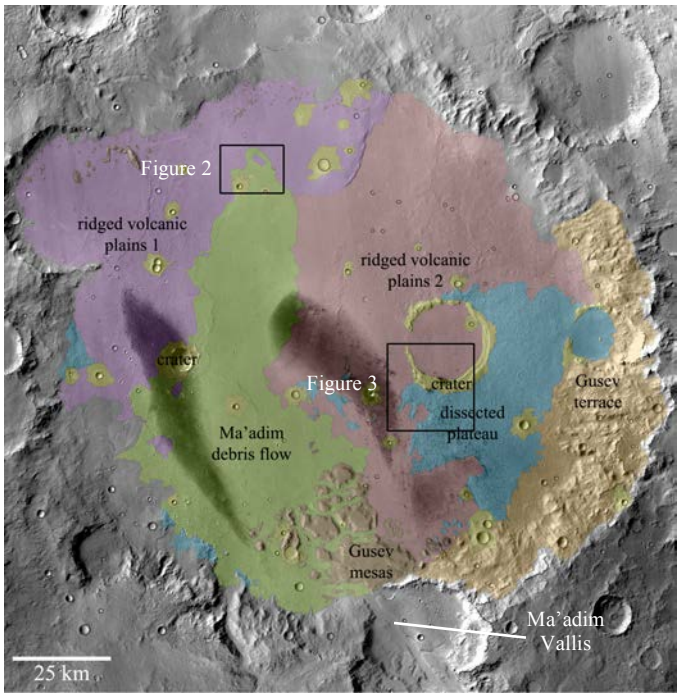

Figure 1. Gusev crater with preliminary geologic map of floor units. Locations of Figures 2 and 3 highlighted by black boxes. Background: CTX global mosaic (Cal Tech Murray Lab). Most of the crater floor appears to consist of volcanic units with a potential covering by sediments extending from Ma'adim Vallis, which dissects Gusev's southern rim (and New Plymouth crater). Note the morphologic variability of the crater rim around its perimeter, with a well-defined expression and preserved terrace to the east and significant modification by subsequent impacts to the west.

Figure 1

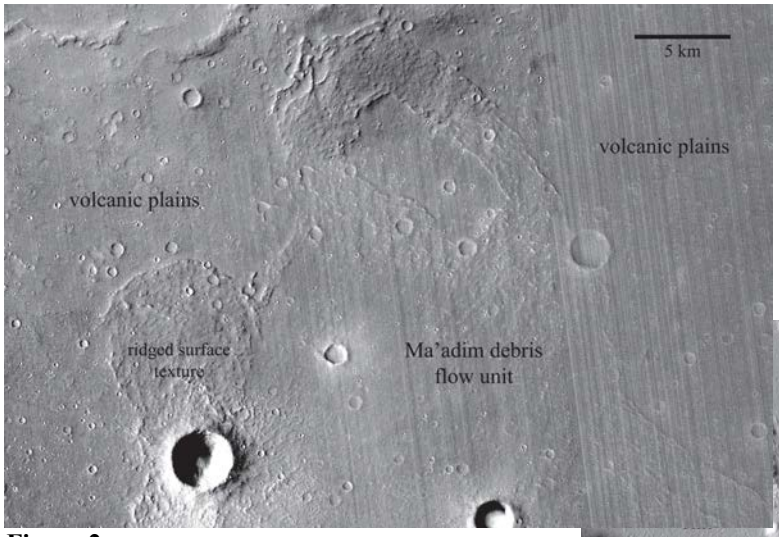

Figure 2. CTX mosaic showing the northern terminus of a flow unit (Ma'adim debris flow unit) on Gusev's floor. The flow extends across both ridged volcanic plains units. Note the ridged surface texture in places and variability in definition of flow margins. At upper center, the flow appears to wrap around a rectangular patch of the underlying surface, forming a kipuka. While the flow unit is interpreted to be a debris flow, the margins exhibit characteristics similar to some lava flows.

Figure 2

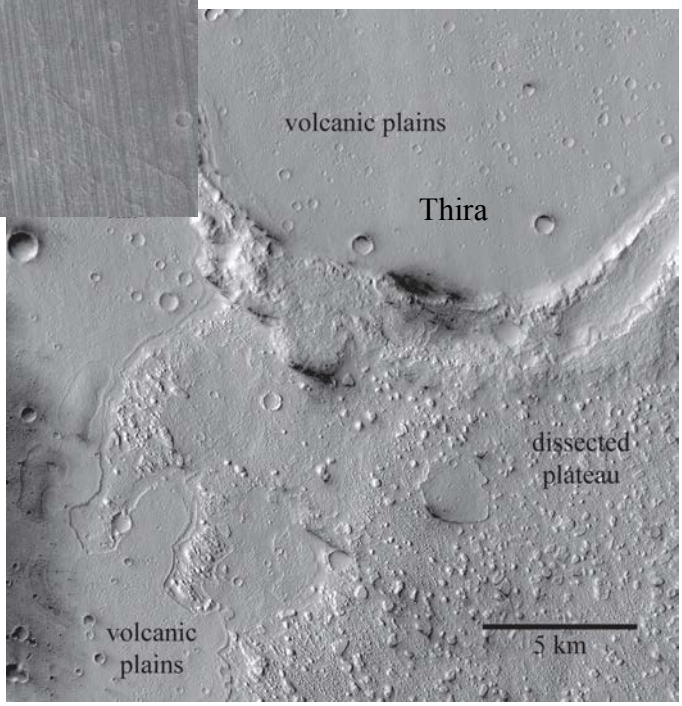

Figure 3. CTX mosaic of central Gusev crater floor showing southern rim of Thira crater with interior smooth volcanic plains. To the south are dissected plateau materials with scattered, polygonal remnants of a once widespread surface layer. To the southwest, note the lobate extensions of volcanic plains against Thira's rim and into the dissected plateau.

Figure 3