GEOLOGIC MAPPING OF GUSEV CRATER, MARS: VOLCANIC RESURFACING OF GUSEV'S FLOOR. 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 geology of Gusev crater (~160 km diameter; 14.53°S, 175.52°E) has been studied through orbital remote sensing combined with exploration of the Columbia Hills and adjacent volcanic plains by the MER Spirit rover [e.g., 1-4]. The geologic history of Gusev crater has been attributed to the combined effects of a variety of geologic processes that span much of Martian history. We are producing a new 1:250K-scale formal geologic map of Gusev crater. Our mapping investigation focuses on the characteristics of the rim and floor deposits and is informed by comparisons to other volcanic regions of Mars and by terrestrial analog studies of volcanic embayment relationships [5].

Background: The existing USGS map of Gusev crater was produced at 1:500K-scale based on Viking Orbiter data [6]. Other studies have mapped Gusev based on geomorphic, thermophysical, and topographic characteristics [e.g., 3, 7-10]. The deposits forming the floor of Gusev crater 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]. Spirit confirmed the presence of basalt on the plains adjacent to the Columbia Hills [13]. The Gusev impact was determined to be Early to Middle Noachian (3.9-4.1 Gy) in age [16].

While there is clear consensus for basaltic lava at the surface, Gusev's infilling history remains undetermined, with potential contributions from multiple processes. Analysis of MOLA data suggested burial of 20-50 km diameter craters and ~1.5 to 3.7 km of infill [10, 17]. Compositional data, surface morphology, and crater size-frequency distributions indicated low viscosity basalts of Hesperian age (~3.65 Gy) dominate the crater floor [8, 13]; a lunar mare-like flood basalt analogy was supported by identification of buried craters, wrinkle ridges, and benches along contacts with crater walls.

Mapping Gusev's Floor: Our GIS-based study utilizes the full suite of high-resolution imaging, topographic, and compositional datasets available for Gusev from multiple Mars missions, including a new DTM of Gusev's floor (24 m/pixel) derived from seven sets of CTX stereo pairs (**Figure 1**).

Using CTX images (5-6 m/pixel), we have identified eight geologic units, including: three main floor units (two ridged plains and an upper or overlying flow unit), plateau and terrace units along the eastern crater rim, and a mesa unit to the south where Ma'adim Vallis dissects the crater rim, along with hills scattered across the crater floor and crater materials. The volcanic ridged plains units exhibit smooth to hummocky surfaces with wrinkle ridges. The upper flow unit has been interpreted as part of the volcanic floor [8, 10] and as fluvio-lacustrine sediments in part emplaced as debris flows [6, 18].

As part of our geologic mapping investigation, we are evaluating different interpretations of Gusev floor units. CTX images reveal morphologic details of the upper flow unit that suggest some similarities to recent (~100 My) flood lavas in the Cerberus plains [19-21]. Key characteristics of Cerberus "platy-ridged" flows include up to km-scale smooth and rough plates, narrow ridges and grooves, and sets of subparallel arcuate ridges over several hundred meters. The ~3^+ Gy older age of Gusev's floor and the accompanying surface degradation precludes comparable fine details like those observed in Cerberus, but Gusev's floor exhibits a) zones of ridged surface texture and b) narrow ridges and larger ridged zones in complex patterns that are local topographic highs and separate adjacent plate-like smooth zones (**Figures 2- 3**).

The flood lavas of Cerberus exhibit two types of flow margins: 1) ridged surfaces with highly sinuous margins consistent with low viscosity sheet-like flow and 2) smooth surfaces over 100-500 m zones with steep margins that suggest inflation [19-21]. In order to assist in our interpretations of volcanic contacts on Gusev's floor, we are also characterizing the morphology and topography of terrestrial basalt flow margins that show evidence of different scales and magnitudes of inflation [5].

In combination with analyses of the surface morphology of Gusev geologic units and in order to help characterize formation processes, we are examining the topographic characteristics of the numerous contact and embayment relationships on Gusev's floor. These include curvilinear margins (bench-like), lobate margins, and many potential kipukas as Gusev floor units incompletely covered pre-existing floor materials, such as the Columbia Hills. Preliminary results for a group of ten kipukas to the south of and including the Columbia Hills (**Figure 4**) show mean changes in elevation of ~22.4 m along contact lengths between ~3.5 and 15.3 km. All contact elevations for the group of ten kipukas range between -1946 and -1854 m, with mean values for individual kipukas between -1936 and -1891 m. Observations and measurements of both geologically recent Martian lava flows (e.g., Cerberus) and terrestrial analogs provide important comparisons to and constraints for assessing volcanic processes and stratigraphy and degradational history in locations like Gusev crater.

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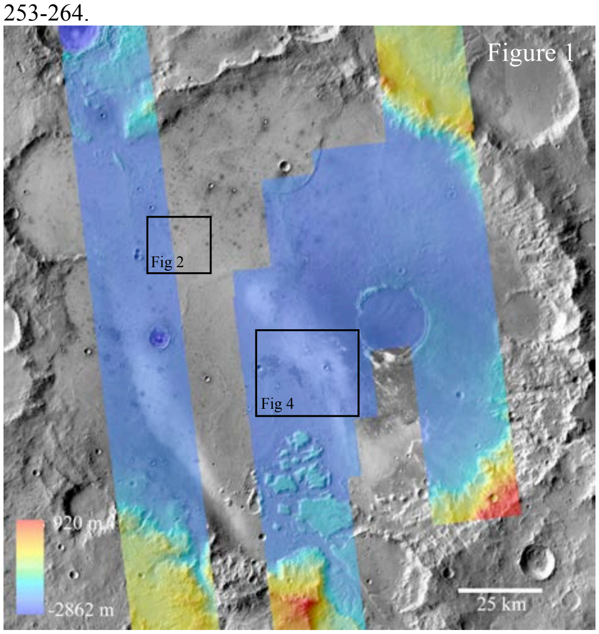
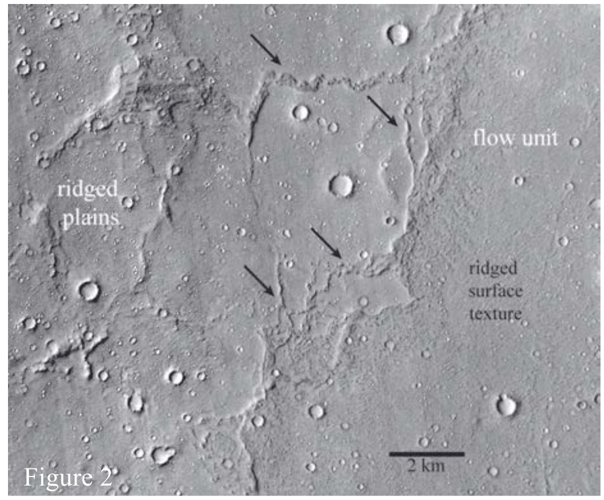
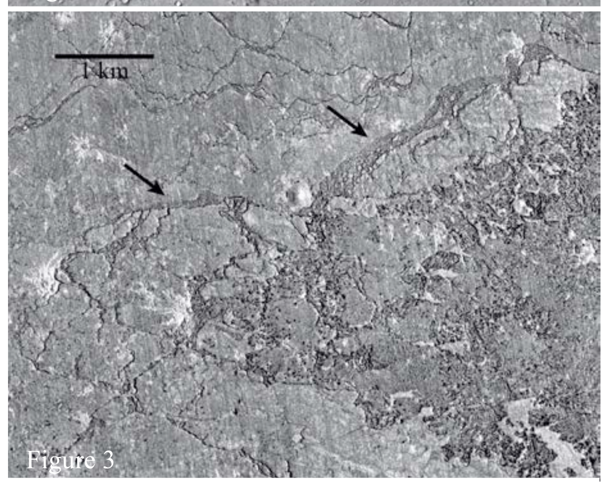


Figure 1. CTX DTM (from Ames Stereo Pipeline) of part of Gusev floor over THEMIS IR mosaic. High-resolution topography allows detailed examination of geologic contacts.





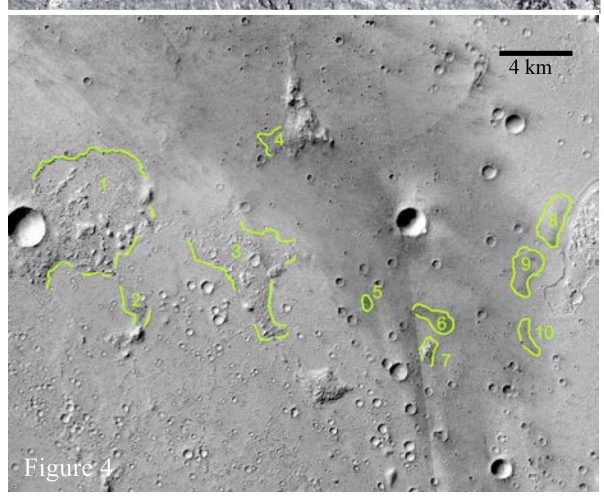


Figure 2. Contact zone between ridged plains and upper flow unit in west central Gusev. Note complex flow margin with prominent ridges adjacent to smooth areas. **Figure 3.** Young flow surface in Cerberus plains with ridged texture (at right) and prominent ridges/ridged zones delineating smooth plates within surface crust. **Figure 4.** Group of 10 kipukas near Columbia Hills (#4) for which contact elevation measurements have been made from the CTX DTM mosaic.