MER FIELD GEOLOGIC TRAVERSE IN GUSEV CRATER, MARS: INITIAL RESULTS FROM THE PERSPECTIVE OF SPIRIT.

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Introduction. This report casts the initial results of the traverse and science investigations by the Mars Exploration Rover (MER) Spirit at Gusev crater [1] in terms of data sets commonly used in field geologic investigations: Local mapping of geologic features, analyses of selected samples, and their location within the local map, and the regional context of the field traverse in terms of the larger geologic and physiographic region. These elements of the field method are represented in the MER characterization of the Gusev traverse by perspective-based geologic/morphologic maps, the placement of the results from Mössbauer, APXS, Microscopic Imager, Mini-TES and Pancam multispectral studies in context within this geologic/morphologic map, and the placement of the overall traverse in the context of narrow-angle MOC (Mars Orbiter Camera) and descent images. A major campaign over a significance fraction of the mission will be the first robotic traverse of the ejecta from a Martian impact crater along an approximate radial from the crater center.

The Mars Exploration Rovers have been conceptually described as “robotic field geologists” [2], that is, a suite of instruments with mobility that enables far-field traverses to multiple sites located within a regional map/image base at which in situ analyses may be done. Initial results from MER, where the field geologic method has been used throughout the initial course of the investigation, confirm that this field geologic model is applicable for remote planetary surface exploration.

The field geologic method makes use of near-field geologic characteristics (“outcrops”) to develop an understanding of the larger geologic context through continuous loop of rational steps focused on real-time hypothesis identification and testing. This poster equates “outcrops” with the locations of in situ investigations and “regional context” with the geology over distance of several kilometers.

Using this fundamental field geologic method, we have identified the basic local geologic materials on the floor of Gusev at this site, their compositions and likely lthologies, origins, processes that have modified these materials, and their potential significance in the interpretation of the regional geology both spatially and temporally.

Field Geologic Strategy. Near-field examination of panoramic (Pancam and Navcam) and multispectral (Pancam and Mini-TES) data sets have been used to map recurring characteristics and outline hypotheses about surrounding features. Targets of opportunity in the near field have been selected from these characteristics for detailed in situ investigation using the Athena instrument suite, including instruments (APXS, Mössbauer and Microscopic Imager) deployed to the soils and to the rock Adirondack and multi-spectral observations of nearby rocks and soils, such as light-toned rocks and bright soils. Based on the results of these individual site investigations, and an understanding of the regional location of the rover, a traverse strategiy has been designed that increases the potential that the local observations can be used to understand the regional geologic setting

Mapping within the Panoramic Data Bases. For perspective-based mapping purposes, geologic/morphologic mapping in Spirit Pancam data sets [3] has been divided into near-field (≤20 m) and far field (>20 m to horizon) segments. This is based on the apparent increase in object distortion, the decrease in resolution and accurate ranging, and corresponding decresae in resolvable geologic information beyond 20m.

In the near field three obvious principal materials include rocks, soils, and aggregated fines (drifts and ripples). Details of on-going hypotheses and their evaluation in the geologic context of Gusev crater are outline in Cabrol et al [this volume]. Rocks appear mostly fine-grained and to occur in light and dark, angular and more rounded, and vesicular and smooth varieties, (sub 100 micron grain sizes from MI [1,4] data). No unequivocal sedimentary rocks have been observed as of the time of this writing, but a full characterization of the rocks in all of the instruments remains to be done.

Many of the anomalously light toned rocks in the near-field at the first analysis location are too small to be adequately resolved in Mini-TES. Targets of more substantial dimensions will be necessary for complete characterization. Multispectral information has been compiled for limited areas on light-toned rocks. These initial results suggest that the light-toned rocks are simply dust-colored dark rocks. Initial multispectral data implies that some of the darker rocks are consistent with olivine-bearing mafic rocks [5]. The latter observation is consistent with initial Mössbauer and APXS [6] results on soils and rocks and suggests a basaltic composition. The widespread evidence for dust in multispectral and Mini-TES spectral emissivity [6] data are initially confirmed from results of brushing using the RAT prior to RAT operation on at least one rock.

In the far field there is potentially greater variety, but also greater distortion due to foreshortening and thus loss of visual detail. Nonetheless several broad characteristics defined include apparent boulder clusters or groupings, an association of boulder clusters with surrounding bright soils, additional bright depressions of various diameters similar in morphology to Sleepy Hollow, numerous far-field impact crater rims, and several exceptionally large boulders.

Local Geology in Regional Context. Geologic characteristics are being mapped along a traverse that makes use of the post-EDL MOC and descent images, in conjunction with low-compression stereo Pancam images and Navcam images in the traverse direction images. These bases are being used to outline the details of a traverse across the ejecta and towards the rim of a 200 m-diameter impact crater, nick-named “Bonneville”, centered 430 meters from the landing site (Figure 1)..

A course from the landing site northeast towards the crater “Bonneville” is designed in order to sample diversity in the ejecta materials and morphology with distance from the impact crater. The goal is (1) to observe variations in ejecta characteristics with distance such as detailed topography, block size, abundance, and lithology coordinated with in situ observations of soils at selected sites along the traverse, (2) to determine if substrate materials are systematically arrayed with distance according to possible differences in substrate stratigraphy, (3) to observe the interior of the crater walls for in situ exposures of possible substrate materials, and (4) to invstigate the bright dunes and dark material within the crater, and (5) to determine if the descent heat shield is presents, and, if so, the possible nature of the darkening of the far crater rim as observed in association with the heat shield impact area. A key focus will be to search for rocks excavated by the crater that provide evidence pro or con for the hypothesis that Gusev was once the site of a lacustrine environment.

In addition to observations of the surface using the science instruments, the rover itself is being used to reconstruct physical characteristics of the surface in the context of local terrain models along the length of the traverse. This will be done by systematic imaging of the rover wheel tracks and by deconvolution of the rover kinematics during the traverse with mechanical characteristics of the subsurface materials.

Geologic mapping and terrain physical characteristics along the traverse will be tied to a narrow, but long, base map image consisting of along-the-way Pancam and Navcam image “wedges” in orthographic projection. Detailed observations of “touch-and-go” sites of analysis of opportunity, selected instrument investigation sites, mission “locations”, and a variety of Hazcam and remote sensing observations sets will be sited within the traverse base. Figure 1 shows that the traverse will take the rover out of a dark area of possible dust devil tracks into a brighter and presumably dustier area, a relationship that be seen in low compression color Pancam images of the traverse path and

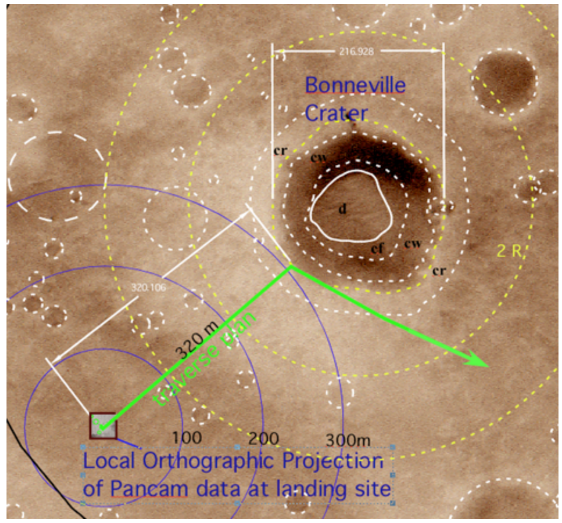

Figure 1. Traverse plan for Spirit includes a 320 m drive to the rim of the 220 m-diameter “Bonneville crater” rim. Along the way, systematic traverse science may include a variety of panoramic images reprojected to orthographic reference and remote sensing observations of near-field targets of opportunity in addition to several (~4) sites of more detailed investigation. MOC post EDL base image (MGS & Malin Science Systems). Yellow circles, increments of one crater radius; dark circles, 100 m increments centered on the landing site. The small box at the landing site is a 30 m orthographic projection of Pancam images (from Ron Li). An array of similar images and corresponding in situ and remote sensing data will constitute a geologic traveres strip from the distal ejecta to the crater rim. Cr, crater rim; cw, crater wall; cf, crater floor; d, dunes. North is toward the top of the image.

crater rim. Thermal inertia is also higher nearer the crater rim, suggesting a rockier surface near the rim. The results will constitute the first geologic traverse map, or geotraverse strip, on another planet.

References. [1] Squyres and the Athena Science Team, this volume; Malin and the Athena Science Team, this vol”ume; [2] Squyres et al., JGR, 2004; [3] Bell et al., 2004, JGR; [4] Herkenhoff et al., 2004, JGR; [5] Christensen and the Athena Science Team, this volume; [6]McSween and the Athena Science Team, this volume; [7] Arvidson et al., 2004, JGR].