CHARACTERIZATION OF NON-ORGANIZED SOILS AT GUSEV CRATER WITH THE SPIRIT ROVER DATA. N. A. Cabrol[1], R. Greeley[2], and the Athena Science Team [1]NASA Ames Research Center. Space Science Division. MS 245-3. Moffett Field, CA 94035-1000. Email: ncabrol@mail.arc.nasa.gov. [2] Arizona State University. Department of Geology Arizona State U. Box 871404 Tempe, AZ 85287-1404. Email: greeley@asu.edu.

1.0 Introduction: We surveyed the characteristic of non-organized soils at Gusev crater at microscale and macroscale in four main traverse regions: (1) Landing site to Bonneville crater; (2) Bonneville to West Spur; (3) the West Spur region; and (4) the Columbia Hills up to sol 363. Non-organized soils are defined as soils traversed by Spirit that do not include drifts, ripples, or dunes.

2.0 Methods: We used data from the Microscopic Imager (MI) and the Panoramic Camera (PanCam) to identify and characterize non-organized soils at Gusev crater. Representative images of typical soils at macro and microscale were selected based on quality (focus) over the area covered by the field-of-view (FoV). Image processing was performed for both scale using the Photoshop application.

2.1. Microscopic Images: MI is a black-and-white microscopic imager with 31 micron-per-pixel (µm/pxl) resolution. To be resolved with sufficient accuracy, a particle must be at least be 4 pixels in the FoV. When grains were smaller than ≤125 µm we chose not to measure them and took into account the surface area they cover in the FoV instead. In cases where non-organized soils are mixed grain-size populations, we provided the grain-size distribution of the fraction superior to 125 µm and the surface area covered by the smaller fraction.

MI images provide the sedimentologic characteristics of the sample, such as the grain-size distribution, the grain shape, micro-texture, small-scale morphology, and qualitative and quantitative properties (e.g., individual grains, clusters, sticky, powdery). In few instances, MI 3-D images were reconstructed from Spirit data when two sets of images of the same sample were acquired in two positions by sliding the robotic arm along the horizontal plane, providing different angle and shading. However, in general, MI images provide a flat view of 3-D particles, and are treated in this analysis as thin sections. Therefore, constraints and limitations of this technique are the same as those encountered in the laboratory while inspecting thin sections under the microscope. They include: Uncertainties in the measurement accuracy of the length and width, and in the assessment of the shape of a particle. These limitations have been studied and quantified, showing that the smaller the grain size, the higher the uncertainty [Thomas et al., 2003]. Lighting condition impacts the ability of accurately measure grains as well. To mitigate this issue, we selected images where lighting was homogeneous either over the entire FoV or over a representative surface area of the image that was used for subsampling. The geometry of the sample (grain packing) can also be an issue when grains are partially buried underneath others. In such case, they were not measured either.

To assess the particle populations and grain-size distribution, representative surface areas were selected within the surveyed images and the statistical counts were then adjusted to the total FoV area (~9.6 cm^2). The NIH application was used to derive grains properties, such as length, width, shape, and angularity.

2.2 Pancam Images: Pancam was used to provide context to the MI images and color information using Pancam filters. They were also used to identify interesting soils that were not surveyed subsequently by MI.

3.0 Soils Types and Characteristics:

From microscale and macroscale observations, non-organized soils at Gusev can be classified according to characteristics that may include:

- *grain-size distribution*
- *morphology*
- *physical properties*
- *Vertical structure* (in trenches)
- *albedo*

and/or a combination of all those characteristics. Some samples represent clear classes whereas other show a mixture of various types, possibly indicating a transition from one soil region to another, and/or, that the surveyed soil sample is the result of a combination of processes. The types below represents a first attempt at classifying the non-organized soils. Four main types are describes, some including sub-classes.

3.1 Soil Types: This classification is based on MI image interpretation:

Type 1: *Very fine to fine grained soils* (example sols 013, 015, 051, 65, 158, 166). Individual grains are below measurement resolution. Clusters of grains (in average between 400 µm and less than 1 mm in size) are observed over a large portion of the MI FoV (>60%). Tubular-like structures seem to be present in a majority of the surveyed samples, and their origin could encompass: erosion, water evaporation, lighting artefacts. Other raised features include soil flakes projecting shadow, which indicates cohesiveness. The albedo is homogeneous over the entire sample. Under compaction from the MB plate, some of these soils behave like flour, indicating a very fine-grained composition (example sols 235, 240, 258)

Type 2: *Mixed soils* (example sols 044, 046, 70, 075, 105, 106, 107, 141, 164, 167). Type 2A. The soil is mostly a mixture of very fine to fine- grained particles and pebble size material comparable to Type A soils. A few sand-size particles are also observed but constitute only few occurrences. Pebbles are sub-angular to sub-rounded. Soil and pebble albedo are comparable, with few variations due to local dust cover or removal. Mixed soils range from pebble-rich (≥ 50% of FoV surface area covered) to pebble-poor (<50%). Type 2B. The soil is a mixture of fine sand particles and pebble-size material. Clusters of very fine-grained particles are present but represent a minor statistical count. Type 2C. The soil is a mixture of a wide range of particle size (from below measurable resolution to granules and pebbles) and includes crusty material as well. Albedo varies in the sample (example sol: 181).

Type 3: *Rocky soils* (example sols 071, 279, 281, 314). This type is dominated by rocks (sub-angular, smooth) that can occupied a significant portion of the MI FoV (~20%) or smaller pebble-size material. Finer material are clustered in crusty material that break up in clear fracture cuts. This crusty, cohesive material can break down to mm-size flakes. Fine-sand particles are collecting on top on larger flakes. No specific vertical structure of the subsurface can be observed in this crumbled-like material.

Type 4: *Granular soils* (example sols 77). This type shows a combination of Type A and embedded rounded-granule size material. It is observed near drifts and probably results from granules being blown away from local drifts and ripples.

3.2. Trenches: In several cases, trenches allowed to access the near subsurface and observed the vertical structure of the soils. In some cases, the vertical structure includes grain-size and albedo variations. Sol 116 trench also shows horizontal lineations that could be consistent with cycles of material accumulation.

Our poster will present the results of the statistical analysis of MI and Pancam images, the hypotheses and range of interpretations for the formation and evolution of the different types of soils observed, and their distribution along Spirit's traverse in Gusev. We will discuss these results at the light of the mineralogical and chemical analysis performed *in situ.*

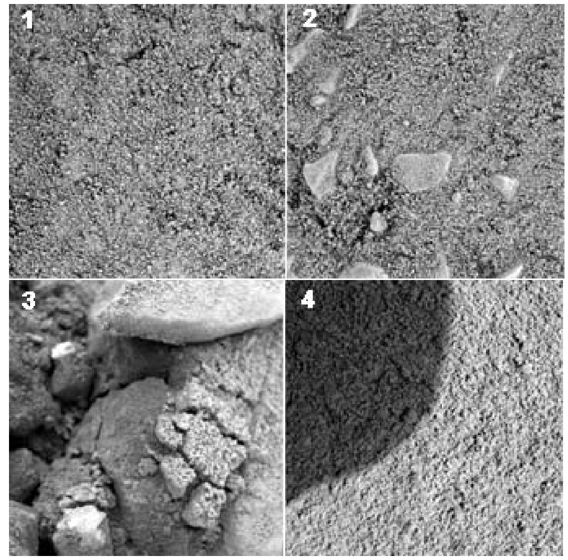

Figure 1: Typical Non-organized soils in Gusev crater: 1. Type 1: Very fine to fine-grained (Sol 015 MI: 2M127691266); 2. Type 2: Mixed (Sol 046, MI: 2M130463097); 3. Type 3: Rocky (Sol 071, MI: 2M132663637); 4. Type 4. Granular (Sol 077, MI: 2M133197288).

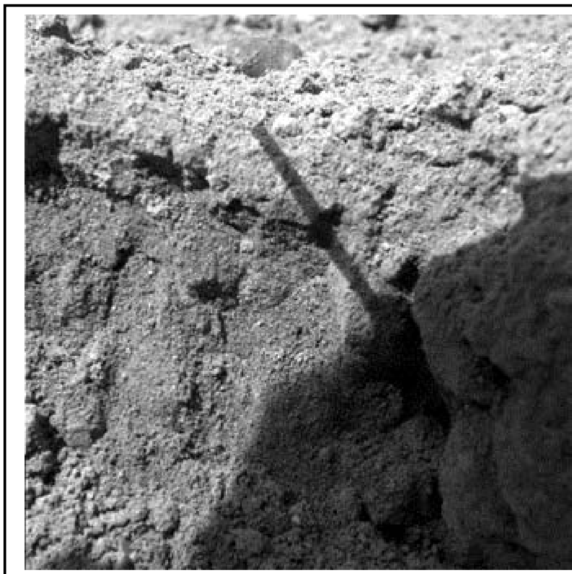

Figure 2: Sol 116 trench provides an insight into the near subsurface and gives information about the vertical structure of the soil. Albedo, compaction, grain-size material vary with depth. Lineations could be consistent with layers of material added through temporal cycles.