TEXTURAL AND CHEMICAL EVIDENCE OF HYDRODYNAMIC SORTING IN SEDIMENTS IN GUSEV CRATER. I. O. McGlynn[1], H. Y. McSween Jr.[1], and C. M. Fedo[1], [1]Deptment of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996 (imcglynn@utk.edu)

Introduction: The present surface of Mars is dominated by aeolian processes. Exposed outcrops are abraded by saltating grains that impact, leaving some grains embedded and introducing chemical contamination. The surface is regularly modified by global dust storms, mixing material at all scales. Such aeolian action even interferes with the operation of the Mars Exploration Rovers (MER) [1].

Sedimentary features such as layering, sorting, and cementation have been found at Meridiani Planum and Gusev crater, and show direct evidence of mixing rocks and fines [2,3,4]. Aeolian and possibly fluvial transport processes have mixed locally-derived sediments with compacted fine-grained dust present in the upper 1 mm surface. The physical sorting of sediments found at both Meridiani Planum and Gusev Crater may have caused chemical and mineral fractionation. Aeolian processes may fractionate particles with different densities, producing soils with different chemical concentrations.

Methodology: Grain size analyses of sediments in Gusev Crater were performed on images from the Microscopic Imager (MI). With the high spatial resolution images (31 µm/pixel) it is possible to identify surface particles as small as 2-3 pixels or ~100 µm [5]. Over 5000 images have been recorded by Spirit, providing an ample basis to evaluate surface processes in Gusev Crater. Soil materials from MI observations were correlated with APXS chemical analyses. Images were selected for suitability of texture analysis based on when the imager dust cover was open, surface illumination, and image focus for undisturbed or minimally disturbed surfaces.

The entire field of view for each MI image was assumed to be representative of the same surface measured by APXS spectra. Usually MI image and APXS spectra acquisition measurements are taken within 1 or 2 sols. With the short time between MI and APXS measurements, surfaces should be unchanged without mobilization or alteration.

Grain size analysis was performed in a similar manner to prior MI studies using the National Institutes of Health free image processing application ImageJ [6,7]. Observable individual grains were manually outlined. Irresolvable grains (< 200 µm) were detected in a semi-automated method with a high-pass filter to accentuate grain boundaries and a watershed separation to isolate grains. Measurements are statistical approximations of distinct grains and should not be interpreted as absolute grain dimensions. Resulting grain measurements included the major axis and minor axis lengths, grain area, circularity, and perimeter of each grain. All grains are classified using the Wentworth scale.

Grain size of sediments: Four distinct grain size distributions were observed from MI images. The majority of soil targets have a bimodal distribution of very fine-grained mud-sized particles and larger sand-sized grains including Crest Morning, Sugar, Bear Paw, Lands End, Hang Two, Mawson, and Progress (Fig. 1). Other sites are mostly covered by fine mud-sized grains including Greeneyes, Conjunction Junction, Paso Robles, and Whymper. A third distribution of a small number of large gravel-sized granules with a high abundance of very fine-grained mud-sized particles is at Ramp Flats, Bitterrootflats, and Hole Mayfly. The El Dorado dune field is unique with a unimodal sand-sized grain distribution. Dust is believed to be present in all sites, but is indistinguishable at MI spatial resolution limits.

Bulk composition of sediments: Sedimentary transport by fluvial and aeolian processes should be identified from mineralogical fractionation. The relative depletion of heavy oxides containing FeO_T, TiO_2, and Cr_2O_3 are a strong indication of aeolian fractiona-

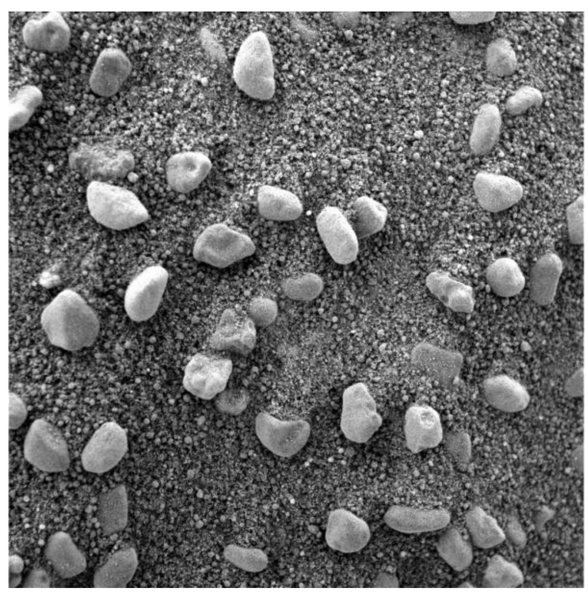

Figure 1. Typical range of mud and sand sized grains in Gusev Crater for undisturbed soil target "Mawson" from MI image 2M198449742EFFAR00P2936M2M1 acquired on sol 812.

tion from aeolian sorting is reflected in TiO_2, Cr_2O_3 concentrations (Fig. 2). Cr2O3 is most depleted for images with mud-sized grains while least depleted for images with sand and mud-sized grains. A minor depletion of TiO_2 is found among the mud-sized grains, consistent with prior studies. A similar fractionation is not evident for FeO. Higher FeO content for targets with mud-sized grains could result from differences in source material chemistry. The prevalence of dust in all sites could also mask chemical compositions.

Without the ability to isolate individual grains, the grouping of APXS sites based on grain properties assumes that images with mud-sized particles experienced the highest degree of physical weathering. Sites with gravel-sized grains only have a few grains that cover a small fraction of the target surface, represent moderate physical weathering. Sites with a high abundance of sand-sized grains represent the least amount of physical weathering due to the relative reduction of mud-sized grains.

In the absence of hydrolysis or other forms of chemical weathering, soils derived from physical weathering of local rocks should retain the same bulk chemistry as the parent material. However with hydrodynamic sorting and with mixing of aeolian transported dust, the chemistry of soil sediments reflects a more complex provenance.

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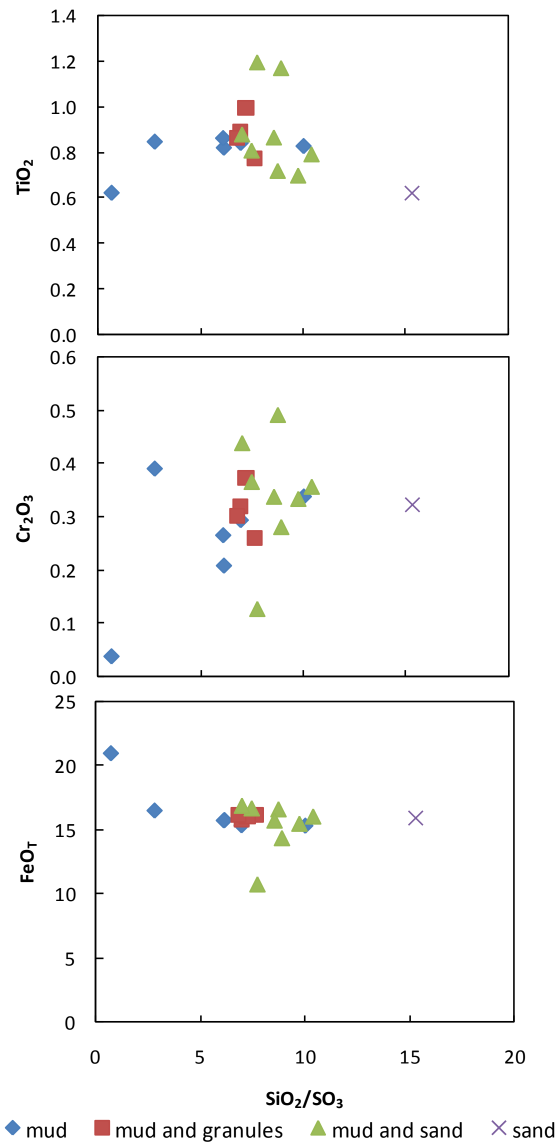

Figure 2. Aeolian processes may fractionate particles with different densities, producing soils with different concentrations of oxides. Heavy mineral fractionation in soils from hydrodynamic sorting for TiO_2 and Cr_2O_3 has a correlation with MI grain size. Fractionation of FeO by wind-driven transport is not detected and may result from dust admixture with soils or some degree of chemical weathering.