MINERALOGICAL CHARACTERIZATION OF SOILS IN GUSEV CRATER AND MERIDIANI PLANUM, MARS.

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Introduction: The details of surface composition and regolith evolution provide critical information to understand current elemental and mineralogic concentrations, their regional differences, and the timing and mechanisms of the formation of alteration products. An accurate assessment of the sedimentary record provides the only direct method of reconstructing the past environmental conditions of Mars.

Additionally, identifying the major components in fine-grained soil provides a bridge to understanding the crustal composition of Mars and how the planet's geology may have evolved over the past 4 billion years. The characterization of surface composition and textural variability will constrain the geologic history and contribute to understanding the processes and history of climate on Mars and to determining the evolution of the surface of Mars.

Sediments found on the current surface of Mars should reflect a wide range of source materials and subsequent alteration histories. The chemistry and mineralogy of sediments can reflect unweathered bedrock or altered equivalents.

The purpose of this study is to estimate the abundance of major mineral phases of soils at the MER landing sites Gusev Crater and Meridiani Planum from Alpha Proton X-Ray Spectrometer (APXS) and Mössbauer spectrometer (MB) data. With the determination of soil mineralogy at the MER landing sites, it is possible to test the extent of alteration from hydrolysis and non-aqueous weathering.

Methods: Mineral abundances are estimated from elemental oxides recorded by the Alpha Photon X-Ray Spectrometer (APXS) mounted on the Mars Exploration Rovers Spirit and Opportunity [1]. To reduce the limitations of normative calculations, the distribution of iron-bearing phases from the Mössbauer Spectrometer (MB) [2] and thermal infrared spectral data from the Miniature Thermal Emission Spectrometer (Mini-TES) [3] were combined to complement APXS chemistry method already developed and applied for Gusev rocks [4], but not yet attempted for soils. Soil mineralogy is only estimated when APXS [5, 6] and MB **[7, 8, 9]** chemistry is recorded for soil targets.

Mineralogy estimations of soils are more complex than rock counterparts. The soil samples must be adjusted to account for the admixture of both igneous minerals and alteration products such as silica, clays, and sulfates present. Primary and alteration iron-bearing minerals can be evaluated from corresponding MB spectra. Bulk soil chemistry is adjusted to account for secondary alteration products. Sulfates and chlorites are removed from the bulk soil chemistry, and assumed to be in equal molar percentages. MB data for Fe-minerals are converted to modal proportions. The concentrations were then renormalized to correct for Fe-free minerals that could not be detected by MB from abundances calculated from APXS data. Secondary silica components such as glass have been estimated at 11% from Mini-TES values at Meridiani Planum [10] and are applied here for soils at both MER sites. The bulk chemistry is then normalized to 100% and used for CIPW calculations. Alteration compo-

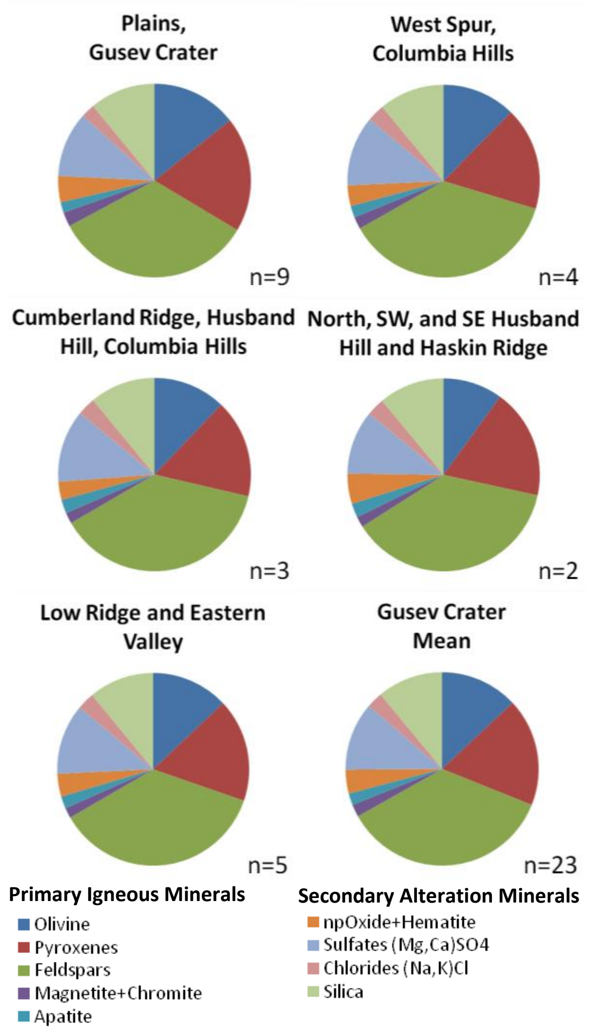

Figure 1. Estimated mineral composition of soils at Gusev Crater averaged and grouped by geographic location.

nents are then added to the reported mineralogy.

Mineral Abundances: The estimated mineral assemblages of soil targets in Gusev Crater (Fig. 1) and Meridiani Planum (Fig. 2) are largely similar to estimates of rock mineralogy [4] and in agreement with Mini-TES values for Gusev soils [10]. The surface sediments are basaltic in composition consisting of olivine, pyroxene, feldspar, and secondary alteration minerals. Removal of sulfates, chlorides and silica components depicts sediments comprised of igneous minerals. The soils are of an igneous composition with limited chemical weathering. The abundance of olivine limits the possibility of hydrolysis. Secondary alteration from nonaqueous weathering is possible. This indicates the surface environments at both MER landing sites are dominated primarily by physical weathering from aeolian processes.

Mineral composition of soils has higher variability within each landing site than when compared between Gusev Crater and Meridiani Planum. Estimated olivine values for Gusev soils vary by 8%, pyroxene by 10% and feldspars by 6%. These differences can be possibly attributed to variations in igneous source material or minor differences in weathering. Mean soil compositions for Gusev and Meridiani are largely similar, due to the similarity of basaltic source material.

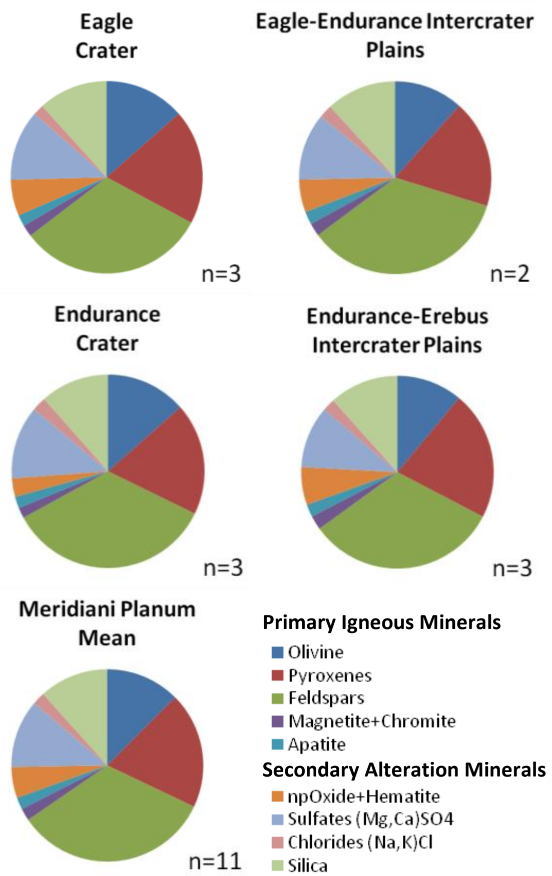

Figure 2. Estimated mean mineral composition of soils at Meridiani Planum averaged and grouped by geographic location.

Conclusions: It is possible to estimate the mineralogy of soils using APXS, MB, and Mini-TES constraints. The soils are derived from basalt with minimal chemical weathering, and are largely formed by physical processes. The composition of soils are globally homogeneous, with higher variability within site each site.

References:

[1] Reider R. et al. (2003) JGR 108, doi:10.1029/2003JE002150. [2] Klingelhöfer G. et al. (2004) *Science* 306, 1740-1745. [3] Christensen P. R. et al. (2004) *Science* 305, 837-842. [4] McSween H. Y. et al. (2008) *JGR* 113, doi:10.1029/2007JE002970. [5] Yen A. S. et al. (2006) *JGR* 111, doi:10.1029/2006JE002797. [6] Ming D. W. et al. (2008) *JGR* 113, doi:10.1029/2008JE003195. [7] Morris R. V. et al. (2006) *JGR* 111, doi:10.1029/2005JE002584. [8] Morris R. V. et al. (2006) *JGR* 111, doi:10.1029/2006JE002791. [9] Morris R. V. et al. (2008) *JGR* 113, doi:10.1029/2008JE003201. [10] Rogers A. D. and Aharonson O. (2008) *JGR* 113, doi:10.1029/2007JE002995.