DETERMINING THE CHEMISTRY OF THE BRIGHT PASO ROBLES SOILS ON MARS USING MULTISPECTRAL DATA SETS.

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Introduction: The Mars Exploration Rover (MER) in Gusev Crater has exposed in its tracks an unusual occurrence of a soil high in sulfur and high in phosphorus [1-3] at a site called Paso Robles. This salty soil is thought to be composed of the following: Fe^{3+}-, Mg-, and Ca-sulfates; Ca-phosphate; hematite, halite, allophane, and amorphous Si [1]. We are currently studying a large suite of sulfate minerals [e.g., 4-8] using a variety of methods including midinfrared emission, reflectance, and micro-transmission spectroscopies, plus visible-near infrared (VNIR) spectroscopy and Mössbauer (MB) spectroscopy. Included in our sulfate studies are numerous Fe^{3+} sulfates that are clearly an important mineral phase of the anomalous Paso Robles soils. Hence, we are applying our spectral databases to the interpretation of various MER datasets to further explore and better understand the chemistry of these salt-rich soils. The focus of this work is to attempt to identify the sulfate chemistry of the Paso Robles soils using a unified application of emissivity, VNIR, and Mössbauer spectroscopy.

Emissivity Spectra: The soil exposed in the MER tracks is typically dark, and the bright soil at Paso Robles that contains ~32% sulfate [1] is fairly rare, but has been found in more than one location (e.g., also at Arad and Tyrone). Miniature Thermal Emission Spectrometer (Mini-TES) [9] data of rover track soils that are dark (from sols 400 and 403) and bright (sol 404) were studied. Spectral deconvolution of the bright-soil spectrum was conducted using an endmember array that included the dark-track soil as well as common rock-forming minerals and a diverse suite of sulfates.
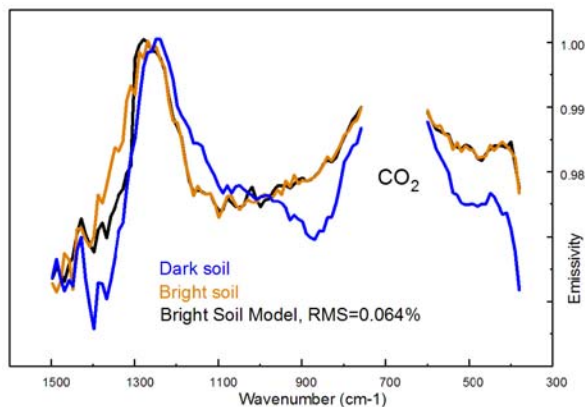

Fig. 1: Mini-TES spectra of bright and dark track soils and the modeled fit to the bright spectrum.

The deconvolution result (Fig. 1) achieved an RMS of 0.064%. The result showed the bright soil spectrum to be dominated by ~49% dark-track soil; plus ~13% kornelite ($Fe_2(SO_4)_3\cdot7H_2O$) (XRD pending) , ~13% yavapaiite ($KFe(SO_4)_2$), and ~7% metahohmannite ($Fe_2(SO_4)_2O\cdot4H_2O$) (XRD pending) [all ferric sulfates]. APXS data [3] show the Paso Robles soils to be depleted in K; however, omitting the K-bearing yavapaiite from the allowed endmembers severely degrades the deconvolution fits. At or below the canonical "5% detection limit" were leonite (~5%), ferricopiapite (~3%), and a smattering of other minerals, including apatite (Ca-phosphate) at 0.2%. However, the identifications of these minor mineralogies may be inaccurate.

VNIR Spectra: Clustering via statistical analyses of the data from the Panoramic Camera (Pancam) [10] scenes of Paso Robles' tracks provided "typical" and "anomalous" spectra. The anomalous spectra occurred in the bright regions of the images. These spectra exhibited diagnostic spectral characteristics (e.g., reflectance maximum at ~670 nm, a minimum near 800-850 cm, and a convex upward feature near 480 nm) that are indicators of the possible presence of coquimbite, kornelite, copiapite, fibroferrite, and yavapaiite mixed with darker soil constituents. These identified sulfates are all ferric-bearing minerals.

Mössbauer Spectra: Paso Robles MB spectra were processed using *MERView* [11]. An extensive suite of sulfates have been compared to the data and likely mineral candidates have been identified, including Fe (III) sulfates. Details are forthcoming.

Results: On the basis of our results to date. We believe the sulfates of the anomalous bright soil exposed in the tracks at Paso Robles are dominated by coquimbite/kornelite (and perhaps yavapaiite) with other ferric sulfates possibly being present.

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