A SPECTRALLY UNIQUE UNIT DISPERSED THROUGH THE SOUTHERN HIGHLANDS OF MARS.

T. D. Glotch[1], J. L. Bandfield[2], and M. Osterloo[3], [1]Jet Propulsion Laboratory, California Institute of Technology (tglotch@gps.caltech.edu), [2]Arizona State University, [3]University of Hawaii at Manoa.

Introduction: We have identified a spectrally unique unit distributed throughout the southern highlands of Mars. This unit, identified in Thermal Emission Imaging System (THEMIS) infrared imagery is characterized by higher band 5 (1075 cm^{-1}) emissivity than the surrounding terrain, with a pronounced blue slope toward lower wavenumbers. Most exposures of this unit are small, making high-spectral resolution analysis with Thermal Emission Spectrometer (TES) data difficult. Analysis of TES data over a relatively large exposure of this unit in Terra Sirenum is consistent with a large component of iron oxides, and a relatively small abundance of plagioclase feldspar. A more detailed analysis of this region is given by [1].

Method: We searched for exposures of the spectrally unique unit on the THEMIS publicly released data website http://themis-data.mars.asu.edu/. Images with an average surface temperature above 220 K may be displayed as “4-panel images” which show three separate decorrelation stretched (DCS) [2] radiance images (bands 875, 964, and 642) in addition to a monochrome surface temperature image. The unit of interest is generally displayed as blue, green, and yellow/orange respectively in the three separate DCS images (Figure 1). We catalogued the location of each exposure, and chose several of the larger exposures for compositional analysis using the THEMIS and TES data.

TES spectra over areas of interest were atmospherically corrected using the non-negative least squares deconvolution algorithm of [3]. Spectra from two OCKs (5932 and 3794) were atmospherically corrected separately, giving consistent surface spectral shapes. The two resulting surface spectra were then averaged together for compositional analysis to reduce noise. The compositional analysis was performed using a spectral library that includes plagioclase feldspars, high and low Ca pyroxenes, several olivines, sulfates, carbonates, clays, and glasses, and iron oxides/oxyhydroxides, including hematite, magnetite, maghemite, goethite, lepidocrocite, and akaganéite.

In addition, we used factor analysis and target transformation techniques [4-5] in attempt to isolate components that may be responsible for the spectral differences between the exposures of the unit of interest and the surrounding plains.

Results: Figures 1 and 2 show typical exposures of the spectrally anomalous unit. Figure 1 shows the identifying characteristics of the unit when displayed as three separate DCS mosaics. All images in Figure 2 are displayed as bands 8, 7, and 5, in red, green, and blue respectively. Exposures of the unit are sometimes seen in crater floors (e.g. Figure 1) but more often occur as small, isolated exposures in the southern highlands intercrater plains (Figure 3.)

Surface spectra derived from two separate OCKs are shown in Figure 3 along with TES Surface Type 1 (ST1) [6]. The spectra differ from ST1 from ~800-1300 cm^{-1} as well as at longer wavelengths, where the spectra have an overall lower emissivity than the ST1 spectrum. The composition derived from the average of these two spectra (Figure 3b, Table 1) is high in Fe-oxides (primarily as magnetite, with smaller amounts of maghemite and hematite) and pyroxene (primarily low-Ca pyroxene). There are also smaller amounts of high-Si phases, which include primary volcanic glasses and smectite clays, olivine, and sulfates. Preliminary analasis of other regions identified in the THEMIS images shown in Figures 1 and 2 indicate similar oxide abundances to that seen in Terra Sirenum, but with variable pyroxene and plagioclase abundances.

Because linear deconvolution of TES spectra has indicated a high oxide component associated with the units shown in Figures 1 and 2, we performed factor analysis and target transformation in an effort to isolate this component. Figure 4 shows that although the recovered spectra are noisy, there are relatively good matches to magnetite and maghemite. This is consistent with the results of linear deconvolution. When iron oxyhydroxides such as goethite, lepidocrocite, and akaganéite are used as target vectors in the target transformation process, a good fit between the data and the target vector is not achieved.

Conclusions: We have identified a spectrally unique unit in the southern highlands of Mars using THEMIS IR DCS images. Analysis of TES data over this unit reveals iron oxide abundances that are are higher than the maximum abundance derived from the Meridiani Planum hematite-rich region. Although we can not yet rule out other spectral effects such as slopes due to anisothermality, high magnetite and maghemite abundances are consistent with the derived surface shape. Future work will investigate whether Ti- and Al-oxides may also be present in these regions. If the derived spectral shape is indeed due to compositional uniqeness, then the small exposures of this unit may represent a primary volcanic composition significantly different from any seen previously on Mars.

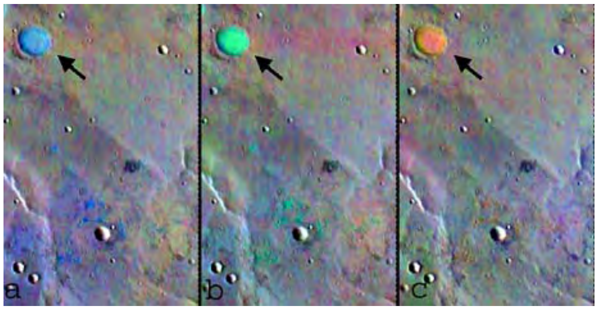

Figure 1. This THEMIS infrared image I07815002 shows a typical exposure of the unit of interest displayed (arrows) in three different DCS band combinations. a) Bands 8, 7, and 5. b) Bands 9, 6, and 4. c) Bands 6, 4, and 2.

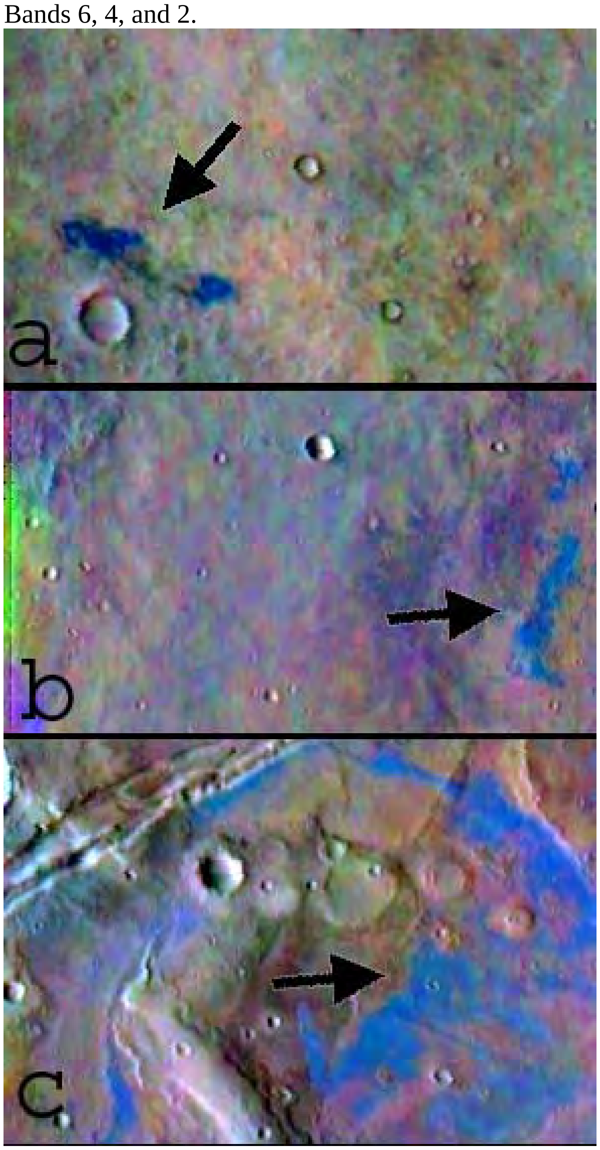

Figure 3. Examples of the spectrally unique unit in band 875 DCS images (arrows). a) I01935005. b) I17537001 c) I07808003.

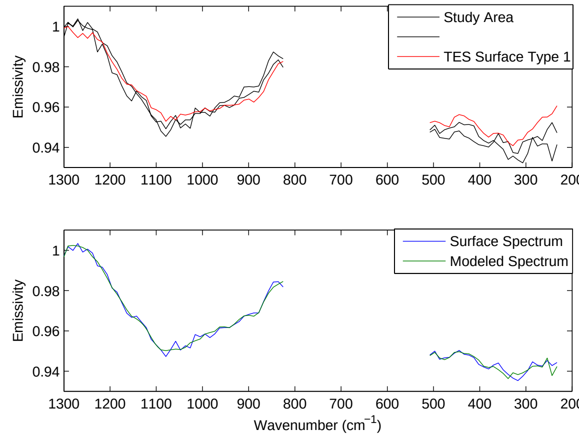

Figure 3. TES Spectra of the Terra Sirenum study area. a) Two surface derived surface shapes compared to TES ST1. b) Average surface and modeled spectra.

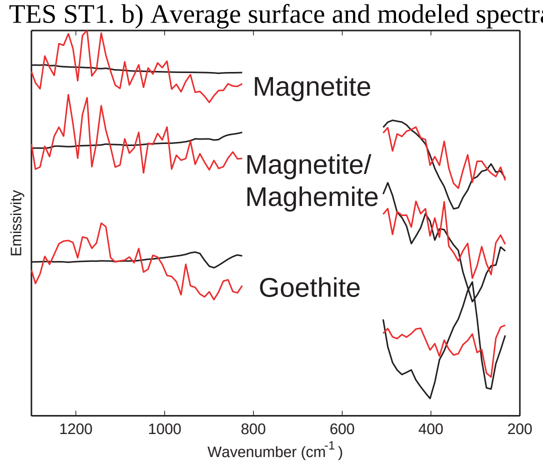

Figure 4. Comparison of oxide endmembers (in black) with potential scene endmembers recovered using factor analysis and target transformation (in red).

Table 1. Estimated mineralogy from TES of Terra Sirenum unit. Numbers in parentheses are numerical errors determined by the deconvolution algorithm.

Phase	Abundance
Plagioclase Feldspar	12 (4)
Pyroxene	26 (11)
Olivine	7 (2)
Fe-Oxide	26 (4)
High-Si Phases	17 (6)
Sulfate	8 (3)
Other	4 (4)

References: [1] Osterloo, M. et al., *this conference*. [2] Gillespie, A. R. et al. (1986) *Rem. Sens. Env.*, 20, 209-235. [3] Rogers, A. D. et al. (2006) *LPSC XXXVII*, #2273. [4] Bandfield, J. L. et al. (2000) *J. Geophys. Res.*, 105(E4), 9573-9587. [5] Glotch, T. D., and Bandfield, J. L. (2006) *J. Geophys. Res.* 111, E12S06. [6] Bandfield, J. L. et al. (2000) *Science*, 287, 1626-1630.