ANALYSIS OF A SPECTRALLY DISTINCT SURFACE FEATURE IN THE TERRA SIRENUM REGION OF MARS FROM THEMIS AND TES.

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Introduction: We identified a spectrally distinct region in the southern highlands of Terra Sirenum (near ~205° E, -33° N) during a survey of Mars Odyssey Thermal Emission Imaging System (THEMIS) daytime infrared (IR) decorrelation stretched (DCS) images. The region lies in the Noachian cratered plateau material (Nplc) [1] and is defined by extensive and densely cratered uplands mostly in the central and south polar regions where there are many buried to partly buried large craters. Intercrater areas are flat and smooth and in places channels and chaotic terrain dissect the region. Lobate scarps and grabens are common while ridges are rare. The Sirenum Fossae cuts through the northwest section of the region of interest.

Data: THEMIS is a multispectral imager that provides mineralogical and atmospheric data at nine wavelengths from 6.78-14.6 μm, in ~32 km wide swaths at a spatial resolution of 100 m per pixel [2]. Combining THEMIS with the Mars Global Surveyor Thermal Emission Spectrometer (TES), a hyperspectral inferometric spectrometer, which has selectable ~5 or ~10 cm^{-1} sampling between ~5 and 50 μm [3], yields a powerful approach to mapping surface compositional variations. TES also contains broadband visible (0.3-2.7 μm) and thermal (5-100 μm) bolometers that are used to examine albedo and thermophysical properties of the Martian surface [3].

Compositional variations: We mosaicked THEMIS daytime IR DCS radiance images to determine the extent of the material of interest as well as highlight compositional variations. The DCS enhances color separation in images with high interchannel correlation, making feature discrimination easier [4, 5]. Our DCS mosaic shows bands 8, 7, and 5 in red, green, and blue respectively (Figure 1) and shows that there appear to be at least three spectrally distinct units, which appear in this band combination as blue, purple, and yellow. The focus of our study is the blue unit, which is globally uncommon, although other occurrences have been observed [6]. Individual images within the study region (~205.20 - 206.60°E, 33.50 - 31.80°S) were selected for detailed compositional analysis of each of the units. The blue unit is generally contained within the purple unit and is also located in a slight depression relative to the surrounding plains (~50m). The blue deposit appears to flow, follow channels, and abuts, but does not cross, Sirenum Fossae.

Thermophysical properties: Nighttime temperatures represent the thermophysical properties of the top 10's of centimeters of the surface [7, 8]. A relatively high nighttime temperature usually signifies that the material is composed of higher thermal inertia material than neighboring materials. Variations in thermal inertia can be linked to differences in particle size, with larger particles having greater thermal inertias [7]. THEMIS nighttime band 9 infrared data within the study region were mosaicked, colorized, and overlaid onto the THEMIS daytime band 9 mosaic (Figure 2).

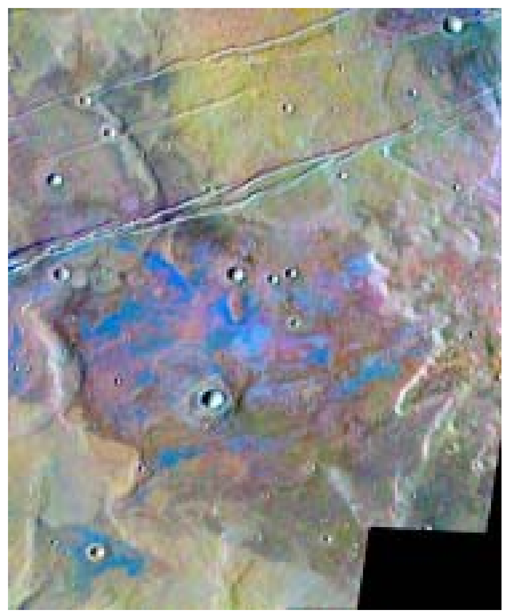

Figure 1. THEMIS DCS mosaic in Terra Sirenum. Image is ~ 83.1 km across.

The red hues correspond to higher temperatures and therefore are indicative of higher thermal inertias. The DCS blue unit appears to correlate with the higher nighttime temperatures, however there are also areas where the unit has lower nighttime temperatures. We used TES bolometric thermal inertias to quantify the units' thermal inertias. Figure 3 shows 6 OCKs chosen for the least amount of spatial overlap overlaid on the THEMIS band 9 daytime mosaic. The thermal inertias range from ~220 to 375 J $m^{-2} K^{-1} s^{-1/2}$ and the average is 293 J $m^{-2} K^{-1} s^{-1/2}$ over the region. The blue DCS unit appears to have values that range from ~250 to 315 J m^{-2} K^{-1} $s^{-1/2}$. The DCS yellow unit has values that range from ~236 to 312 J m^{-2} K^{-1} $s^{-1/2}$ and the DCS purple unit contains values that range from ~265 to 340 J m^{-2} K^{-1} $s^{-1/2}$. Lambert albedos derived from TES yield relatively low albedos that range from 0.11 to 0.14. The DCS blue unit consists of albedos that range from ~0.12 to 0.14, yellow ~0.12 to 0.13, and purple from ~0.12 to 0.14. Based on analysis from [9] these values correspond to a unit composed of sand, rock, bedrock, and/or duricrust.

Figure 2. Colorized THEMIS night IR mosaic overlaid on a THEMIS band 9 daytime IR mosaic.

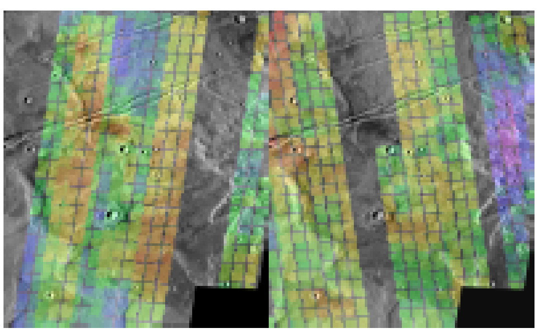

Figure 3. Left: TES bolometer derived thermal inertias (220-375 J m^{-2} K^{-1} $s^{-1/2}$). Right: TES Lambert albedos for 8 OCKs covering the region (0.11-0.14).

Compositional analysis: To examine compositional variations, we selected THEMIS daytime IR data that have an average surface temperature above 260 K, dust opacity values below 0.2, and water ice opacities below 0.1.

THEMIS spectra. We have obtained the average (minimum 300 pixels) apparent emissivity spectrum of each unit (Figure 4). The yellow and purple units are not statistically distinguishable, but the blue unit is distinguishable from the other two. The yellow and purple units have greater absorptions than the blue unit in bands 4, 5, and 6 and slightly less in bands 8 and 9. The largest elevation difference between the regions of interest is 196 m, and therefore the differences between spectra are not due to atmospheric opacity differences [11]. Even though the spectral differences may appear to be simply due to contrast, the amount of 'contrast' is not uniform across all bands and therefore the differences can only be explained by compositional distinctness.

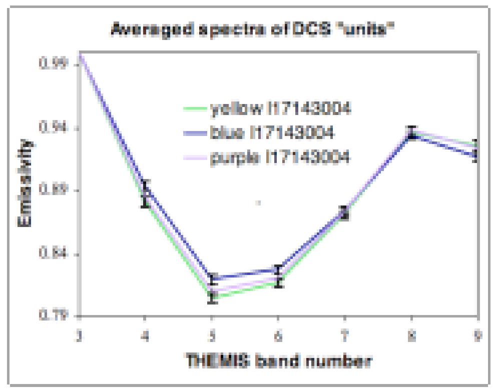

Figure 4. Average emissivity spectra for units in Figure 1.

Conclusions and future work: Based on the radiance DCS and the THEMIS spectral ratio analysis, the region is composed of at least two distinct surface compositions. Thermophysical properties from the analysis suggest the region is composed of relatively high thermal inertia material with relatively low Lambert albedos. Further investigation of the region using THEMIS thermal inertia data may be required due to the small scale of the deposits. Analysis of TES emissivity data for the region is underway to more precisely assess the nature of the surface compositions.

References: [1] Scott, D. F. and Carr, M. H. (1978) M25M G I-1083, USGS. [2] Christensen, P. R., et al., (2003) *Science*, 300, 2056-2061. [3] Christensen, P. R., et al., (2001) *JGR*, 106, 23,823-23,871. [4] Gillespie, A. R., et al., (1986) *Remote Sens.Environ.*, 20209-20235. [5] Gillespie, A. R. (1992) *Remote Sens. Environ.*, 42(2), 147-155. [6] Glotch, T. D., et al., this meeting. [7] Kieffer, H. H., et al., (1977) *JGR*, 82, 4249-4291. [8] Mellon, M. T., et al., (2000) *Icarus*, 148, 437-455. [9] Putzig, N. E., et al., (2005) *Icarus*, 173, 325-341. [10] Ruff, S. W., et al., (2002) *JGR*, 107, doi:5110.1029/2001JE001580. [11] Bandfield, J. L. et al. (2004) JGR, 109. Doi:10.1029/2004JE002289.