**EMISSIVITY SPECTRUM OF A LARGE "DARK STREAK" FROM THEMIS INFRARED IMAGERY.**

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**Introduction:** "Dark streaks"[1-4], also known as "slope streaks", are unusual surface features found on Mars that are known to appear and fade away on timescales of years [5]. Various explanations have been proposed for their origin and composition, including dry avalanches [3] and wet debris or precipitates from brines [2,4,5]. Previous investigations have been based on analysis of panchromatic imagery and altimetry from Viking and Mars Global Surveyor missions. We have obtained an infrared emissivity spectrum of a large dark streak on the north western edge of Olympus Mons, using imagery from the THEMIS instrument [6] on the Mars Odyssey 2001 spacecraft.

**Observations by THEMIS:** Dark streaks appear across a large fraction of the surface of Mars [4], and many are observed in the vicinity of Olympus Mons (and other sites of volcanic origin). "Dark" streaks get their name from observations of surface brightness at visible wavelengths, but in the infrared they appear as bright streaks (Figs.1,2). Panchromatic instruments such as the Mars Orbital Camera [7] return images with spatial resolutions of a few meters per pixel, and many narrow dark streaks (~20m wide) and fewer larger (~200m wide) streaks are seen in these images. THEMIS-IR [6] measures 10 spectral bands, from 1650–600 $cm^{-1}$, each ~1 m wide), at a spatial resolution of ~100m/pixel. Hence, only the largest dark streaks are suitable for spectral studies that wish to minimize problems with mixed materials in pixels.

We searched the database of publicly available 20m/pixel, visible wavelength THEMIS-VIS [8] for large dark streaks, and found a suitable candidate (Fig.1) in panchromatic THEMIS image V02339006, collected 2002-06-25 at central latitude, longitude of (21.412N,222.473E), on the north western slopes of Olympus Mons. Two daytime infrared images, collected a month apart, are available for this area: I02239005 (2002-06-25) and I02701002 (2002-07-24). We use the radiometrically corrected (RDR) images for these scenes, and carried out a manual band-to-band coregistration of the imagery to correct for the residual band-to-band misregistration in the standard data product. To avoid unnecessary manipulation of the spectra, we restricted our coregistration transformation to a simple (band dependent) translation. A vertical shift of 1.3 pixels/band and a horizontal shift of 1pixel/band were used to produce the IR band (8,6,4) RGB composite image in Fig. 2 (bands with central wavenumbers of ~850, 1000, 1150 $cm^{-1}$, respectively). The streak, which appears dark at visible wavelengths (~650nm), appears bright in the infrared.

**Estimating surface temperatures:** Following the prescription for analyzing THEMIS-IR imagery described by the instrument team [9], we used the infrared band 3 (~1300$cm^{-1}$), which is believed to be minimally impacted by atmospheric dust and water ice, to estimate the surface brightness temperature. For image I022395505, we obtained brightness temperatures in the range 220K (in the deepest shadows) to 269K (on sun facing slopes), and for image I02701002, we obtained temperatures between 221K and 258K. The 100m scale spatial distribution of temperatures is shown in Figs.3 and 4. The pattern of temperature variation appears consistent across scenes. Notice that the dark streak region is spatially correlated with warm (~260K) temperatures in both images.

**Extraction of relative emissivity spectra:** Given that we have estimated the surface temperature from band 3, we are only able to extract relative emissivity spectra from the remaining infrared bands (band 10 is also unavailable, as it was designed to observe a CO2 atmospheric absorption band). We divided the coregistered spectrum at each pixel by a Planck function at the appropriate pixel band-3 brightness temperature, convoluted with the bandpasses of the THEMIS-IR instrument [9]. The results are shown in Figs. 4 and 5. Detailed analysis of the spectral shapes will be the subject of a future publication, although we note in passing that the spectra from image I02701002 show an additional peak in infrared band 5 which may be due to enhanced atmospheric dust over the scene on that day. In any case, the patterns of coloration in the infrared band (8,6,4) composite images appear broadly consistent across scenes.

**Discussion:** Spatially resolved infrared spectra offer the opportunity to investigate the physical surface composition and temperature distribution at pixel scales (~100m for THEMIS-IR, ~3km for Mars Global Surveyor TES instrument [10]). Multispectral imagery is limited in spectral depth, and it is important to consider how atmospheric constituents affect individual bands without the advantages of radiative transfer modeling and hyperspectral imagery [10]. The consistency of our results across images collected a month apart suggest that THEMIS-IR will be useful for further investigation of dark streaks.

**References:** [1] Morris E. (1982) *JGR, 87,* 1164. [2] Ferguson H.M. and Lucchitta B.K. (1984) in

*Planetary Geology and Geophysics Program Report*, 188-190. [3] Sullivan R.P., et al. (2001) *JGR, 106*, 23607. [4] Schorghofer N., Aharonson O., and Khatiwala S.(2002), *GRL, 29,* No. 23, 2126. [5] T. Motazedian (2003) *LPSC XXXIV,* Abstract #1840. [6] see, e.g., Christensen P. R. et al. (2003) *LPSC XXXIV,* Abstract #1519. [7] Malin M.C. et al. (1998) *Science, 279,* 1681. [8] Bell III J.F., et al. (2003) *LPSC XXXIV,* Abstract #1993. [9] Smith M.D., et al. (2003) "Themis instrument description and atmospheric observations", presented at "Mars atmospheric modeling and observations", Granada, Spain, Jan 13-15, 2003. [10] Christensen P. R., et al. (1998) *Science, 279,* 1692.

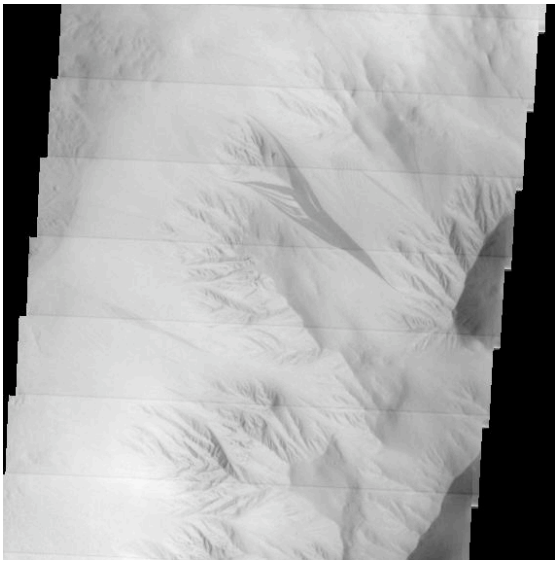

Figure 1: THEMIS-VIS of dark streak

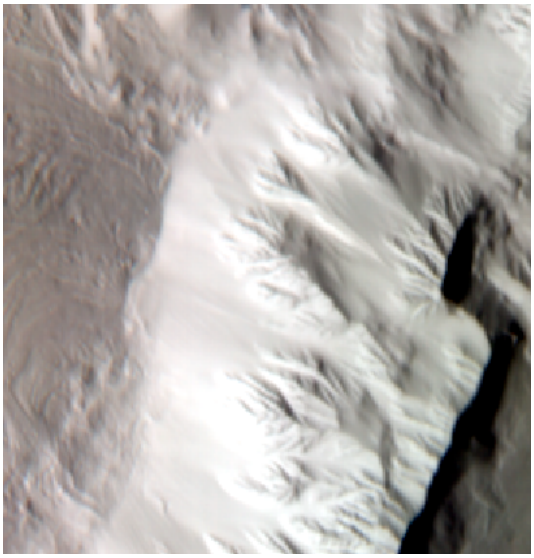

Figure 2: THEMIS IR band (8,6,4)

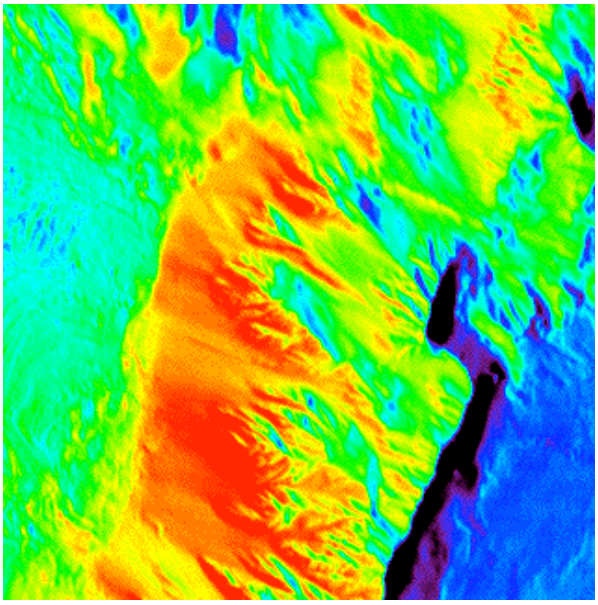

Figure 3A: Temperature map for scene 06-25

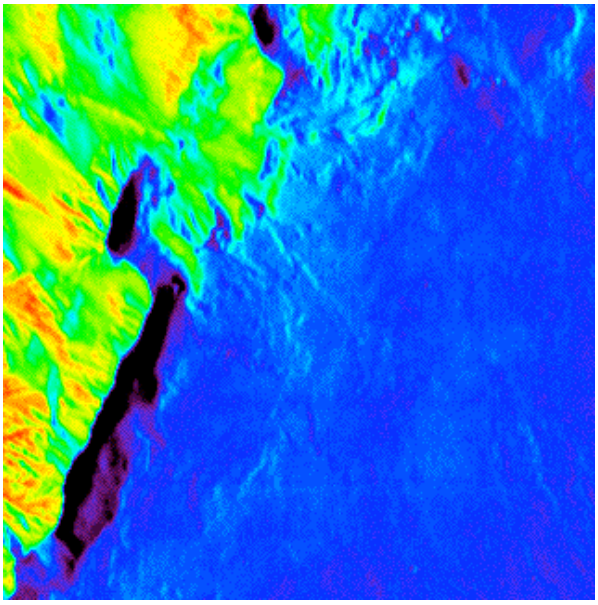

Figure 3B: Temperature Map for 07-24

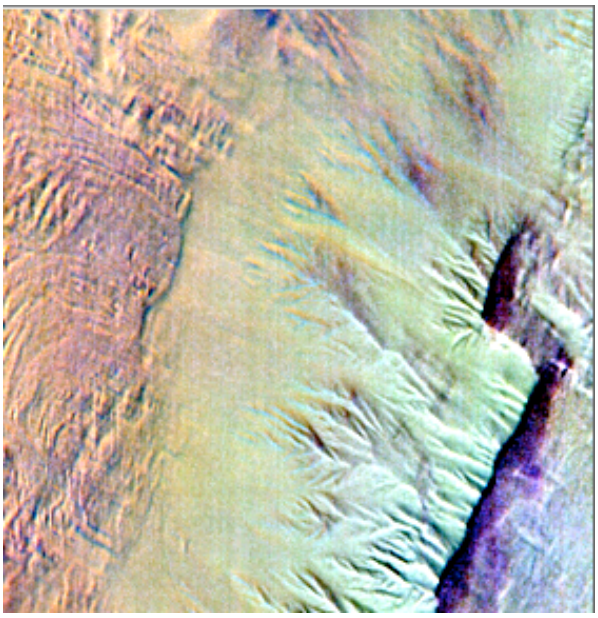

Figure 4A: Relative emissivities, bands (8,6,4)

Figure 4B: Relative emissivities, bands (8,6,4)