THERMAL AND SPECTRAL ANALYSIS OF AN INTRACRATER DUNE FIELD IN AMAZONIS PLANITIA.

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Introduction: Intracrater dune fields were first recognized in Mariner 9 images and they occur in a variety of terrains [1,2]. Detailed studies of dunes yield important information about past and present aeolian activity, the dominant force currently responsible for modifying the Martian surface. The dune field in this study is in an unnamed crater at approximately 18°N, 190°E, in Amazonis Planitia.

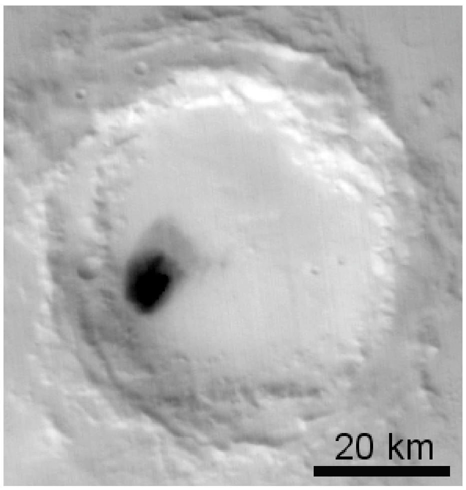

Figure 1. MOC WA image (red wavelength) of crater with dune field [5].

The dune field appears as a dark-toned splotch about 8 km in diameter on the western side of the crater floor (Fig. 1). Extending off the northeastern edge of the dune field is an area intermediate in tone between the dune field and the brighter crater floor materials. Here we present thermal and spectral analysis of the dune field and nearby materials, using data from the Mars Odyssey THEMIS and MGS TES.

Data: The THEMIS infrared subsystem is a multispectral imager which provides mineralogic and atmospheric information from ten-band images (nine wavelengths between 6.78 – 15 µm) ~32 km wide at a spatial resolution of 100 m [3]. TES is a hyperspectral interferometric spectrometer with selectable ~5 or ~10 cm^{-1} sampling between ~5 – 50 µm) [4]. TES also contains broadband visible (0.3 – 2.7 µm) and thermal (5 – 100 µm) bolometers; these subsystems are used to examine albedo and thermophysical properties of the Martian surface [4].

Methods: Figures 2 and 3 show THEMIS daytime and nighttime brightness temperature images calculated from radiance values in band 9 (12.57 µm). The most noticeable difference between the two images is the apparent size and shape of the thermal anomaly associated with the dune field. In the daytime image, the thermal high is associated with the dark-toned materials in the MOC image. At night, the thermal high associated with the dune field is larger than in the daytime image and is correlated with the intermediate-toned materials in the MOC image. Thus, the intermediate-toned materials in the visible image are thermally indistinct from the crater floor during the day, but are hotter at night.

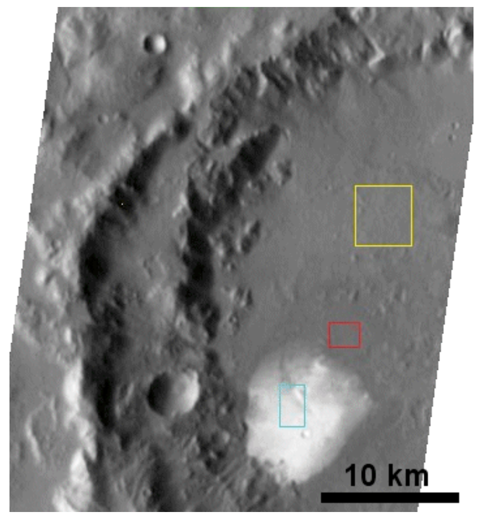

Figure 2. THEMIS daytime image I02053002 (L_s=21.2), band 9 (12.57 µm). Lighter pixels are warmer. Boxes denote the locations of data shown in Figs. 4 and 5.

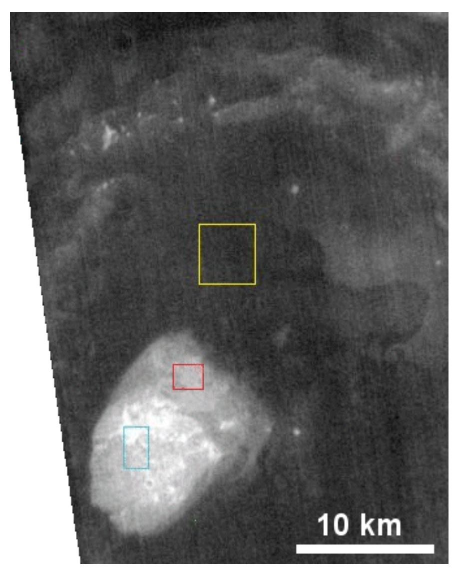

Figure 3. THEMIS nighttime image I05480011 (L_s=149.8), band 9 (12.57 µm). Lighter pixels are warmer.

Using these images, we defined three major units: dune field material that is always thermally distinct from the rest of the crater floor ("hot dune", blue box in Figs. 2 and 3), a unit that is thermally distinct from the crater floor only at night ("warm dune", red box), and the crater floor itself (yellow box). Figure 4 shows the average day- and nighttime brightness temperatures for the three units. The warm dune material is similar in temperature to the crater floor during the day, but at night has a temperature closer to that of the hot dune. Figure 4 also shows the minimum TES albedo for each unit. TES thermal inertias (in units of J/m^2 K sec^{-1}) are about 370-410 for the hot dune unit, 370-375 for the warm dune unit, and 150 for the crater floor. These values correspond to equivalent particle diameters of ~1.9-2.9 mm, ~1.9-2.1 mm, and 35 μm respectively [6].

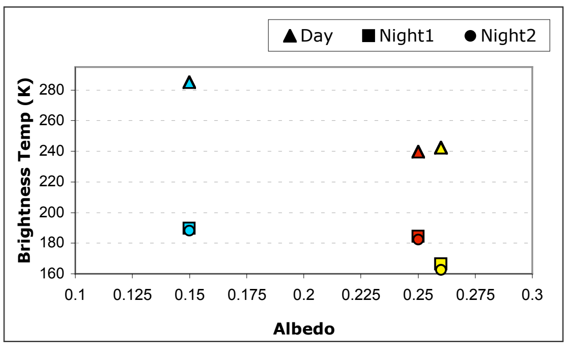

Figure 4. Day- and nighttime brightness temperatures and albedos for three units color-coded to Figures 2 and 3. Night 1 is from the image shown in Figure 3, and Night 2 refers to THEMIS image I06591010. Standard deviations are smaller than symbols.

Next, we converted the THEMIS radiance images to emissivity and examined the spectral characteristics of the hot dune and crater floor units. The average spectra for these two units are plotted in Fig. 5. Both spectra show a broad absorption between 8 and 12 μm that is dominated by atmospheric silicate dust, but the difference spectrum indicates that the two units are spectrally distinct.

Conclusions and Further Work: The thermal and spectral data indicate that the crater floor materials are distinctly different from the material composing the dune field. The nighttime infrared data are dominated by the thermophysical properties of the upper 10-15 cm of the surface. The thermal inertia of the crater floor is consistent with silt-sized particles, whereas the higher inertia of the dune material is consistent with a much larger particle size (granule-sized). Typically, coarse (higher inertia) materials are cooler during the day than are fines. The temperatures observed in the daytime infrared data, however, are strongly influenced by albedo, with darker surfaces absorbing thermal energy preferentially relative to brighter surfaces. The TES thermal inertia data and THEMIS nighttime brightness temperatures indicate that the warm dune unit contains large particles. However, the albedo and average daytime temperature of the warm dune unit are much closer to the albedo and brightness temperature of the crater floor material, suggesting that a layer of fines overlies the dune material. Because the warm dune unit is *visibly* darker than the rest of the crater floor in the MOC image shown in Fig. 1, we interpret this dust layer to be optically thin at both thermal and visible wavelengths (< ~6 microns). The lack of dust on the hot dune may be due to active saltation.

The spectra in Fig. 5 indicate that the hot dune material is composed of a spectrally distinct material compared to the crater floor. The low emissivities at 6.78 μm can be attributed, in part, to the presence of water vapor and/or particle size effects. The increased emissivity between 8 – 12 μm and the reduced emissivity at 6.78 μm in the crater floor spectrum, relative to the hot dune spectrum, support the hypothesis that the crater floor is composed of finer material. In future work we will expand our spectral analysis to the warm dune unit and examine higher resolution TES spectra in order to investigate the dominant mineralogy of the exposed dune material.

References: [1] Christensen, P. R., (1983) *Icarus, 56,* 496-518. [2] Fenton, L. K. et al. (2003) *JGR., 108,* 5129-5167. [3] Christensen, P. R. et al. (2003) *Science, 300,* 2056-2061. [4] Christensen, P. R. et al. (2001) *JGR, 106,* 23,823-23,871. [5] Malin, M. C. et al., [M1002743], MSSS MOC Image Gallery (http://www.msss.com/moc_gallery/), 2000. [6] Presley, M.A. et al., (1997) *JGR, 102,* 6551-6566.

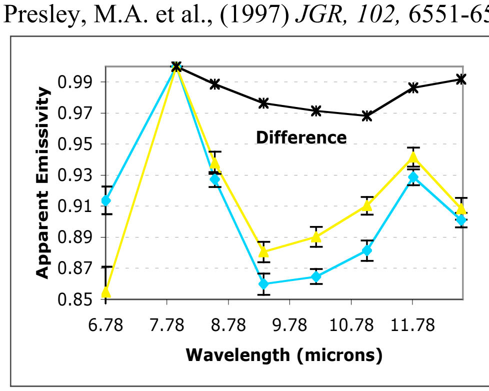

Figure 5. THEMIS apparent emissivity spectra of the hot dune and crater floor units. Blue and yellow spectra are color-coded to Figures 2 and 3. Error bars represent the standard deviations of the averages.