**THERMOPHYSICAL PROPERTIES OF THE SURFACE OF ISIDIS BASIN, MARS.**

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**Introduction:** Isidis Planitia contains some of the highest values of bulk thermal inertia (>450 J $m^{-2}$ $K^{-1}$ $s^{-1/2}$) on the surface of Mars (Fig. 1) [1]. There has been very little investigation of the surfaces of high thermal inertia observed in remote-sensing datasets since the Viking era. Of the current and past missions to the Martian surface, the Mars Pathfinder landing site contains the highest values of thermal inertia values derived from TES, with a mean value of 390 J $m^{-2}$ $K^{-1}$ $s^{-1/2}$. The higher values of thermal inertia in the Isidis basin describe a surface with more extreme thermophysical properties than those observed at mission landing sites on Mars. Two questions were at the focus of this study: (1) what types of surfaces are responsible for the high-values of thermal inertia and (2) what geologic mechanisms gave rise to the complex pattern of high thermal inertia now observed in the Isidis basin?

**Methods:** We compared the thermal inertia data to a variety of complementary data sets. These comparisons included: (1) TES thermal inertia to TES albedo, (2) THEMIS night infrared radiance (IR) to topography data from MOLA, (3) THEMIS thermal inertia to visible data from THEMIS and MOC, and (4) TES thermal inertia and albedo data to wind velocities and surface shear stresses simulated using the Mars Regional Atmospheric Modeling System (MRAMS) [2]. The TES and THEMIS thermal inertia data were derived using the standard thermal model used to derive TES thermal inertia [1]. The THEMIS night IR mosaic was constructed by matching the mean radiance of overlapping regions of individual THEMIS night IR frames [3]. MRAMS simulations were run for four different times of year, corresponding to Ls ~ 0, 90, 180, and 270 using a series of three nested grids where the resolution of the smallest grid was approximately 15 km horizontally, and ~ 30 m vertically at the surface.

**Results and Discussion:** The comparisons were designed to test four scenarios for creating the high values of thermal inertia the basin: (1) a mixture of coarse grains in a surface composed of unconsolidated material, (2) thinning of a dust mantle over a high thermal inertia material, (3) increased rock abundance, and (4) induration of a fine- grained material.

*TES Thermal Inertia:* The TES thermal inertia, with patterns and values similar to the THEMIS thermal inertia (Fig. 1), shows large variations in thermal inertia throughout the basin with values ranging from 200 – 300 J $m^{-2}$ $K^{-1}$ $s^{-1/2}$ in the northern and western regions of the basin and much higher values of >450 J $m^{-2}$ $K^{-1}$ $s^{-1/2}$ in the southern regions of the basin. The northern edges of the areas of high thermal inertia show no correlation to significant topographical features while the southern boundary strongly correlates with the base of the southern wall of the basin.

*TES Albedo:* TES albedo measurements are generally constant across the basin with values in the range of 0.20 – 0.25. Darker patches, with an albedo of ~ 0.18, do exist in isolated patches along the southern boundary, but no significant albedo features correspond with the areas showing high thermal inertia.

*Grain size:* Typically, higher values of thermal inertia on Mars imply larger grain sizes for unconsolidated soil particles. However, values much greater than ~420 J $m^{-2}$ $K^{-1}$ $s^{-1/2}$ for an unconsolidated surface are unlikely

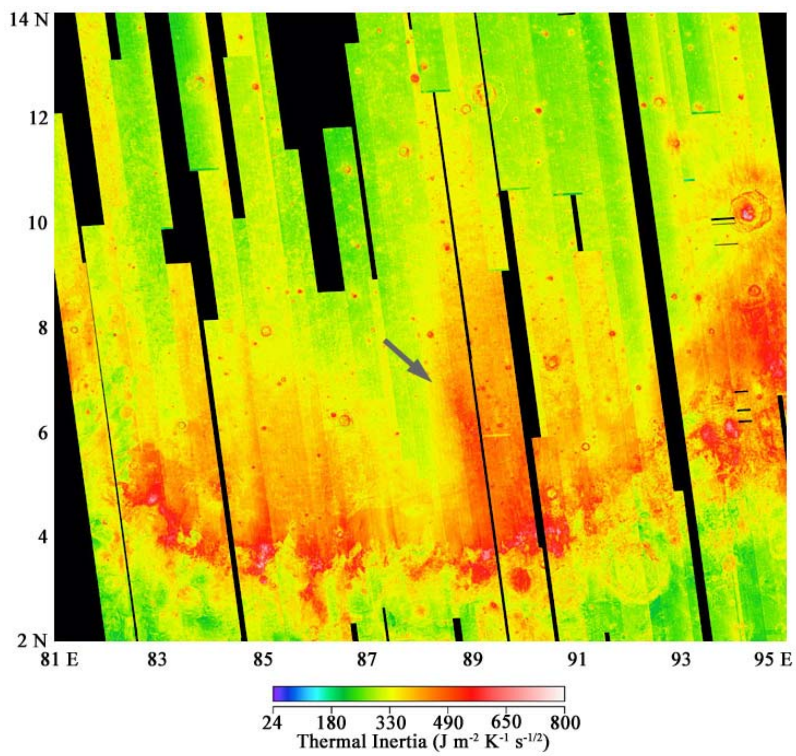


**Fig. 1: THEMIS thermal inertia. The gray arrow marks the "central lobe" and the location of Fig. 2.**

on Mars [4]. Since Isidis contains thermal inertia values approaching 700 J $m^{-2}$ $K^{-1}$ $s^{-1/2}$, an increase grain size alone cannot account for the values of thermal inertia present in the basin.

*Dust Mantle:* If a dust mantle was responsible for the variations of thermal inertia within Isidis, it would require that either (1) the entire basin have the albedo of a surface dominated by dust (~ 0.27) or (2) the variations in albedo follow the variations in thermal inertia with higher albedo matching areas of lower thermal inertia. Since TES albedo is generally uniform with values below ~0.27, a dust mantle is unlikely to be a factor in the variations and values of thermal inertia present in the basin.

*Rock Abundance:* High rock abundance could be causing the high thermal inertia. One scenario linking the high values of thermal inertia to rock abundance was suggested by Bridges *et al*. [5]. They suggested that the high thermal inertia in the south is due to rocks originating in the highlands to the south, which were carried into the basin via debris flows. However, the pattern of high thermal inertia areas within the basin and lack of high thermal inertia areas south of the basin argue against this scenario. The pattern of high thermal inertia in the basin shows no correlation to topographical features evident in MOLA topography data. In addition, some of the areas of high thermal inertia, such as the "central lobe" of high thermal inertia (arrow, Fig. 1), show a large northward extent, but comparatively small longitudinal extent. It is unlikely that a debris flow originating in highlands to the south would create this pattern across relatively flat ground. In addition, regions of high thermal inertia are confined to the basin floor and are not present on the basin's southern wall or in the highlands to the south of the basin, where the debris flows would have originated. High rock abundance could produce the high values of thermal inertia; but if this was the case, it would be more likely that the pattern of high and low thermal inertia represents geologic activity after the debris flow.

*Induration:* A scenario in which the high thermal inertia results from a soil highly indurated by salts or another cementing agent is most consistent with data sets analyzed. The pattern of thermal inertia could either represent (1) a variable degree of induration within the surface layer or (2) the exposure of a more highly indurated subsurface by erosion. Induration should not significantly affect the albedo beyond the range observed with TES, and increasing the degree of induration (i.e., increasing the amount of cementing agent present between the soil grains) can raise the thermal conductivity of the soil sufficiently to produce the high values of thermal inertia present in TES and THEMIS data.

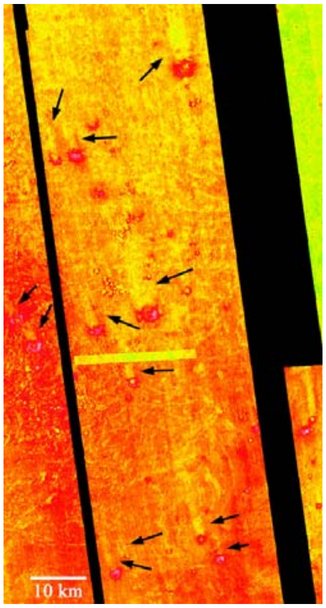


**Fig. 2: Northward Streaks in THEMIS thermal inertia**

*Small-scale streaks:* Small, northward trending streaks are evident in the THEMIS thermal data (arrows, Fig. 2 ) and suggest that aeolian processes have played a significant role in creating the pattern of thermal inertia now present on the basin floor. These streaks of relatively lower thermal inertia are present throughout the central lobe of high thermal inertia and are consistently oriented toward the north-northwest, canted approximately 7 – 10° from the THEMIS imaging track. We have observed no visible signature for these streaks where THEMIS and MOC visible images are available.

*Atmospheric modeling:* Simulations with MRAMS show no winds capable of creating the north-trending streaks of lower thermal inertia, but winds do match the orientations of dark streaks observed in MOC images in close proximity to these thermal inertia streaks. Results from the MRAMS simulations indicated that current, nominal winds are incapable of creating the large patterns of thermal inertia on either the large scale (Fig. 1) or the streaks present at smaller scales (Fig. 2). If the pattern of thermal inertia does result from aeolian processes, they are more likely to be formed under conditions present during dust storms or under a previous wind regime no longer active on Mars.

*Knobby terrain:* Another possibility for the creation of the pattern of thermal inertia in the basin is the presence of the knobby terrain. Areas of high thermal inertia are typically smooth and relatively devoid of knobby terrain, but areas of low thermal inertia are often dominated by the knobby terrain. In the THEMIS thermal data, rings of relatively lower thermal inertia are present surrounding individual knobs, which may support a tuff cone origin for the knobs if these rings of lower thermal inertia represent an ejecta blanket of fine grained material [6].

**References:** [1] Mellon, M. T., et al. (2000) *Icarus, 148*, 437-455. [2] Rafkin, S. C. R., *et al.* (2001) *Icarus, 151*, 228-256. [3] Martinez-Alonso, S. *et al.* (2004), *JGR*, in press. [4] Jakosky, B. M. (1986), *Icarus, 66*, 117-124. [5] Bridges, J. C., et al. (2003), *JGR, 108*. [6] Greeley, R., and S. A. Fagents (2001), JGR, 106, 20,527-20,546.