FIRST LOOK AT THE THERMOPHYSICAL PROPERTIES OF THE DISSECTED MANTLE. J. F. Mustard† 1 Department of Geological Sciences, Box 1846, Brown University, Providence RI, 02912 John_Mustard@brown.edu

Introduction: Previous studies have identified a latitude dependent surface layer that appears to be continuous poleward of 60°, absent equatorward of 30°, and discontinuous in the 30–60° N and S latitude bands [1, 2, 3]. Based on apparent physical properties observed in Mars Orbiter Camera (MOC) images and Mars Laser Altimeter (MOLA) data, and the distinct latitude dependence of these observations, the surface layer has been interpreted to be ice-rich where continuous, an interpretation supported by recent Mars Odyssey results [4, 5, 6]. The discontinuous zone is interpreted to be the a degraded equivalent of the continuous layer [2, 3], and as such represents the maximum extent of a recent excursion in the stability of near-surface ground ice towards the equator. Here I report on preliminary analysis of THEMIS brightness temperature data [7] of observations in the mid-latitude zones to assess if the degraded mantle has properties distinct from the underlying substrate.

The MOC images provide high spatial resolution observations of morphology, but each image covers a very small portion of the surface. In addition to the ability to identify composition, the THEMIS observations provide unique insights into the near-surface thermal properties [7] and it is this property examined here. The goal here is to examine nighttime THEMIS images of surfaces that exhibit distinct properties of dissected mantle identified in MOC images [2] to provide insight into the regional and global properties of the ice-rich surface layer.

Data Processing and Integration: To focus this first look, previous observations of dissected mantle were used to select THEMIS images. A database of MOC observations has been created identifying a particular surface morphology characterized by the following features: 1) a smooth, intact surface is present, 2) the smooth material is broken up or dissected somewhere in the scene, 3) the pitted or hummocky terrain resulting from dissection is distinct from dunes, yardangs, or other eolian features [2]. Over 15,000 MOC images have been systematically analyzed and classified according to the presence or absence of these features. The images were examined orbit by orbit without knowledge of geographic location to minimize bias in the recognition of the terrain. Over 1700 images exhibit this morphology.

Three regions were selected for this preliminary analysis: Reull Vallis for the presence of viscous flow features in combination with the dissected mantle [Milliken et al., 2003], a region of knobby terrain near 185°W 34°S, and the Nili Syrtis regions north of Syrtis Major (287°W, 29°N). For each region, co-located MOC daytime and THEMIS nighttime images were examined for the correspondence between the observed MOC morphology and the nighttime temperature. Nighttime temperature is used as a proxy for thermal inertia, based on the principle that materials that are relatively warm at night have a higher thermal inertia than materials that are relatively cool. There are many possible causes of such temperature differences, including particle size, relative rock abundance in the pixel, cementation, and relative albedo. Full determination of the true properties requires detailed modeling which will be the focus of future investigations. The objective in this first-look is qualitative examination and assessment of any correlation between MOC morphology and THEMIS nighttime temperature.

Nili Syrtis: This region marks the transition from the highlands of Arabia and Syrtis Major to the northern lowlands (Figure 1). The terrain is rugged, with abundant steep slopes. Here the dissected mantle is sparsely represented, primarily preserved on north-facing slopes. It is apparently thin, and good examples of substrate exposed beneath the thin mantle are observed in MOC images. This represents an extreme equatorward example of the postulated ice-rich surface layer.

Figure 1. Nili Syrtis region (287°W, 29°N) showing the locations of THEMIS nighttime images (black lines, I01402006, left and I01739003, right)) and MOC observations (white lines, M0803907 left, M0304128 right). Background image (M0803908) is 120 km across.

The THEMIS images show a wide range of nighttime temperatures (brightness temperature between 210 and 240 K, Figure 2) that correlated with morphology seen in the MOC images (Figure 1). The warmest surfaces within the field of view of the MOC images are...
equator facing in M0803907. This occurs in a valley as seen in Figure 1. There is no apparent dissected mantle on the equator-facing slope, though a circular region of cooler material corresponds with fill in a crater on this slope. To the north of this valley on the pole-facing slope, the temperatures are significantly cooler. This region corresponds to remnant dissected or degraded mantle. The mantle appears to have lower thermal inertia than the equator-facing slopes where no mantle is present. In MOC image M0304128, a distinct change from relatively cool to relatively warm temperatures is observed in the THEMIS data near the mid-point of the MOC image. This corresponds to a transition in morphology from remnant mantle in the cool regions and a flat-lying region from which the mantle has apparently been removed in the warm region. The boundary is very distinct in both MOC and THEMIS data.

**Figure 2.** Left THEMIS nighttime images (I01402006, left and I01739003, right) with locations of MOC observations (black lines, M0803907 left, M0304128 right). Width of image approximately 65 km.

**Reull Vallis:** This region is notable for the presence of viscous flow features on pole-facing slopes that can be modeled with the rheology of ice under martian conditions [8]. Gullies are relatively common on these same slopes [9] and the dissected mantle is also typically present [2]. However the mantle is commonly absent from equator-facing slopes in Reull Vallis. Due to the limitations of space, it is not possible to present data as for the Nili Syrtis region, and thus only the observations will be discussed.

There is a distinct asymmetry in nighttime temperatures between pole-facing and equator-facing slopes. The slopes are steep in these valley (20-25°). The equator-facing slopes are typically warmer than the surrounding terrain, and the pole-facing slopes are typically not distinguished from their surroundings. MOC images show that the pole-facing slopes have a relatively thick deposit of material that exhibits viscous flow features. The most plausible material to exhibit such features is an ice-saturated soil, and modeling shows that such a material would flow under the influence of gravity under martian conditions [8]. However, the THEMIS images show that the thermal properties are not distinct from dust/soil.

**Knobby Region:** In this region there are abundant knobs between 100 and 1000 meters in diameter. The tops of the knobs are bright, but exhibit a morphology of bedrock with a light coating of dust. In contrast the region between the knobs exhibits a morphology characteristic of the dissected mantle. The major difference is that the albedo is distinctly lower than the tops of the knobs.

THEMIS nighttime images show that the knob tops are warm relative the slopes and inter-knob regions. Expanding to a regional view suggests that the thermal properties of the inter-knob region are not distinctly different from dust/soil. Therefore even though this region exhibits properties typical of the cemented mantle, it is not thermally distinct. Also, it is typical in this region to observe an asymmetry in the temperature of crater walls, where the pole-facing slopes are not distinguishable from their surroundings which the equator-facing slopes are relatively warm.

**Discussion and Conclusions:** These observations suggest that the latitude-dependent surface layer in the mid-latitude regions is not distinct from dust/soil. This is consistent with global thermal inertia analyses which do not show any latitude dependent properties of the martian surface. This the mechanism that cements this layer must not create a thermally distinct material. Sublimation of ice from ice-saturated loess leaves behind a lightly cemented substrate of loess [10]. This appears to be a reasonable analog for the regions of remnant mantle on Mars.

**References:**