THEMIS OBSERVATIONS OF LOW-ALBEDO INTRACRATER MATERIALS AND WIND STREAKS IN WESTERN ARABIA TERRA.

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Introduction: Thermal infrared day and night images (100m/pixel) from the Mars Odyssey Thermal Emission Imaging System (THEMIS) are used for thermophysical and spectral analyses of low-albedo intracrater materials and wind streaks in Western Arabia Terra. THEMIS data are compared with Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) derived surface compositions and Mars Orbiter Camera (MOC) observations to constrain origin hypotheses for these materials.

Background: Western Arabia Terra has numerous impact craters with large low-albedo wind streaks emanating from dark "splotches" on crater floors (Fig. 1a: Radau Crater 17.1°N, 4.8°W: 114.5 km diameter). The physical properties of, and genetic link between, these materials have been the subject of considerable study and debate for nearly three decades [*e.g.,* 1-10].

Intracrater Materials: Most models for the formation of dark intracrater splotches involve the entrapment of sand sized particles that can be transported into, but not out of, craters by wind [*e.g.,* 1-3]. Supporting evidence for an eolian origin of these materials comes from Mariner 9, Viking, and MOC observations of barchan dune fields [*e.g.* 1-8].

Atmospherically corrected thermal emissivity data from TES [11, 12] have been used to identify two spectral surface units within these low-albedo deposits [13] (Fig. 1b). The Surface Type 1 unit (ST1) forms a central core in dark features on crater floors while the Surface Type 2 unit (ST2) forms a surrounding arc on the dark downwind sides of crater walls [13]. ST1 has been interpreted as a largely unweathered basalt [13-18] while ST2 has been variously interpreted as andesite [15, 16], oxidized crystalline basalt [17], or partly weathered basalt [18]. The transition between these compositions appears to occur near the floor-wall interface and is correlated with a transition from high-thermal inertia dune materials (~400-550 $J/m^2Ks^{1/2}$) to lower-thermal inertia dune-free materials (300-400 $J/m^2Ks^{1/2}$) [13].

Wind Streaks: Several hypotheses exist for the origin of adjacent low-albedo wind streaks (Fig. 1a). Some models interpret them to be a result of saltation and traction, consisting of sandy material deflated from adjacent dark intracrater deposits [1, 3] or the result of material being stripped from the surface to reveal a darker substrate [*e.g.,* 9]. Conversely, [10] proposed that dark wind streaks formed by the deposition of dark silt from plumes of suspended material. This view is now supported by MOC observations that suggest the dark materials are mantle deposits of finer-grained sediment deflated from adjacent crater floors, not sand sized particles [7, 8].

TES ST2 materials, and possibly small amounts of ST1, are observed in the adjacent low albedo wind streaks (Fig. 1b); however, a mixing trend is not as evident as within the impact craters. There does not appear to be a discernable compositional difference across (east-west) dark wind streak material and the often-observed bright red deposits along their margins.

THEMIS Observations: Figures 2a and 2b show THEMIS day and night calibrated Band 9 radiance (12.57 µm) images of Radau Crater where brighter shades reflect higher temperatures relative to darker shades. MOLA shaded relief images with superimposed THEMIS tracks are shown for reference.

THEMIS day/IR observations of low-albedo intracrater materials and wind streaks show higher average temperatures (~258K) compared to high-albedo materials (~244K). During the day, albedo is the dominating factor that controls surface temperatures as low-albedo materials absorb more solar radiation than high-albedo materials. There does not appear to be a discernable temperature difference for TES ST1 and ST2 materials in day/IR images.

THEMIS night/IR observations of low-albedo intracrater materials show higher average temperatures (~185K) compared to high-albedo materials (~168K). Wind Streak materials have lower night/IR temperatures (~172K) compared to intracrater materials and do not display a discernable temperature difference across their margins. During the night, particle size is the dominating factor that controls surface temperatures as coarse-grained materials (sand- to silt-sized particles) retain more heat compared to fine-grained materials (finer silt- to clay-sized particles). TES ST1 and ST2 intracrater materials have similar average night/IR temperatures (~185K), reflecting coarse-particle sizes, compared to wind streak materials (~172K), which are finer-sized.

Figure 3 is a THEMIS emissivity band ratio map (7/5:8/7:8/5) of Radau Crater. With temperature effects removed, variations are attributed to different surface compositions. Figure 3 illustrates that TES derived ST1 and ST2 compositions observed in low-albedo intracrater materials (Fig. 1b) are also identified with THEMIS emissivity data. The distribution of material observed with TES data [13] is also observed with THEMIS data as the ST1 unit forms a central core in dark features on crater floors while the ST2 unit forms a surrounding arc on the dark downwind sides of crater walls. The transition between these compositions again appears to occur near the floor-wall interface. TES ST2 materials observed in wind streaks are also observed with THEMIS emissivity data.

THEMIS Interpretations: The THEMIS emissivity image (Fig. 2c) provides much greater spatial resolution compared to the TES map (Fig. 1b) and appears to show ST2 materials being derived from ST1 materials. In this case, ST2 is plausibly explained as a weathered finer-grained basalt fraction (containing some clays) winnowed by winds from coarser basaltic sediment on the crater floor. If oxidized basalt particles are fine grained, they too might be winnowed and concentrated on crater walls. ST2 materials observed in wind streaks are interpreted to be particles deflated from ST1 intracrater deposits, which escape the crater rim, and mantle the surface. This model agrees well with the MOC model [7, 8] that dark-wind streaks form by the deposition of dark silt from plumes of suspended material. The transition from ST1 to ST2 intracrater materials is interpreted to reflect decreasing particle sizes, controlled by mineralogic differences between an unweathered basalt component and partly weathered basalt component.

References: [1] Arvidson R. E. (1974) *Icarus*, 21, 12-27. [2] Christensen P. R. (1983) *Icarus*, 56, 496-518. [3] Thomas P. C. (1984) *Icarus*, 57, 205-227. [4] Sagan C. et al. (1972) *Icarus*, 17, 346-372. [5] Peterfreund A. R. (1981) *Icarus*, 45, 447-467. [6] Edgett K. S. and Christensen P. R. (1994) *JGR*, 99, 1997-2018. [7] Edgett K. S. and Malin M. C. (2000) *JGR*, 105, 1623-1650. [8] Edgett K. S. (2002) *JGR*, 107, (E6) ,10.1029. [9] Soderblom L. A. et al. (1978) *Icarus*, 34, 446-464. [10] Thomas P. and Veverka J. (1986) *Icarus*, 66, 39-55. [11] Bandfield J. L. et al. (2000) *JGR*, 105, 9573-9587. [12] Smith M. D. et al. (2000) *JGR*, 105, 9589-9608. [13] Wyatt M.B. et al. (2003) *JGR* submitted. [14] Christensen P. R. et al. (2000) *JGR*, 105, 9609-9621. [15] Bandfield J. L. et al. (2000) *Science*, 287, 1626-1630. [16] Hamilton V. E. et al. (2001) *JGR*, 106, 14733-14746. [17] Minitti M.E. et al. (2002) *JGR* 107 (E5), 10.1029. [18] Wyatt M.B. and McSween H.Y. (2002) *Nature* 417, 263-266.

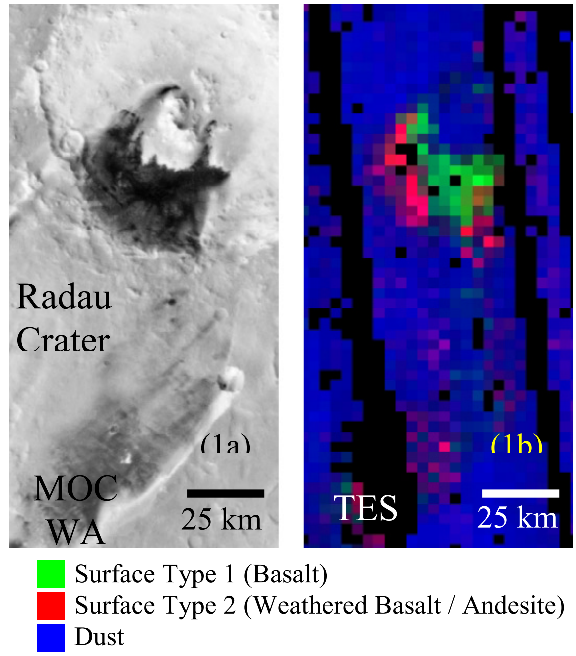

Figure 1: a) MOC wide-angle image of Radau Crater. b) TES derived surface compositions

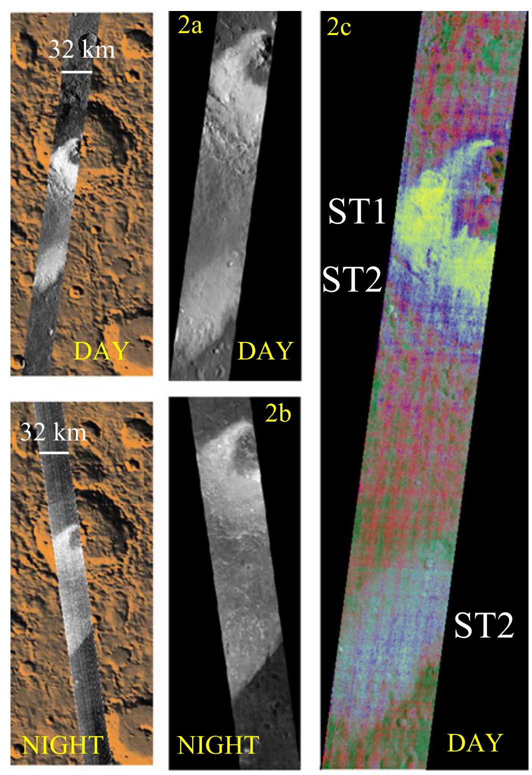

Figure 2: a & b) THEMIS day and night calibrated Band 9 radiance images of Radau Crater. c) THEMIS emissivity band ratio image showing TES ST1 and ST2 materials.