SURFACE CHARACTERISTICS OF THE DAEDALIA PLANUM LAVA FLOW FIELD DERIVED FROM THERMOPHYSICAL AND GEOLOGICAL MAPPING.
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Introduction: Spectral investigations of lava flow fields in the Tharsis region are hindered by mantling of the Martian surface by dust and sand [1]. While global homogenization of eolian material usually impedes accurate interpretation of underlying bedrock, it is important to consider that some mantling deposits may be locally derived and preserve signatures of the bedrock [2-3]. Ultimately, it is critical to identify the degree of eolian mantling at a study site to determine if the bedrock spectral signature can be discerned and any local alteration conditions detected.

The use of multiple datasets with different spatial and spectral resolutions allows for the analysis of lava flows previously considered too heavily mantled for spectral studies. Higher spatial resolution images such as HiRISE and CTX are used to identify surface morphology, whereas lower spatial resolution and higher spectral resolution thermal infrared (TIR) data are used to determine composition and particle size.

Background: Daedalia Planum is covered by one of the main flow aprons originating from the SW flank of Arsia Mons, the southernmost Tharsis shield volcano [4-5]. The study area was selected for its coverage by multiple datasets, extensive lava flow fields, and recent flow field mapping [6-8]. Lava flows in the study area have a predominately elongated, sinuous morphology (figure 1).

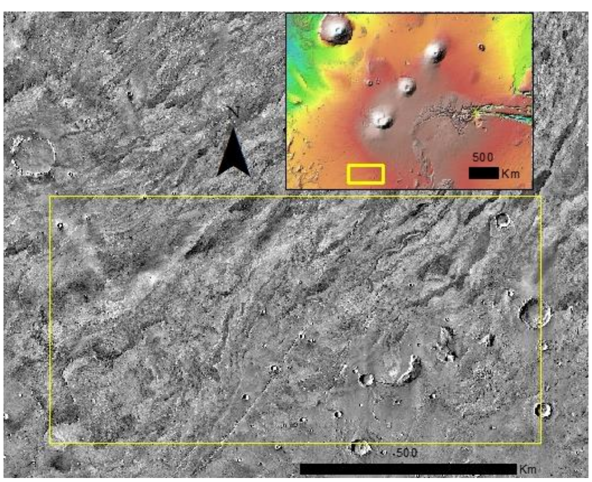

Fig. 1. THEMIS IR daytime temperature map of the study area (yellow box) in Daedalia Planum located SW of Arsia Mons. MOLA color map inset is included for context [9].

Previous studies identified a predominantly basaltic composition in the region with a TES-derived albedo of roughly 0.22-0.24 and a dust cover index of 0.94-0.97 [10]. Recent detailed geologic mapping using THEMIS, CTX, and HiRISE images of this study area suggest the presence of rugged outcrops of lava distinct from the mantling material and defined three types of lava flows (elongate flows with 1) bright (VIS), rugged or 2) dark (VIS), smooth surfaces and 3) broad flow lobes that were found to be older than the elongate flows) [8].

Methods: A combination of visible and TIR datasets were examined to quantify the thermophysical variability of lava flows in the study area. These datasets include CTX and HiRISE, the TES dust cover index, THEMIS day and night IR, and thermal inertia (TI) derived from THEMIS night data [11-12]. CTX images were primarily used to define individual flow boundaries, determine local flow superposition relationships, and interpret surface morphology for each flow [6-8]. Thermal inertia and THEMIS IR day and night data were compared to the high-resolution mapping to assess the thermophysical response of individual flows (figure 2) [11-12].

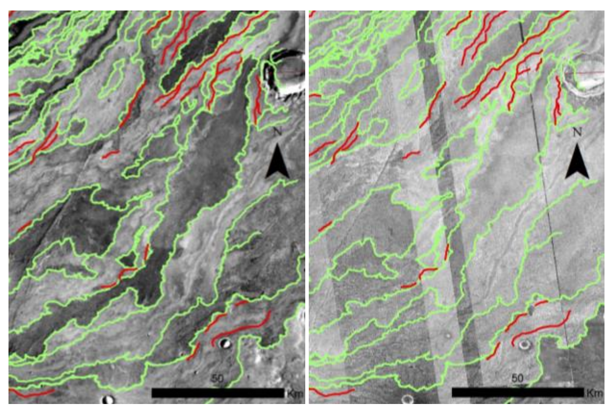

Fig. 2. THEMIS daytime IR mosaic (left) [9] and thermal inertia derived from THEMIS nighttime IR data (right) [11] showing flow variability. Flow mapping by Crown et al. [8].

The following constraints were applied to select THEMIS data for this analysis: (1) all bands (1-10) acquired, (2) collected between the local hours of 2:00-6:00 for night and 15:00-18:00 for day, and (3) surface temperatures of 225-350 K for day acquisitions. To investigate the thermophysical characteristics of the flows, four categories were defined based on day and nighttime THEMIS IR temperature data (table 1).

Category	IR Day Temp.	IR Night Temp.
A	High	High
B	High	Low
C	Low	High
D	Low	Low

Table 1. *Four categories based on THEMIS-derived temperature data.*

Region of interests (ROIs) were then defined with a standardized area [1.5km x 1.5km] to analyze the thermal inertia and temperature response between and along flows. Statistical analysis of the ROIs (using only data from the same THEMIS stamp) was then performed to better characterize flow surfaces within the flow field (figure 3). Finally, the THEMIS defined category, thermal inertia, and flow type defined by Crown et al. 2015 [8] were compared to determine whether the thermophysical variability correlated with the flow types mapped.

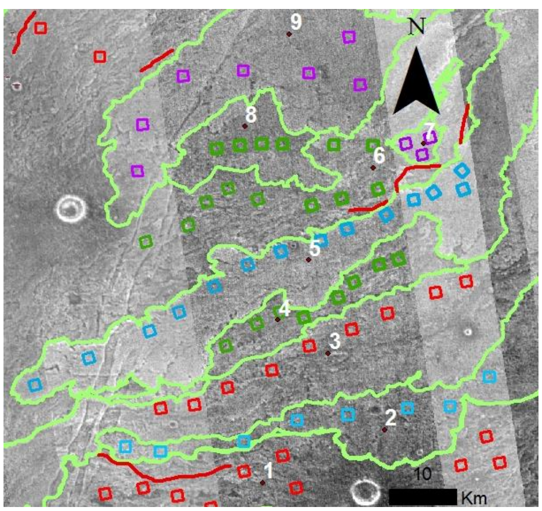

Fig. 3. *ROIs (colors corresponding to the flow categories in table 1) in a subsection of the study area overlain on the nighttime THEMIS-derived thermal inertia [11].*

Results and Discussion: For a region considered well-mantled, the lava flow field in Daedalia Planum does contain TI and temperature variations. Analyses of these flows reveal that some display a higher thermal inertia compared to adjacent flows. This variability suggests that this is not only an albedo-influenced phenomena and that perhaps the presence of different particle or block size distributions, linear mixing of mantling and lava outcrops, and/or different emplacement processes could be occurring.

Comparison of the category, thermal inertia, and flow type also reveals trends in the data. Flows identified as smooth elongate lobes [8] always have a high daytime temperature and are identified as either category A or B. Flows identified as category D, having low daytime and nighttime temperatures, always display a rugged surface morphology. Analysis of these data suggests an interesting correlation between flow type and thermophysical characteristics (figure 4).

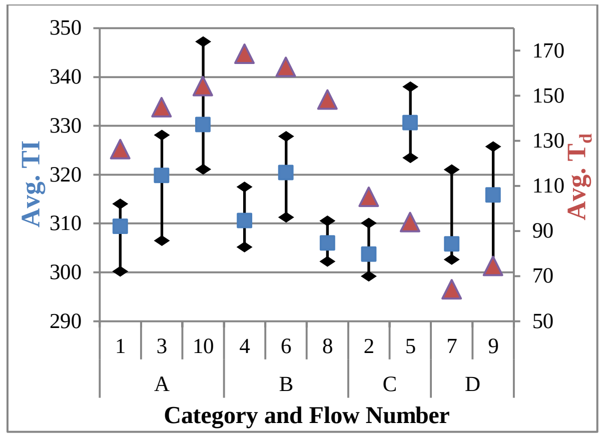

Fig. 4. *Average thermal inertia (minimum and maximum transect) and daytime surface temperature for flows labeled in figure 3. Taken from THEMIS Stamp I05878006.*

Summary: Analyses of thermophysical properties reveal that individual flows respond differently to diurnal heating. Because this variability correlates with geologic mapping, the thermophysical results are therefore sensitive to flow emplacement conditions, which is significant for a well-mantled region. Continued work is ongoing to characterize regional trends across the flow field, as well as variations within all the flows. This information should ultimately constrain how the emplacement process may have changed over time and constrain the use of TI in other dusty regions on Mars.

References: [1] Malin M.C. et al. (2001) *JGR*, *106*, 429-23, 570. [2] Edgett K.S. et al. (1993) *J. Arid Environ.*, *25*, 271-297 [3] Johnson J.R. et al. (2002) *JGR*, *107*, E6. [4] Crumpler L.S. et al. (1996) *Geol. Soc. Spec. Publ.*, *110*, 725-744. [5] Lang N.P. et al. (2009) *J. Volc. And Geotherm. Res.*, *185*, 103-115. [6] Crown D.A. et al. (2010) *LPSC*, *XLI*, abs. 2225. [7] Crown D.A. et al. (2014) *AGU*, *Fall*, abs. P41B-3906. [8] Crown D.A. et al. (2015) *LPSC*, *XLVI*, abs. #1439. [9] Edward C.S. et al., (2010) *JGR*, *116*, E10008. [10] Ruff S.W. et al. (2002) *JGR*, *107*, 5127. [11] Fergason R.L. et al. (2004) *JGR*, *111*, E12004. [12] Christensen P.R. et al. (2001) *JGR*, *106*, 823, 871.