HOW MANTLED ARE THE LAVA FLOWS IN DAEDALIA PLANUM? C. M. Simurda[1], M. S. Ramsey[1], and D. A. Crown[2], [1]Department of Geology and Planetary Science, University of Pittsburgh, 4107 O'Hara Street SRCC, Room 200, Pittsburgh, PA, 15260; [2]Planetary Science Institute, 1700 E. Fort Lowell Road, Suite 106, Tucson, AZ, 85719; cms256@pitt.edu.

Introduction: Mantling by eolian material (i.e., dust and sand) hinders spectral investigations of the Martian surface. It therefore becomes critical to identify the degree of this mantling to determine whether the bedrock spectral signature can be discerned. To achieve this goal, multiple datasets of Daedalia Planum, with diverse spatial and spectral resolutions, are examined to study lava flows previously considered too heavily mantled for spectral analysis.

To determine the degree of mantling on the flows, thermal properties are used to identify particle size due to the grain-size dependence of thermal conductivity [1]. Modeled thermal conductivity measurements under Mars conditions suggest that the detection of coarse grained particles are obscured by interstitial fines and low thermal inertia regions may be explained by a mixture of coarse plus fine grained material [2]. For lava flows, such a mixture may represent larger outcroppings with interstitial dust/sand.

Therefore, both high spatial and spectral resolution datasets are used to identify flow surfaces with this type of mixture. Higher spatial resolution images from HiRISE and CTX are used to identify the physical surface structure, and higher spectral resolution thermal infrared (TIR) data are used to determine composition, particle size, and thermophysical properties of the flows. Identification of flows with a mixture of outcroppings and interstitial dust/sand in this study can potentially be used to extrapolate the spectral signature of the larger lava outcrops.

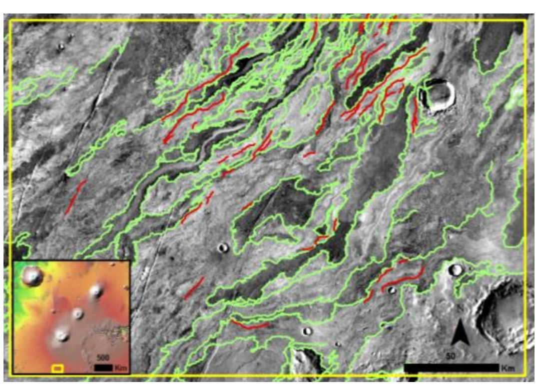

Fig.1. *THEMIS IR day temperature map of the current study area (yellow box) in Daedalia Planum with lava flow (green) and channel boundaries (red) defined by Crown et al. [7]. MOLA color map inset is included for context [5].*

Background: Daedalia Planum contains one of the main flow aprons originating from the SW flank of Arsia Mons (figure 1), the southernmost Tharsis shield volcano [3-4]. These flows have a predominately basaltic composition [5]. The study area was selected for its coverage by multiple datasets, extensive lava flow fields, and flow field mapping [6-8]. Recent detailed geologic mapping using visible (VIS) datasets suggests the presence of rugged outcrops of lava distinct from the mantling material [8].

Methods: VIS and TIR datasets were examined to quantify the thermophysical variability of the lava flows over an expanded portion of the flow field compared to our previous study [9]. The study area was significantly increased to include 30 lava flows ranging in length from roughly 6 km to 170 km. This attempted to capture the diversity of thermophyscial responses displayed in this region. The datasets used for analysis include CTX and HiRISE, the TES dust cover index, THEMIS day and night IR, and thermal inertia (TI) derived from THEMIS night data [10-11]. CTX images were used to define individual flow boundaries and interpret surface morphology for each flow as either smooth or rugged [6-8].

A main goal of this continued study was to visually and thermally identify rugged areas potentially mixed with interstitial dust that can be used to extrapolate the bedrock spectral signature. Thermal inertia and THEMIS IR day and night data were compared to the high spatial resolution mapping to assess the thermophysical response of individual flows in relation to surface morphology [10-11]. To constrain these differences, four categories were defined based on day and night 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.*

Over 450 regions of interest (ROIs) were defined with a standardized area [500m x 500m] to assess the variability of TI and temperature within individual flows and from flow to flow (figure 2). This is both a significant expansion in the number of ROIs collected and a decrease in the area compared to previous studies to improve accuracy [9]. Statistical analysis (including ANOVA to assess the variance) of the ROI data was also performed. Finally, the THEMIS defined category, thermal inertia, and flow type defined by Crown et al. 2015 [8] were compared to identify any areas with potential unmantled exposures.

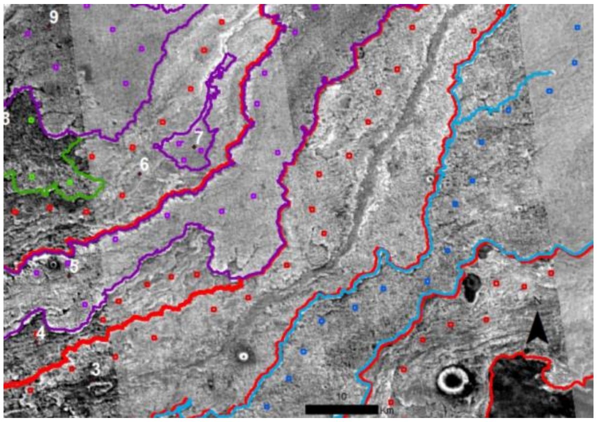

Fig.2. *ROIs (colors corresponding to the flow categories) in a section of the study area overlain on the night THEMIS-derived thermal inertia [10].*

Results and Discussion: The extent of the TI and temperature variation in the lava flow field suggests the presence of different particle size distributions or linear mixing of mantling and lava outcrops. If the area was completely covered with an optically thick layer of dust, the temperature and TI should only vary based on slopes that create a shadowing effect restricting the maximum temperature reached by the fine material.

Twelve flows identified as smooth elongate lobes [8] present a higher day temperature (either category A, having high day and night temperatures, or B, having high day and low night temperatures) suggesting that these flows may have a continuous layer of dust.

Twelve flows identified as either category D, having low day and night temperatures, or category C, having low day and high night temperatures, always display a rugged surface morphology. This extensive statistical analysis of the thermophysical responses of the lava flows suggests that the THEMIS data may be detecting signatures from the lava outcroppings as well as the interstitial eolian material in rugged flows (figure 3). With the identification of these flows with potentially exposed lava outcroppings, modeling the percentage mixtures that would produce the calculated TI values for the category C and D lava flows will determine whether or not it is possible to extrapolate the signature of only large outcrops.

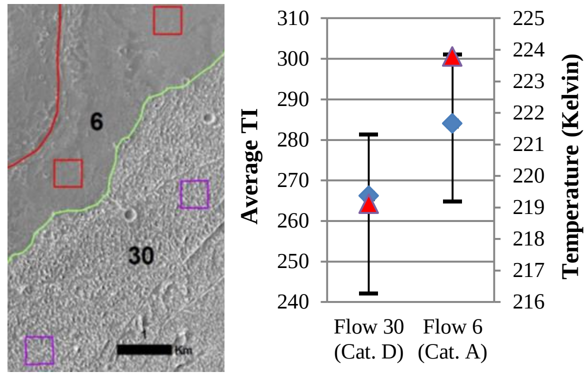

Fig.3. *Chart of average thermal inertia (blue diamonds with minimum and maximum range) and day temperature (red triangles) for two example flows of smooth and rough surfaces alongside a CTX image of the neighboring flows. Thermal inertia calculated from I26258019 and day brightness temperature from I52324002.*

Summary: Analyses of surface thermophysical properties and surface morphology reveal that individual flows in Daedalia Planum respond differently to diurnal heating suggesting that the area is not completely (or uniformly) dust mantled. Areas within the rugged flows identified as potential locations of unmantled lava outcrops (e.g., category A or C) can be targeted for spectral studies and potentially unravel the complex flow emplacement conditions.

Work is ongoing to determine the best mixing model to identify the percentages needed to produce the calculated TI values. These percentages can then be used to extrapolate spectral and thermophysical signatures of only large outcrops, which will constrain changes in the down-flow composition and ultimately the emplacement process over time. Such an approach should be applicable to other dusty regions on Mars.

References: [1] Presley M.A. and P.R. Christensen (1997) *JGR*, *102*, E3, 6551-6566. [2] Mellon et al. (2014) *8th Intern. Conf. on* Mar. abstract 1107. [3] Crumpler L.S. et al. (1996) *Geol. Soc. Spec. Publ.*, *110*, 725-744. [4] Lang N.P. et al. (2009) *J. Volc. And Geotherm. Res.*, *185*, 103-115. [5] Edward C.S. et al., (2010) *JGR*, *116*, E10008. [6] Crown D.A. and M.S. Ramsey (2016) *J. Volc. And Geotherm. Res.*, Article In Press. [7] Crown D.A. et al. (2014) *AGU, Fall,* abs. P41B-3906. [8] Crown D.A. et al. (2015) *LPSC, XLVI*, abs. #1439. [9] Simurda C.M. et al. (2016) *LPSC, XLVII*, abs. #2594. [10] Fergason R.L. et al. (2004) *JGR*, *111*, E12004. [11] Christensen P.R. et al. (2001) *JGR*, *106*, 823, 871.