# Surface Characteristics of the Daedalia Planum Lava Flow Fields Derived from Thermophysical and Geological Mapping

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## Introduction

Significant mantling of the Martian surface by dust and sand (e.g., in the Tharsis region) negatively influences the ability to remotely investigate the underlying bedrock [1]. Global homogenization of eolian material impedes the interpretation of underlying bedrock, but it is important to consider that some mantling deposits may be locally derived and preserve signatures of that bedrock [2-3]. Using datasets with different spatial and spectral resolutions may allow interpretations of surface features previously considered too extensively mantled for spectral studies. Higher resolution imaging datasets such as HiRISE and CTX are used to identify surface formations, whereas lower resolution thermal infrared data are used to determine composition and particle size. Investigating thermophysical properties combined with flow morphology can constrain the possible composition, eruption rates, and flow emplacement properties across the flow field.

## Location

Daedalia Planum is covered by one of the main flow aprons originating from the SW flank of Arsia Mons, the southernmost Tharsis shield volcano (figure 1) [4-5]. This region was selected for its extensive lava flow field, coverage by multiple datasets, and recent flow field mapping [6-9]. Previous studies suggest that this area is predominantly basaltic in composition and has a Thermal Emission Spectrometer (TES)-derived albedo of roughly 0.22-0.24 and a dust cover index of 0.94-.97 [10]. However, analysis of CTX and HiRISE images suggest the presence of minimally-mantled lava outcrops that are distinct from the mantling material. Three types of lava flows were identified: elongate flows with 1) bright (VIS), rugged or 2) dark (VIS), smooth surfaces and 3) broad flow lobes found to be generally older than the elongate flows [8-9].

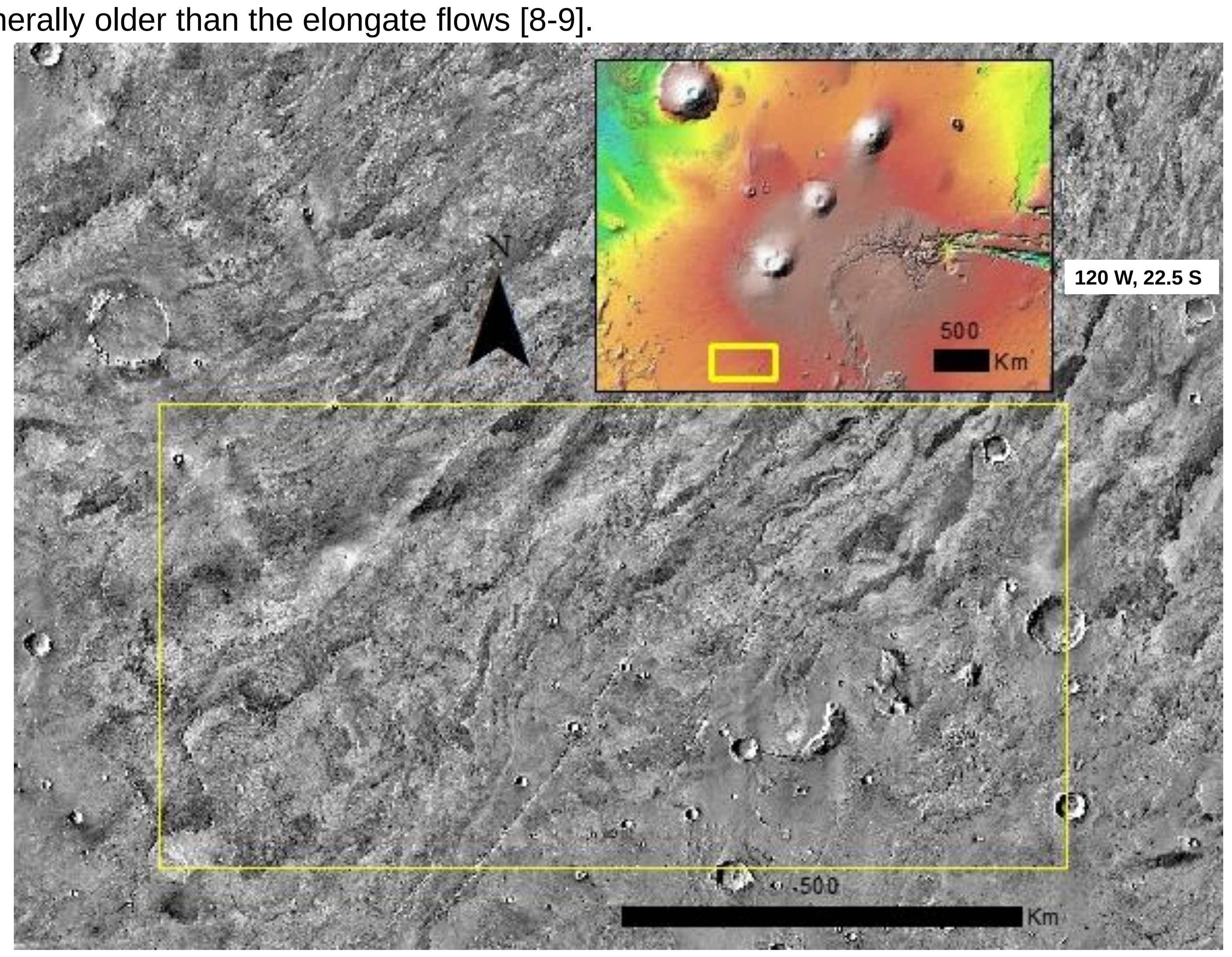



**Fig. 1.** THEMIS IR daytime temperature composite of the study area (yellow outline) in the Daedalia Planum region located SW of Arsia Mons [11]. MOLA color map inset shows the location of the Tharsis study site.

## Datasets

**Lava Flow Boundaries and Surface Textures**
- MRO High Resolution Imaging Science Experiment (HiRISE)
- MRO ConTeXt Camera (CTX)

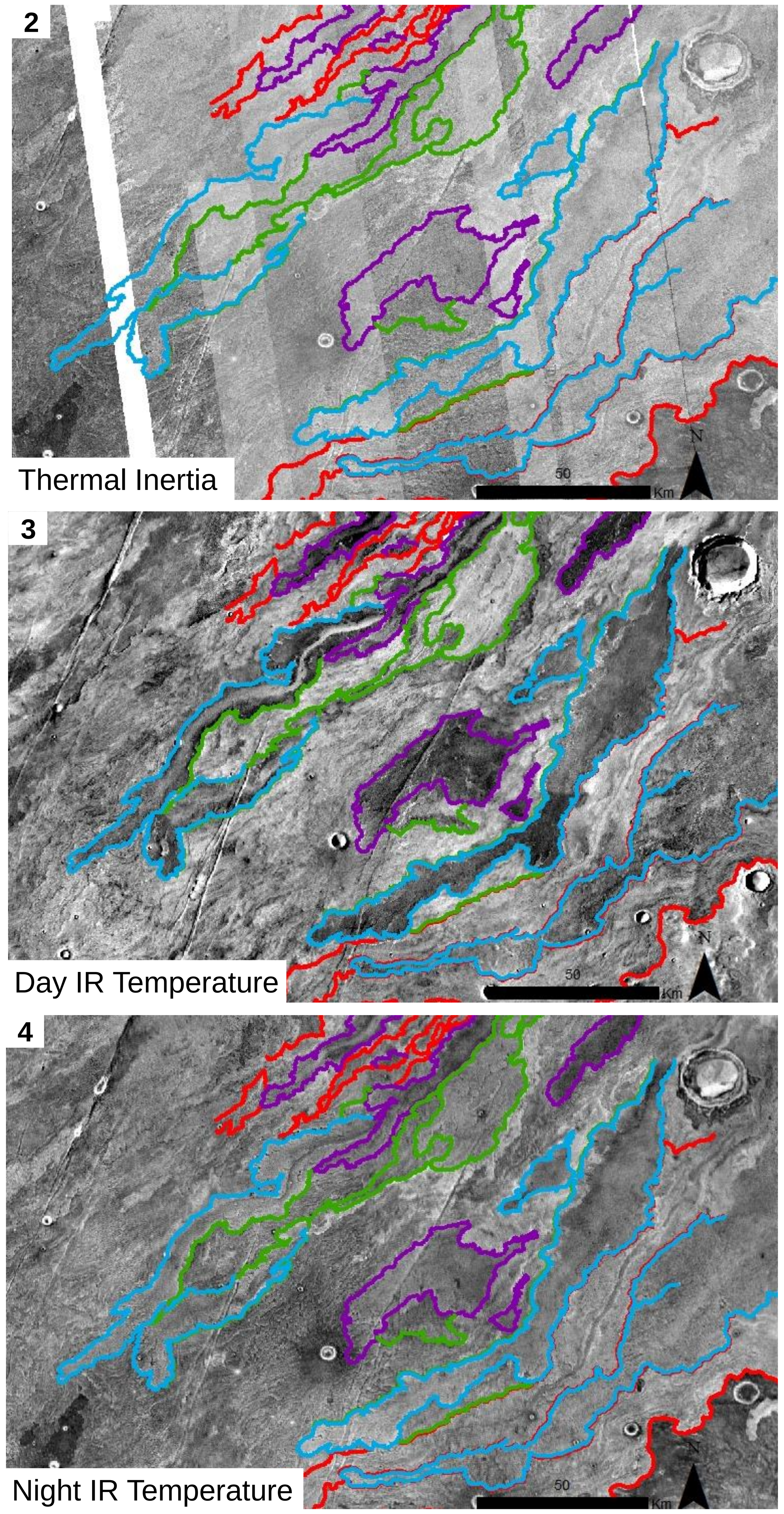
**Thermophysical Properties**
- Thermal Emission Imaging System (THEMIS) IR Temperature Day and Night
- THEMIS Derived Thermal Inertia (TI)
- Thermal Emission Spectrometer (TES) Dust Cover Index

Specific limitations were placed on the Thermal Emission Imaging System (THEMIS) infrared (IR) database search to ensure the best quality data would be selected. The following criteria were used:

*(1)* ***contained all 10 bands***
*(2)* ***collected between the local hours of 2:00-6:00 (night) and 15:00-18:00 (day)***
*(3)* ***surface temperature of 225-350 K for day acquisitions***

Thermal inertia (TI) derived from THEMIS IR night data were compared with THEMIS IR day data to determine the thermophysical response of the identified flows over a diurnal cycle (figures 2-3) [12-13]. Additionally, in order to assess compositional variability to the flow material, different channels from THEMIS IR data were compared (6-4-2, 8-7-5, and 9-6-4). CTX and HiRISE images were used to identify flow boundaries, local flow superposition relationships, and surface morphology.

## Comparison of Thermophysical Properties




**Figs. 2-4.** [2] Thermal Inertia derived from THEMIS IR night [12], [3] THEMIS IR day temperature mosaic, and [4] THEMIS IR night temperature mosaic [11] showing flow variability. The colors of outlined flows correspond with the four categories in table 1 and the boundaries are defined by Crown et al. [8-9].

## Methods

To investigate the thermophysical characteristics of the flows, four categories were defined based on day and nighttime THEMIS IR temperature data (table 1).

| Categories | IR Day Temperature | IR Night Temperature |
|---|---|---|
| A | High | High |
| B | High | Low |
| C | Low | High |
| D | Low | Low |

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

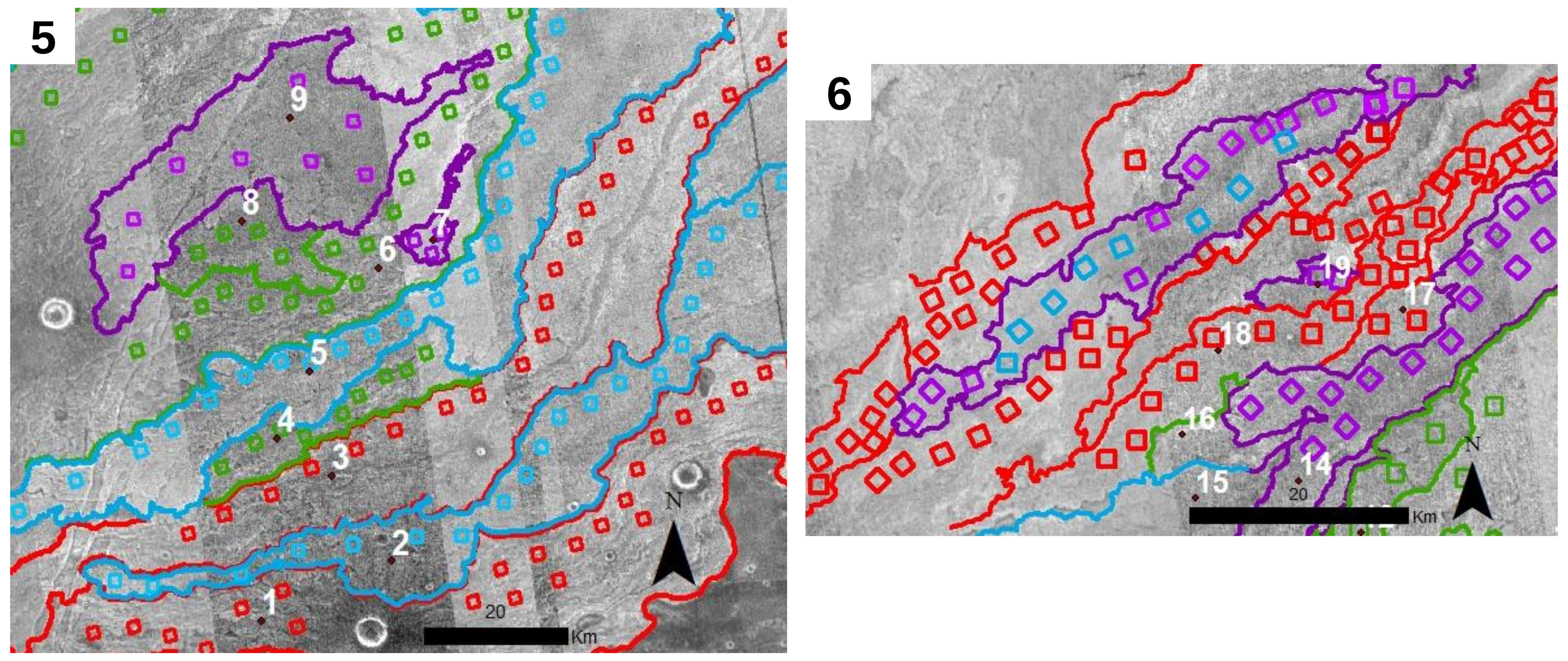



**Fig. 5-6.** ROIs (colors corresponding to the flow categories in table 1) in two subsections of the study area overlain on the nighttime THEMIS-derived thermal inertia [12] and flow boundaries (green and red lines) [8-9].

Region of interests (ROIs) were then defined with a standardized area [1.5 km x 1.5 km] to analyze the TI 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 (figures 5-6). Finally, the THEMIS defined category, TI, and flow type defined by Crown et al. 2015 [8-9] were compared to determine whether the thermophysical variability correlated with the flow types mapped.

## Results and Future Work

For a region considered well-mantled, analyses of these flows reveal that some display a higher TI 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. Further comparison of the category, TI, and flow type also reveals trends in the data. Flows identified as smooth elongate lobes [8-9] always have a high daytime temperature and are identified as category A or B with either a high or low nighttime temperature. Flows identified as category D, having low daytime and nighttime temperatures, always display a rugged surface morphology. Both rugged and smooth flows have been identified as categories B and C. Further investigation is necessary to identify a more subtle trend. Derived TI averaged along a flow does not vary drastically between neighboring flows, suggesting a more specific relationship between the amount of mantling and exposed bedrock. Thus, analysis of these data suggests an interesting correlation between flow type and thermophysical characteristics (figure 7).

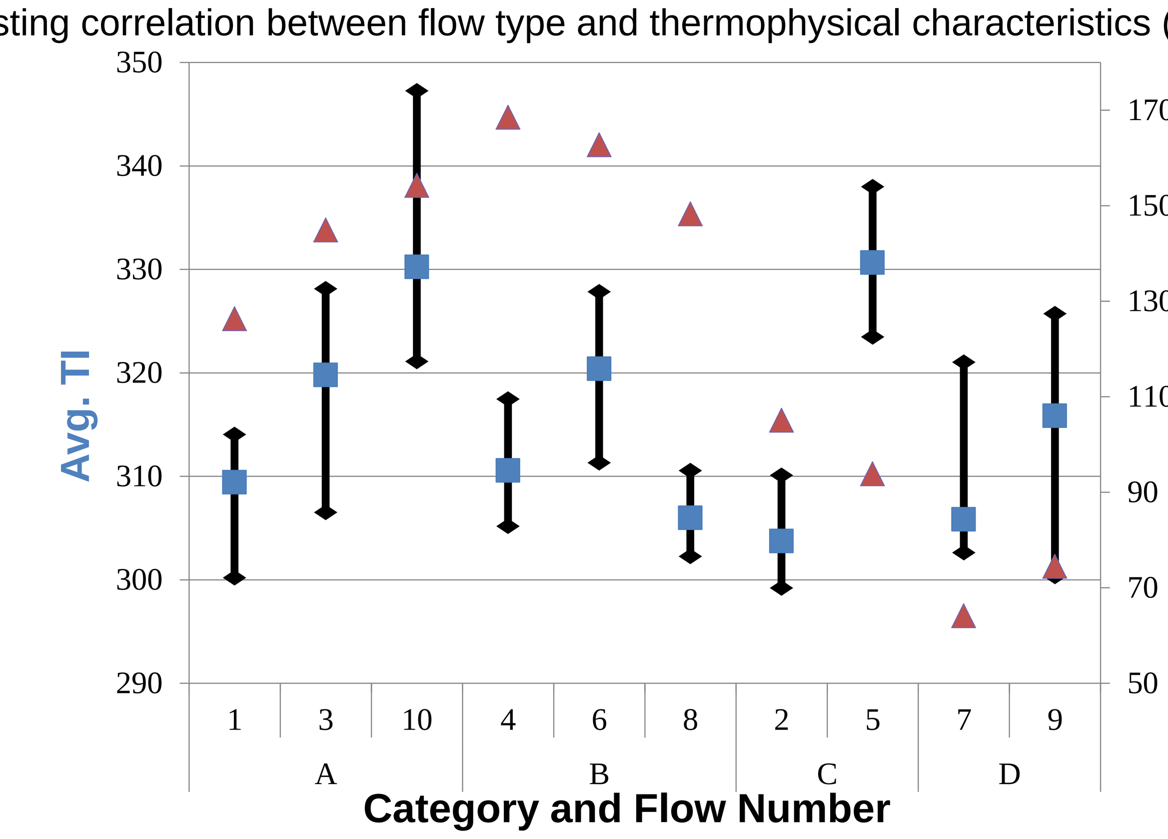



**Fig. 7.** Example of average thermal inertia (minimum and maximum transect) and daytime surface temperature for flows labeled in figures 5-6. Taken from THEMIS Stamp I05878006.

Analyses of thermophysical properties reveal that individual flows respond differently to diurnal heating. Because this variability correlates with the geologic mapping, the thermophysical results are therefore sensitive to flow emplacement conditions, which is a significant finding 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 determine how the emplacement process may have changed over time and constrain the use of TI in other dusty regions on Mars.

## Acknowledgements

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