**THERMOPHYSICAL CHARACTERIZATION OF SOUTHERN HEMISPHERE DUNES ON MARS.**
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**Introduction**: Investigation of eolian dunes, specifically dune morphology and thermophysical properties, provides insight into local climate and climate trends. Characterizing apparent thermal inertia and small-scale variations within dune fields provides insight into near surface compositions, which can inform local to regional climate trends. Previous research of southern hemisphere dunes has identified a poleward trend in changing morphologies from active to stabilized dunes [1]. Six morphological classes of dunes were established, and it is hypothesized that the changing trends can be attributed to variations in the degree to which subsurface ice cements dunes in place and inhibits their activity. Sharp-crested dunes are located nearest the equator and are the most active dune type observed whereas sand sheets with few low, rounded bedforms are located nearest the pole and are the most stabilized dune type observed. Intermediate dune types become increasingly more stabilized with increasing latitude. The Mars Odyssey Neutron Spectrometer identified a 20% increase in hydrogen concentrations, potentially indicative of subsurface ice, poleward of 50°S [2] coinciding with a decrease of dune activity poleward of 60°S [1]. Using morphological and thermophysical characterization of dunes, our research investigates the presence of subsurface ice in the southern hemisphere of Mars.

**Thermal Inertia:** Thermal inertia, a combination of thermal conductivity, heat capacity, and density, can be used to infer grain size, induration, rock abundance, and bedrock exposure [3]. Additionally, seasonal and diurnal variations of apparent thermal inertia (ATI, derived assuming constant properties) may result from material heterogeneities and can be used to interpret surface and subsurface properties [3,4]. Research presented will focus on the analysis of thermophysical properties of dune fields to interpret near-surface properties and composition.

**Methods:** We analyzed 171 of the largest dune fields in the southern hemisphere that had been previously mapped and classified morphologically [2]. In this work, we assessed the large- and small-scale thermophysical properties and related them to the morphological class for each dune field. Using JMARS [5], we mapped areas of high sand coverage with little bedrock exposure and areas of low sand coverage with high bedrock exposure to assist in characterizing the thermophysical properties of each dune field. We assessed the ATI of each dune field as derived from brightness temperatures obtained by the Mars Global Surveyor Thermal Emission Spectrometer (TES) and the Mars Odyssey Thermal Imaging System (THEMIS). We used TES values to identify the large-scale heterogeneities of each dune field at 3 km/pixel scale and THEMIS values to identify small-scale variations at 100 m/pixel scale. We compared the TES data to results from two-component heterogeneity models to investigate and identify a variety of materials (sand, dust, duricrust, and rock or ice [4], where rock and ice are thermally equivalent) by examining their diurnal and seasonal ATI variations [3,4]. We used the THEMIS data to investigate the small-scale features on the surface to help better identify near-surface properties. Together, TES and THEMIS analysis provides information about the properties of the upper few centimeters of the surface and can be used to track subsurface ice through the identification of a rock or ice thermal signature. In addition to two-layer heterogeneity models, we are employing models of laterally mixed materials and slopes to investigate their effects on ATI.

**Results**: Of the 171 dunes we investigated, approximately half have ATI signatures that closely match thermal signatures represented in two-material heterogeneity models. The most common type of thermal signature is that of 'crust over dust' models while many dune fields had thermal signatures similar to those of 'dust over crust,' 'dust over sand' and 'dust-crust mix' models. We identified 12 sharp-crested dune fields, all of which have a thermal signature most closely matching 'crust over dust'. Thirteen other dune fields, ranging morphologically from slightly degraded to sand sheet, also have thermal signatures most similar to 'crust over dust'. Sharp-crested dunes are unique in that no other morphological class only matched a single thermal class. Additionally, half of the dunes identified as slightly degraded have a thermal signature of 'crust over dust.' Degraded dunes and sand sheets dominantly match 'dust over sand' models. Dunes matching best to 'dust-crust mix' and 'dust over crust' models varied from slightly degraded to degraded. Only six dune fields, ranging from degraded to slightly degraded, had a potential match to a rock or ice thermal signature.

In our analysis of THEMIS data, we divided dunes into three types based on variations in ATI [6]. Type 1 dunes have lower ATI compared to surrounding material and exposed interdunes. Type 2 dunes have crests with higher ATI compared to the troughs and interdunes. Sand sheets are classified as Type 3 dunes and exhibit a homogenous ATI with no interdunes.

**Discussion:** The available heterogeneity models do not fully explain the observed thermal behavior. For example, the Type 1 dune fields have a significant amount of exposed bedrock and underlying material. Therefore TES observations incorporate dune and non-dune material and as a result, the simple two-component models cannot provide an accurate depiction of the thermal behavior of these dune fields. Additionally, Type 2 dunes exhibit high ATI along the crests, which could indicate duricrust or cemented material along the crest. This contradicts the hypothesis that these less degraded dunes located closer to the equator are active, since active dunes would likely have lower ATI as a result of finer grained material along the crest.

**Future Work:** The next step for this research is to explain the discrepancies between derived ATI and predicted dune activity and thermal behavior. Models will be employed to investigate the influence of slope on ATI and will include horizontal mixtures of materials and vertical layering not already considered. We expect this additional modeling work to provide more insight into the derived ATI and how it relates to composition, morphology and activity of a dune field.

**References:**

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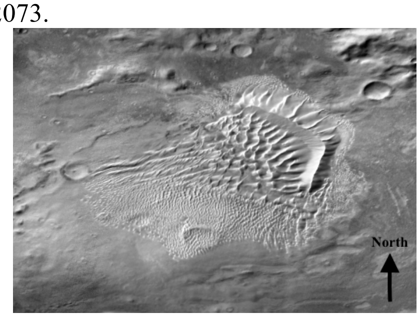


Figure 1: THEMIS Daytime IR 100-m resolution image of a sharp crested dune field located at 12.6°E, 54°S (Image from THEMIS Day IR Global Mosaic v12.0)

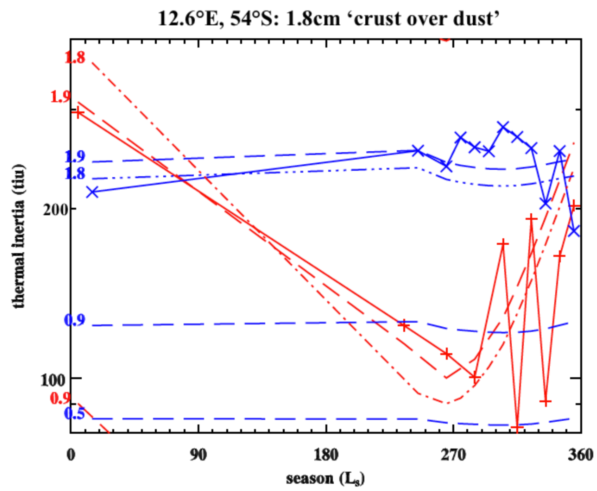


Figure 2: Seasonal apparent thermal inertia for the dune field in Figure 1. TES measurements (symbols and solid lines) are compared with modeled values (dashed lines) for 2AM (blue) and 2PM (red) TES observation times. Colored labels on the left axis indicate model upper-layer thickness in centimeters. The data correlate best with a model of 1.8 cm crust over dust (dot-dashed lines).

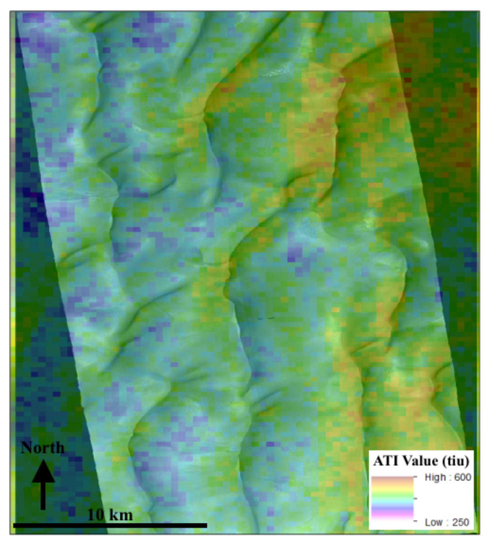


Figure 3: THEMIS apparent thermal inertia (I33864004) overlain on a HiRISE image (ESP_013017_1325) located at 19.5°E, 46.6°S. These Type 2 dunes have crests with higher ATI than that of interdunes and troughs.