ANALYSIS OF THERMAL INERTIA TO UNDERSTAND THE NEAR-SURFACE PROPERTIES OF LAYERED EJECTA CRATERS AND SOUTHERN HEMISPHERE DUNES ON MARS

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INTRODUCTION:

Analysis of thermal inertia and other thermophysical properties can inform the geologic, erosional and depositional history of an area.

Research presented here focuses on application of thermal inertia analysis to constrain the formation and geologic history of layered ejecta craters and southern hemisphere dunes on Mars.

We investigated and classified 171 dune fields and 45 layered ejecta craters to identify the presence of subsurface volatiles through the analysis of derived thermal inertia values and comparisons to two-layer thermal models.

THERMAL INERTIA:

- Thermophysical properties of a material measures its resistance to temperature change which is used to infer grain size, induration, rock abundance and percentage of exposed bedrock\textsuperscript{[41]}
- Thermal inertia units (tiu): Jm\textsuperscript{-2}K\textsuperscript{-1}s\textsuperscript{0.5}\textsuperscript{[7]}
- On Mars, thermal inertia is most influenced by a material’s thermal conductivity\textsuperscript{[8]} and secondarily by heat capacity and density\textsuperscript{[6]}
- Apparent thermal inertia (ATI) is derived from brightness temperatures values obtained at discrete times of day by the Mars Odyssey Thermal Emission Imaging System (THEMIS)
- ATI typically exhibits diurnal and seasonal variations attributed to heterogeneity within the field of view of the observations\textsuperscript{[4]}

THEMIS ANALYSIS:

- THEMIS (100m/pixel scale) used to identify small scale variations within a dune field or crater ejecta blanket
- Analysis limited to nighttime observations because the majority of daytime observations are too close to dusk to provide accurate results\textsuperscript{[10]}

THEMIS ANALYSIS: Craters

Five different characteristics are identified in THEMIS data and each layered ejecta crater can display more than one characteristic. Figures 3-5 are THEMIS ATI overlaying a THEMIS Daytime mosaic.

- a: Rays of high thermal inertia (Figure 3)
- b: Thermal inertia of the ejecta blanket lower than the surrounding terrain (Figure 4)
- c: Thermal inertia of the ejecta blanket higher than the surrounding terrain (Figure 4)
- d: Edge of an ejecta blanket exhibiting a distinct thermal inertia value compared to the surrounding materials (Figure 5)
- e: Lack of a distinct pattern observed in the thermal inertia, equivalent to background (Figure 6)

THEMIS ANALYSIS: Dunes

Three categories of dune fields based on the observed patterns of thermal inertia\textsuperscript{[41]}

Type 1: Exposed substrate in the interdunes, lower ATI compared to the surrounding material (Figure 6)
Type 2: Higher ATI crests than in the troughs (Figure 7)
Type 3: Homogenous ATI with no interdunes (Figure 8)

DISCUSSION:

- Using TES in conjunction with THEMIS provides a clearer picture of the thermophysical properties and behaviors of near-surface materials.
- THEMIS heterogeneity models are useful for identifying large-scale variations and classifying vertical and horizontal mixtures.
- THEMIS is important for identifying small-scale heterogeneities and trends and is advantageous for investigating sparse features that reveal underlying surface material.