GLOBAL DISTRIBUTION OF LOW THERMAL INERTIA HALOS SURROUNDING SMALL YOUNG MARTIAN IMPACT CRATERS.

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Introduction: The Thermal Emission Imaging System (THEMIS) onboard the 2001 Mars Odyssey spacecraft has acquired over 200,000 infrared images of the Martian surface over the first fourteen years of its mission, which were compiled into both daytime and nighttime infrared global mosaics by Edwards *et al.* [1,2] and updated using additional data by Hill *et al.* [3]. Using these global mosaics, Hill and Christensen [4] identified low-thermal inertia halos surrounding small, young impact craters. They were initially hypothesized to be well-preserved recent impact ejecta deposits. However, it is now thought that the low thermal inertia halos may be the result of both fine ejecta material and existing surface regolith that has been disturbed by the impact process, similar to the lunar crater cold spots described by Bandfield *et al.* [5]. They also appear to be related to, although much smaller than, the Martian ejecta halos described by Ghent *et al.* [6] and the rayed craters described by Tornabene *et al.* [7]

Background: The THEMIS instrument consists of two multispectral imaging subsystems; a ten-band thermal infrared imager and a five-band visible/near-infrared imager. The thermal infrared camera has a nominal spatial resolution of 100m/pix and covers a wavelength range of 6.7 μm to 14.8 μm [8]. During the first fourteen years of science operations, THEMIS has completed 100% daytime coverage between 87.3°N - 87.3°S and approximately 95% nighttime coverage between 60°N - 60°S. Hill *et al.*[2] used updated version of the THEMIS global mosaics to produce a combination global map by overlaying a colorized version of the nighttime global mosaic on the daytime global mosaic. The resulting "THEMIS Day IR with Night IR Color" global map can be used to more easily identify surface features with unique thermal characteristics, such as the low thermal inertia deposits surrounding young craters identified by Hill and Christensen [4].

Methods: A visual search of the "THEMIS Day IR with Night IR Color" global map at full-resolution between 60°N - 60°S was conducted and all craters with distinguishable low thermal inertia halos were marked. Nighttime temperatures were used as a proxy for thermal inertia for the purposes of this search. Each of the low thermal inertia halos were then classified.

Classification: Six categories of low thermal inertia halos were defined based on their state of apparent degradation relative to an "ideal" halo (Type 5), shown in Figure 1e.

Type 1: Below Data Resolution. These halos are small enough, usually below 3km diameter, that the 100m/pixel resolution of the THEMIS temperature images made it difficult to classify them based on their state of degradation (Figure 1a).

Type 2: Heavily Degraded. Halos in this category are degraded to the point that they are nearly unrecognizable as halos. This category may include some low thermal inertia deposits that have been misidentified as halos (Figure 1b).

Type 3: Degraded. While the concentric nature of the halos are better preserved in this category, the contrast between the different concentric thermal inertia regions surrounding the center crater is not very high or is inconsistent (Figure 1c) .

Type 4: Modified. The contrast between the concentric thermal inertia regions of these halos is higher and the regions are more obviously concentric, with relatively minor variations (Figure 1d).

Type 5: Preserved. These halos represent the type examples that were initially identified. The thermal inertia contrast between the concentric regions of the halos is large and the outer ring contains very low thermal inertia material that is effectively continuous around the entire halo (Figure 1e).

Type 6: Well-Preserved. These features resemble preserved halos that also have low thermal inertia material covering the young crater at the center. The current hypothesis is that these features are the youngest and/or best-preserved examples in the evolution of the low thermal inertia halos, but other possible origins are still being investigated.

Results: This study has identified and classified 4,024 low thermal inertia halos surrounding small, presumably young, impact craters on the Martian surface between 60°N - 60°S. Mapping the locations of these halos (Figure 2) reveals a non-random pattern with significant concentrations in the southern highlands and southeast of Elysium Mons. These regions are thought to either indicate that the low thermal inertia halos are preferentially forming in those regions (possibly due to the relative strength of the surface material) or that the halos are being preferentially preserved in those regions (possibly due to calmer atmospheric conditions near the surface that do not re-distribute the fine-grained, low thermal inertia material as easily). Analysis of the entire dataset shows a clear evolutionary path for these features that begins with Type 5 (possibly Type 6) and ends with them degrading past Type 2.

Future Work: These low thermal inertia halos will be compared to similar low temperature halos surrounding small, young craters on the lunar surface described by Bandfield *et al.* [5]

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References: [1] Edwards et al. (2011) JGR, 116, E10008. [2] Edwards et al. (2011) JGR, 116, E10005. [3] Hill et al. (2014) 8th International Conf. on Mars, Abstract #1141. [4] Hill and Christensen (2014) AGU, Abstract P33A-4028. [5] Bandfield et al. (2014) Icarus, 231, p221-231. [6] Ghent et al. (2010) Icarus, 209, p818-835. [7] Tornabene et al. (2006) JGR, 111, E10006. [8] Christensen et al. (2004) Space Sci Rev 110: 85-130. . [9] Smith *et al.* (2003) PDS.

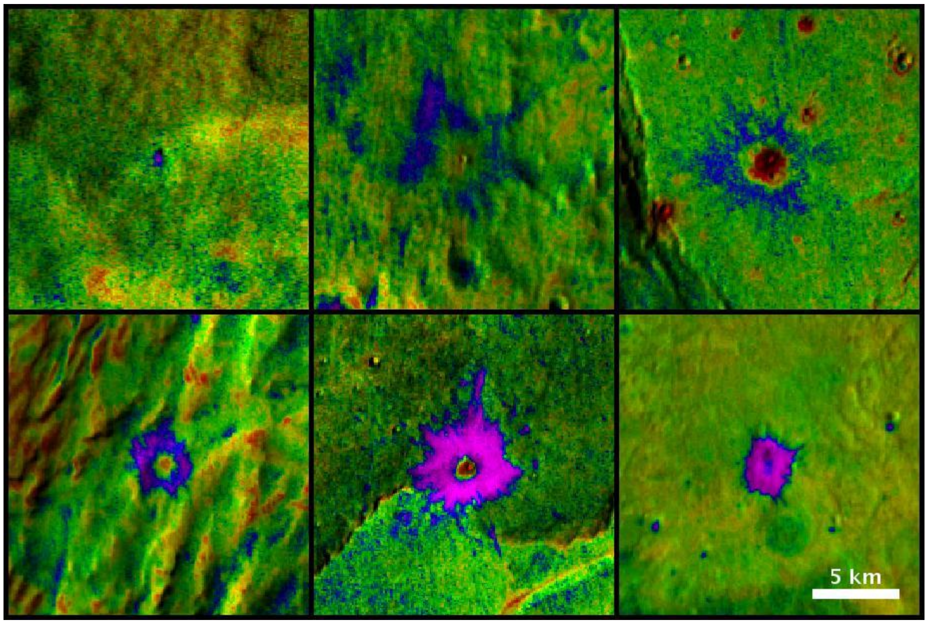

Figure 1: Examples of each category of low thermal inertia halos, taken from the "THEMIS Day IR with Night IR Color" global map: a) Type 1: Below Data Resolution, b) Type 2: Heavily Degraded, c) Type 3: Degraded, d) Type 4: Modified, e) Type 5: Preserved and f) Type 6: Well-Preserved. All images in this figure are at the same resolution.

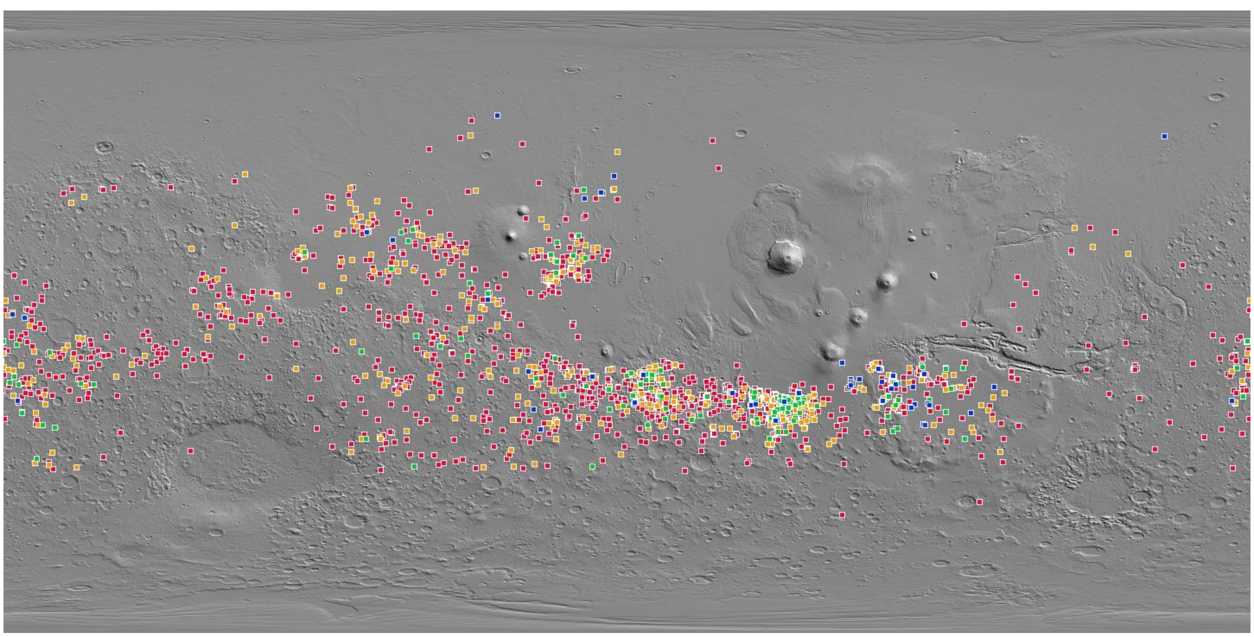

Figure 2: Global map (0°E-360°E) of Types 3, 4, 5 and 6 low thermal inertia halo locations overlaid on a MOLA Shaded Relief. [9] Type 3 (red), Type 4 (yellow), Type 5 (green) and Type 6 (blue).