VISIBLE AND THERMOPHYSICAL CHARACTERISTICS OF THE BEST-PRESERVED MARTIAN CRATERS, PART 2: THERMOPHYSICAL MAPPING OF RESEN AND NOORD. J. L. Piatek[1], L. L. Tornabene[2], K.T. Hansen[2], S.J.Hutchinson[2], N. G. Barlow[3], G. R. Osinski[2,4], S. J. Robbins[5], and A.S. McEwen[6] [1]Dept. of Geological Sciences, Central Connecticut State Univ., New Britain, CT (piatekjel@ccsu.edu) [2]Centre for Planetary Science & Exploration (CPSX) and Dept. of Earth Sciences, Western University, London, ON, [3]Dept. Physics and Astronomy, Northern Arizona Univ., Flagstaff, AZ, [4]Dept. of Physics & Astronomy, Western University, London, ON, [5]Southwest Research Institute, Boulder, CO, [6]LPL, University of Arizona, Tucson, AZ.

Introduction: The work presented here is part of an ongoing project to characterize the morphological and thermophysical characteristics of the best-preserved craters on Mars. Initial results focused on craters near the upper portion of the complex crater transitional boundary [craters of diameter 5-10 km; see 1,2] - ongoing work will expand the sizes included in the study above and below this range. The goal of the project is to define the baseline morphological and thermophysical characteristics associated with well-preserved Martian craters in order to: 1) place more rigorous and objective constraints on what defines the "best-preserved" craters, in an attempt to provide more consistency regarding crater preservation terminology (e.g., pristine, fresh, young), 2) identify and quantify types of crater degradation as a function of locality/region to understand the geologic and climate history of Mars, and 3) improve our understanding of the impact process, including the role of impactor and target effects, and how target surfaces are affected by impact events (e.g., ejecta emplacement, effects of airblasts [e.g., 3,4]).

We deliberately avoid (and seek to phase out) terms, such as "pristine", and "fresh" when describing crater preservation as preservation and age are not always correlated on active surfaces. High-resolution imagery of what are considered to be the best-preserved craters on Mars indicate that even the youngest [e.g., 5-8] show signs of modification by active geologic processes [9].

General Methods: All mapping is done in ArcGIS, using the MOLA 128 pixel per degree elevation dataset as a base layer. Additional datasets (including THEMIS controlled IR mosaics, HRSC DTMS, CTX images, THEMIS-derived thermal inertia mosaics, and HiRISE images) are imported and aligned to the MOLA image as provide a common map reference. The goal of the study is to characterize crater facies, so the map extent is defined to include as many facies as appear to be present, but not necessarily to cover the entire extent of distal deposits (e.g. crater rays, where present).

In geomorphic mapping (based on CTX imagery and informed by HiRISE images where available), morphologic units are defined based on texture, tone, relief, and structure. Units are traced as vector polygon layers and symbolized by specific colors and patterns; colors, similar to those used in the official geologic map of Tooting crater [10]. Related units are given similar hues so that related units have similar hues, so the relationship between groups of units are more apparent. Patterns within units are used to illustrate surface textures that are not necessarily characteristic of the unit, but are present as overprinting features (e.g. sand dunes overlying pitted material on a crater floor).

Thermophysical maps are completed using quantitative thermal inertia (TI) mosaics derived from THEMIS nighttime IR images. Appropriate images are identified first using JMars, and are then processed via either THMPROC [11] or a combination of ISIS and daVinci [12] to remove instrument effects and to map project images prior to generating nighttime temperature mosaics in ENVI. Thermal model-derived lookup tables [13], along with elevation and albedo data, are used to generate quantitative thermal inertia images. In most cases, overlapping images have differing TI values due to the effects of atmospheric dust (reducing incident sunlight and/or insulating the surface), so the value of tau for each image is adjusted so overlapping images have similar TI values. This technique generates a final mosaic that has a consistent appearance with minimal color balancing/blending of individual images.

Thermophysical units are outlined as polygonal features on TI mosaics in ArcGIS, and are defined based on a set of general characteristics. Crater floor deposits are relatively low TI compared to the higher TI walls, which appear bright in THEMIS mosaics. due to the presence of blocky deposits and potential bedrock outcrops. The edges of continuous ejecta units typically have distinct thermophysical boundaries, which have been previously interpreted to represent the "ramparts" of the layered portion(s) of the ejecta [8]. When the margin of continuous ejecta is not thermophysically distinct, its location is inferred using additional datasets (e.g. THEMIS day IR and/or visible imagery). The boundary of the discontinuous ejecta is placed at the furthest extent to which crater processes appear to have modified the thermophysical character of the surface; these deposits typically have an appearance consistent with ballistic emplacement or material affected by airblast, often appearing as variations in TI radial to the crater itself.

Initial geomorphic and thermophysical maps are completed independently and then compared so unit boundaries can be refined and finalized. This comparison allows for identification of units that are only visible in one dataset, as the datasets used are sensitive to different surface properties (surface texture and albedo, compared to heat transfer through a diurnal skin depth) and have different spatial resolutions. This synergy of datasets should allow for better characterization of surface units and correlation to processes related to deposition and modification.

Preliminary Results: Initial morphologic maps have focused on the crater (e.g. Floor, Rim/Wall units) and near-crater ejecta deposits (just to the rampart of the continuous ejecta), with the intent to extend maps beyond this point with a focus on portions of the discontinuous ejecta covered by HiRISE imagery when possible. Units have been subdivided where variations in visible textures (e.g. smooth vs. hummocky) and/or small scale features (such as presence or absence of pits) are apparent, but have similar map colors to facilitate large scale comparisons. Thermophysical maps, because of the lower spatial resolution, have focused on the extent of discontinuous ejecta visible in thermal IR mosaics. Despite the significant differences between the two mapping strategies (including spatial resolution and sensitivity to surface vs. depth of the relevant datasets), the resulting map units are remarkably consistent. In crater floor and wall deposits, higher TIs are associated with expected locations of bedrock (e.g., wall, slumps, floor blocks) and coarse-grained (boulder-sized) talus. Lower TIs also correlate with areas such as low-slopes and topographic lows, where unconsolidated fine-grained materials (i.e., aeolian deposits) are expected to accumulate. Moderate TIs are on moderate to higher slopes where coarse unconsolidated deposits can accumulate below the angle of repose. Within crater floor units, pitted material deposits identified in morphologic maps as containing entrained megablocks are associated with areas of higher TI, suggesting some may represent areas of incipient uplift; such deposits illustrate the different sensitivities of the datasets, as visible reflectance is limited to the upper few microns of a surface, while thermal signatures are influenced by material properties down to the diurnal skin depth (cm to dm scale). Despite the tendency for low TI material to accumulate in crater floors, however, quantitative values suggest that mapped crater floors are not mantled by thick layers of dust, however, and the appearance of "dark" crater floors in thermal imagery may be the result of the association with "bright" crater walls rather than an indication of significant amounts of fine-grained material.

Morphologic and thermophysical variations associated with ejecta deposits suggest influence by different processes and target materials. Continuous ejecta deposits contain pitted material "ponding" in topographic lows within hummocky ejecta deposits, and are often associated with aeolian deposits that also preferentially occur in topographic lows (and are typically associated with lower TI values). Thermophysical variations are present throughout ejecta units (although this is partially due to the criteria used for mapping these units). The distinct margins of the continuous ejecta, however, correlate well with boundaries identified in morphologic maps. Within discontinuous ejecta, radial thermophysical contrasts can vary from crater to crater or even within this unit at a single crater. Some radial deposits consist of moderate TI material with cores of higher TI, possibly due to secondary craters and/or removal of lower TI material due to airblast. Portions of these deposits can have TI values over 500 MKS units, suggesting large blocks rather than fine grained material [14]. Other deposits exhibit low TI rays suggesting deposition of very fine material (dust/fine sand), especially when the target surface presents a a higher TI background.

Closing Remarks: We present ongoing work mapping some of the best-preserved Martian craters, beginning with examples near the transitional diameter for complex craters and expanding to those above and below this size. The ultimate goal of this study includes a new classification/description for craters that accounts for both age and preservation state, as it is clear that the two are not necessarily linked: young does not always equal "best-preserved", especially on active surfaces such as Mars.

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