THERMOPHYSICAL CHARACTERISTICS OF WELL-PRESERVED MARTIAN CRATERS NEAR THE TRANSITION DIAMETER. J. L. Piatek[1], I. Murphy[1], L. L. Tornabene[2], A. Bina[2], N. G. Barlow[3], G. R. Osinski[2,4], and S. J. Robbins[5], [1]Department of Geological Sciences, Central Connecticut State University, New Britain, CT (piatekjel@ccsu.edu) [2]Centre for Planetary Science & Exploration (CPSX) and Department of Earth Sciences, Western University, London, ON, [3]Department Physics and Astronomy, Northern Arizona University, Flagstaff, AZ, [4]Department of Physics & Astronomy, Western University, London, ON, [5]Southwest Research Institute, Boulder, CO.

Introduction: Determining the physical properties of craters and associated ejecta deposits provides a baseline for better understanding processes due to the initial impact and later modification. This work is part of an ongoing study to characterize Martian craters and ejecta in both visible and infrared datasets [1,2], currently focused on craters near the transition diameter (~4–8 km) that display features associated with well-preserved ejecta (*e.g.,* pitted material, sharp morphologies, thermophysical contrast, high depth/Diameter ratio). Mapping of the thermophysical properties of these craters is presented here: corresponding results from mapping of surface morphology in visible images are presented at this conference by [3].

Method: Analyses of the thermophysical properties of ejecta deposits were undertaken using maps of thermal units based on mosaics of quantitative thermal inertia. These mosaics are generated from nighttime thermal infrared images taken from the Thermal Emission Imaging System (THEMIS) instrument. Images acquired at local solar times between 2.0 and 5.0 are identified using JMARS [4] and undergo initial image correction routines via either the THMPROC interface [5] or a processing pipeline that utilizes Davinci and ISIS version 3 [6,7]. Temperatures are derived from radiance data using the normalized emissivity method [8,9]. Quantitative thermal inertia (TI) is derived using lookup tables from the model of [10], considering the solar longitude of Mars and the local solar time when the image was taken as well as the elevation and albedo of the surface. The dust opacity used to determine the TI for an image is varied so that overlapping images (taken at different times) have similar values and produce a more color-balanced mosaic.

Images for mapping are processed into ArcGIS and aligned (if necessary) to the orthorectified THEMIS day infrared images [11] if available, or to the MOLA gridded dataset if not. Thermophysical units are defined using polygons, where the unit contacts are based on a set of pre-defined characteristics (see Table 1). Units are defined using only the TI mosaic if possible, but may rely on information from the daytime IR image if contacts are not clear in the nighttime data.

Results: Comparisons between thermophysical maps for five craters (Table 2) suggest some consistent thermophysical expressions associated with these deposits, as well as some variations in their thermal character. The unique features of each crater may be related to target variability (particularly influences of surface topography) or impact energy, or to differences in either impact or modification processes at each location.

There are distinct thermophysical variations on the floors of each crater: though these often appear darker than ejecta deposits, floor units have similar ranges of quantitative thermal inertia values as the ejecta. The variations in floor TI values can often be correlated with slump/talus deposits in visible images, but may in some cases represent variations in subsurface materials associated with incipient central uplifts [2].

The criteria used to map thermally continuous ejecta includes a distinct thermophysical outer margin. This margin is not visible in TI at either Istok or Gasa craters (Figure 1), although the unit was mapped at Istok using daytime IR. For both, this is likely due to the influence of the topography of nearby larger craters (particularly at Gasa, which is located within a larger crater). At the remaining craters, the continuous ejecta has a clear thermophysical margin: an unnamed crater denoted as "Near Resen" has two distinct boundaries within the continuous ejecta, suggesting effects from multiple processes (Figure 2). At all craters, the continuous ejecta units extend ~1 crater radii from the mapped crater wall unit, with larger extents at Istok (~1.5 crater radii) and "Near Resen" (~3.5 radii).

Thermally discontinuous ejecta at all five craters include both high and low TI deposits (relative to the underlying surface), but the quantitative thermal inertia values are similar. These range from "low" TI values consistent with surface dust and "high" values with coarse sand or larger particle sizes [12], assuming size is the only contributing factor to TI variations within these deposits. The pattern of high and low TI is not the same at all craters, however. Both Istok and "Near Resen" craters have separable high TI inner and low TI outer thermally discontinuous ejecta units, while the discontinuous ejecta units at Noord and Gasa exhibit an inter-fingered mix of high and low TI radial variations rather than distinct inner vs. outer units. The discontinuous ejecta at Resen is uniformly of a higher TI than the background, with no apparent discontinuous ejecta that has a lower TI value. The mapped thermally discontinuous units extend out to at least 10 crater radii from the crater wall unit at all craters, with ejecta at Istok again having the maximum extent (~20 radii).

The topography of the original target surface appears to have influenced deposition and/or modification of ejecta at Gasa and Istok (noted above), but are most discernible at Noord. This crater lies just north of a series of higher hills and ridges, which have clearly influenced the deposition of ejecta to the south. The continuous ejecta margin correlates with the base of these hills, and low TI deposits associated with slopes that face the crater may represent material ballistically ejected by impact and intercepted by the topography.

Conclusions: The thermophysical properties of these well-preserved Martian craters and ejecta deposits have been mapped, and comparisons between maps yield similarities and differences that help illustrate the processes involved. The effect of target topography is evident in variations between ejecta deposits, although the general character is consistent between all mapped craters. Further work will expand crater maps to larger diameter craters, which may exhibit more complex deposits associated with larger impacts, in addition to correlation and comparison with surface morphologies mapped using visible imagery.

References: [1] Piatek, J.L. et al., 2016. *LPSC* 47, #2903. [2] Tornabene, L.L. et al., 2016. *LPSC* 47, #2879. [3] Bina, A. et al., 2017. *LPSC* 48, this conf. [4] http://jmars.mars.asu.edu [5] http://thmproc.mars.asu.edu [6] http://davinci.mars.asu.edu [7] http://isis.astrogeology.usgs.gov [8] Gillespie, A.R. 1985. *JPL Pub 86-38*, 29-44.[9] Realmuto, V.J, 1990. *JPL Pub. 90-55*, 23-27. [10] Putzig, N. and M. Mellon, 2007. *Icarus* 191, 68-94. [11] Edwards, C.S. et al., 2011. *JGR* 116, E10008, doi:10.1029/2010JE003755. [12] Pelkey, S.M. et al., 2001. *JGR* 106, 23909-23920.

Acknowledgments: This work is supported by NASA MDAP grant NNX15AM41G.

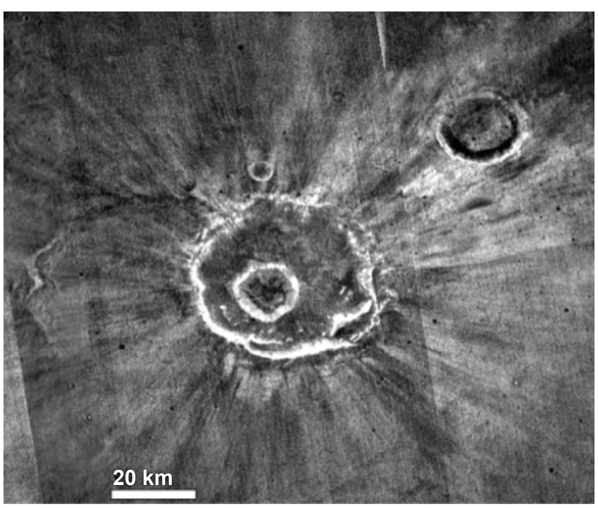

Figure 1: *TI mosaic of Gasa crater, illustrating the lack of a distinct thermally continuous ejecta unit and inter-fingered low/high TI discontinuous ejecta unit.*

Unit	Criteria for Mapping
Crater Floor	All "low" TI material interior to crater walls. May include small areas of higher TI slump materials.
Crater Walls	All "high" TI areas corresponding to 'circular' crater wall/rim materials.
Thermally Continuous Ejecta*	Adjacent to crater walls, outer contact ideally defined by a distinct thermophysical signature (otherwise estimated in daytime IR).
Thermally Discontinuous Ejecta*	Apparent extent of thermophysically distinct radial ejecta and airblast scouring (higher or lower TI).
Included Craters	Craters within ejecta units that have distinct thermophysical patterns but unlikely to be secondaries due to size.
Target Surface	All areas of the mosaic outside the defined discontinuous ejecta unit.

Table 1: *Criteria used to map thermophysical units. Starred units may be subdivided to include thermally distinct deposits that fulfill the same unit criteria.*

Crater	Coordinates	Diameter
Noord	19.27° S, 348.74° E	7.8 km
Resen	27.34° S, 108.9° E	7.6 km
Unnamed crater "Near Resen"	25.8° S, 115.67° E	7.5 km
Gasa	35.72° S, 129.41° E	7.2 km
Istok	45.1° S, 274.2° E	4.6 km

Table 2: *Mapped craters discussed in the text, with latitude/longitude coordinates and diameters.*

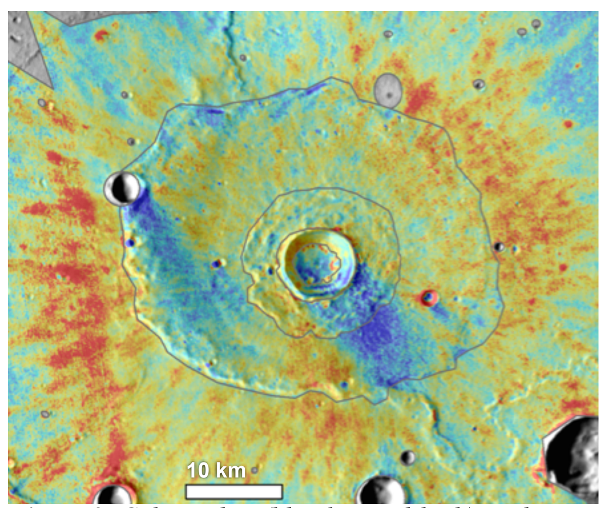

Figure 2: *Colorized TI (blue-low, red-high) on daytime IR for "Near Resen". Two continuous ejecta units and the inner part of the discontinuous unit are visible.*