THERMOPHYSICAL PROPERTIES OF LAYERED CRATER EJECTA DEPOSITS ON MARS. Jennifer L. Piatek[1], Ryker. T. Nolan[1], and Livio L. Tornabene[2] [1]Department of Physics and Earth Sciences, Central Connecticut State University, New Britain, CT 06050 (piatekjel@ccsu.edu), [2]Centre for Planetary Science & Exploration, Department of Earth Sciences, University of Western Ontario, 1151 Richmond Street, London, ON N6A 5B7

Introduction: The majority of fresh impact craters on Mars have continuous ejecta deposits that appear to have been emplaced as sheets of material, sometimes with multiple layers (e.g. [1,2]). These cohesive deposits often have clearly defined margins with distal topographic edges or ramparts. Layered ejecta are thought to form partly as the result of volatile interaction during the impact process - most likely from a subsurface reservoir (either ice or liquid) [3].

Examinations of the morphology of layered ejecta deposits in visible images suggests a complex emplacement process that may include deposition of material fluidized by volatile interaction, ballistic emplacement, and/or modification of the surface by airburst [4]. In some cases, initial cohesive ejecta layers appear to be modified by later stage high energy radial flows that extend beyond the inner layered deposits [5]. Based on a synthesis of terrestrial and planetary observations, the layered ejecta deposits, however, form after the initial ballistically emplaced ejecta and should lie on top of these radial deposits [6].

These differing processes should lead to variations of physical properties of surface materials, particularly those related to particle size and packing density. Changes in these physical properties should lead to variations in the thermal inertia of the surface, which can be identified using nighttime thermal infrared images from the Thermal Emission Imaging System (THEMIS) aboard Mars Odyssey. Thermophysical variations have been used previously to identify low thermal inertia crater rays and to examine the processes that form these features [7] and to examine debris flow processes on ice-related features (e.g. lobate debris aprons) [8], among other studies.

Method: Identification of craters with ejecta blankets that exhibit variations in nighttime brightness temperature was initially conducted using the Mars Crater Database, v1.0 [9] loaded into JMars [10]. THEMIS image processing was completed via the THMPROC web page interface [11], using the undrift/dewobble, rectify, deplaid, and unrectify options. These processing steps should calibrate the images and remove a significant portion of systematic instrument-induced variations. Brightness temperatures are derived from image radiance values using the normalized emissivity method [12,13].

Initial qualitative assessments of surface character were based solely on variations in brightness temperature. For more quantitative results, these temperatures are used along with image parameters such as time of day and solar longitude to predict a value of thermal inertia via a set of lookup tables generated from a thermal model for the surface of Mars [14]. Variations in thermal inertia of a surface are related to variations in the thermal properties of that material (i.e. composition) as well as the physical state (particle size, packing, and induration). Variations in these material parameters should reveal information about the mechanisms that formed and later modified these deposits. Verification of surface character is accomplished by examination of high resolution visible images from the High Resolution Imaging Science Experiment (HiRISE) and Context Camera (CTX) instruments on Mars Reconnaissance Orbiter: coverage from these datasets was also identified using JMars.

Initial Results: In most craters examined during the initial survey, low temperature materials appear to lie on top of the continuous layered ejecta deposits. These deposits appear dark in THEMIS nighttime images, representing a low thermal inertia material that is likely fine-grained, and they typically exhibit radial morphologies that suggest ballistic emplacement (see Figure 1). Clear evidence of flow-related processes are not identifiable in layered deposits, but some lobes exhibit thermophysical variations along the margins that may be related to emplacement processes - typically, ramparts have a higher thermal inertia than the interior of the deposit, which suggests coarser grained materials pushed to the edges of the deposit by flow (see example in Figure 2). Results are complicated, however, due to post-depositional modification of ejecta - ballistic facies are difficult to identify in thermal data at some craters, and this modification may be masking flow-related thermophysical variations within layered ejecta deposits. These modification processes are difficult to uniquely identify in thermophysical images, but evidence of this modification is clearly visible in HiRISE and CTX images, where the surfaces of layered crater ejecta appear mantled by later fine-grained deposits.

Conclusions: Although complicated by the influence of post-impact modification, initial results suggest that coupled thermal and high-resolution image studies of layered deposits will prove valuable for understanding ejecta emplacement and modification processes.

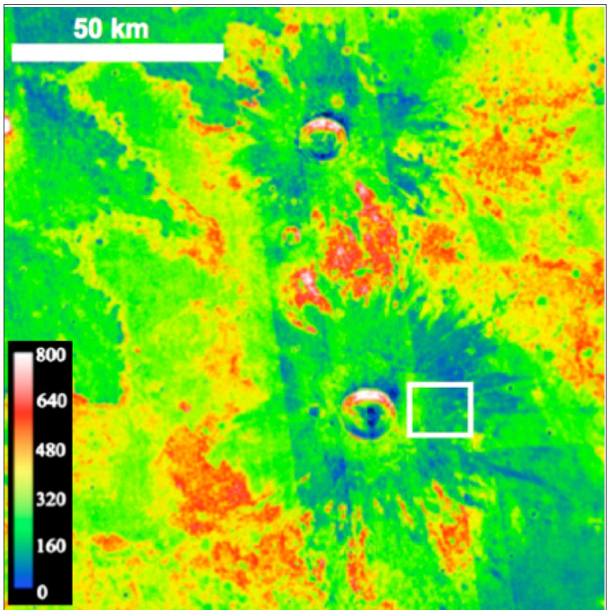

Figure 1a. A group of layered ejecta craters (324.3°E, 22.1°N) have low thermal inertia deposits consistent with ballistic ejecta - it is not clear, however, if the ballistic material lies on top of or underneath layered ejecta. (THEMIS-derived thermal inertia, MKS units)

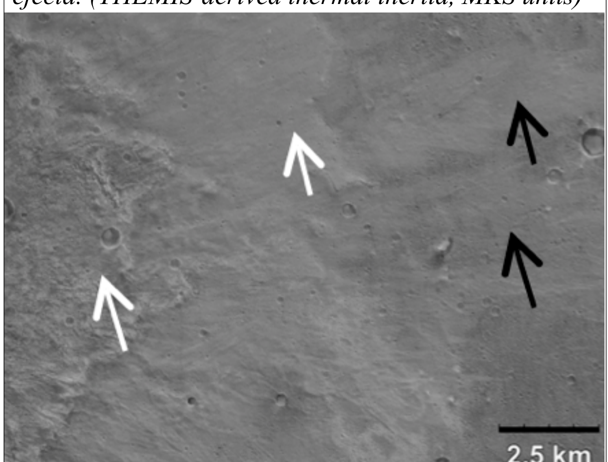

Figure 1b. Portion of CTX image P15_006848_2022_409 just east of the rim of Cave crater (inset on THEMIS image above), illustrating the relationship of the layered and ballistic ejecta deposits. Layered ejecta (white arrows) clearly overlies the ballistic ejecta (black arrows; remnant herringbone patterns discernible).

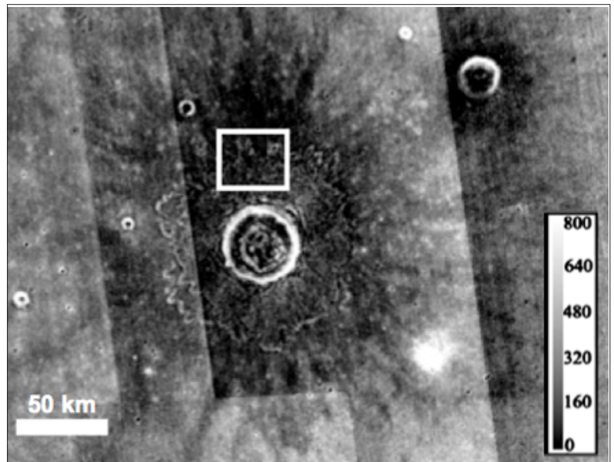

Figure 2a. Possible relationships between layered ejecta and ballistically emplaced material are observed in these craters (156.3°E, 16.8°N). Low thermal inertia material covers layered ejecta, but the higher thermal inertia at the edges of the layers is not obscured. This suggests that layered ejecta may lie on top of the ballistically emplaced material, but it is possible that the ballistic material is not thick enough to alter the thermophysical signature at the edges of the layered deposit. (THEMIS-derived TI, MKS units)

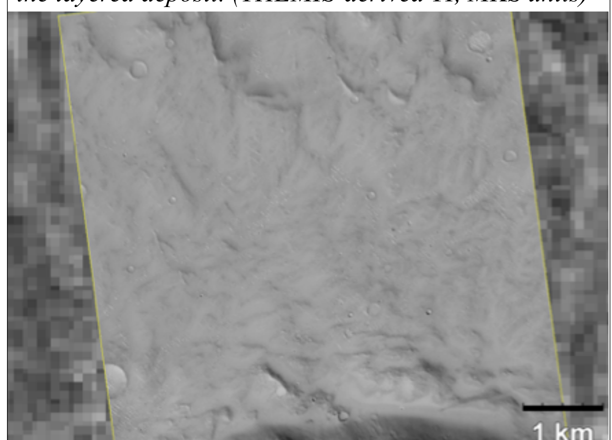

Figure 2b. Portion of HiRISE image ESP_022308_1970 over the layered ejecta crater in the thermal inertia image above (see inset). Topographic lows are mantled by a fine-grained deposit that does not reflect ballistic emplacement. The ejecta deposit has been modified, so the relationship between the ballistic and layered ejecta is no longer clear.

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