IN SEARCH OF PRISTINE MARTIAN IMPACT CRATER EJECTA DEPOSITS J. L. Piatek[1], L. L. Tornabene[2], and G. R. Osinski[2,3] [1]Dept. of Physics & Earth Sciences, Central Connecticut State Univ., New Britain, CT (piatekjel@ccsu.edu); [2]Centre for Planetary Science & Exploration, Dept. Earth Sciences, Univ. of Western Ontario, London, [3]Dept. Physics & Astronomy, Univ. of Western Ontario, London, ON N6A 5B7, Canada.

Introduction: The deposition of impact ejecta is one of the most common but also one of the least understood processes modifying the surfaces of planetary bodies. Ballistic emplacement of material ejected radially during the cratering event is generally accepted as source of material found in the ejecta blankets of craters on airless bodies like the Moon and Mercury [e.g. 1,2]. However, recent observations and theoretical models point out that ballistic emplacement does not account for the observable melt-bearing deposits emplaced as part of (atop) the ejecta [3]. Furthermore, many discernible crater ejecta deposits on Mars display additional morphologies that have been described as “fluidized” or “layered”. These deposits often appear cohesive with well-defined lobate margins, sometimes with distinct topographic relief [e.g. 4]. Ballistic emplacement alone is not sufficient to explain layered ejecta deposits either, which have been hypothesized to be the result of the interaction of the ejecta with volatiles within the pre-impact surface, the atmosphere, or both [e.g. 4-7].

It is difficult, however, to identify the mechanism(s) of emplacement without first separating the morphologies associated with ejecta deposition from those resulting from the varied surface processes that have and continue to modify the Martian surface. The first step in determining which ejecta morphologies result from emplacement and which are the result of modification is to identify the youngest and most well-preserved craters on Mars.

Methods: The youngest craters on a planetary surface are often identified by the presence of easily modified deposits such as crater rays and impact melt deposits [8,9]. Additional indicators such as a dearth of overprinting craters and a high depth-to-Diameter ratio (d/D) consistent with a lack of infilling can be used to further refine this classification [e.g. 10,11]. On Mars, the availability of nighttime thermal infrared data allows for further investigation: many young craters appear to preserve a thermophysical contrast between crater ejecta and the underlying surface. In addition, crater rays that are difficult to discern in visible datasets due to a lack of albedo contrast may be quite distinct in thermal infrared data due to differences in their thermophysical characteristics [12,13]. Our approach utilizes both visible and thermal infrared datasets, giving information about the surface at a range of scales (meter to decameter) and from both the surface and near-surface (down to a thermal skin depth).

Craters with morphologies and thermophysical contrasts consistent with least modified craters are identified in a crater database [14] via global images displayed in JMars [15], as well as those with high thermal contrasts observed in the THEMIS nighttime infrared images. Once identified as a candidate, the features of these craters can be studied in more detail through identification of thermophysical units in THEMIS-derived thermal inertia images, which are then examined in detailed with high resolution images.

Initial Results: Candidate “young” Martian craters, identified initially based on visible morphology(distinct crater relief indicating a lack of infill, possible presence of pitted materials, and a lack of overprinted craters) suggested two classes of ejecta deposits. One type appears to have well-preserved ejecta morphologies in visible images, but lacks the expected thermophysical contrasts (suggestive of modified ejecta), while the other type is thermophysically distinct but may appear to be modified in visible images. For this reason, it was necessary to consider both apparent crater relative age and amount of preservation when trying to classifiy the least-modified craters. This initial examination yielded a four part classification scheme that considers both relative crater age and preservation of ejecta deposits (see Table 1, with corresponding example images in Fig. 1). The “pristine” class (young crater with unmodified ejecta) is represented by Gratteri crater (Fig. 1a), which exhibits thermophysically contrasted crater rays and visible morphologies that suggest little modification. Visible images of Tooting crater (“modified” class, Fig. 1b) suggest the crater is relatively unmodified, as it contains deposits of pitted material that likely represent de-volatilized impact melt deposits [e.g. 16], but the ejecta deposits lack thermophysical contrast both within the deposits and with the underlying surface. The lower nighttime temperatures on the Tooting ejecta suggest modification has taken place, likely from thick deposits of dust.

Although lacking the visible morphologies generally considered associated with young craters, the ejecta deposits of “well-preserved” craters have clear thermophysical contrasts with the background (Kontum crater, Fig. 1c), but visible images show evidence of significant modification of these deposits. The final image pair (unnamed crater, Fig. 1d) illustrates a “degraded” crater with a visibly modified ejecta blanket that exhibits little/no apparent thermophysical contrast.

Future Work: Utilizing a synergistic approach that combines analyses of both visible and thermal datasets, we are continuing to refine classification of the youngest and freshest craters on Mars. The eventual goal is to examine in detail a set of young, pristine Martian craters to identify the characteristics of primary ejecta deposits prior to modification. These characteristics could be used to provide a critical baseline for understanding how ejecta is emplaced and what role volatiles may play in these processes.

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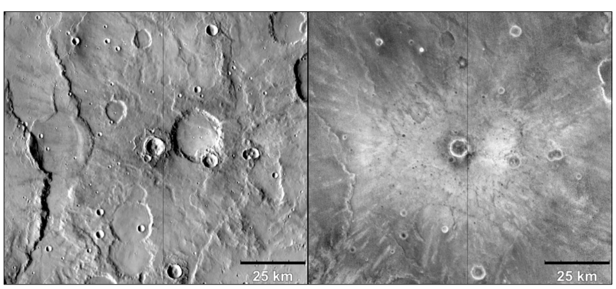
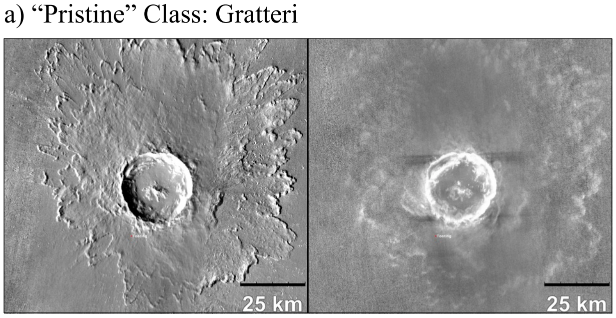
Table 1: *Preliminary age and preservation criteria.*

Preliminary Classification	Age/ Preservation	Attributes		
		Visible	Thermal Contrast	Morphometric
"Pristine"	Young/ Fresh	Few overprinting impacts No infill deposits Pitted materials	High	High d/D ratio Sharp crater features
"Modified"	Young/ Slightly Modified	Few overprinting impacts Some post-impact infill deposits pitted materials partially obscured/absent	Low to moderate	Moderate to low d/D
"Well-preserved"	Old/ Well-preserved	Moderate/High overprinting impacts Some fill deposits pitted materials not recognized	Low to high	Moderate to high d/D Sharp crater features
"Degraded"	Old/ Modified	Moderate/high overprinting impacts Post-impact infill deposits No pitted materials	Low to non-existent	Moderate to low d/D Muted crater features

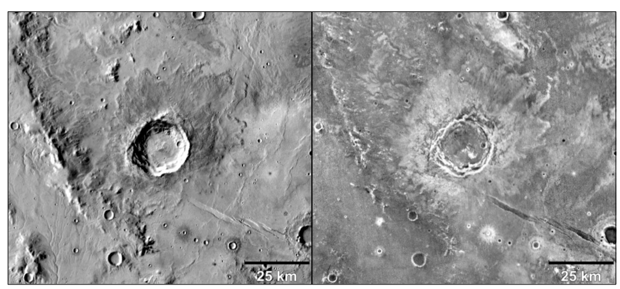
Figure 1. *THEMIS daytime (left) and nightime (right) TIR images of example craters in each age/preservation class.*



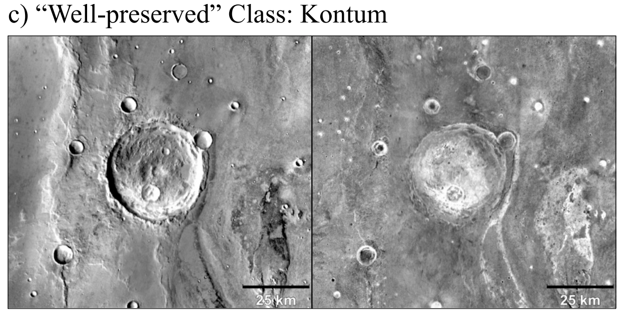
a) "Pristine" Class: Gratteri



b) "Young/Modified" Class: Tooting



c) "Well-preserved" Class: Kontum



d) "Degraded" Class: unnamed crater, Chryse Planitia