EVIDENCE FOR TWO FUNDAMENTAL TYPES OF LAYERED EJECTA CRATERS ON MARS AND PROPOSED NOMENCLATURE SYSTEM

Nadine G. Barlow[1], Joseph M. Boyce[2], and Peter J. Mouginis-Mark[2]
[1]Dept. Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010
[2]Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI 96822

Introduction

We propose a modification to the current Mars impact crater nomenclature system [1] to account for observed differences in crater ejecta morphology. We also present morphometric evidence to support this proposal because it is the most objective and easiest to apply as a criterion for identification of morphologic types.

Most fresh Martian impact craters larger than ~3-km-diameter (D) are surrounded by a layered ejecta deposit consisting of one (single layer ejecta, SLE), two (double layer ejecta, DLE), or more than two (multiple layer ejecta, MLE) layers [1] (Fig. 1). While all SLE, DLE, and MLE craters display many similar characteristics, there are notable and important exceptions (e.g., Fig, 2) that likely provide information about emplacement processes. Recently we have suggested that there are at least two morphologic types of DLE craters (i.e., DLE Type 1 and DLE Type 2) [2-5] (Table 1). Some MLE craters display the same characteristics as the DLE Type 1 craters. Herein we will refe to the SLE, DLE Type 2, and MLE Type 2 craters as “SDM craters”, while DLE Type 1 and MLE Type 1 craters will be called “Type 1 craters”.

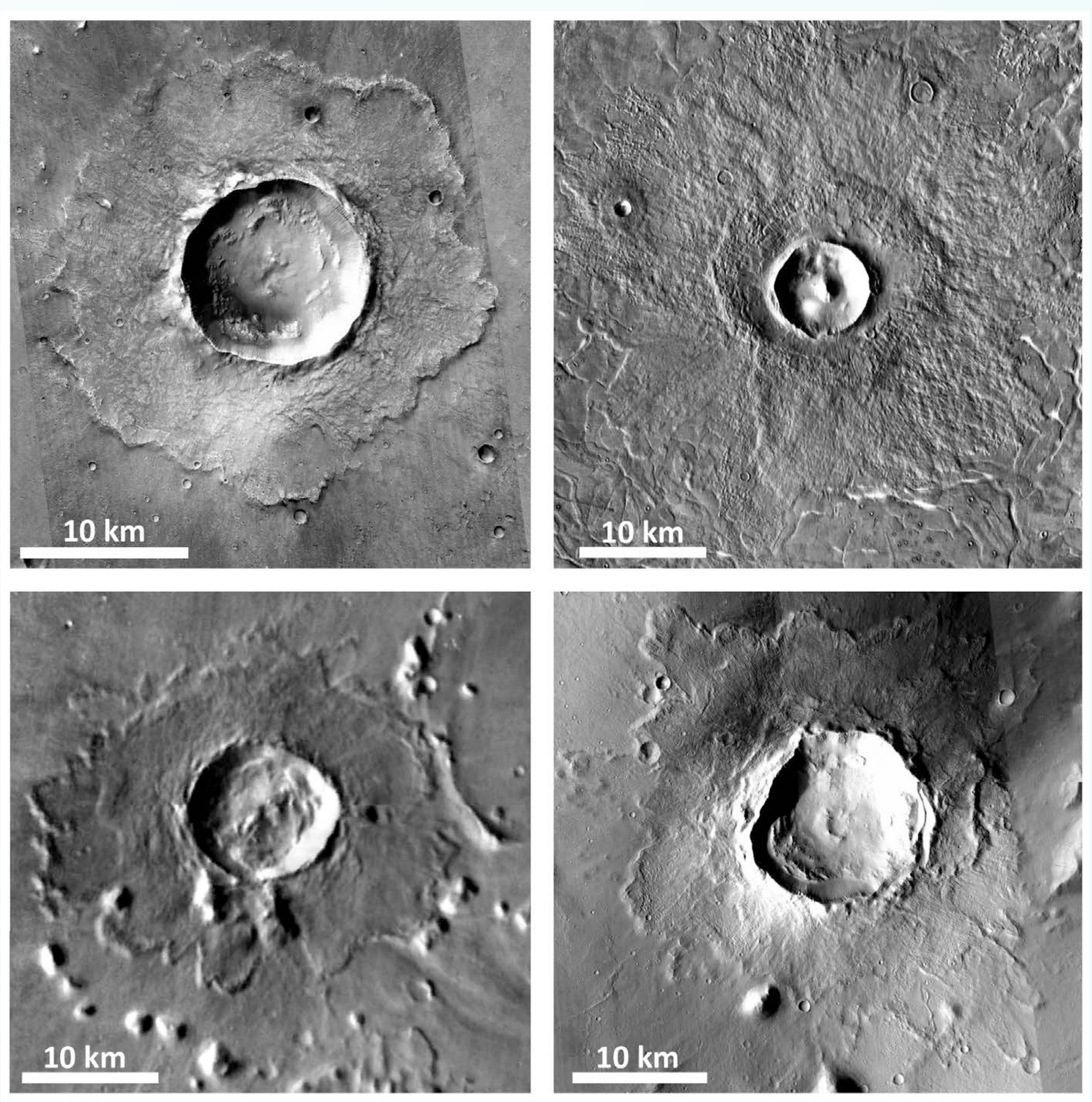


Figure 1: Top Left: 11.9-km-D Pansk crater (20.62° 318.88°E) displays a single layer ejecta (SLE) morphology. (CTX mosaic) Top Right: This 19.5-km-D crater (38.53°N 99.28°E) displays a Type 1 double layer ejecta morphology (DLE Type 1). (THEMIS day IR mosaic) Bottom Left: 11.0-km-D Nutak crater (17.42°N 329.74°E) is an example of a Type 2 DLE crater. (THEMIS day IR mosaic) Bottom Right: This 13.1-km-D crater (9.24°N 182.74°E) displays a multiple layer ejecta (MLE) pattern. (CTX mosaic).

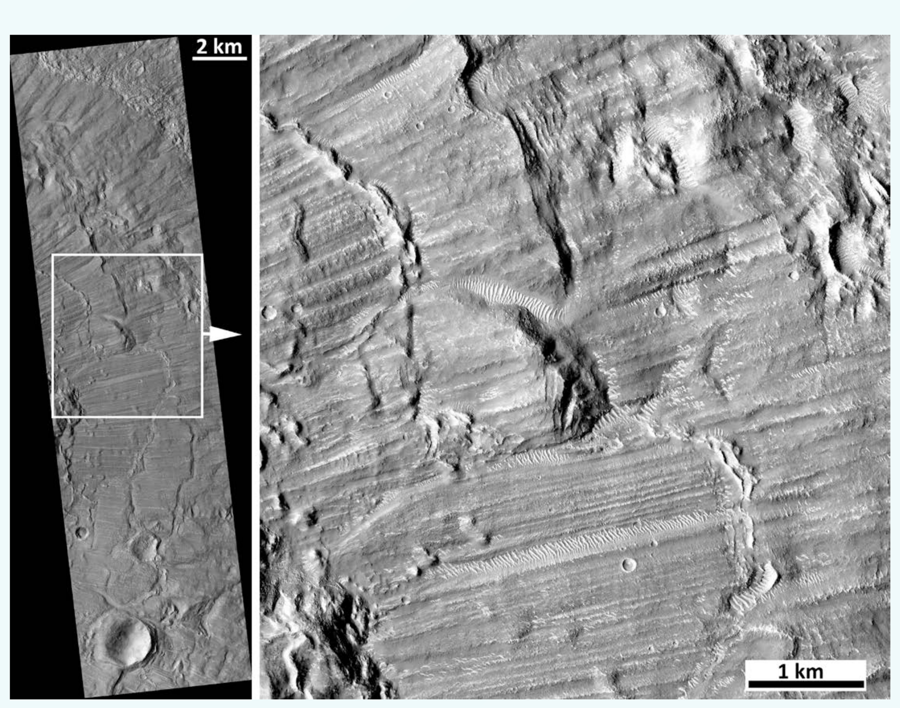


Figure 2: Radial grooves transect most fresh ejecta deposits but the characteristics of these grooves are different between SDM and Type 1 craters. The grooves crossing the inner ejecta layer of Type 1 crater Bacolor are shown. (HiRISE image PSP_009044_2135)

Distinguishing Characteristics

	SDM Craters	Type 1 Craters
Layers (Fig. 1)	Thin sinuous lobate deposits	Thicker ~circular inner layer; thin sinuous outer layer.
Topography (Fig. 3)	No moat	Moat immediately exterior to crater rim
Rampart Width (Fig. 4)	Narrow for all layers. Similar rampart width layer to layer. Width increases slightly as D increases.	Inner layer terminates in broad rampart. Outer layer rampart is narrower than inner, but broader than for SDM craters.
Radial Grooves (Fig. 2, 5)	Width of radial grooves ~constant with distance from rim. Slight increase in groove width as D increases. Morphologically similar to grooves on landslides.	Groove width increases with distance from rim. Groove width increases as D increases, but at a different rate than for grooves on SDM craters. Transect pre-existing obstacles.
Other		Outer layer has a distinct surface morphology of radial sinuous grooves and ridges which typically cure around obtacles.

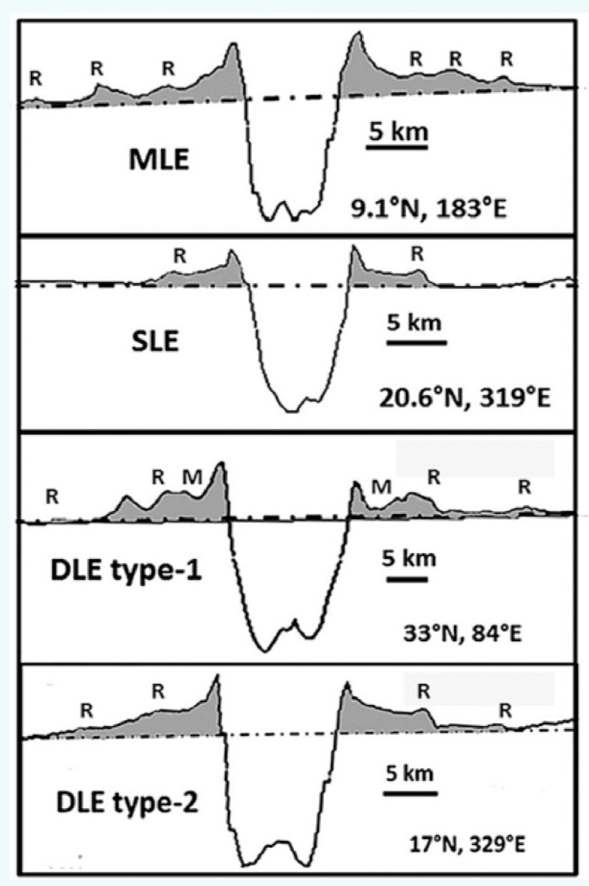


Figure 3: Topographic profiles across example crater morphology types. Broader rampart widths and the presence of a topographically-depressed moat exterior to the rim are distinguishing features of Type 1 craters.

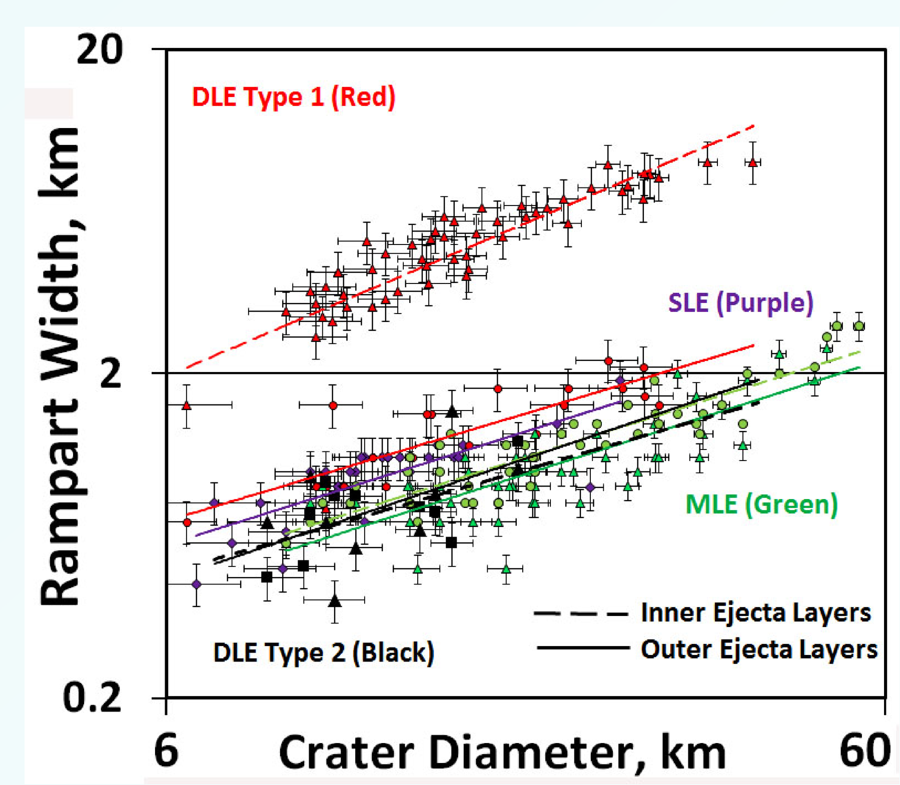


Figure 4: Rampart width as a function of crater diameter. Rampart widths for SDM craters display similar relationships. The rampart terminating the inner ejecta layer of DLE Type 1 craters is much broader. (Log-Log plot)

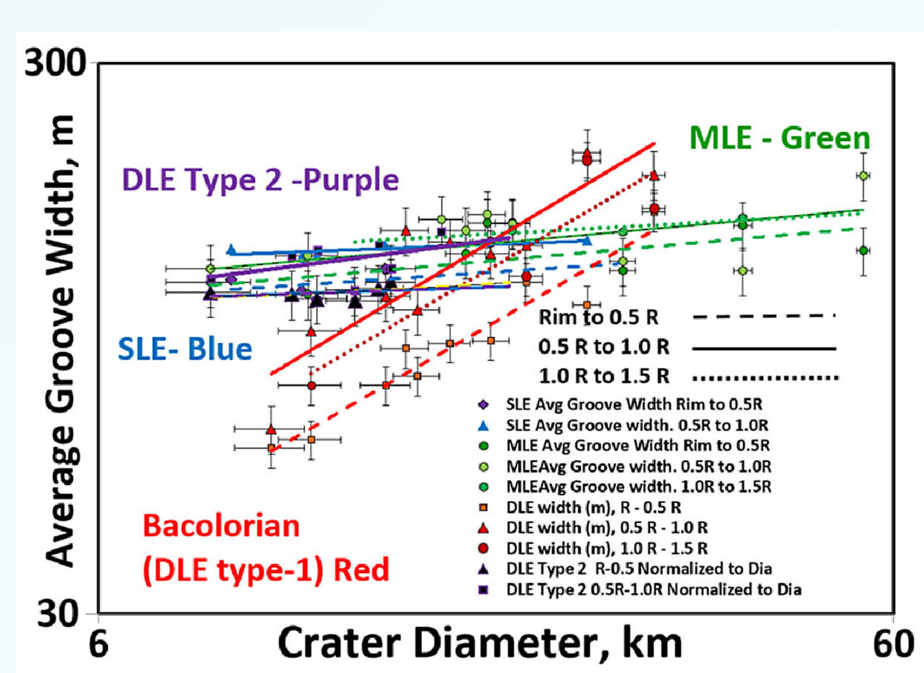


Figure 5: Groove width as a function of distance from the rim and crater diameter. SDM craters display similar groove width patterns while DLE Type 1 craters are statistically different. (Log-Log plot)

Revised Nomenclature Proposal

Evidence points to the presence of two major and distinct types of layered ejecta types not accounted for in the current nomenclature system. We believe their presence warrants an update to the current nomenclature system. For example, Type 2 DLE craters appear to be simply a transitional morphology between one and multiple ejecta layers but formed by the same process [e.g., 8]. The similarities in the general characteristics of Type 2 DLE craters with SLE and MLE craters indicate that they are well described by the current nomenclature system [1]. We propose that Type 2 DLE craters simply be called DLE craters. Based on the morphologic and morphometric evidence summarized here, the Type 1 (DLE and MLE) craters form a separate class which we suggest be named in a manner similar to that used by volcanologists for volcanoes with different eruptive styles; i.e., after a type example crater. We propose the name “Bacolorian DLE craters” for this class, after the 21.2-km-diameter Bacolor crater (33.0°N 118.6°E) which clearly displays the typical Type 1 crater characteristics and which has been well-studied by a number of researchers (Fig. 2, 6). The suffix “ian” seems appropriate since it literally means “of the same group” or “similar to”.

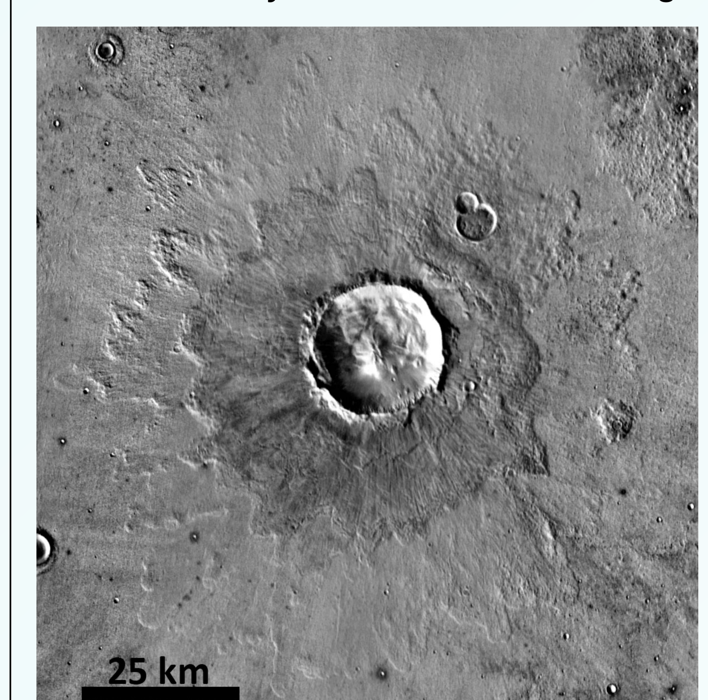
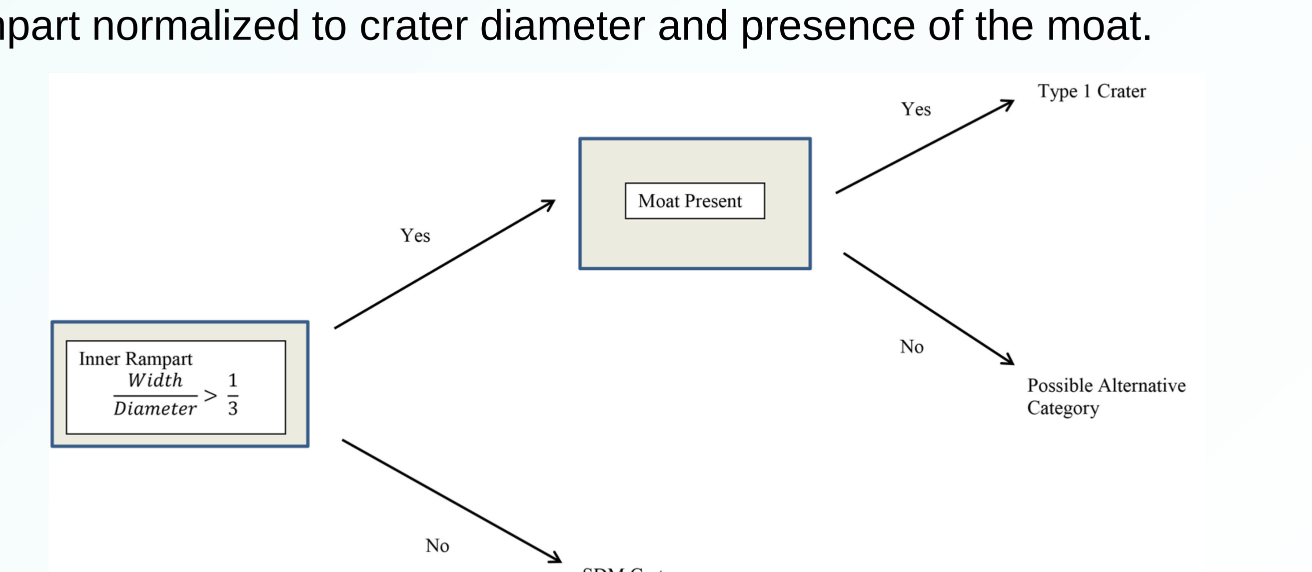


Figure 6: The 21.2 km diameter Bacolor crater (33.0ºN, 118.6ºE) displays the characteristics of the Type 1 craters and is proposed here to serve as the type example of this crater class. (THEMIS day IR mosaic)

Decision Tree

To facilitate classification of DLE and MLE craters into DLE, MLE, or Bacolorian craters, we propose developing a decision tree of easily measured morphometric quantities. This method also will allow determination of whether more than two types of DLE and MLE craters exist. At a minimum, the decision tree will include width of inner ejecta rampart normalized to crater diameter and presence of the moat.



A DLE or MLE crater displaying a broad inner ejecta rampart and a moat (and on fresh craters the presence of curvilinear texture on the outer ejecta layer) would be classified as a Bacolorian DLE or MLE crater. One displaying a narrow inner ejecta rampart, no moat, and no curvilinear texture on a fresh outer ejecta deposit would be classified as a DLE or MLE crater without additional descriptors. Detailed analyses of Bacolorian craters will provide insights into whether they form by a similar process as SDM but with different target characteristics or if they form in a completely different manner.

References

[1] Barlow N. G., et al. (2000) *JGR, 105*, 26733-26738. [2] Barlow N. G. (2015) *46th LPSC*, Abstract #2216. [3] Barlow N. G. (2015) *GSA SP 518*, 31-63. [4] Boyce J. M. et al. (2015) *6th Planet. Crater Consortium Mtg*, Abstract #1507. [5] Boyce J. M. et al. (2016) *47th LPSC*, Abstract #1327.