A NEW ANALYSIS OF RAMPART CRATER EJECTA THICKNESS PROFILES ON MARS. A. L. Damptz[1], L. S. Glaze[2], and S. M. Baloga[3], [1]Dept. of Earth and Environmental Sciences, University of Illinois at Chicago, 845 W. Taylor St., Chicago, IL 60607 (adampt2@uic.edu), [2]Planetary Geodynamics Laboratory, Code 698, NASA GSFC, Greenbelt, MD, 20771 (lori.s.glaze@nasa.gov), [3]Proxemy Research, Gaithersburg, MD, 20882 (steve@proxemy.com).

Introduction: Martian impact craters typically possess distinct layered ejecta blankets, consisting of one or more layers of material emplaced by fluidization processes that differ from those found on other planetary surfaces. The various morphologies identified have been categorized into three groups: single layered ejecta (SLE), double layered ejecta (DLE), or multiple layered ejecta (MLE) [1]. Rampart craters further classify SLE, DLE, and MLE morphologies describing those layered ejecta patterns that are terminated in a distal ridge. Morphologic studies suggest that the emplacement of layered deposits resemble a ground hugging flow that can be described as a continuum fluid emanating from the rim of the crater and flowing over the surface [2, 3].

We provide a data set that quantitatively characterizes rampart crater deposits through measurements of, 1) crater radius and rampart runout distance, 2) rampart plan form ("lobateness"), and 3) radial rampart thickness profile. This data compilation will guide theoretical and numerical modeling to further understand the emplacement of impact crater ejecta and the presence of water in target materials.

Figure 1. Double layer ejecta rampart crater (17.998°N, 289.251°E).

Region of study: The area of focus is in the Lunae Planum region, latitudinal band 30°N to 10°S and longitudinal band 280°E to 320°E. A previous study evaluated the crater diameter and measured the lobe number of distal ejecta for twenty-nine fresh craters on Lunae Planum [4]. Approximately thirty-five fresh rampart craters of different ages and target properties have been analyzed for this study expanding on Barnouin-Jha's previous work to include rampart profiles and additional craters located in the general area suitable for detailed morphometric analysis. Key data sets used in this study include the THEMIS daytime infrared global mosaic, Mars Orbiter Laser Altimeter (MOLA) DEM, and Mars Orbiter Camera (MOC) images.

Crater Radius and Rampart Runout Distance: Crater radius and runout distance provide important constraints on theoretical and numerical models of ground hugging flow. The crater radius is the primary indicator of the energy involved in an impact event while the ejecta runout distance is the basic quantity that indicates how the initial momentum of the flow was dissipated. The THEMIS daytime infrared global mosaic was the principal imagery used to determine the crater radius and runout distance. Any available high resolution MOC images were used to document the types of surface morphologies observed at each crater.

Using the commercially available geospatial image software, ENVI, 32 transects of each crater were used to derive the average diameter of each crater and ejecta runout distance, extending from the crater wall to rampart front. All dimensions are consistent with [4] for those craters observed in both studies.

Rampart Plan Form: The azimuthal structure of rampart craters is often referred to as "sinuosity", "ejecta mobility", or "lobateness" [5, 6]. The existence of lobate structures and quasi-periodicities at the deposit margins provides an important constraint for determining the admissible physical processes that terminated flow advance [2, 3, 7]. Consequently, measurements of these features could help us 'work backward' to constrain the nature of the processes that formed them.

There are a variety of approaches to characterizing the rampart plan form variability. One approach is to count the number of "lobes" around the rampart margin [4]. Alternatively, a more quantitative measure called "lobateness", has been used [8]. The Kargel lobateness measure [8] compares the linear distance along the rampart margin with the circumference of a circle with an effective radius defined by the plan form area of the crater and rampart deposit.

For this study, we fit the ejecta deposit with an ellipse rather than a circle. The analogous statistic is simply the ratio of the linear distance along the rampart margin to the perimeter of the ellipse:

$$\Gamma = \frac{P_{ejecta}}{P_{ellipse}}$$

Radial Rampart Thickness Profile: Thickness profiles, and the shape of the flow front, provide the primary information required to constrain rheologic properties of continuum flow. Further, the details of the topography are necessary to differentiate the mechanisms that cause one type of crater to form versus another (i.e., SLE vs MLE). This information is a critical measurement for determining the physics of how the flow finally came to rest [3, 4]. It also provides direct information regarding the complexity of the surface.

The primary data set used to determine rampart slope was the MOLA gridded data. Eight radial transects were taken in order to derive the average thickness and shape of the ejecta deposit at each crater. The rampart front is often masked by the surrounding topography. Thus, each radial transect extended beyond the rampart front to capture the ejecta surrounding the crater and any pre-existing topography within close proximity. To quantify the shape of the flow font from the MOLA data, the elevation as a function of distance, extending from the crater rim outwards was plotted. Runout distances collected from the THEMIS data were used to estimate the location of the flow front in the MOLA data. The rampart slope and front slope were calculated from each profile, as illustrated in Figure 2, and averaged. In some cases, not all profiles were utilized in the estimation of average slopes due to a greater degree of variability in the topography.

Results: Compiled dimensions and associated uncertainties are shown in Table 1.

Discussion: As expected, ejecta runout distance is strongly correlated with crater diameter indicating that more impact energy results in longer flows. Interestingly, a correlation is also evident between lobateness and crater diameter. This result is consistent with intui-

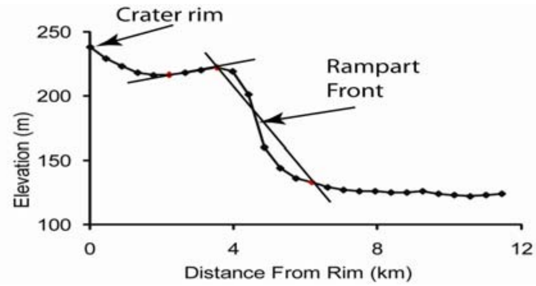

Figure 2. Example topographic profile for crater shown in Figure 1. Red markers indicate endpoints for estimating slopes of the rampart (left) and rampart front (right).

tion and implies that as impact energy increases (and thus ejecta runout distance), the instabilities that occur in radial flow also being to have a more substantial influence on the final planform. Conversely, the slopes associated with the ramparts themselves do not appear to show any statistically significant correlation with the impact energy (and hence the runout distance). This may imply that the size and shapes of the ramparts are more closely associated with the rehology of the flowing material, and perhaps are influenced by the composition of the impact target material. This may have implications for the presence or absence of water. Future modeling efforts will focus on the dynamic conditions required to generate rampart shapes constrained by the measurements in Table 1. Emphasis will be placed on the rehology of the flowing material and whether or not water was involved.

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Table 1. Example dimensions and statistics for several rampart craters in Lunae Planum.

North Latitude	East Longitude	Crater Diameter, km	Average runout distance [a], km	Lobateness	Average rampart slope[b], deg	Average rampart front slope[b], deg
11.321	300.929	6.6 ± 0.1	3.4 ± 0.1	1.49	1.23 ± 0.4	-1.98 ± 0.3
4.686	288.523	6.8 ± 0.1	6.6 ± 0.1	1.72	0.77 ± 0.2	-1.85 ± 0.3
18.589	293.041	10.3 ± 0.1	6.3 ± 0.2	1.65	1.00 ± 0.2	-1.86 ± 0.2
17.998	289.251	10.3 ± 0.2	7.4 ± 0.3	1.94	1.50 ± 1.5	-1.35 ± 1.4
6.884	297.48	12.2 ± 0.1	10.2 ± 0.4	1.86	1.12 ± 0.3	-1.87 ± 0.5
16.397	294.629	13.8 ± 0.0	9.1 ± 0.2	1.67	1.47 ± 0.3	-2.18 ± 0.2
-6.037	294.167	15.0 ± 0.4	10.9 ± 0.5	1.92	0.55 ± 0.2	-1.07 ± 0.1
6.814	296.505	16.9 ± 0.2	15.8 ± 0.5	2.43	1.25 ± 0.5	-0.90 ± 0.2

[a]Average runout distance is the distance from the crater rim to the rampart front.
[b]Not all profiles are used to calculate average.