VOLUMETRIC ANALYSIS OF MARTIAN RAMPART CRATERS. E. S. Ackerman, Bates College, Lewiston, Maine, 04240 (eackerma@bates.edu).

Summary: The Mars Orbital Laser Altimeter (MOLA) 128 pixels/degree global topographic data set [1], in combination with Mars Orbital Camera (MOC) images and Viking 256 pixels/degree rectified Mars digital image model (MDIMs) [2], provide resolutions high enough to measure Martian rampart craters in detail sufficient to perform volumetric analysis on both the crater cavity and the ejecta blanket. Comparing ejecta volume to crater cavity volume may indicate whether there is a volatile component being added to the ejecta flow.

Background: The morphology of the ejecta blankets surrounding many Martian impact craters exhibits a lobate structure, with pronounced distal ridges bordering the ejecta facies. These craters have been termed rampart craters. The specific process which emplaces this type of ejecta is uncertain, but it may be some combination of a subsurface volatile component [3] and the low atmospheric pressure on Mars [4]. Craters can provide a valuable tool to determine surface and subsurface properties, but the mechanics of their formation must first be understood. The purpose of this investigation is to use ejecta volumes in comparison with estimated transient cavity volumes to determine whether a volatile component is present during ejecta emplacement.

Methodology: The ~110 craters selected for measurement include all of the craters with sufficient MOLA resolution exhibiting rampart characteristics located on the ridged plains geologic unit [5] of Lunae Planum, in an area ranging from approximately -30° to 30° latitude and 45° to 90° east planetocentric longitude, comprising Viking quads MC-10 and MC-18. This area was selected because of its relative flatness and smoothness, wide latitudinal coverage, and the presence of ridges intersecting rampart ejecta blankets, offering a method of verification of ejecta thicknesses. An example crater is shown in Figure 1.

The system used for volumetric measurement involved several different software packages, which were combined to make the most consistent and efficient measurements possible. Craters in the field area were identified for measurement on Viking MDIMs (Figure 1). For each crater, an Excel worksheet was used to help automate the volume calculation process. A digital elevation model (DEM) was created from MOLA mission experiment gridded data records (MEGDRs), as shown in Figure 2. For each crater studied, two profiles were taken from the DEM, one through the northern area of the ejecta blanket, and one through the southern area. North and south profiles were used because the MOLA profiles from which the global MEGDRs were interpolated run in strips from north to south, and only actual MOLA tracks, not global MEGDR interpolations, were measured in order to maximize accuracy.

Figure 1: Viking 256 pixels/degree MDIM of a rampart crater at 16.39° N 65.38° E. Crater diameter is approximately 14 km. Note ridges overlain by ejecta blanket.

Figure 2: MOLA 128 pixels/degree MEDGR image of the crater in Figure 1. Color is elevation based; vertical resolution is exaggerated 6x. Note low resolution interpolated area on lefthand side of rim.
The extracted profiles of each crater were separated into three distinct sections: rim, ejecta blanket, and rampart. These sections are shown in Figure 3. The rim section was defined as the distance from the point at which the interior of the crater intersects the pre-impact surface to 1/5 of the crater radius outwards. The rampart section was defined as the distance from beginning of the upslope section at the edge of the ejecta blanket to the end of the downslope section. The ejecta blanket was defined as the distance between the end of the rim and the beginning of the rampart. These parameters were adjustable, and were altered to best fit each profile. Crater rim perimeter, ejecta rampart perimeter and ejecta area were calculated using Viking 256 pixels/degree MDIMs and the ImageJ image processing program. Total ejecta volume was calculated by adding the cross sectional area of the rim multiplied by the crater rim perimeter to the cross sectional area of the rampart multiplied by the rampart perimeter to the average ejecta thickness multiplied by the ejecta area. The crater cavity was measured using the GRIDVIEW gridded topographic data analysis program [6].

Results and Preliminary Analysis: Before final analysis, the data will be corrected to account for differences between the measured crater cavity volume and the transient crater volume, in order to better reflect the total amount of material which was ejected from the crater. Fallback ejecta will also be accounted for. The ejecta volumes will be corrected for ejecta bulking due to fragmentation. Based on these corrections, it will be possible to use the transient cavity volume to ejecta volume ratio to estimate how much, if any, volatile content would be required to create the observed ejecta volume. In addition to determining the role that volatiles play in the formation of rampart craters, an estimate of subsurface volatile content is important for the understanding of many other Martian surface properties, such as groundwater table depth and evolution.

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