POST-EMPLACEMENT DEFLATION OF MARTIAN LAYERED EJECTA FROM THE FLOW BODY THICKNESS/RAMPART THICKNESS RATIO: CONCEPT STUDY AND PRELIMINARY FINDINGS. Joseph M. Boyce and Peter Mouginis-Mark, Hawaii Institute Geophysics and Planetology, University of Hawaii, Honolulu, HI 96822 (jboyce@higp.hawaii.edu).

Introduction: We suggest that the morphometry of the ramparts ridges at the distal edges of ejecta layers around impact crater potentially can provide valuable insight into the presences and amount of water in Martian ejecta. We present morphometric data for 20 craters ~6 – 45 km in diameter, and compare rampart height to comparable features seen on dry landslides.

Background: Ramparts ridges commonly develop at the leading edge of Martian ejecta layers as well as other poly-dispersive geophysical granular flows such as landslides and debris flows [1 - 9]. Such ramparts can form at the leading edge of dry or water-rich granular flows [10 - 17]. In poly-dispersive debris ramparts are typically the result of particle segregation processes that produce accumulation of coarse particles at the flow's leading edge [5 - 7, 10 - 17]. Under certain circumstances [17] they can form in dry mono-dispersive flows, but are much broader than those on multi-dispersive flows (Fig. 1a). This concentration of coarse grains forms a high friction barrier that is pushed along by the flow and tends to slow the flows progress [5, 10 - 17]. During emplacement, the thickness of the flows immediately behind these ramparts is typically about the same height as the rampart because the slopes of the ramparts are composed of cohesionless grains that readily collapses (i.e., avalanche) as they are pushed along [17].

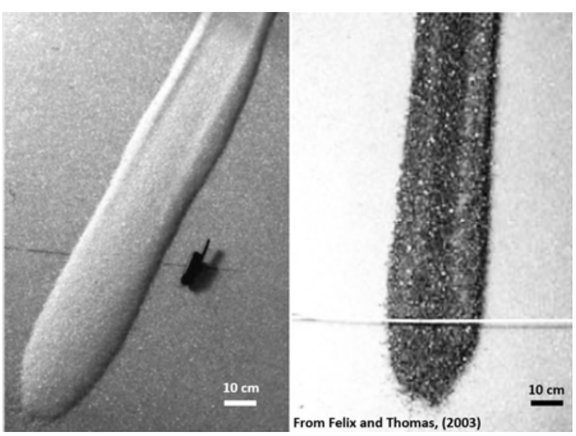

Figure 1. Dry granular flow experiments from [17]. On the left, a broad rampart on the distal end of the flow composed of mono-dispersive particles. On the right, a narrower distal rampart on a flow composed of poly-dispersive particles. Each flow is ~ 20 cm across. Note levees on the flanks of the flows.

Whether the flows are wet or dry can have a substantial effect on their geometry, and so offers the potential for further understanding Martian impact crater ejecta emplacement. If the flow is dry, then the flow material immediately behind the rampart will remain nearly the same thickness as during flow, i.e., nearly the same thickness as the rampart. The main difference in height will mostly be from differential compaction caused by grain size differences. However, this is not the case for flows containing substantial water. In these flows water adds to the volume and when the flows come to a halt, water leaks out causing deflation proportional to the volume of water they contain. However, observational and experimental evidence suggests that the distal rampart ridges of water-rich, granular flows (e.g., debris flows) are nearly dry during their emplacement, and hence show little post-flow deflation [12]. As a result, in such flows, the post-flow difference between the thickness of their ramparts (h_r) and the thickness of the flow body immediately behind it (h_f) is a measure of post-emplacement deflation of the flow body. We suggest that the only reasonable cause of such deflation is water loss.

Data: Average h_f/h_r ratio of test subjects: We investigate this concept for Martian craters by measuring (using MOLA PDER data, and CTX-derived DEMs) the thickness (in an average of 5 places) of the outermost ramparts (h_r), and the thickness of flow bodies (h_f) immediately behind them on six single layer ejecta [SLE], four double layer ejecta (DLE) Type 1, and ten multilayer ejecta craters [MLE] to obtain the average ratio of h_f/h_r for each crater (Fig. 2). In addition, the rampart at the distal edges of a long-runout Martian landslide (8°S, 315°E) in Valles Marineris was measured. For such measurements to provide useful information, they must also be placed in the context of a completely dry flow where deflation from withdrawal of fluid has not occurred. We propose that the best example for this purpose is the Tsiolkovskiy landslide on the Moon. The h_f/h_r ratio for Tsiolkovskiy is ~ 0.75 (based on LOLA data in 5 places). This value is <1.0 and is likely mostly the result of differential compaction of the finer material behind the rampart compared with the coarse material in the rampart [17].

<u>Results</u>: The average h_f/h_r ratio of the layered ejecta of craters mentioned above are plotted in Fig. 3. This plots shows that all h_f/h_r ratio values are well below the value for dry flows, with the average h_f/h_r ratio all types of layered ejecta craters is ~ 0.29 (ranging by ± 0.17). However, we have found that there is a considerable range in h_f/h_r ratio values along each rampart (Fig. 3), but have not yet collected sufficient data to determine if there are significant differences from crater type to crater type.

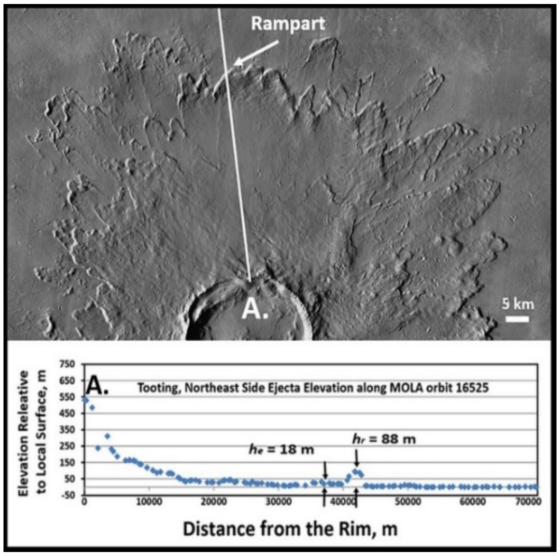

Figure 2. Example of measurement of ramparts on MLE crater, Tooting crater (~ 29 km dia.), on Mars.

The h_f/h_r ratio for a sample landslide in Valles Marineris (8ºS, 315ºE) was determined to be ~0.80, approximately the same as the rampart of Tsiolkovskiy (Fig. 4). This suggests little deflation, and hence, likely little water in the slide, consistent with the conclusions of [18 – 20].

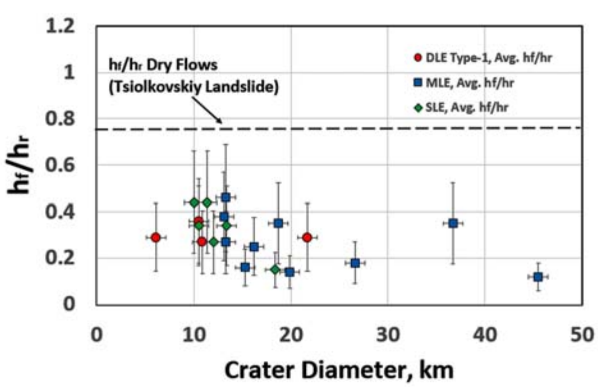

Figure 3. The ratio of the thickness of flow bodies (h_f) immediately behind the ramparts on the test craters to the thickness of their outermost ramparts (h_r). The error bars are the standard deviation of the average measurement values for each rampart and ejecta thickness indicating considerable variation in these values along ramparts.

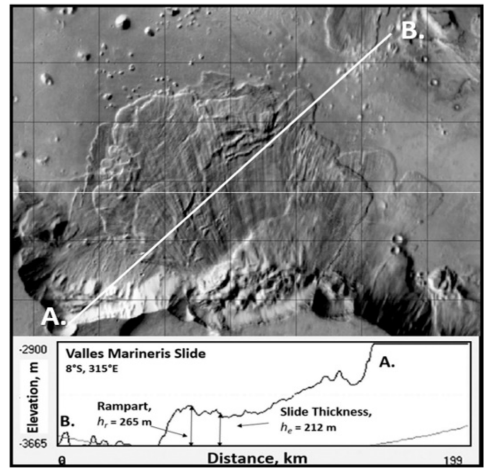

Figure 4. Example rampart on distal edge of a long run-out landslide in Valles Marineris (8ºS, 315ºE). Images is from THEMIS Day time IR mosaic, elevation data is MOLA.

Conclusions: If the deflation model applies to Martian ejecta ramparts, then our measurements suggest that the outermost ejecta layer of Martian layered ejecta deflated an average of >50% compared with completely dry poly-dispersive flows (i.e., the Tsiolkovskiy landslide on the Moon). Assuming that the deflation is entirely due to water loss, then as much as half of the original volume of the outer ejecta layers of craters was water [13 - 15]. Furthermore, our measurements suggest that the materials of some large landslides in Valles Marineris were dry, in agreement with [19].

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