Implications of the Rampart Craters on Ganymede to the Mechanism for Emplacement of Fluidized Ejecta:

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Introduction: The controversy of the mechanism for Martian impact crater ejecta fluidization is centered around the affects of volatiles in the target materials, the atmosphere, or some combination of both (e.g., 1-10). Even with the recent acquisition of higher quality Mars data, this issue is still vigorously debated with little evidence identified that conclusively supports any position. Ganymede may provide some tantalizing insight. Though it lacks an atmosphere, Ganymede has substantial volatiles in its crustal materials. Previous investigators have identified pedestal craters on Ganymede [both single layer ejecta (SLE) and double-layer ejecta (DLE) craters] and have attributed the morphologies to the affects of physical properties of volatiles in the target [11-16]. However, no lobate ejecta deposits terminating in ramparts like those around Martian craters were been identified. We have made a preliminary review of Galileo images of Ganymede to study the details of impact crater ejecta to look for morphological evidence of fluidization.

Results: In our preliminary examination of Galileo images of Ganymede we have identified craters with ejecta lobes that terminate in rampart ridges (Figure 1). Even thought the sample is small because of the scarcity of high-resolution, low-sun angle images of fresh craters, we have observed SLE craters that are similar morphologically to Martian SLE craters [17], and at least one crater with multiple ejecta layers, but this crater is morphologically most similar to Martian DLE craters. The average width of ramparts (W_{av}) around the SLE craters appear to be a function of crater diameter (i.e., $W_{av} = \sim 0.14\ D^{0.95}$, compared with $W_{av} = \sim 0.1\ D^{1.01}$ for Martian rampart craters from the data of [18]). Our measurement of EM and Γ of these craters is generally consistent with that of [14] with lower values for Ganymede craters than for Martian craters (e.g., EM = ~ 1 for SLE craters and inner ejecta layer of multi-layer ejecta (MLE) crater, and EM = ~ 2 for the outer ejecta layers of MLE craters on Ganymede). This is also consistent with predicted narrower ejecta layers by [19] for a target with high ice content. We have found rampart craters on Ganymede exclusively in the groove terrain, which could be due to 1) difficulty in identification of low-relief ramparts in the rough, dark heavily craters terrain, 2) the limited high-resolution image coverage, or 3), a genetic relationship (e.g., higher crustal temperatures in the grooved terrain) between ejecta fluidization and the tectonically active grooved terrain. In addition, we have also examined images of craters on Callisto and Enceladus and found no rampart craters.

Discussion and Conclusions: Lobate ejecta deposits with terminal ramparts have been identified around fresh Ganymede craters suggesting that their ejecta behaved in a way similar to that of Martian fluidized ejecta around SLE and DLE (and MLE) craters. Considering the absences of an atmosphere on Ganymede this suggests that the presence of an atmosphere may be unnecessary for production of rampart ejecta like that on Mars. Moreover, the unique association of these craters with the grooved terrain (and lack of such craters on other icy bodies) may indicate a genetic relationship. However, this relationship may also be a product of the effects of image resolution, coverage or rough terrain.

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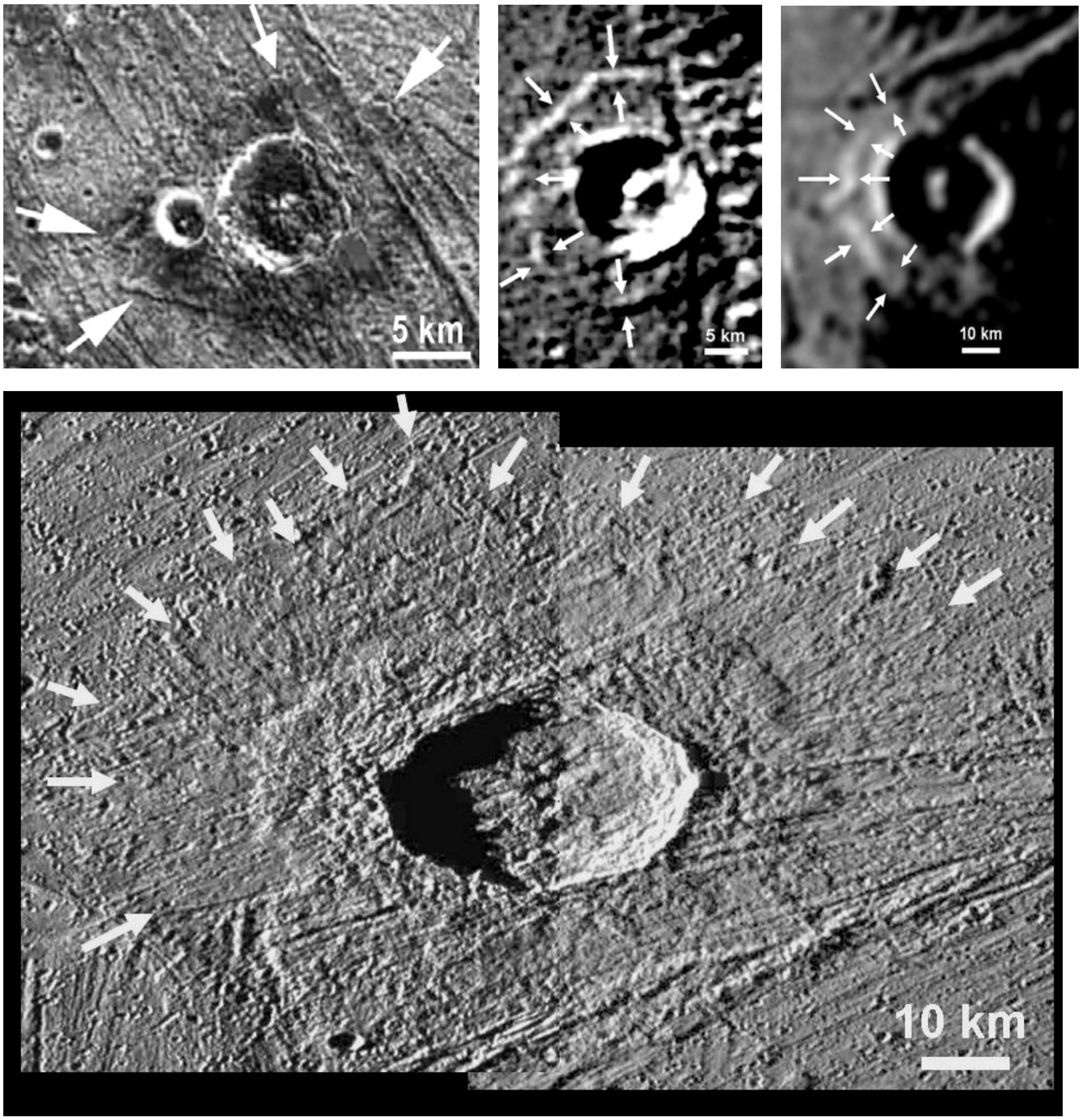

Figure 1: Image at top left is of the SLE crater Nergal (8 km diameter, 39ºN, 201ºW) showing lobate ejecta deposits (arrows) with terminal ramparts (~ 1 km wide) similar to those of Martian SLE craters. The image at the top middle is an unnamed 15 km diameter SLE crater with terminal ramparts that are ~ 2 - 2.5 wide (arrows). The unnamed SLE crater on the right is ~ 34 km across with a rampart ~ 3.5 - 4 km wide. The mosaic at the bottom is of the Achelous (63ºN, 12.5ºW), a crater with a thick pedestal-like inner layer, and thin outer ejecta layers with V-shaped rampart (~ 1 km wide) terminations. The arrows outline the outer ejecta layers.