SMALL DIAMETER CRATER SHAPES AND GEOMETRY ON IAPETUS AND RHEA. E. G. Rivera-Valentin[1], P. Schenk[2], O. L. White[2], [1]Arkansas Center for Space and Planetary Sciences, University of Arkansas (*eriverav@uark.edu*), [2]Lunar and Planetary Institute.

Introduction: *Cassini* orbiter high resolution images have been used to create topography maps of the icy Kronian satellites using photoclinometry, stereo, and shadow length measurements [1]. Such images allow for the analysis of small impact craters, which are more heavily influenced by surface mechanical properties whereas their larger counter parts have been shown to be strongly influenced by gravity [2]. The depth/diameter (d/D) ratios of these craters is specifically important as it is affected by crater excavation, collapse, and post-cratering modification [2, 3]; thus providing insight into surface mechanical properties and geologic history. Though a mean d/D ratio ≥ 0.2 has been found for various bodies [4], studies on asteroids have found smaller values indicative of loose surface material and mass movement processes that may reduce the average crater depth. In this study, we focus on Iapetus and Rhea due to their proven cratering similarities [5]. A comparison of the depth/diameter values for craters on or near the equatorial ridge of Iapetus and away from the ridge is specifically studied.

Methods: The image database used for this study included two high resolution (0.01 km/pixel) images of the dark terrain on the equatorial ridge of Iapetus and a context image with a resolution of 0.1 km/pixel. Two high resolution images from Rhea, one encompassing a secondary impact field and another with no obvious secondary impact indication, were also analyzed as a comparison.

The simple to complex crater transition for Iapetus has been found to occur at 11 ± 3 km [6], while for Rhea has been shown to occur at much smaller diameters (~8 km) [4]. Though morphological features of the studied craters were analyzed in order to ensure only simple craters were studied, the diameter range was also limited to at max 2 km above the transition diameter for each satellite.

In order to encompass the topography of the surrounding terrain, profiles were made extending one diameter in length on either side of the crater. Diameter measurements were then taken from rim to rim while depth was given as an average depth from the rim to floor of either side of the crater. Corrections to depth measurements were made to account for craters on inclined terrain. Crater wall slope (α) measurements were found as a weighted average by calculating the slope for every data point from rim to crater floor.

Results: Mean d/D ratios for both Iapetus and Rhea are less than expected. Previous measurements of lower resolution images for larger crater diameters showed a mean value of 0.221 for Rhea [4] and 0.2 for the moon [7], which also agreed well with laboratory simulations of impacts into icy regoliths [8]. The mean d/D ratios found here for Iapetus is 0.13 and for Rhea is 0.12. Distinct craters, though, showed d/D ratios near 0.2. As expected, the secondary field measured on Rhea has a much smaller value of 0.06. The mean d/D ratio of Rhea's simple craters, though, agree well with the average found on Iapetus. Craters away from the Iapetian equatorial ridge showed an average d/D ratio of 0.15; however, this value is not significantly different from those on or near the equatorial ridge (0.12).

Crater wall slopes ranged from 31° for the most distinct craters to 5° for relaxed craters. Mean slopes measured were 15.4° and 10.6° for Iapetus and Rhea respectively. Secondaries on Rhea exhibited a more relaxed nature with a mean crater wall slope of 7.4°. Large craters on Iapetus away from the ridge were more distinct, with mean crater wall slopes of 17.1°. A summary of these values is found in Table 1.

Table 1. Summary of results. The error margin is given by the standard deviation of the data set.

Satellite	Count	Resolution (km/Pixel)	Mean d/D	Mean α (°)
Iapetus (total)	136	-	0.13 ± 0.04	15.4 ± 4.7
Iapetus (context)	50	0.1	0.15 ± 0.04	17.4 ± 3.6
Iapetus (ridge)	86	0.01	0.12 ± 0.05	14.5 ± 5
Rhea (total)	203	-	0.09 ± 0.05	10.6 ± 5.4
Rhea (simple)	90	0.06	0.13 ± 0.04	14.7 ± 4.6
Rhea (secondaries)	113	0.03	0.06 ± 0.03	7.4 ± 3.4

Log D vs Log d: Figure 1 plots the diameter vs depth values for Iapetus (A) and Rhea (B) in log space. Figure 1B shows a significant change in the least squares fit (LSF) slope at a diameter of 1.05 km. The transition diameter was found by subdividing the data and sequentially applying a LSF to the log of the values of each subgroup. The slope for each LSF and its expected statistical variation to a 95% confidence interval using a two-tailed student t-test was then analyzed and the subgroup whose slope range was farthest a part was considered the most statistically significant difference.

Analysis showed the slope of the LSF for crater diameters < 1.05 km was 1.49 ± 0.2, while for D > 1.05 km was 0.74 ± 0.2, confirming visual expectations of a significant slope change. However, this could be a statistical artifact due to the limited number of data points available. A similar statistically significant slope change was not found for Iapetus. The LSF slope for all of the Iapetus data points is 1.04 ± 0.03, which is within error similar to the LSF slope for D > 1.05 km on Rhea (1.01 vs 0.94). Figure 1A also shows that there is no significant difference between craters on or near the ridge and those away from it.

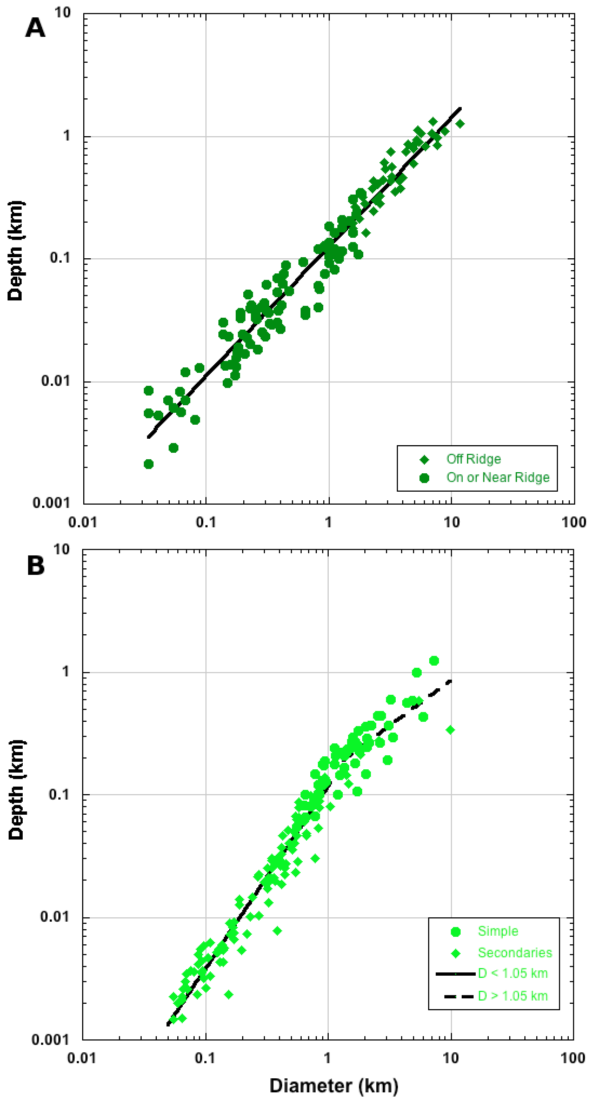

Fig. 1: Crater rim-to-rim diameter (D) versus depth (d) for (A) Iapetus and (B) Rhea on log axis. Rhea data exhibits a marked transition at 1.05 km.

Conclusions: Average d/D ratios less than 0.15 were consistently found for both Iapetus and Rhea, demonstrating a similarity to the values found for the asteroids Eros (0.13), Gaspra (0.14), and Ida (0.15) [3, 9, 10]. As suggested by Robinson *et al*. [3] for Eros, shallower material may be looser and thus may better favor mass movement events. Several examples of partially filled craters with eroded walls were found on both Iapetus and Rhea, perhaps indeed indicating infilling as a source for a low d/D ratio. Low d/D ratios may also arise by rapid burial of small craters from ejecta emplacement of larger nearby craters as suggested by Sullivan *et al*. [10] for the asteroid Ida.

The mean d/D ratios and crater wall slopes for craters on or near the ridge versus for craters away from the ridge did not demonstrate any statistically significant differences. This may indicate similar surface material properties for both ridge material and Iapetian dark material, which may elucidate the exogenic source for the equatorial ridge; however, it may also imply a broader extent for the equatorial ridge material. Indeed, terrain slope measurements of the context image show the surrounding topography is not horizontal, but rather is inclined far from the equatorial ridge. Terrain south of the equatorial ridge was found on average to have a 15° slope while northern terrain was sloped at 5° on average.

The statistically significant change in slope in the D vs d plot for Rhea may indicate a transition in the cratering regime. Craters with D > 1.05 km show a slope very similar to that found in previous studies of simple craters on Rhea (0.81) [4], while the LSF slope for Rhea craters with D < 1.05 km is distinct even compared to Iapetus. This unique transition occurred in both studied crater types and in all Rhea images. Thus it may not be a characteristic of secondary craters, but rather a characteristic of both cratering populations implying the cause for this transition may be related to the surface mechanical properties of Rhea. The mean d/D ratios for the two regimes observing only simple craters from Figure 1B, however, are the same, which is not expected if a true transition has occurred.

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