CRATER FORMATION AND MODIFICATION ON RHEA FROM TOPOGRAPHY. B. Aponte-Hernandez[1], E. G. Rivera-Valentín[1], P. M. Schenk[1], M. R. Kirchoff[2]; [1]Lunar and Planetary Institute, Universities Space Research Association, Houston, TX (*bhernandez@usra.edu*), [2]Southwest Research Institute, Boulder, CO.

Introduction: Cassini high resolution images have been used to create topographic maps of the icy Kronian satellites using photoclinometry, stereo, and shadow length measurements [1]. Morphological measurements of crater diameter (D), depth (d), and wall slopes (α) facilitated through this data set allows for an improved understanding of past heating events experienced by the mid-sized moons (MSMs) of Saturn (e.g., [2]), as well as other post-crater modification processes, such as infill by ejecta or impact-induced seismic alteration [3]. Specifically, the depth-to-diameter ratio, or d/D, has been used to infer heat-related crater relaxation on the icy moons of Saturn. Though fresh lunar craters have a mean $d/D \sim 0.2$ [4], studies on asteroids [5] and icy moons [3, 6, 7] have found smaller values on the order of 0.1, indicative of loose surface material, crater infill processes, differences in target material mechanical properties, and/or significant past heating events.

Here we expand upon earlier work [8] to study the d/D, α, and morphology of craters on Rhea. We investigate relationships between d/D and α, as well as crater diameter and morphology (e.g., simple or complex) to elucidate the post-impact processes that have modified craters on Rhea.

Methods: Topographic maps used for this study, were derived from two Cassini ISS high resolution images at 0.18 km/pixel (see Table 1 for details). The minimum crater size was limited to $D > 3$ km (~20 pixels across). The simple-to-complex crater transition diameter (D_t) on Rhea is suggested to be 4.5 km [2] or 8.6 km [9]; thus, studied craters should primarily be complex craters.

Table 1. Description of image set.

Image	Count	Area (km^2)	Latitude	Longitude
A	742	4.75x10^5 km^2	54.2844	321.296
			-8.9766	259.837
B	2	1.65 x10^4 km^2	3.99263	276.525
			-5.9431	267.485

We used QVIEW in the Integrated Software for Imagers and Spectrometers (ISIS) to measure the diameter and depth of each identified crater as well as to identify the crater morphology. Four profiles, separated by 90° in azimuth, are taken for every analyzed crater. In order to include the surrounding terrain, each profile extended at least one crater radius in length on either side of the crater. A total of 744 craters were analyzed.

The crater diameter was measured from rim to rim, and the depth from rim to crater floor or lowest topographic point. The crater diameter and depth are found as the average D and d for the profiles. The crater wall slope (α) was calculated by finding the least squares fit (LSF) slope (β) of the topography from the rim to crater floor, such that $\alpha = \tan^{-1} \beta$ with resulting error to the 90% confidence.

Results: The average diameter studied was 15.4 km ± 8.7 km with an average depth of 1.2 km ± 0.45 km. The smallest identified crater was 4.21 km; therefore, most craters should be complex [2]. The biggest diameter was 109.7 km, giving us an opportunity to view the complex-to-basin transition that occurs at a diameter of 96 km [1]. In Figure 1, we plot the diameter and corresponding depth for all studied craters. The LSF slope of the values in log-log space is 0.55 ± 0.04, which is indistinguishable from the value found by [2] of 0.49 ± 0.02 or by [9] of 0.559 ± 0.163 to a 90% confidence following a standard t test. No significant slope changes occurred within the data set suggesting no transitions in cratering regime are distinguishable; however, the difference between our largest measured crater and the complex-to-basin transition diameter is only ~14 km.

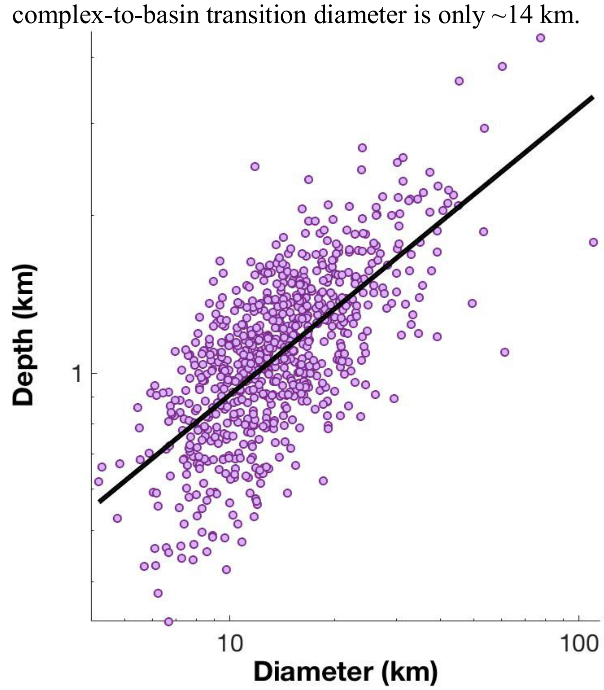

Figure 1. Crater rim-to-rim diameter in km versus rim-to-floor depth (circles) in km on log axis with LSF line.

The *d/D* ratio ranged from 0.03 to 0.22 with a mean *d/D* ratio of 0.09 ± 0.03. The slope values ranged from 4.6° to 24.4° with a mean crater wall slope of 13.7° ± 3.8°. The relationship between α and *d/D* is shown in Figure 2. The data is fit with an LSF line of slope 115 ± 5.5 (error to 90% confidence); therefore, a linear correlation exists between crater wall slope and *d/D*. However, several craters are outside of the 90% confidence prediction limits, which may suggest these craters are primarily affected by different processes than those that follow the general trend.

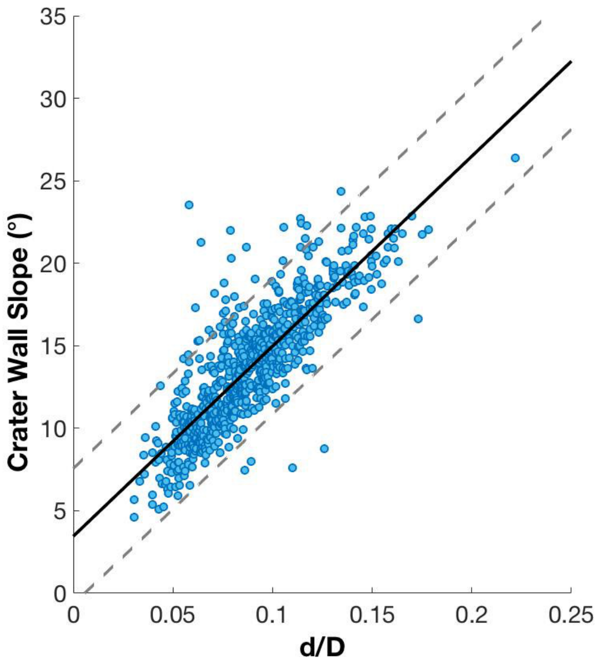

Figure 2. Diameter-to-depth ratio (*d/D*) versus crater wall slope.

Because $4 < D_t < 10$ [2, 9], we sampled craters below 10 km in diameter to study their morphology. For these 199 craters, their 4 topographic profiles were examined for morphological signs of simple or complex craters. The number of simple and complex craters was then binned into 1 km bins. In Figure 3, we plot the ratio of the number of simple to complex craters in each bin. Error is derived by propagating the Poisson counting error for each crater type in each bin. An LSF fit to the data suggests that no significant correlation exists between diameter and simple-complex ratio to 90% confidence (i.e., a non-zero slope cannot be ruled out), which suggests the population can be characterized by the weighted mean of the data in Fig. 3, which is 0.51 ± 0.2. Therefore, there exists a significant number of simple craters with $4 < D < 10$ km, suggesting the transition to complex craters is still occurring.

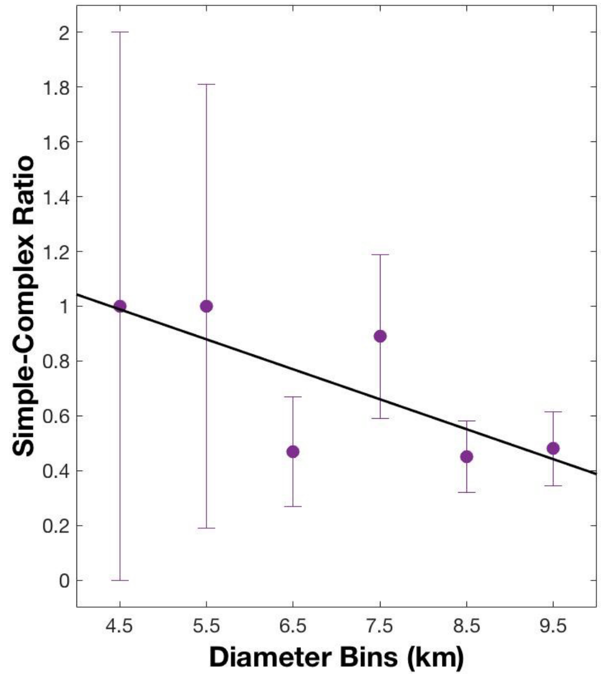

Figure 3. Ratio of the number of simple and complex craters in 1 km diameter bins.

Discussion & Conclusions: Our measured depths and diameters for the sampled crater population on Rhea agrees well with previous results [2, 6, 9]. We find that the *d/D* values for the studied craters are significantly correlated with the measured crater slope. If crater infill was the dominant post-impact crater modification process on Rhea, this relationship would not hold; as depth changed, crater wall slope would not. Therefore, we find that a process that nearly simultaneously relaxes the crater's depth, diameter, and slope, such as heating events or seismic shaking, is dominant on Rhea. Although, we note that several craters are outside of the 90% confidence prediction limits suggesting that crater infill is active, though not dominant, on Rhea.

Furthermore, we find that the transition from simple to complex crater morphology is broad. Nearly 40% of all studied craters with diameters $4 < D < 10$ km were simple craters. Further analysis is required to find the diameter at which only complex craters occur.

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