THE MORPHOLOGY OF CRATERS ON 433 EROS. C. M. Ernst[1], O. S. Barnouin[1], R. W. Gaskell[2], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 (carolyn.ernst@jhuapl.edu), [2]Planetary Science Institute, Tucson, AZ 85719.

Introduction: The Near-Earth Asteroid Rendezvous (NEAR)-Shoemaker spacecraft mapped the entire surface of asteroid 433 Eros during its 2000-2001 orbital mission. The Multi-Spectral Imager (MSI) revealed a regolith-covered surface that is heavily cratered at large scales. At small scales, Eros exhibits an unexpected deficiency in small craters [1]. Areas with low small crater densities correlate well with radial distance from the Shoemaker crater, and not with its presumed ejecta pattern, suggesting seismic shaking from the impact event might have removed the small craters [2]. Here, we investigate the morphology of Eros's large craters to examine crater degradation processes on Eros.

Methods: We begin by measuring the depth (d) and diameter (D) of the largest craters on Eros (≥ 500 m diameter) using co-registered, high-resolution images (from the MSI) and NEAR Laser Rangefinder (NLR) lidar data as well as a stereophotoclinometry (SPC) shape model [3]. Four profiles were taken across each crater, and average values for depth and diameter were recorded (Figure 1). Due to their size, most of these large craters likely predate the formation of Shoemaker, which is considered the youngest large crater on Eros [4]. If seismic shaking from the Shoemaker impact has acted to erase small craters through regolith movement [1,5,6], larger craters should also be affected (primarily their depths), and a correlation with radial distance should be observable.

The use of the SPC shape model allows the measurement of any profile across any crater on the surface of Eros, not limiting the dataset to those craters with NLR tracks through their centers. As a result, the use of the SPC shape model is critical to this study, making its verification essential. MSI/NLR co-registered data were used to assess the accuracy of the SPC shape model. Identical NLR and SPC profiles taken across ten craters yielded small RMS values (between 5 and 15 m). In general, SPC measurements yield slightly higher rims, steeper slopes, and larger depths than those from the NLR; however, the overall agreement between the two datasets remains strong, validating the accuracy of the SPC shape model for use in this study.

Results: Figure 2 shows the positions of the 301 craters measured. There is an obvious dearth of large craters within the Himeros and Shoemaker impact structures. Figure 3 shows the relationship between depth and diameter for these large craters. The average d/D ratio for these craters was 0.16, and smaller craters were generally more degraded than larger ones. The smallest of the observed craters (500 - 1000 m) exhibit the largest degree of modification. The upslope walls

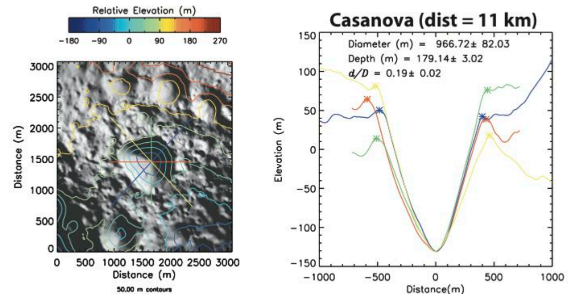

Figure 1. SPC model of Casanova crater (left) and corresponding depth and diameter measurements (right).

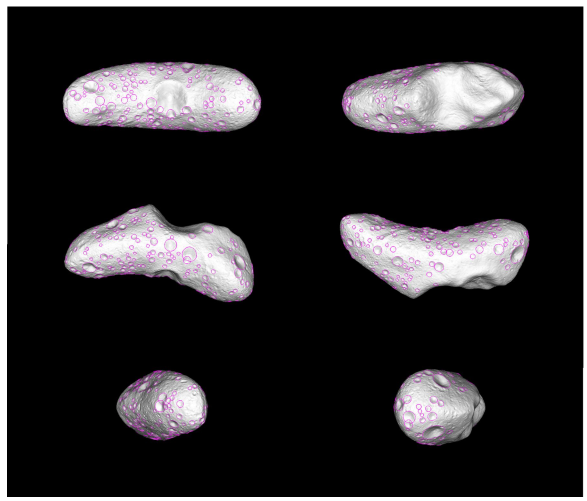

Figure 2. The positions of the 301 measured craters ≥ 500 m in diameter on the surface of Eros.

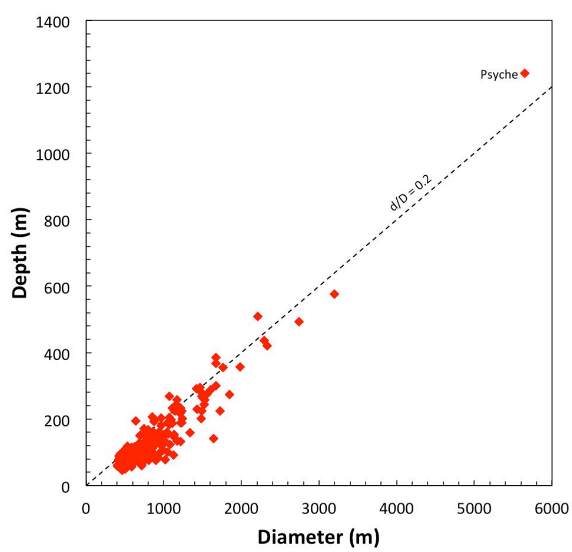

Figure 3. The depth versus diameter measurements for 301 Eros craters ≥ 500 m in diameter. The dotted line indicates a d/D ratio of 0.2 (that expected for fresh lunar craters).

of the craters appear to be most modified. All of these observations are consistent with expectations for modification by seismic shaking.

Figure 4 shows the diameter to depth ratio normalized to local slope for the measured craters as a function of radial distance from the center of Eros's five largest impact structures: Shoemaker, Himeros, Psyche, Selene, and Narcissus. The d/D ratios observed for the large Eros craters appear to follow a decreasing trend with proximity to Shoemaker, i.e., craters closer to Shoemaker appear more modified than those at larger distances. A stronger trend can be seen at distances between 5 and 10 km, a range that correlates well with observations of crater deficits as a function of distance from Shoemaker for crater diameters between 200 and 1000 m [2]. When plotted against distance from the other impact structures, no such trend is observed, supporting a link between the formation of Shoemaker crater and the observed crater distribution on Eros.

Conclusions: Large craters on Eros show a correlation between their d/D ratios and their radial distances from Shoemaker crater, supporting the Thomas et al. [2] model for the removal of small craters by seismic shaking from the Shoemaker impact event. The craters examined here were too large to be erased by seismic shaking events on the asteroid, but their morphologies reflect degradation due to shaking-induced regolith movement. The data suggest that significant loose material was present prior to the formation of Shoemaker crater – enough to fill and erase the small craters and to modify the larger craters. A competent layer of material must be present at some depth that prevented the larger craters from fully collapsing. The interior of Eros must attenuate seismic waves quickly, even for such a large impact as Shoemaker, as the crater degradation effects are observed mostly within 10 km of the impact structure.

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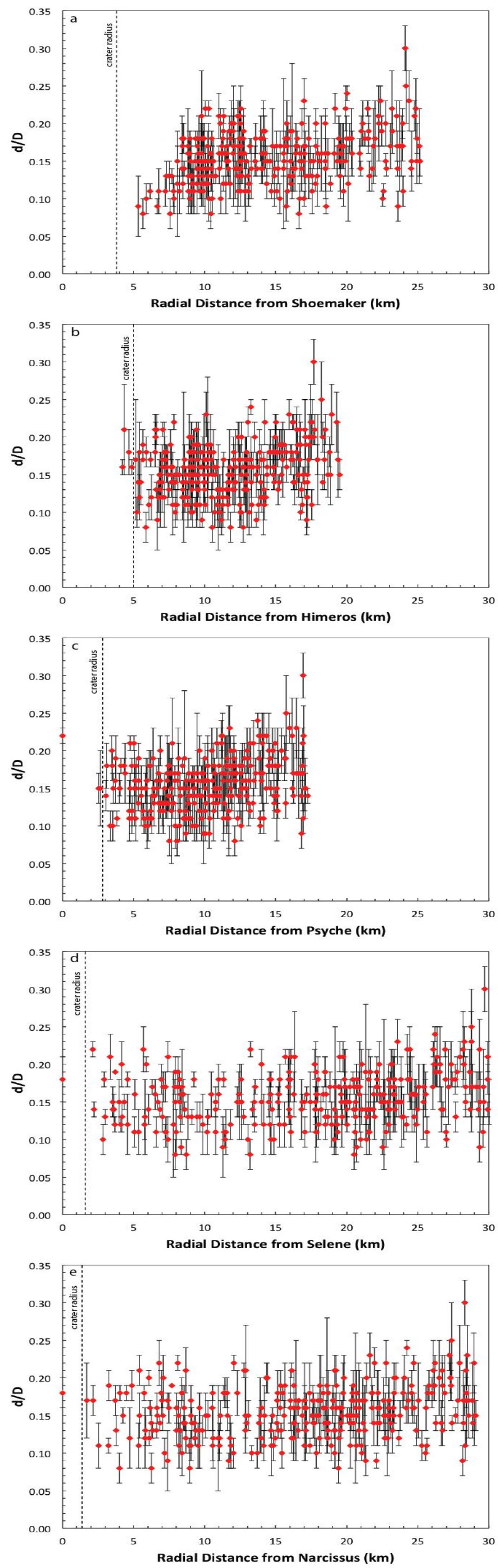

Figure 4. Diameter to depth ratio normalized to local slope for large (≥ 500 m) Eros craters as a function of radial distance from the center of Eros's five largest impact structures: (a) Shoemaker, (b) Himeros, (c) Psyche, (d) Selene, and (e) Narcissus. When plotted versus distance from Shoemaker, there is an observable decreasing trend between 5 and 10 km, which is consistent with the results from Thomas et al. [2].