AUTOMATED DEPTH/DIAMETER AND TOPOGRAPHIC-CROSS-PROFILE MEASUREMENTS BASED ON GT-57633 CATALOGUE OF MARTIAN IMPACT CRATERS AND MOLA DATA.

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Summary: The methods for the automated depth/ diameter and topographic-cross-profile measurements were applied to the newly available GT-57633 catalogue and MOLA data. The result is improved insight into the global geometric properties of Martian craters.

Introduction: Martian impact crater properties differ appreciably from those on the Moon, and reflect both gravitational and regional target properties [1]. Thanks to the availability of MOLA data, numerous diameter (*D*) dependent impact crater parameters and relationships can be measured [2], such as depth (*d*), rim height, central peak height, central peak diameter, cavity shape, etc. For numerous studies *d/D* relationship [3,4] as well as topographic-cross-profile [2,5] is important. However, while different authors generally agree that Eq. (1) is a good approximation for relationship between *d* and *D* for fresh and pristine impact craters, large variety of α and β has been reported. As given in [1], α=0.26 and β=0.67 for $D < 7$km (simple craters), while α=0.36 and β=0.49 for 7km $< D <$ 110km (complex craters). While in [2] the same values are reported for α and β for large craters, reported values for small craters are α=0.21 and β=0.81. Reported values in [6] for large craters are α=0.44 and β=0.38. In [7], reported values for the global average of fresh complex craters are α=0.37 and β=0.46, while significantly different values α=0.25 and β=0.82 are reported for the deepest of fresh complex craters. For complex craters (12km $< D <$ 49km) values reported in [8] are α=0.381 and β=0.52 for pristine craters and α=0.315 and β=0.52 for fresh craters. To obtain results that represent large number of craters and global trends, the measurements of a large number of craters are required. Significant efforts have already been invested in this direction to provide automated measurements [9,10]. In our previous work, for evaluation of Crater Detection Algorithms (CDAs) [11], the GT-57633 catalogue of Martian impact craters was assembled [12]. In this work, we will present automated depth/diameter and cross-profile measurements applied to these craters.

$$d = \alpha \cdot D^{\beta} \qquad (1)$$

Methods: GT-57633 catalogue for each crater, among other data, contains diameter. According to its diameter, each crater belongs to one of the seven following ranges: (1) 1km $\le D <$ 2km; (2) 2km $\le D <$ 4km; (3) 4km $\le D <$ 8km; (4) 8km $\le D <$ 16km; (5) 16km $\le D <$ 32km; (6) 32km $\le D <$ 64km; and (7) 64km $\le D$. For all ranges, the following is done for each crater.

Topographic-cross-profile. Using 1/128° MOLA data, for each crater 128 samples are taken for each of 64 different radial angles. Samples are taken from the center of crater to the distance of two radii. Once this is performed, for each of the 128 distances from the crater center, average elevation is computed for 64 values taken at different radial angels. While it can happen that some pixel from MOLA data is sampled more than once on smaller craters and some other skipped on larger craters, this is not a problem due to a large sampling resolution. The result of this method is 2-D representation of 3-D crater shape.

Depth/diameter relationship. Once topographic-cross-profile is computed, minimum is found within distance range between crater's center and radius. A crater depth is measured as a difference between elevation at this minimum and elevation at crater rim. Having this value, *d/D* can be computed as well.

Average topographic-cross-profile. Once topographic-cross-profile is computed for each crater, all values are scaled to the diameter size of 1000km. For this purpose linear transformation is used so that the shape of a crater and *d/D* ratio are preserved. Once all craters are scaled, average elevation is computed for each distance from the crater center.

Inner-classification of topographic-cross-profile. For each average topographic-cross-profile, *d/D* is computed. Using this value, all craters from this range are classified on those with higher and those with lower *d/D*. The whole procedure is recursively repeated 3 times. The result is that the craters within each diameter range are additionally classified into 8 sub-groups regarding their *d/D* value.

Results: The numbers of craters inside each of seven ranges are 310, 13311, 18602, 13181, 7861, 3452 and 916. All the craters are shown in Fig. 1 wherein *d/D* is shown in log/log scale. As expected, only some deepest craters are above graph that represents Eq. (1). In Fig. 2, the topographic-cross-profiles are shown for ranges from 4 to 7. As expected, profiles of larger craters are shallower when scaled to the same size. The resulting numbers (e.g. α and β) depend on the defined percentage (e.g. for 12.5% deepest craters) of complete population, so they are not given here.

Conclusion: The automated depth/diameter and topographic-cross-profile measurements made possible analysis of 57633 craters. Such a large number of craters leads to globally more representative, statistically more significant, more precise results. Global trends of crater rim and central peak can also be observed.

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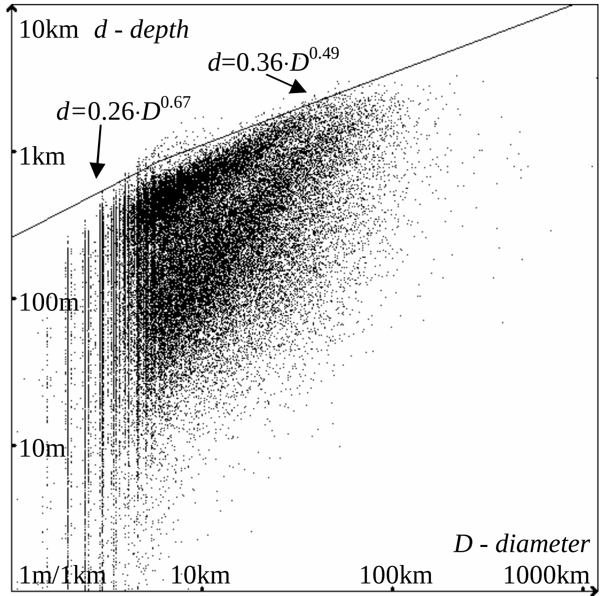

Figure 1: Depth/diameter in log/log scale for all craters from GT-57633 catalogue and graph of Eq. (1).

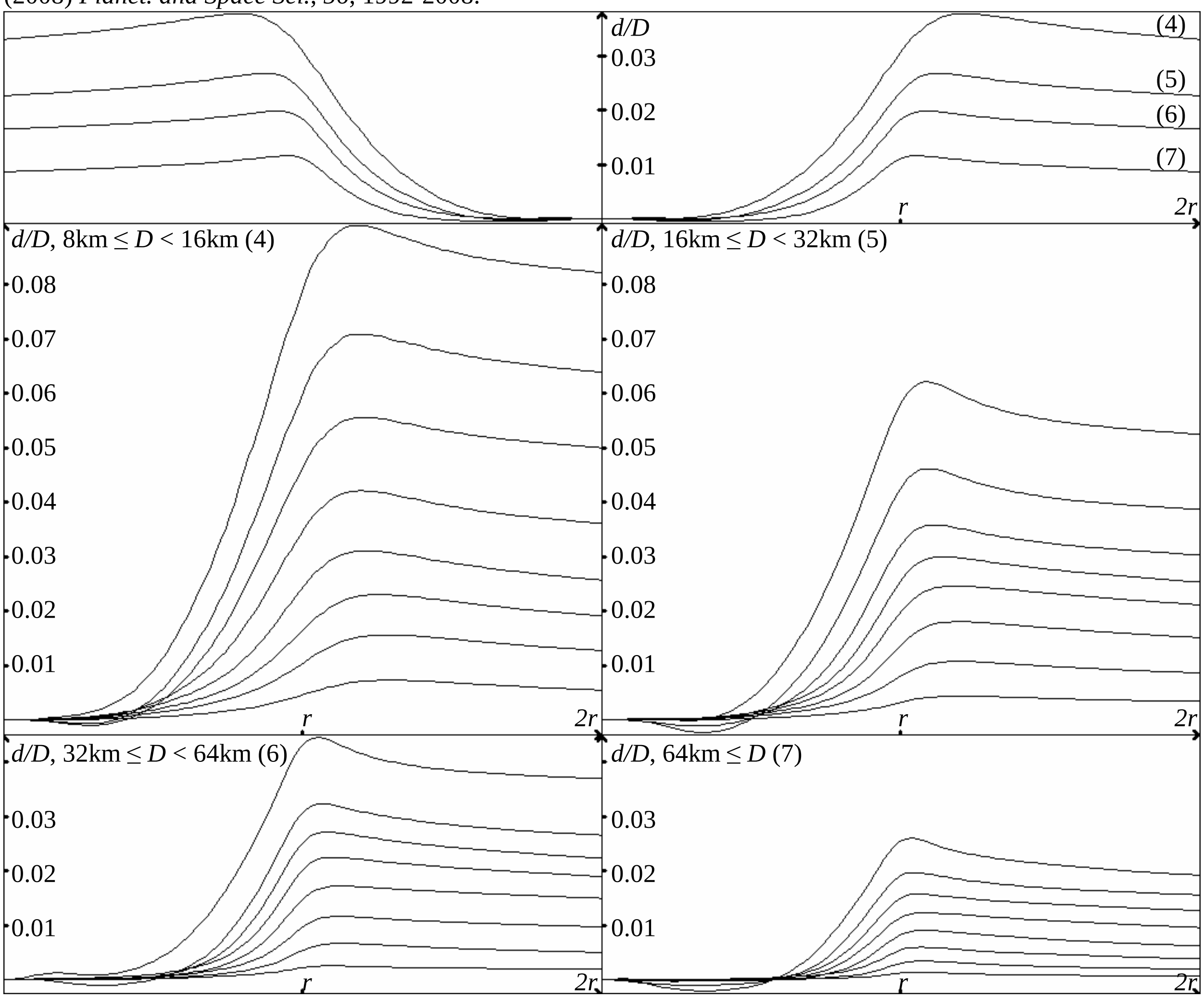

Figure 2: The average topographic-cross-profiles for 4 groups (top) and more detailed insight into each (bottom).