A MORPHOMETRIC ANALYSIS OF MARTIAN IMPACT CRATERS 21-30 KM IN DIAMETER

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Introduction: An ongoing MOLA analysis of the morphology of complex impact craters on Mars is being conducted to identify temporal changes in morphometric relationships between crater landforms. Understanding how craters have been degraded with time on Mars should provide insight into geologic activity and other geologically dynamic bodies in our solar system.

Methods: A list of potential complex craters was created from the Barlow Catalog of Large Martian Impact database [1] by filtering several parameters. These included selecting for: crater rim diameter between 21-30 km, craters with central peaks, and excluding significantly oblique craters.

Measurements were taken of the apparent diameter rim, apparent diameter of the central peak, and the apparent maximum and minimum heights of the crater floors to ascertain the morphologies. A crater range from 21 km to 30 km was selected from the Mars Crater Database 2.0[1] to supplement another project that is studying crater ranges from 10-20 km [2]. From this we determined the relationships of these complex crater morphologies across the three Martian age terrains, and the data set was separated into each specific terrain.

Using the MOLA 128 ppd interpolated surfaces, eight topographic profiles were collected across the rim through the center of the crater. From each transect several parameters were determined: rim-to-rim diameter (D), diameter of the central peak (D_{cp}) and the height of the central peak (h_{cp}). Parameters from all eight transects from each crater were averaged. Rim diameters were determined by measuring the length (along each profile) between the highest points along the rim immediately adjacent to the crater interior where slope changes occur. The location of the rim was confirmed by the identification of (relatively high thermal inertia) bedrock in THEMIS night-TIR imagery. Likewise, central peak boundaries were delineated as prominent slope changes occurring between the highest point in the central peak and the surrounding crater floor. Each boundary coincided with the transition between higher thermal inertia materials ("bedrock") of the central peak and lower thermal inertia materials (sediment) of the crater floor.

Results: The total number of craters that met the minimum criteria in the size range of 21-30km was 244. After preliminary analysis of the crater database, it was found that craters superimposed on Noachian-aged terrain are the most abundant. Craters situated in Hesperian and Amazonian chronostratigraphic units decrease in their percentages of the total population respectively (9% Hesperian & 5% Amazonian). This is expected due to the respective durations over which these geologic units have been exposed. These two younger terrains are still being surveyed and further analysis of current collected data is needed. We report the results of the Noachian population here.

Results for the Noachian population (which includes all impact craters that have formed since the Noachian) are shown in Figures 1 and 2. Both the D_{cp} and h_{cp} increase with increasing crater diameter. The diameter of the central peak increases following the relationship $D_{cp} = 0.29D$, while the height of the central peak follows the relationship Follows $h_{cp} = 0.001D^{1.97}$

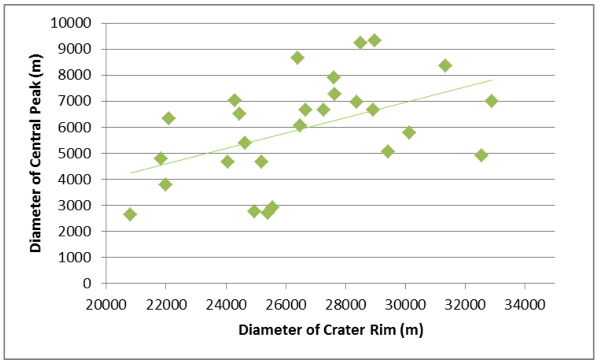

Figure 1. Relation of Rim Diameter and Central Peak Diameter

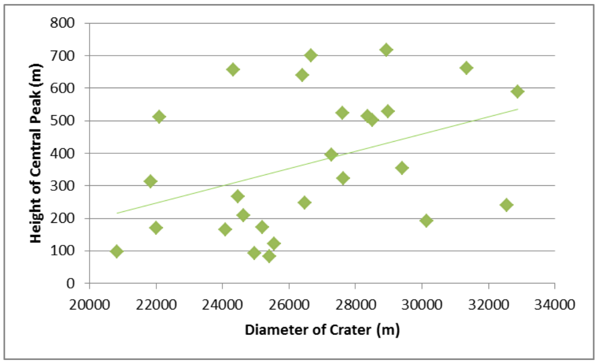

Figure 2. Relation of Rim Diameter vs. Height of Central Peak

Discussion: Preliminary results from Noachian-aged chronostratigraphic units are higher than those reported from previous studies on other solid bodies throughout the solar system that follow the relationship $D_{cp} = 0.23\ (\pm 0.03)D$ [3]. Our results indicate that this sub-population of impact craters has larger central peak diameters relative to D than the average for solid solar system bodies and a similar Noachian population of complex craters [2]. There are many possible explanations as to why, which include error in determining D or D_{cp}, strength and composition of the Martian terrains when compared to other planetary bodies, or the variable amount of volatiles present in the geological history of Mars.

A similar pattern is also seen with increasing height of the central peak and the diameter of the crater rim by 0.026; which can be expressed by the equation $h_{cp} = 0.0006D^{1.97}$ [4] where h_{cp} is the height of the central peak and D is the diameter of the rim. [4] Our results indicate that the central peak height is proportionately larger than average central peak heights for other solar system bodies and a similar Noachian population of complex craters [2].

With continued examination of Noachian, Hesperian, and Amazonian chronostratigraphic units and their respective crater populations, we expect to identify systematic trends in morphometric relationships that reflects extensive weathering and erosion on Mars over geologic time. For example, h_{cp} should decrease over time with continued erosion and deposition of central peak materials on the crater floor. Likewise the apparent D_{cp} should increase as sediment is shed onto the surrounding floor, making determination of D_{cp} even more challenging in older crater populations. Similarly, the depth/diameter ratio will decrease with increased sedimentation over time. Future work will examine these potential trends.

References: [1] Barlow N.G., 2006, Status Report on the "Catalog of Large Martian Impacts". 37th annual Lunar and Planetary conference, March 13-17 2006[2] Brusnahan H. and Milam K., 2012, Lunar and Planetary Space Conference, abs. This volume [3] Pike, 1985, Some Morphologic Systematics of Complex Impact Structures. Meteoritics vol. 20, 49-68 [4] Hale & Grieve, 1982, Volumetric Analysis of Complex Lunar Craters: Implications for Basin Ring Formation. Journal of Geophysical Research, Vol. 87 No. S1 PP. A65-A76.