MORPHOMETRY OF LARGE MARTIAN IMPACT CRATERS. Jared B. Howenstine[1] and Walter S. Kiefer[2], [1]Dept. of Astronomy, University of Massachusetts, Amherst MA 01003, jhownest@student.umass.edu, [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058, kiefer@lpi.usra.edu.

Introduction: The topography of impact craters and basins contains important information about both the initial formation and the subsequent modification of the structure. Previous studies of the morphometry of martian impact structures using MOLA topography data examined craters smaller than 110 km in diameter [1,2]. In this study, we emphasize larger craters in order to build a database that will support subsequent gravity modeling of large martian craters.

Methods: We selected 42 craters from the USGS Planetary Nomenclature database [3]. Our measurements are complete for named craters with diameters between 200 and 500 km. In order to connect our results to the smaller craters studied by Garvin and colleagues, we measured selected craters in the diameter range 66 to 200 km. We have also measured three large impact basins, Hellas, Argyre, and Isidis.

For each crater, we extracted a set of topographic profiles from the MOLA gridded topography using the program GRIDVIEW [4]. Typically, we extracted four profiles through the center of the crater, oriented roughly north-south, east-west, northeast-southwest, and northwest-southeast. On each profile, we measured the crater diameter, the crater depth, and the rim height. The crater depth is measured rim to floor, and the rim height is measured with respect to the external plains. By measuring four profiles for each crater, we determined 4 crater diameters, 8 crater depths, and 8 rim heights for each crater, providing a measure of the statistical variability in the measurements.

Crater Depths: Figure 1 shows our crater depths plotted as a function of crater diameter along with one sigma uncertainties. Because of the high precision of the MOLA topography, these uncertainties do not correspond to measurement errors but rather reflect the actual azimuthal variability of each crater. Following past practice for both lunar and martian craters [1,2,5], we treat the deepest craters of a given size as the most likely to be pristine and (at least relatively) unmodified by subsequent erosion or interior deposition. These eleven craters with diameters between 66 km (Wahoo) and 326 km (Newton) are shown as blue diamonds in Figure 1. The black line is the power law fit, $d = 0.44\ D^{0.38}$, where d is depth and D is diameter. The exponent of 0.38 in this power law is somewhat less than that of 0.49 found by Garvin et al. [2] for craters between 7 and 110 km in diameter. A similar decrease in power law exponent is seen when comparing small and moderate size craters on both Mars [2] and the Moon [5] and is a consequence of the shallowing of large craters due to gravitational collapse. Our measured depths for craters with diameters between 66 and 100 km are 0.5-0.9 km shallower than Garvin's power law. This is probably a consequence of the limited number of small craters that we have measured, so that we have not identified the most pristine craters in this size range. Including deeper craters at small D will cause our power law exponent to decrease. We are currently measuring additional craters with diameters of 100-200 km to improve that portion of the curve.

Craters that are shallower than predicted by the power law are typically interpreted as being partially filled by some sort of volcanic or sedimentary depositional event [e.g., 6]. Figure 1 shows that most large craters on Mars have experienced significant interior deposition. For example, Gusev crater, the site of the Mars Exploration Rover Spirit, has a measured depth of 1.6±0.7 km and a predicted depth of 3.1 km. The depth anomaly of 0.8 to 2.2 km is an estimate of the fill thickness on the floor of Gusev.

Figure 2 shows the extrapolation of our power law depth curve to large diameters and our measured depths for Hellas, Isidis, and Argyre. The extrapolation indicates post-impact crater fill thicknesses of < 1.1 km at Hellas, 2.6 ± 1.0 km at Argyre, and 2.9 ± 0.7 km at Isidis. Independent mapping of Hellas found post-impact deposition of at least 1 km of lava and 1 to 2 km of eolian sediments inside Hellas, with significant later erosion of the eolian deposits [7]. We are currently measuring the Hellas floor depth in regions that specifically avoid the mapped eolian fill units, which should improve our estimate of the lava fill thickness. Preliminary results do not differ much from the value given above.

Rim Heights: Our measurements of rim heights for craters in the diameter range 66 to 105 km are consistent with Garvin et al.'s power law curve [2]. Ongoing measurements of craters with diameters between 100 and 200 km are necessary before we can confidently present a power law for diameter and rim height of the larger craters.

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References: [1] Garvin and Frawley, Geophys. Res. Lett., 25, 4405-4408, 1998. [2] Garvin et al., LPSC 33, abstract 1255, 2002. [3] http://planetarynames.wr.usgs.gov [4] Roark et al., LPSC 35, abstract 1833, 2004. [5] Pike, Geophys. Res. Lett., 1, 291-294, 1974. [6] Williams and Zuber, Icarus 131, 107-122, 1998. [7] Tanaka and Leonard, J. Geophys. Res., 100, 5407-5432, 1995.

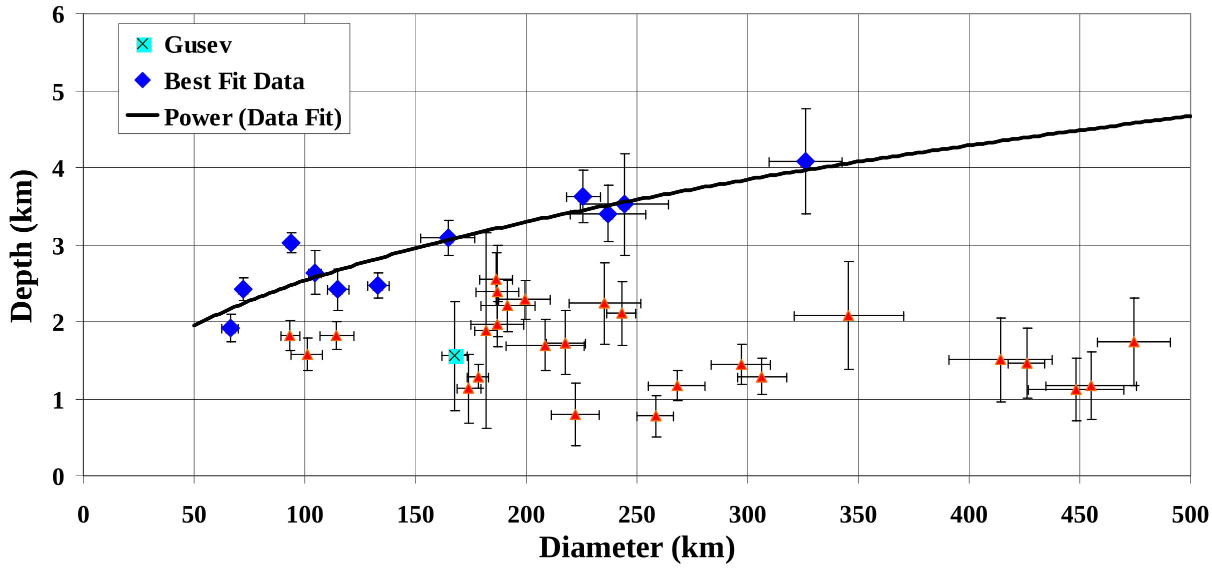

Figure 1. Depth versus diameter for impact craters between 66 and 500 km in diameter on Mars. The blue diamonds are the craters used to define the power law curve shown in black. Gusev crater is shown as an aqua square, and all other craters are shown as red triangles. Error bars illustrate the one-sigma variability in the measurements for each crater.

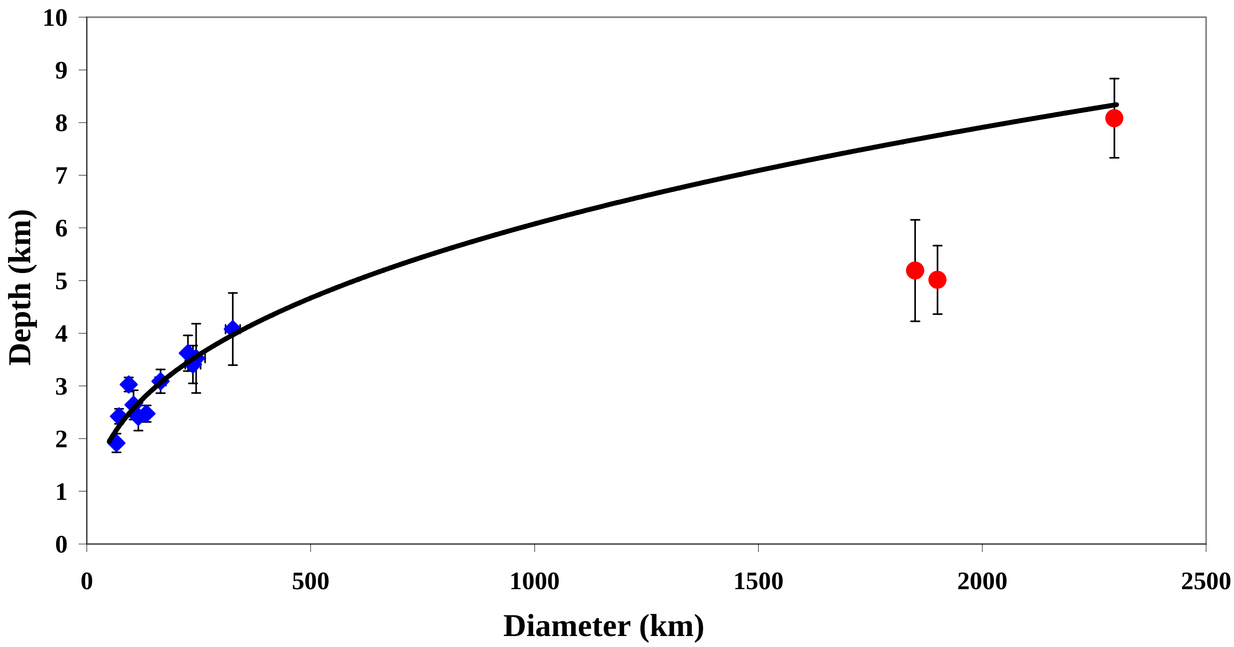

Figure 2. The black line is the depth-diameter power law extrapolated to larger diameters. The blue diamonds show the basins used in Figure 1 to define the power law. The three red circles are our results for the impact basins Argyre, Isidis, and Hellas. Although Hellas intersects the power law curve, it was not used in determining the power law parameters.