SUMMIT PIT CRATERS ON MERCURY AND COMPARISONS TO CENTRAL PEAK CRATERS R.M. Horstman[1] and N.G. Barlow[2], [1]Dept. of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86005 rianu090@gmail.com [2]Dept. of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 860011-6010 Nadine.Barlow@nau.edu

Introduction: Central pit craters display a depression near the center of the crater. It is largely believed that target volatiles, primarily in the form of H_2O-ice, are responsible for the formation of central pits due to their abundance on bodies with volatile-rich crusts. However, a small number of central pit craters have been reported on the Moon and Mercury [1,2]. This suggests that central pits may form by a different method not involving subsurface volatiles.

Central pits are classified into two general types: floor pits and summit pits (Fig. 1) [3]. Floor pits are depressions at the bottom of the crater, with an elevation of the pit floor is lower than the floor of the crater. Summit pits are depressions found atop a central uplift such that the elevation of the pit is higher than that of the crater floor. Studies done by Barlow et al. [3] find that floor pits are about twice as common as summit pits on Mars.

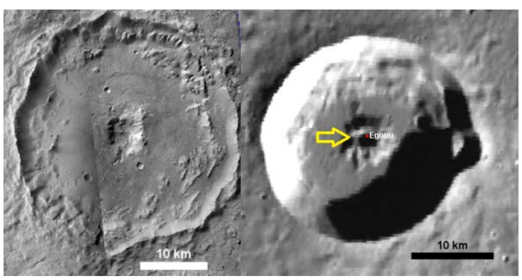

Figure 1: Left: Central pit on Mars, located at 34.797°N, 161.083°E. This crater shows floor pit morphology. Right: Summit pit named Egonu on Mercury located at 67.142°N, 61.568°E.

Previous studies have identified central pits on Mercury [1,2]. Xiao and Komatsu [2] identified 27 central pits on Mercury in a diameter range from 13 to 33 km and found the central pits share characteristics with summit pits on Mars [3]. This study uses the latest images taken by MESSENGER prior to mission completion in spring 2015. In this study we analyzed the distribution of central pits on Mercury and their relationship with central peaks.

Methodology: We used the MESSENGER MDIS global mosaic (250 m/pixel resolution) to measure and classify all craters. We identified 32 craters in the 13 to 47 km diameter range. We used the crater tool in JMARS to make the measurements. Complex craters were classified and separated into individual data files for central peak craters, peak ring basins, and central pit craters. Central pit and peak ring diameters were measured, as were the basal diameters of central peak structures. These data was input into an Excel spreadsheet for analysis. A combination of Excel and Python scripting was used to analyze the data. Data from JMARS was used to construct a shapefile for use in ArcMap to produce distribution maps of the different complex crater morphologies.

Preliminary Results: We identified 32 central pit craters on Mercury, all of the summit pit type. This is slightly more than the number of central pit craters found by [2], although we find that many of the central pit craters listed by [2] do not display the characteristics of central pits and instead appear to be arcuate central peaks. We also identified summit pits not found by [2], likely due to the improved resolution of the updated MESSENGER mosaic used in this study. Figure 2 shows the distribution of the central pit craters in this study. The slightly higher frequency of central pit craters in the northern hemisphere is likely a resolution effect.

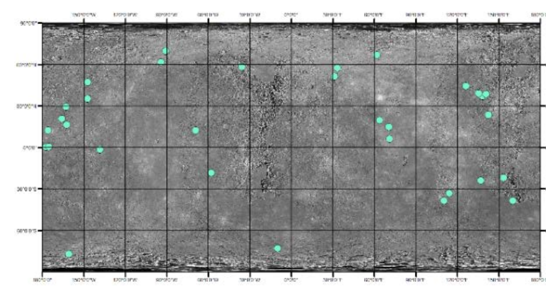

Figure 2: Central Pit distribution on Mercury.

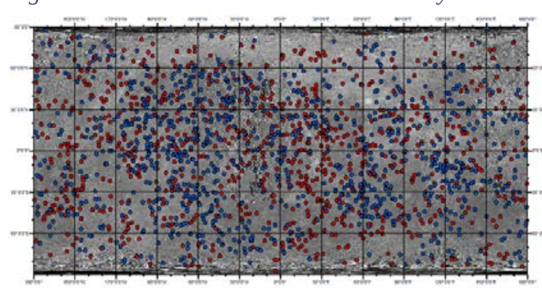

Figure 3: Central Peak Distribution on Mercury. Blue dots represent 'simple' peak craters and red dots represent 'complex' peak craters. No significant difference was found between the two in our survey.

Central peaks are very common, and occur across the entire surface of Mercury (Fig. 3). We identified

1760 central peak craters and divided them into "simple" (single peak) and "complex" (multiple peaks) categories.

Central pit craters range in diameter from 14 to 47 km in diameter, with a median diameter of 23 km (Fig. 4). Figure 5 shows the diameter distribution for central peak craters. Central peaks range in diameter from 8 to 251 km, with a median value of 38. We found no statistical difference in the diameter ranges of simple and complex peaks.

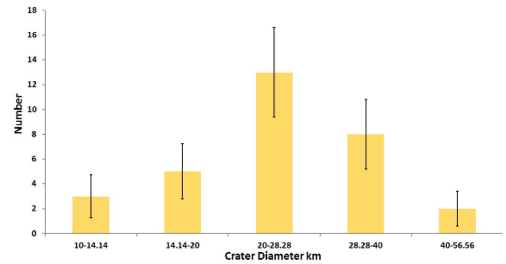

Figure 4: Central Pit occurrence by diameter. Error bars are calculated from the Poisson distribution for errors.

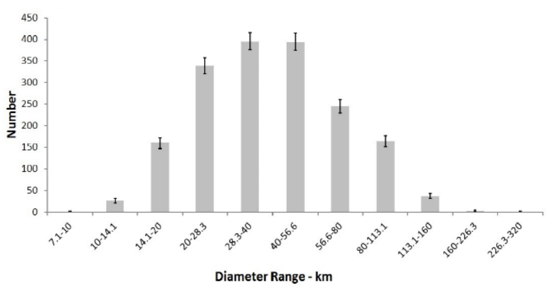

Figure 5: Central Peak occurrence by diameter. Error bars are calculated from the Poisson distribution for errors.

The diameters of central pit craters (all summit pits) fall within the peak diameter range of central peak craters (14.1-56.6 km). The overlap in diameter range and distribution suggests that summit pits form in the same materials and in the same manner as central peaks but undergo a subsequent collapse at the top of the uplift to create the pit. To test this assertion further, we measured the basal diameters of all central peaks and summit pits. Figure 6 shows the ratio of the peak to crater diameter (D_{pk}/D_c) for central pits. D_{pk}/D_c ranges from 0.1 to 0.3 with a median value of 0.17. Figure 7 shows D_{pk}/D_c for central peaks. D_{pk}/D_c ranges from 0.05 to 0.65 with a median value of 0.15, which is very close to that of central pits.

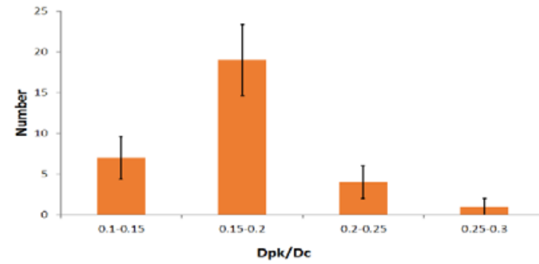

Figure 6: Dpk/Dc for Central Pits. Error Bars are calculated from the Poisson distribution for errors.

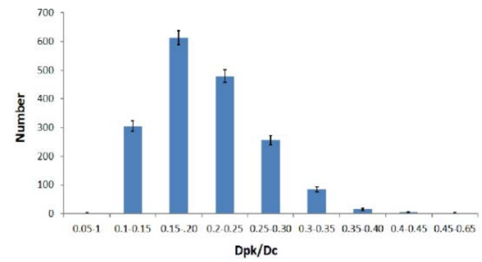

Figure 7: Dpk/Dc for central peak craters. Error bars are calculated from the Poisson distribution for errors.

Conclusions: Summit pit craters share strikingly similar characteristics with central peak craters on Mercury. For example, summit pit craters correlate with the diameter range of the highest frequency values for central peak craters. In addition, we find that the median D_{pk}/D_c ratios for both central peaks and summit pits are statistically identical. The distribution of summit pit craters, like central peak craters, shows no concentration on particular terrain units. The planet's crust is likely volatile-poor, and the lack of correlation of summit pit crater distribution with areas attributed to volatiles, such as the hollows [4] or the polar ice deposits [5], suggests that volatiles are not responsible for summit pit formation on Mercury. Thus summit pits are likely formed simply by collapse of a brecciated core in normal central peaks, similar to the mechanism proposed for lunar central pits [6, 7].

This study reveals that summit pit craters share similar characteristics with central peak craters. Our analysis shows that central pit craters are unlikely to form in the volatile-poor surface of Mercury and that the pit like features identified in this study are unrelated to central pits found on icier bodies.

References: [1] Schultz, P.H. (1988) *Mercury*, 274–335. [2] Xiao Z. and Komatsu G. (2013) *PSS, 82*, 62-78. [3] Barlow N.G. (2010) *LPSC*, 41, Abs. #1065 [4] Thomas R. J. et al. (2014) *Icarus, 229*, 221-235. [5] Chabot N. L. et al. (2013) *JGR, 118*, 26-36. [6] Croft S.K. (1981) *PLSC* 12, 196-198. [7] Elder C.M. et al. (2012) *Icarus*, 221, 831-843.