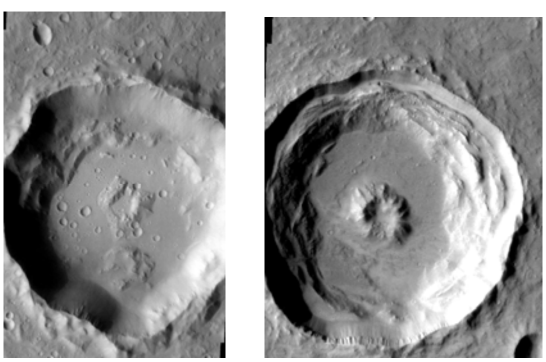
MARTIAN CENTRAL PIT CRATERS: SUMMARY OF NORTHERN HEMISPHERE RESULTS N. G. Barlow, Dept. Physics and Astronomy, NAU Box 6010, Northern Arizona University, Flagstaff, AZ 86001-6010, Nadine.Barlow@nau.edu.

Introduction: Central pit craters are unique landforms found on bodies with volatile-rich crusts such as Mars, Ganymede, and Callisto. Several formation models have been proposed for central pits, including (1) vaporization of target volatiles during crater formation and subsequent release of gases near the center of the transient cavity [1-3], (2) collapse of a central peak [4], and (3) excavation into subsurface liquid water reservoirs [5, 6]. We are conducting a survey of central pit craters on both Mars [7] and Ganymede [8] to determine their characteristics and distributions in an effort to determine the environmental conditions under which these morphologies form and constrain the possible formation mechanisms. We have completed our survey of central pit craters in the northern hemisphere of Mars and report here the results of this study.

Types of Central Pit Craters: Central pit craters on Mars are divided into those where the pit lies directly on the crater floor ("floor pit") (Fig. 1a) and those where the pit lies atop a central rise or central peak ("summit pit"; sP) (Fig. 1b). Floor pits are further subdivided into symmetric pit (SY) and asymmetric pit (AP), depending on the planform of the pit. Using THEMIS daytime IR and visible imagery, we cataloged a total of 13,996 craters in the northern hemisphere of Mars, of which 842 (6%) displayed a central pit. SY pits constitute 60% of all central pit craters in the northern hemisphere while sP pits comprise 36% and AP are 4% of the total.



(a) (b)

Figure 1: (a) Example of a floor pit (SY) crater. Crater is 18.2 km in diameter and located at 14.03°N 110.51°E. (THEMIS image V09795017) (b) Example of a summit pit (sP) crater. Crater is 15.8 km in diameter and located at 11.45°N 138.70°E. (THEMIS image V10418014)

Diameter Range: The lower diameter limit of our survey was 5 km. However, we did note that central pits sometimes occur at smaller crater diameters than this cutoff, suggesting a survey of higher resolution MOC, HRSC, and HiRISE imagery could supplement the central pit database. SY craters range in diameter from 5.0 to 114.0 km. Diameters of sP craters range from 5.5 to 125.4 km and AP craters were found in the 10.8 to 103.9 km diameter range. Fig. 2 shows the frequency of SY and sP craters as a function of diameter. The frequency peak for both SY and sP craters occurs in the 10-15 km diameter range.

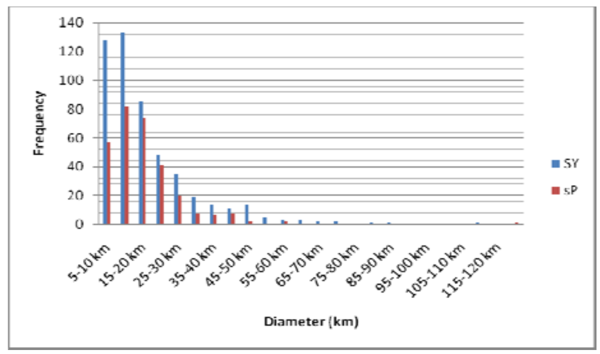


Figure 2: Frequency of floor (SY) and summit (sP) craters as a function of latitude.

Distribution of Central Pits: Central pits in the martian northern hemisphere were found from the equator up to 70°N latitude. The frequency of central pits decreases with increasing latitude (Fig. 3). This could be a real effect or the result of the high-latitude mantling layers cloaking the pits. The results of our survey of the southern hemisphere central pit craters [7] will provide important insights into which option is likely.

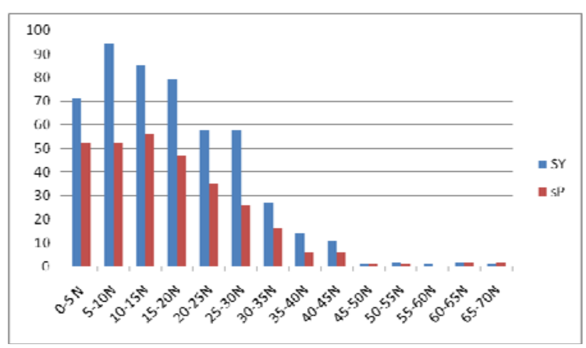


Figure 3: Frequency of floor (SY) and summit (sP) craters as a function of latitude.

Slight regional variations in central pit distribution are seen in the near-equatorial region of the northern hemisphere. When normalized to the total number of craters in the same region, we find enhancements of central pit craters in the Tharsis, Elysium, Lunae Planum, and Syrtis Major regions. This suggests that the layered lava and possible sedimentary units covering these regions preferentially favor the formation of central pits in craters forming in these units. Although central pit craters are seen in the same regions as many of the channels, their normalized frequencies are not as high as those in the four previously mentioned volcanic regions.

No strong variation is seen in the distributions of SY, AP, and sP craters. Regions with high concentrations of SY craters also tend to show high concentrations of sP craters.

Ejecta: Figure 4 shows the relationship between central pit craters and ejecta morphology. Ejecta morphologies include single layer (SL), double layer (DL), multiple layer (ML), pedestal (Pd), and no ejecta (No). In all cases, central pit craters are most commonly found in association with the ML ejecta morphology.

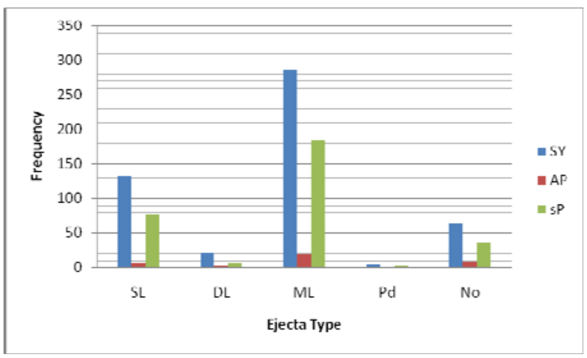


Figure 4: Relationship between central pit type and associated ejecta structure.

Preservational State: Central pits are found in craters with a wide range of preservation, indicating that the conditions favoring central pit formation have existed over most if not all of the planet's history. Preservation is classified in a 0.0-7.0 scale, with 0.0 indicating a "ghost" crater and 7.0 indicating a pristine, very fresh crater [9]. Figure 5 shows the frequency of each of the central pit types as a function of preservational class.

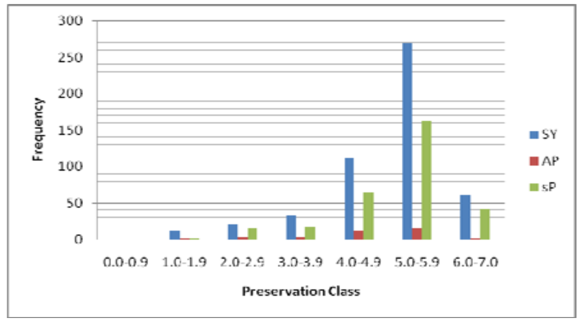


Figure 5: Frequency of central pit types as a function of crater preservational class.

Pit Diameter: The ratio of the pit diameter (D_p) to the crater diameter (D_c) may provide insights into the concentration of ice in the target material. In previous studies we have found that D_p/D_c is smaller for sP craters than for SY or AP craters, indicating that the pit is smaller relative to the parent crater for sP craters. We also have found that D_p/D_c is larger for central pit craters on Ganymede than for Mars [8]. We are still conducting this portion of the study to determine how the new results for the northern hemisphere compare with our previous incomplete studies and will present results at the meeting.

Implications for Central Pit Formation Models: The presence of summit pit craters, where the pit occurs atop a central peak, contraindicates the model that central pits form by collapse of a central peak [4]. The model of central pit formation by excavation into a subsurface liquid water layer [5, 6] is supported by the correlation with ML ejecta morphology, which has been proposed to form by excavation into liquid water layers [10]. However, the presence of pit craters over the entire northern hemisphere, and the lack of strong correlation with channeled region provides an argument against this model. The model of formation by release of gases during transient crater formation is supported by our observations.

Acknowledgements: This work is supported by NASA MDAP Award #NNX08AL11G.

References: [1] Wood C. A. et al. (1978) *Proc. 9th LPSC*, 3691-3709. [2] Pierazzo E. et al. (2005) *Large Meteorite Impacts III*, 443-457. [3] Stewart S. T. and L. E. Senft (2008) *Large Meteorite Impacts and Planetary Evolution IV*, Abstract #1423. [4] Greeley R. et al. (1982) in *Satellites of Jupiter*, Univ. AZ Press, 340-378. [5] Croft S. K. (1983) *JGR, 88*, B71-B89. [6] Bray V. J. et al. (2006) *LPS XXXVII*, Abstract #1175. [7] DeVries R. J. and N. G. Barlow (2009), *LPS XL*, this volume. [8] Alzate N. and N. G. Barlow (2009), *LPS XL*, this volume. [9] Barlow N. G. (2004) *GRL, 31*, L05703, doi: 10.1029/2003GL019075. [10] Barlow N. G. (2005) *Large Meteorite Impacts III*, 433-442.