DISTRIBUTION OF RIMMED, PARTIALLY RIMMED, AND NON-RIMMED CENTRAL FLOOR PITS ON MARS. K. M. L. Garner[1] and N. G. Barlow[2], [1]University of Rochester, Rochester, NY 14627, kgarner2@u.rochester.edu, [2]Dept. Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010, Nadine.Barlow@nau.edu.

Introduction: Many craters on Mars, Ganymede, and Callisto display central floor pits, an otherwise rare impact structure. Central floor pit craters are characterized by a centrally located depression within the craters' relatively flat floor. Several models for central pit formation have been proposed, including collapse of a central peak [1], excavation into layered targets [2], explosive release of vapor [3], and drainage of melt produced by impact into ice-rich material [4-6]. Even less well understood is why some floor pits are surrounded by complete or partial upraised rims while others are not. This study classified a subset of floor pit craters on Mars according to the presence or lack of a pit rim and looked at the distribution of these features.

Methodology: We classified 798 central floor pit craters ≥5-km-diameter covering the entire Northern hemisphere and a section of the Southern hemisphere between 0°-30°S, 180°-360°E. We used imagery from Mars Odyssey Thermal Emission Imaging System (THEMIS) visible (18 m/pixel resolution), Mars Reconnaissance Orbiter Context Camera (CTX) (6 m/pixel), Mars Global Surveyor Mars Orbiter Camera (MOC) (1.5-12 m/pixel), and Mars Reconnaissance Orbiter High Resolution Imaging Science Experiment (HiRISE) to classify each central floor pit as rimmed, partially rimmed, or non-rimmed (Fig. 1). We used ArcGIS to investigate the distributions of each pit type.

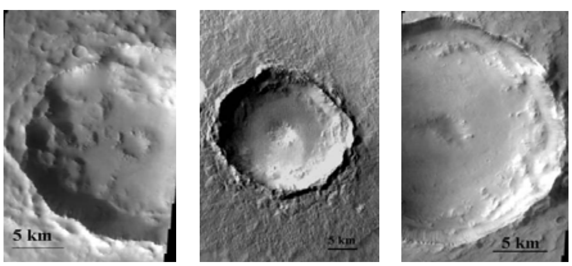

Figure 1: Examples of the three types of floor pit craters. Left: 21.8-km-diameter crater with 3-km-diameter rimmed pit (THEMIS V16837012). Middle: 5.2-km-diameter partially rimmed pit in 24.8-km-diameter crater (THEMIS I11284045). Right: 24.0-km-diameter crater containing 4.2-km-diameter non-rimmed pit (THEMIS V27642032).

Results: We classified 798 central floor pits as rimmed, partially rimmed, or non-rimmed. We did not find statistically significant variations in our classifications as image resolution increased. We measured diameters of both the parent crater and the central pit for each of the pit types. Diameters of the craters containing the pits ranged from 5 to 114 km. As shown in Figure 2, partially rimmed pits dominate across most of the diameter range. Percentage of non-rimmed pits decreased as pit diameter increased, transitioning to partially rimmed pits around pit diameters of 2 km and to rimmed pits around pit diameters of 11 km (Fig. 3).

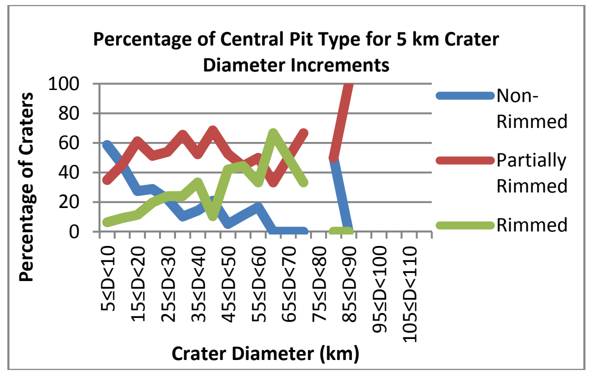

Figure 2: Percentile distribution of central floor pit crater types for 5 km crater diameter increments.

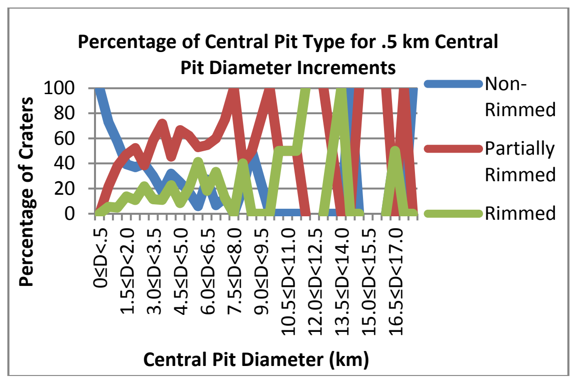

Figure 3: Percentile distribution of central floor pit crater types for .5km central pit diameter increments.

We divided the study area into 5° latitude by 5° longitude boxes and calculated the percentage of floor pit craters of a specific type to the total number of floor pit craters within each box. Figure 4 shows the resulting distributions. Rimmed central floor pit craters dominate along the highlands side of the Martian hemispheric dichotomy. Craters containing partially-rimmed floor pits are common throughout the equatorial region (in both highlands and plains materials) except for the Tharsis Province where there is an overall lack of all craters. Non-rimmed central floor pit craters make up the majority of floor pit craters within volcanic regions of Mars, particularly in Elysium, Lunae Planum, the Solis/Sinai/Syria region, and Syrtis Major. These results suggest that terrain properties strongly influence the formation of rims around the central pits.

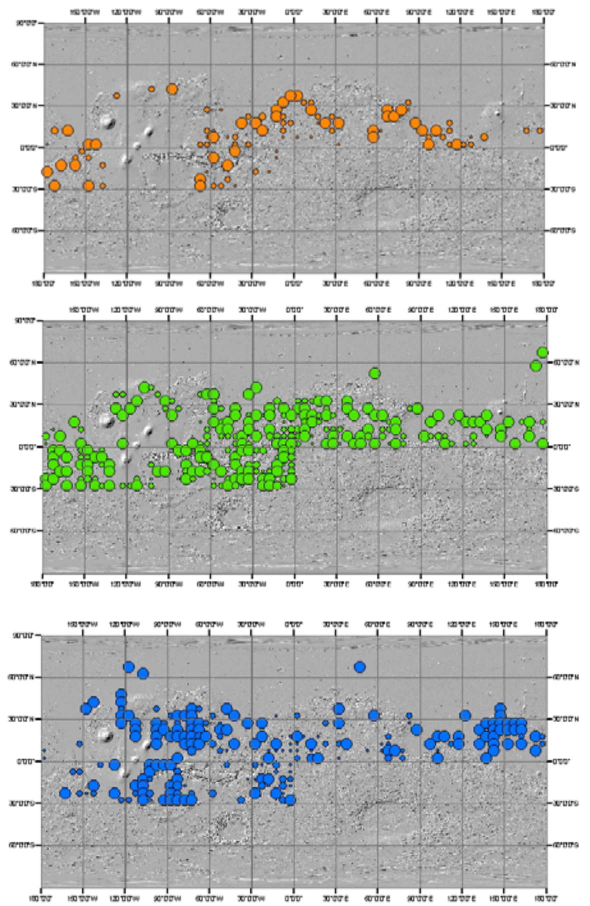

Figure 4: The study area was divided into 5° latitude by 5° longitude boxes and the percentage of pit craters of each type relative to total number of floor pit craters in each box was computed. Largest circles represent 100%. Top: Distribution of rimmed pit craters. Middle: Distribution of partially rimmed pit craters. Bottom: Distribution of non-rimmed pit craters.

Central pit craters on Mars display either a floor pit (where the pit occurs directly on the crater floor) or a summit pit (where the pit occurs atop a central peak or rise). We compared the distribution of our three types of floor pit craters with the distribution of summit pit craters within the study region (Fig. 5). We find that rimmed floor pits occur in the same geographic areas as summit pit craters whereas non-rimmed floor pit craters tend to occur in regions with few or no summit pit craters. Previous studies revealed that the distribution of summit pit craters overlaps that of central peak craters [7]. Our results suggest that the strength characteristics of highlands material favor the formation of central peaks, summit pits, and rimmed floor pits. Alternately, the strength characteristics of volcanic plains regions favor formation of non-rimmed floor pits.

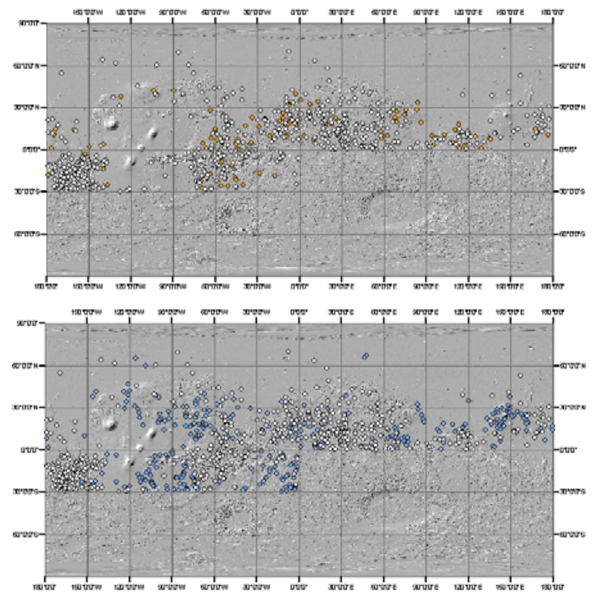

Figure 5: Top: Distribution of all summit pit craters (white) and rimmed floor pit craters (orange) within the study area. Bottom: Distribution of summit pit craters (white) and non-rimmed central floor pit craters (blue).

Discussion: The results of this preliminary study of rimmed, partially-rimmed, and non-rimmed floor pits suggest that the prevalence of each type depends on diameter of both the crater and the pit itself. We also find evidence that terrain properties strongly influence formation of rims around floor pits. Strength of the target material appears to be key and may relate to the coherence and/or volatile content of the target. The distribution of rimmed floor pit craters overlaps that of summit pit craters and central peak craters and dominates within the highlands regions along the hemispheric dichotomy. Alternately non-rimmed floor pit craters are found in volcanic regions where rimmed floor pit and summit pit craters are less frequent. Partially-rimmed floor pit craters overlap with both the rimmed and non-rimmed floor pit distributions. This dependence of floor pit type on terrain provides additional constraints when considering the various proposed central pit formation models.

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