CENTRAL PIT, CENTRAL PEAK, AND ELLIPTICAL CRATERS IN THE MARTIAN NORTHERN HEMISPHERE: NEW RESULTS FROM THE REVISED CATALOG OF LARGE MARTIAN IMPACT CRATERS. N. G. Barlow, Dept. Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010, Nadine.Barlow@nau.edu.

Introduction: Martian impact craters display a range of morphologic and morphometric variations. Previous analyses of central pit, central peak, and elliptical craters on Mars were conducted using the *Catalog of Large Martian Impact Craters* (*Catalog 1.0*), compiled from Viking data [1-3]. *Catalog 1.0* is being revised (*Catalog 2.0*) using Mars Global Surveyor (MGS) and Mars Odyssey data [4]. Updating of northern hemisphere craters is complete, allowing comparisons between the two *Catalog* versions in this region. Here we report on results for central pit, central peak, and elliptical craters in Mars' northern hemisphere.

Catalog Comparison: *Catalog 1.0* contained information on 12,920 craters ≥5-km-diameter in the northern hemisphere. Improved image resolutions and clarity provided by Odyssey's Thermal Emission Imagining System (THEMIS) instrument has resulted in identification of 14,225 craters ≥5-km-diameter, an ~10% increase. All craters in *Catalog 1.0* were reviewed: diameters were remeasured using ArcGIS tools, coordinates updated to MDIM 2.1 [5], and ejecta and interior classifications revised based on THEMIS image analysis [6]. *Catalog 1.0* craters were generally have diameters within 10% of their *Catalog 2.0* values. Preservation state of *Catalog 2.0* craters was classified on a 0.0-7.0 scale, with 0.0 corresponding to a "ghost" crater and 7.0 being a pristine crater [7]. Although preservation state is a proxy for crater age, the variety of geologic processes operating across Mars throughout its history means that craters of similar preservation state in widely separated regions of the planet may not be contemporaneous.

Central Pit Craters: Martian impact craters, like those on Ganymede and Callisto, often display central pits [8], which can occur either directly on the crater floor ("floor pits") or atop a central rise or peak ("summit pits"). The number of craters classified as floor pits has increased from 165 in *Catalog 1.0* to 565 in *Catalog 2.0*. Summit pit craters also have increased, from 173 to 334. Both floor and summit pits are found in similar diameter ranges (5.0-114.0 km vs 5.5-125.4 km, respectively) and locations within the northern hemisphere. Fig. 1 suggests that more central pit craters are found in the heavily cratered highlands regions of the northern hemisphere. But when we divide the planet into 10° latitude by 10° longitude blocks and normalize the number of pit craters to the total number of craters within each region, we find very few locations where pit frequencies exceed 10%. Fig. 2 shows the locations where floor pit craters exceed 10% concentration—these results suggest that floor pits occur preferentially on volcanic units, perhaps because of the layered nature of these regions.

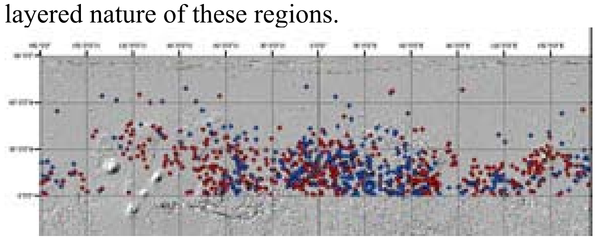

Figure 1: Distribution of central pit craters in northern hemisphere. Red = floor pits, blue = summit pits.

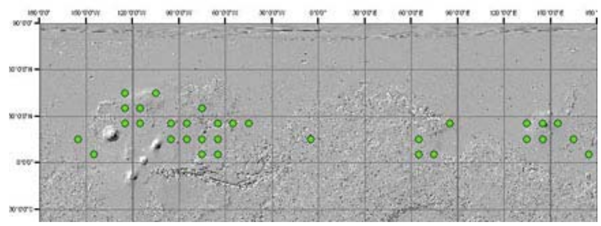

Figure 2: Regions where floor pit concentrations exceed 10% of total number of craters in 10° latitude x 10° longitude boxes.

Pit diameter (D_p) is compared to parent crater diameter (D_c) and found to range between 0.02 and 0.48 for floor pits and 0.03 to 0.29 for summit pits. Pit diameter is roughly linear with crater diameter (Fig. 3). The ratio of summit pit diameter (D_p) to the peak basal diameter (D_{pk}) ranges from 0.09 to 0.89 (median = 0.37). No statistically significant variation in D_p/D_c or D_p/D_{pk} is seen with latitude (up to 70°N, which is the highest latitude at which central pits are found), indicating that pit size is not strongly dependent on variations in subsurface ice concentration.

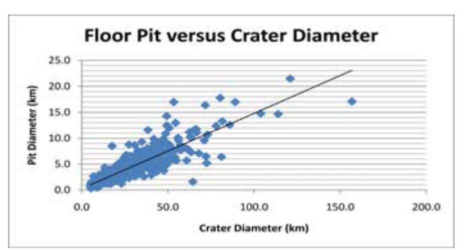

Figure 3: Pit Diameter vs crater diameter.

Central Peak Craters: The number of craters in the Martian northern hemisphere classified with a central peak has increased from 751 in *Catalog 1.0* to 1012 in *Catalog 2.0*. Central peak craters range in diameter from 5.0 to 139.8 km and are distributed over all terrain units in the northern hemisphere (Fig. 4). Central peak, floor pit, and summit pit craters all occur in the same regions (compare Fig. 1 and 4) and on the same stratigraphic units.

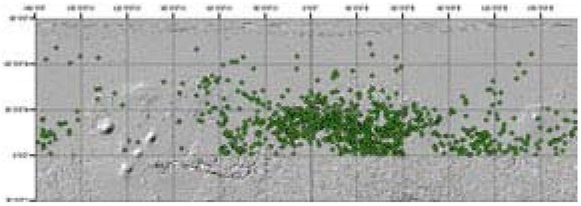

Figure 4: Distribution of central peak craters in the northern hemisphere of Mars.

The ratio of central peak basal diameter (D_{pk}) to parent crater diameter (D_c) ranges from 0.05 to 0.76, with a median of 0.33. This wide range is partly due to the various preservational stages of the craters since many of the older craters have floor deposits which cover the base of the peak. Fresher craters typically have peak basal diameters which are 40%-50% of the crater diameter. Fig. 5 shows an approximate linear trend between crater diameter and peak basal diameter.

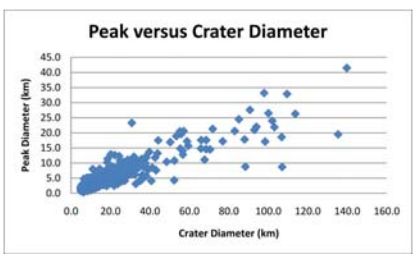

Figure 5: Peak basal diameter versus crater diameter.

Elliptical Craters: Elliptical craters in *Catalog 1.0* were identified solely on crater shape. *Catalog 2.0* elliptical craters are identified from both non-circular shape and presence of an asymmetric ejecta blanket [9]. This has increased the number of elliptical craters in the northern hemisphere from 88 in *Catalog 1.0* to 465 in *Catalog 2.0*. Most of these craters are only slightly elliptical in planform—75% have a minor to major axis ratio of >0.70.

Elliptical crater orientation is measured as the azimuthal angle (0° = north; 90° = east) of the major axis. Fig. 6 shows the range of azimuthal angles for elliptical craters in the northern hemisphere—there is only a slight preference for elliptical craters to be oriented approximately east-west (azimuthal angle near 90°). Previous studies of Martian elliptical craters suggested that planetary polar wander had randomized a predominantly east-west orientation [10]. No such trend is apparent when the azimthual angle of craters is considered as a function of preservation class (Fig. 7).

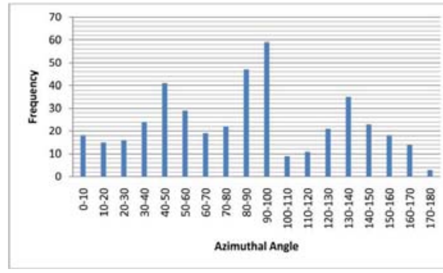

Figure 6: Distribution of elliptical crater major axis orientation. Azimuthal angle measured from north (0°) through east (90°) to south (180°).

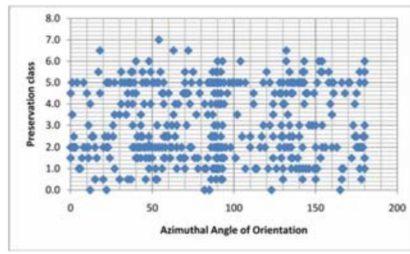

Figure 7: Distribution of elliptical crater major axis azimuthal angle of orientation as a function of crater preservational state.

Discussion: The increased identification of central pit, central peak, and elliptical craters makes *Catalog 2.0* more complete for investigations of these features. New results from *Catalog 2.0* analysis include (1) highest concentrations of floor pit craters occur in volcanic regions, (2) linear relationship seen between crater diameter and pit diameter and crater diameter and peak basal diameter, and (3) no indication of major change in elliptical crater major axis orientation with crater preservation/age. Extension of this study to the southern hemisphere will allow us to determine if these trends are global in extent.

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