STUDIES OF IMPACT CRATERS IN THE MARTIAN NORTHERN HEMISPHERE. N. G. Barlow, Dept. Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010. Nadine.Barlow@nau.edu.

Introduction: We are conducting a number of studies of impact craters on Mars, many of which include craters in the northern hemisphere. These studies include (1) comparison of crater data in the original and revised versions of Barlow's *Catalog of Large Martian Impact Craters* [1, 2], (2) detailed analysis of central pit crater distribution, morphology, and morphometry [3], (3) investigation of the role of volatiles in the evolution of Arabia Terra [4, 5], and (4) studies of the distribution, characteristics, and formation of Low-Aspect-Ratio Layered Ejecta (LARLE) craters and their relationship to pedestal craters [6-8].

Catalog of Large Martian Impact Craters: The original *Catalog of Large Martian Impact Craters* provided location, size, and morphology information on 42,283 impact craters ≥5-km-diameter as determined from analysis of Viking data [1]. We are updating the *Catalog* with new image and topography data from recent orbiting missions (MGS through MRO) [2]. Location, size, and morphology updates for northern hemisphere craters is complete. Comparison of the original and revised versions of the *Catalog* reveals:

- The number of craters ≥5-km-diameter identifiable in image data (i.e., not including buried craters only detectable through MOLA or radar data) has increased from 12920 to 14224 (Fig. 1). This is largely due to improved image quality and higher resolution.

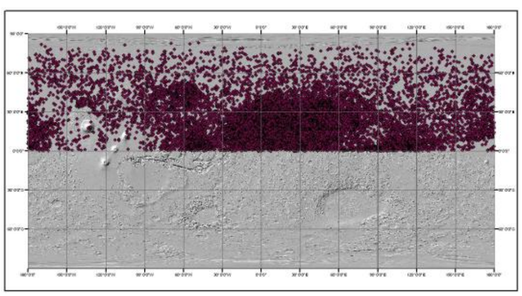

Figure 1: Distribution of northern hemisphere craters in revised *Catalog*.

- The number of craters with a classifiable ejecta morphology has increased from 4664 to 5809.
- The number of craters with a classifiable interior morphology has increased dramatically from 1700 to 6973.

We are currently conducting a comparative analysis of the quality of data between the two *Catalog* versions and will report on the results at the meeting. The revised *Catalog* is being used (and expanded upon) for the research projects described in subsequent sections.

Central Pit Craters: The revised *Catalog* contains location, crater diameter (D_c), pit diameter (D_p), D_p/D_c, preservational, and morphology data on 566 floor pit and 333 summit pit craters in the Martian northern hemisphere. Analysis of these craters reveals:

- Floor pit craters range in diameter from the cutoff limit of 5.0 km up to 114.0 km with a median of 15.2 km. Summit pit crater diameters range from 5.5 to 125.4 km with a median of 15.6 km.
- Pit diameters range from 0.3 to 17.8 km with a median of 2.4 km for floor pit craters and from 0.3 to 13.9 km with a median of 1.7 km for summit pit craters.77% of floor pits and 94% of summit pits are smaller than 4.2 km.
- Floor pits tend to be larger relative to their parent crater than summit pits. D_p/D_c for floor pits ranges from 0.02 to 0.48 with a median of 0.15. D_p/D_c for summit pits ranges from 0.03 to 0.29 with a median of 0.12.
- Floor and summit pit craters do not show any strong correlation with specific geologic units. They also overlap in distribution and size with central peak craters (Fig. 2).

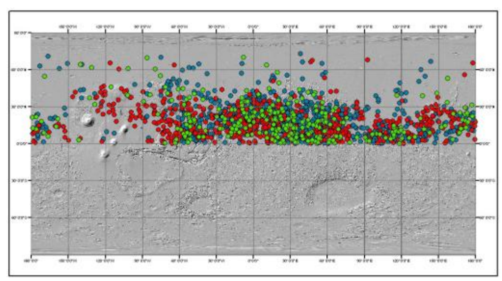

Figure 2: Distribution of floor pit (red), summit pit (green), and central peak (blue) craters.

- Floor pits can show complete rims, partial rims, or no rims around the pit. A preliminary analysis [9] of northern hemisphere floor pit craters suggests that rimmed floor pits preferentially form on highlands regions and tend to have larger D_p. Non-rimmed floor pits occur in volcanic regions and decrease in frequency with increasing D_p. A more detailed study of the different floor pit types is on-going, including geologic mapping of a few pristine examples and analysis of pit depths.

Our studies of Martian central pit craters are being utilized in comparison studies of central pit craters on other planetary bodies [e.g., 10] in an attempt to better constrain the formation mechanism(s) of these features.

Arabia Terra: We are conducting a detailed study of impact crater interior morphologies in order to investigate the role of both subsurface and surficial volatiles in Arabia Terra between 0°-40°N 330°E-85°E [4, 5]. This project is ongoing, but current results include:

- Surficial ice mantles and lineated terrain interpreted as glaciers extend as far south as 27°N latitude.
- Terrain softened craters are most common north of 30°N latitude.
- Nested craters are found at a variety of elevations and are not consistent with the theory that they formed by impact into marine environments.
- Layered ejecta morphologies and central pit craters are found throughout the study region, indicating the presence of subsurface ice reservoirs.
- Chaotic floor textures are most common in craters on high slopes, suggesting downward movement of groundwater may enhance the formation of floor fractures.
- Crater size-frequency distribution analysis using the CraterStats2 software indicates the overall age of the study region is 4.2 Ga. Table 1 shows the ages of specific interior morphologies obtained by this analysis. These represent the maximum age of the associated process creating the morphology.

Table 1: Ages of Arabia Terra morphologies

Morphology	Age (Ga)
Layered Deposits	3.99 ± 0.01
Chaotic Textures	3.93 ± 0.02
Pitted floors	3.92 +0.01/-0.02
Lineated Floor Deposits	3.77 ±0.03
Central Pits	3.48 +0.06/-0.11
Terrain Softening	1.89 ± 0.56

LARLE Craters: We have identified 139 Low-Aspect-Ratio Layered Ejecta (LARLE) craters ≥1-km-diameter in the ±75° latitude range, with 95 (68%) located in the northern hemisphere. LARLE craters are characterized by the presence of an extensive ejecta deposit extending well beyond the normal layered ejecta blanket. Characteristics of LARLE craters in the northern hemisphere include:

- 62% of the northern hemisphere LARLE craters lie poleward of 35°N, with most occurring on units of the Vastitas Borealis formation. The few equatorial LARLE craters are primarily found within the Medusae Fossae Formation.
- The radius of both the average and maximum extent of the LARLE deposit (R_d) is much greater than that of normal layered ejecta blankets (Fig. 3). Average ejecta mobility ratio (EM = R_d/R_c, where R_c is the crater radius) ranges between 3.7 and 14.8, whereas maximum EM extends up to 21.4.

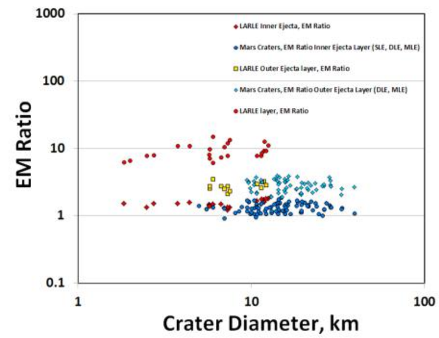

Figure 3. Comparison of EM values for LARLE craters and other layered ejecta morphologies on Mars.

- LARLE craters range in diameter from the cutoff value of 1 km up to 12.2 km. Larger LARLE craters tend to be found at higher latitudes.
- The LARLE layer is very thin (aspect ratios $\sim 10^{-5}$), displays dunes and swales in the outer regions, terminates in a sinuous "flame-like" edge, travels over preexisting topography, and appears to originate at the outer edge of the normal layered ejecta deposit.
- We propose that LARLE craters are less-eroded versions of pedestal craters.

Our observations of the distribution and morphologic/morphometric characteristics of the LARLE craters leads us to propose formation as a base surge deposit from impact into thick fine-grained mantles [11].

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