Use of the IMPACT Program for Measurement of the Depth to Diameter Relationships of Craters in the High Latitudes (70°–80°) of Mars: Implications for Geologic History of those Areas: Joseph M. Boyce, Mouginis-Mark, Peter, Garbeil, Harold: Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI. 96826; jboyce@higp.hawaii.edu

Introduction: As a practical test of the IMPACT program [1] automated method of measuring crater geometry, we have been exploring its use for studying the degradation history of impact craters in the polar regions of Mars. These regions hold important clues to the geologic and climate history of Mars, because this is where most of the volatiles are expected to occur. As an extension of our previous work in the northern high-latitudes of Mars, we have collected depth (d) and diameter (D) data for 460 craters in two regions in the southern high latitude (70°-80°S), Thyles and Prometheus. Both of these regions are Noachian age. The d/D data collected in these areas are compared with similar data for craters in the Hesperian age northern lowland plains from 70°-80°N (centered on about latitude 325°E) in order to search for signs of geologic processes. The latitudinal limits of the regions studied are equatorward of the latitudes where image data from Viking, MGS and MO reveal thick deposits fill craters and mantle the polar regions. In addition, for comparison purposes, similar data have been collected for craters on the Hesperian age ridged plains in Sinai Planum. The craters in this area exhibit sharp morphologies and show no signs of being mantled or severely eroded.

The data were collected employing the technique developed by Mouginis-Mark et al [1] that uses the MOLA gridded DIM (1/64°). Craters were measured in the ~2 to >100 km diameter range. Depths were measured in two ways, from the crater floor to the elevation of the surrounding surface (ds), and from the crater floor to its rim crest (d_R). Taken together these two measurements provide further insight into the nature of the surface processes responsible for the d/D observed relationships [2].

Results: Figure 1 is a plot of d_R/D relationships for a combination of the southern high latitudes, the lowest part of the northern basin, and the ridged plains of Sinai Planum. This plot shows that craters of the Sinai region are, in general, deeper than those at the high-latitude sites, with the slope of its best fit curve the same as that of the southern region, but different than the north. The slope of the best-fit curve for complex craters for the northern craters is 0.47, while for the best-fit slopes for the southern and Sinai craters are both about 0.67. A similar trend is also found in the simple crater population where in the north the slope is 1.49 and in the south and Sinai regions they are both significantly steeper at about 2.40 each. As a result of these differences in slope, craters smaller than about 11 km diameter in the north are systematically shallower than similar size craters in the other two areas. However, above 11 km there are a significant number of craters in the south that are shallower than craters in the north. In addition, the range (scatter) in depths is small in the north and Sinai compared with the craters in the south, with a few large craters (>50 km) in the south that are so shallow they fall outside the general d/D relationship (i.e., the 0.67 slope curve).

Figure 2 is a plot of ds/D relationships for the same craters shown in Figure 1. This plot shows that, like the d_R/D data, the craters of Sinai Planum are systematically deeper than craters in the other areas. This plot also shows that the floors of most craters smaller than about 11 km diameter in the northern high latitudes are nearly at the same elevation as the surrounding surface (slope = -0.023). Because of this, 200m has been added to each of the ds values to make all values positive. Above 11 km diameter, the relationships between the different populations is similar to that of d_R/D, with the slope of the best-fit curves for complex craters in the north at 0.92 and in the south and Sinai at 0.48 and 0.46 respectively. In addition, the range (scatter) in depth for a given diameter is small for the northern high latitude and Sinai craters compared with the southern high latitude data.

Discussion: The differences in d/D from area to area suggest either the work of different types or rates of surface processes (deposition and/or erosion) or target material properties. Our previous work found that the d/D relationships in the northern lowland plains are the result of mantling by the Vastitis Borealis Formation (VBF). However, neither of the other areas show d/D with characteristics similar to the crater population in the north suggesting that the VBF is unique to the north and that its origin is not strictly related to its high latitude location. Furthermore, the d/D relationships of craters in the south high latitudes and Sinai Planum show similarities in slopes of their curves, and displacement of these curves that is consistent with their relative age suggesting that these areas may have been affected by similar surface processes. The slope of the d/D curves, the high degree of scatter, and symmetric nature of data points around the best-fit curve (except for a few large craters) in the south, are all consistent with an old surface that has undergone long-term erosion. However, there are a few large (> ~50 km dia.) shallow craters in the southern region whose depths are more consistent with the effects of viscous relaxation of the rims [3] though burial by a thick mantle cannot be ruled out. In addition, significant target material property differences between the areas can be ruled out because some similar size craters from each area show overlapping high d/D values. This suggests that these are relative young craters that initially formed with about the same d/D in each area. Finally, we note that several of the relationships described here may be influenced by the measurement techniques employed in the IMPACT program. Further research on the specific methods of measuring craters, as outlined in our companion abstract [5] appears warranted.

Reference: [1] Mouginis-Mark, P. J. et al, (2003), LPSC XXXIV: 2040-2041. [2] Boyce, J. M., et al, (2003), LPSC XXXIV, 1472-1473. [3] Pathare, A., et al, (2002), LPSC XXXIII. [4] Garvin, J.B., et al, (2002) LPSC XXXIII, 1255-1256. [5] Mouginis-Mark, P.J. et al. (2003) this abstract volume.

Figure 1. Depth from Rim/Diameter for Craters in the Polar Regions of Mars (Sinai for Comparison)

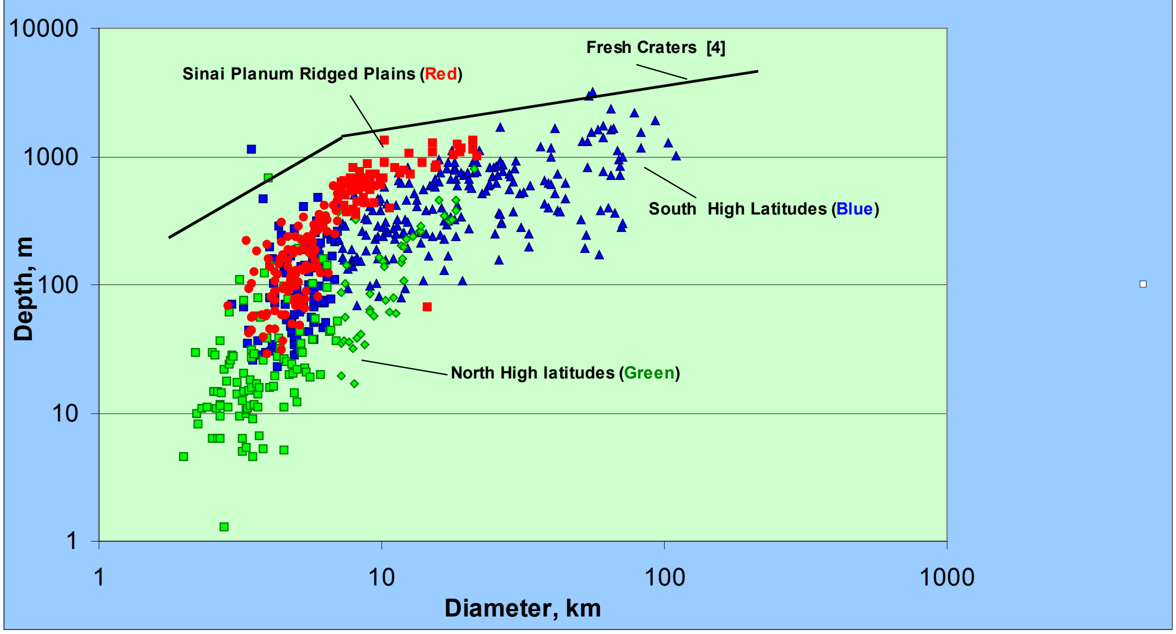

Figure 2. Depth from the Surrounding Surface/Diameter for Craters in the Polar Regions Compared with those in the Sinai Region of Mars