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: The polar regions of Mars hold important clues to the geologic and climate history of that planet, because this is where most of the volatiles are expected to occur. As an extension of our previous work on the degradation history of impact craters on Mars [1], we have collected depth (d) and diameter (D) data for 460 craters ranging from 3km to 110km in two regions in the southern high latitudes (70°-80°S). These regions include, Thyles Rupes (108°–220° Long.) and Prometheus (50°-90° Long.). Both of these regions are Noachian age. In addition, for comparison purposes, similar data have been collected for craters on the Hesperian age ridged plains in Sinai Planum where the surface appears to have had a simpler geologic history. 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 the Hyperboreae Undae region of Vastitis Borealis) in order to search for signs of geologic processes. The latitudinal limits of the high latitude regions studied are equatorward of the thick polar layered deposits.

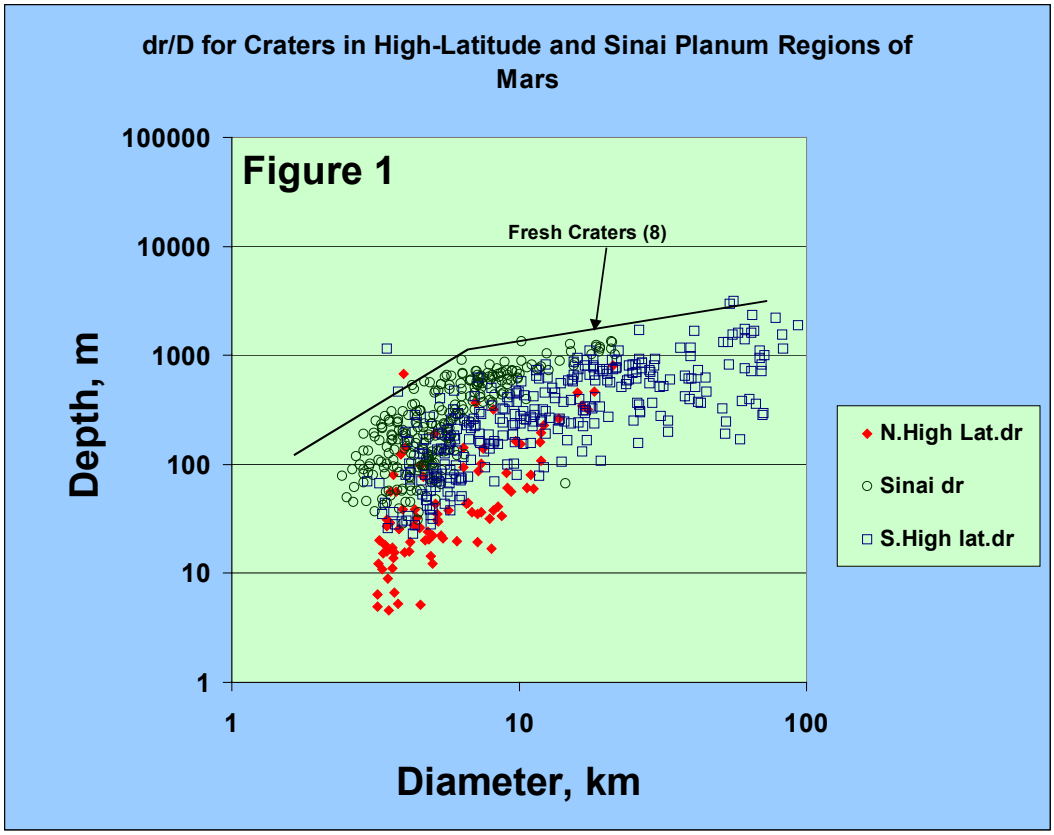
The data were collected employing the technique [3] that uses the MOLA 1/128 degree gridded DIM to measure crater morphologic properties. Craters were measured in the ~2 to >100+ km diameter range, although the spatial resolution of the DIM only provide accurate d/D information for all craters larger than about 5-6 km. Crater depth was measured in two ways, from the crater floor to the elevation of the surrounding surface (d_s), and from the crater floor to its rim crest (d_R). Taken together these two measurements provide much greater insight into the relationship between d/D and the processes that effect d/D.

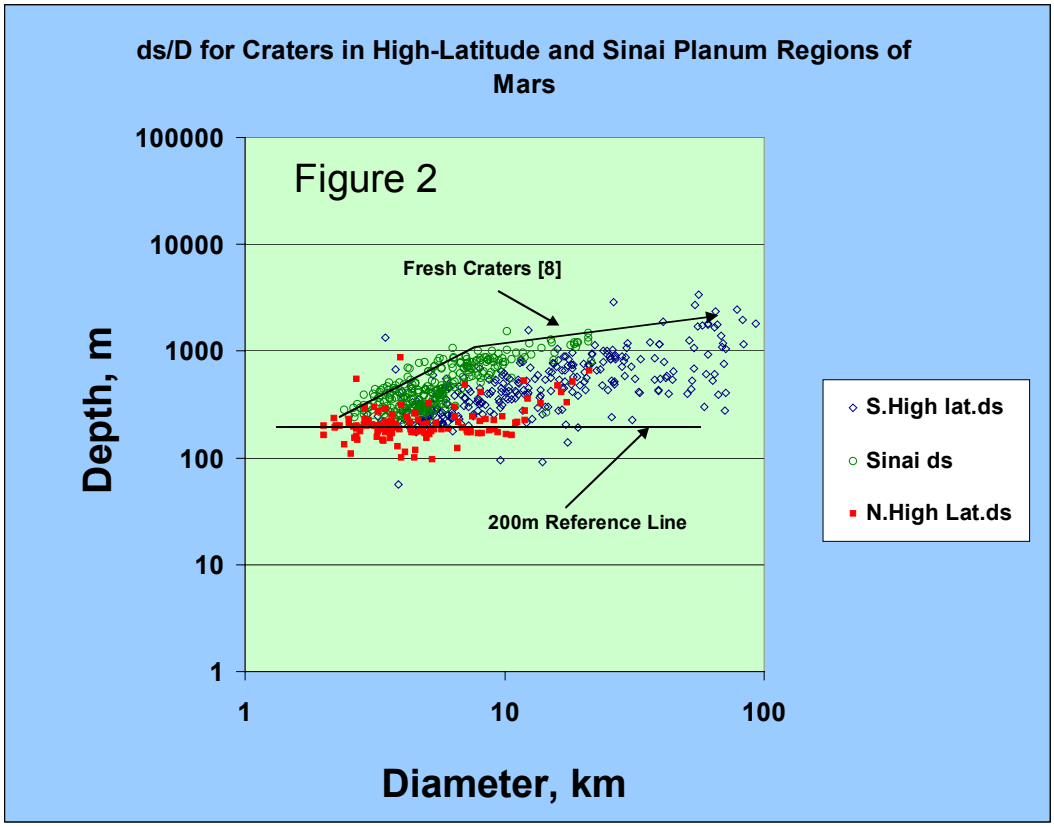
Results: Figure 1 is a plot of d_R/D relationships for a combination of the regions described above. This plot shows that though craters in the Sinai region are systematically deeper than the other areas the slopes of the best-fit curves for Sinai and the high southern latitude study region are the same (both are 0.67 for complex and 2.40 for simple craters). However, there is considerable range (scatter) in depths for relatively small craters and a few large craters (>50 km) in the south are so shallow that they fall significantly outside the general d/D relationship. In contrast, the best-fit curves for the population of craters in the northern high-latitudes are 0.47 for complex and 1.49 for simple craters, reflecting that craters <12km diameter in the north are systematically shallower than the other craters populations.

Figure 2 is a plot of d_s/D relationships for the same craters shown in Figure 1. It shows that the d_s/D relationships are for the southern high latitudes and Sinai are similar to their d_R/D data (their best-fit curves have nearly the same slopes). In contrast, the floors of northern crater <12km diameter tend to cluster around a d_s of zero (the same elevation as the surface surrounding the crater). This results in best-fit curves with slopes of -0.023 (craters <12km) and 0.92 (craters >12km). Because many of the craters floors in northern craters are near or above the elevation of the surrounding terrain, 200 m has been added to each of the d_s values in Figure 2 to make them positive on this log-log plot.

Discussion and Conclusions: The characteristics of the d/D in each area are due mainly to the operation of surface processes (deposition and/or erosion, viscous relaxation), although target material properties may have had some minor effects. Consistent with our previous work [1,2], we suggest that the d/D relationships in the northern lowland plains are primarily the result of mantling by the Vastitis Borealis Formation. The d/D relationships of craters in the southern high-latitudes and Sinai Planum show no characteristics of mantling, but instead show characteristics of long-term, constant and continuous erosion. In addition, the large crater population in the southern high latitudes shows the effects of viscous relaxation [4, 5, 6] of crater rims, possibly caused by abundant subsurface ice. Both high-latitude areas have no craters with fresh crater d/D ratios. This may be due to target material properties [7] or the effects of recent thin dust-ice deposits [8, 9] on crater depths.

References: [1] Boyce, J. M., et al, (2003), LPSC XXXIV, 1472-1473. [2] Boyce, J.M., (2003), 6th Inter. Conf. Mars; 3193; [3] Mouginis-Mark, P. J. et al, (2003), LPSC XXXIV: 2040-2041. [4] Pathare, A.V., et al, (2002), LPSC XXXIII, 1972. [5] Turtle, E., et al, (2003), LPSC XXXIV, 1891. [6] Passey, Q.R., (1982), Ph.D. Thesis, Caltech. [7] Garvin, J.B., et al, (2003) 6th Inter. Conf. Mars, 3277. [8] Mustard, J., et al, (2001), Nature, 412, 411-413. [9] Head, J.W., et al, (2003), Nature, 426, 797-802.


dr/D for Craters in High-Latitude and Sinai Planum Regions of Mars
Figure 1
Fresh Craters (8)
Depth, m
100000
10000
1000
100
10
1
1
10
100
Diameter, km
N.High Lat.dr
Sinai dr
S.High lat.dr


ds/D for Craters in High-Latitude and Sinai Planum Regions of Mars
Figure 2
Fresh Craters [8]
200m Reference Line
Depth, m
100000
10000
1000
100
10
1
1
10
100
Diameter, km
S.High lat.ds
Sinai ds
N.High Lat.ds