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Abstracts

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DEPTH-DIAMETER RATIOS FOR MARTIAN IMPACT CRATERS: IMPLICATIONS FOR TARGET PROPERTIES AND EPISODES OF DEGRADATION.

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Mariner 9 and Viking imagery reveal that martian impact craters exhibit a wide variety of crater depths that have been attributed to varying stages of crater degradation. In 1984, Pike and Davis derived an empirical relationship between fresh crater depth and diameter based on a photoclinometric analysis of 47 simple and 84 complex craters across Mars [1]. A new study combining photoclinometric and shadow estimation techniques for the derivation of crater depths reveals that a single depth-diameter (d/D) relationship does not adequately describe the observations across all of Mars. When a statistically reliable d/D relationship for fresh craters within a specific region can be derived, d/D ratios for nonpristine craters in the same area can be compared to the ratio for fresh craters for an estimate of the degree of degradation that has affected the region. Preliminary analysis indicates that most of the studied regions display well-defined localized variations in crater degradation, suggesting episodes of enhanced regional obliteration.

This study determines crater depth through use of photoclinometric profiles [2]. Random checks of the photoclinometric results are performed using shadow estimation techniques. The images are Viking Orbiter digital format frames; in cases where the digital image is unusable for photoclinometric analysis, shadow estimation is used to determine crater depths. The two techniques provide depth results within 2% of each other. Crater diameters are obtained from the photoclinometric profiles and checked against the diameters measured from the hard-copy images using a digitizer. All images used in this analysis are of approximately 40 m/pixel resolution. The sites that have been analyzed to date include areas within Arabia, Maja Valles, Memnonia, Acidalia, and Elysium. The d/D analysis of fresh craters within the five regions is listed in Table 1. Only results for simple craters (craters <5 km in diameter) are discussed here because of the low numbers of complex craters presently measured in the analysis. General results indicate that impact craters are deeper than average within the Medusae Fossae Formation of the Amazonis-Memnonia region. This is likely the result of impact into fine-grained, friable deposits [3]. A wide range in d/D values exists within the heavily cratered terrain of Arabia, Maja Valles, and Memnonia; this may reflect either differences in the particle size of the target material or in the composition of the target. Craters within the martian northern plains show a tendency to become shallower with increasing latitude, as exemplified by the different d/D ratios in Elysium vs. Acidalia. This result has been proposed by previous investigators [4] as an indication of increasing amounts of subsurface ice as the polar regions are approached. This explanation is supported by evidence of lobate ejecta morphologies surrounding fresh impact craters down to 1 km in diameter in Acidalia, based on the theory that lobate ejecta morphologies result from impact into subsurface ice reservoirs [5]. Sufficient numbers of fresh impact craters have been included in the d/D analysis within the Maja Valles, Elysium, and Acidalia regions of Mars to provide a statistically viable relationship. Within these regions we can therefore compare the d/D ratios of nonpristine impact craters to the average d/D ratio for fresh craters and obtain an estimate of the amount of degradation that the nonpristine impact craters have experienced. Dividing the measured crater depth by the depth expected for fresh craters of identical size gives a percentage change in depth. Restricting the comparison to simple craters provides a quantitative measure of the degree of degradation suffered by craters <5 km in diameter within the region of study. The results indicate that localized areas within the general regions have experienced varying amounts of degradation. No correlation between the region of degradation and geologic unit or thermal inertia is observed. Crater size-frequency distribution analyses can provide some general information about the timing of these obliteration episodes, but the error bars are large and therefore little about the relative timing of these episodes can be deduced at the present time. Continuing analysis with larger numbers of impact craters will help to reduce these error limits and perhaps allow comparisons of the timing of these obliteration episodes between different regions.

In conclusion, a single d/D relationship for fresh impact craters on Mars does not exist due to changes in target properties across the planet's surface. Within regions where target properties are approximately constant, however, d/D ratios for fresh craters can be determined. In these regions, the d/D ratios of nonpristine craters can be compared with the fresh crater d/D relationship to obtain information on relative degrees of crater degradation. This technique reveals that regional episodes of enhanced degradation have occurred. However, the lack of statistically reliable size-frequency distribution data prevents comparison of the relative ages of these events between different regions, and thus determination of a large-scale episode (or perhaps several episodes) cannot be made at this time.

TABLE 1.

	Simple Craters		Complex Craters	
Region	N	d/D	N	d/D
Arabia	8	0.07 (±0.05)	1	0.09 (± ∞)
Maja Valles	41	0.06 (±0.06)	7	0.04 (±0.02)
Memnonia				
Noachian Terrain	14	0.21 (±0.05)	11	0.17 (±0.05)
Medusae Fossae	6	0.35 (±0.04)	6	0.23 (±0.05)
Elysium	32	0.12 (±0.02)	5	0.05 (±0.05)
Acidalia	57	0.06 (±0.03)	8	0.06 (±0.05)

Error limits reflect the range of d/D values for the data used.

References: [1] Pike R. J. and Davis P. A. (1984) *LPSC XV*, 645–646. [2] Davis P. A. and Soderblom L. A. (1984) *JGR, 89*, 9449–9457. [3] Barlow N. G. (1993) *LPS XXIV*, 61–62. [4] Cintala M. J. and Mouginis-Mark P. J. (1980) *GRL, 7*, 329–332. [5] Barlow N. G. and Bradley T. L. (1990) *Icarus, 87*, 156–179.