HISTORY OF MAJOR CRATER DEGRADATIONAL EVENTS ON MARS: PRELIMINARY RESULTS FROM CRATER DEPTH AND DIAMETER MEASUREMENTS Joseph M. Boyce, Peter Mouginis-Mark, Harold Garbeil, Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, Hawaii; and Laurence A. Soderblom, U.S. Geological Survey, Flagstaff, Arizona.

Introduction: In an effort to gain insight into the degradational history of Mars, we have measured the depth (d) and diameter (D) of 4355 craters (D ranging from 6 km to over 200 km) using the technique developed by [1] applied to the 128th degree MOLA digital elevation model for both lowland and highland terrains. The locations of these craters are shown in Figure 1.

Results and Discussion: A preliminary assessment of the data suggests that location (in particular latitude), terrain type and terrain age have been important factors in controlling the development of the d/D relationships of craters on Mars. Scatter plots for d/D distributions for craters in mid and high-latitude, Noachian (Figure 2 a, b) and Hesperian-age (Figure 3 a, b) highland and Hesperian/Amazonian-age lowland terrain (Figure 4a, b) show that the "fresh" crater d/D distribution of complex (i.e., strength regime) lowland craters is ~ $d = 0.37\ D^{0.46}$ while that of the complex craters, in highland Noachian and Hesperian-age terrain is ~ $d = 0.180\ D^{0.72}$. However, in the high latitudes, fresh craters are only found between 30 and 55 km diameter in Noachian-age highland terrain > +/- 30˚, and between 12 and 70 km diameter in the northern lowlands > 50˚ N (Hesperian highlands do not show these trends). More commonly, the regions sampled have an abundance of relatively fresh and deep craters with the smaller of these craters, on average, being proportionally shallower than large craters. This produces a steeper slope to the d/D distribution function for these craters compared with fresh crater d/D curve, one consistent with partial burial. In addition to this population of relatively deep craters, the d/D distributions of the crater populations commonly show clusters or modes of shallower craters that approximately parallel (although always steeper) the fresh crater d/D distribution. We suggest that these are produced by episodes of rapid crater degradation caused by major erosion or blanketing events. Furthermore, we suggest that the slopes of the d/D distribution functions of these clusters are an indicator of the type of event (i.e., erosion produces steeper slopes while blanketing produces shallower slopes) [2, 3] and that the relative number of craters within each cluster is an indicator of relative age (Figure 5). For example, shallow, Early Noachian-age craters are common on terrain of all ages. These craters are thought partially buried by large scale volcanic flooding in the Late Noachian [4, 5]. Similarly, in the Noachian-age mid-latitude highlands a clustering of intermediate-depth (i.e., in between the old subdued craters and the fresh and deep craters) Later Noachian-age craters occurs whose d/D distribution function (i.e., in particular, its slope) is consistent with erosional degradation, possibly a result of fluvial processes [e.g., 2, 2, 6, 7]. In addition, a clustering of intermediate depth craters is also found in the northern lowlands. However, the shallowing of craters in this cluster is due to partial burial by the Vastitis Borealis Formation (VBF) in the Late Hesperian/Early Amazonian [8, 9, 10].

Conclusions: These observations are in general consistent with those of other workers (mentioned above) and suggest that a planet-wide period of resurfacing occurred early in the Later Noachian, followed by a period of rapid erosion, possibly fluvial, later in the Noachian that rapidly degraded landforms in the mid-latitude region. The effects of this Late Noachian-age degradational episode is not recognized in crater d/D distributions in high-latitude terrains suggesting that the operation of processes responsible for producing the distribution may have been latitude dependent. Following this event, the VBF was emplaced, possibly by water that carved the outflow channels. In the highlands from Early Hesperian, and in the lowlands from the later Hesperian/Amazonian onward, craters appears to have been degraded principally by infilling (probably eolian) and burial by volcanic materials. Furthermore, the presence of relatively small craters in Hesperian-age, high-latitude terrain, but the absence of small fresh craters in high-latitude in both Hesperian/Amazonian-age lowland and Noachian-age highland regions hint at processes that require substantial water in surface and near surface materials [11, 12].

References: [1] Mouginis-Mark, P.J., et al. (2004) *J. Geophys. Res.*, 109(E8), doi:10 1029/2003JE002147; [2] Forsberg-Taylor, N. K., et al. (2004), *J. Geophy. Res., 109(E0)*, 5002, doi:10 1029/2004JE002242; [3] Boyce, J. M., et al., (2004), *Lunar Planet. Sci. XXXV*, abs #1967; [4] Scott, D. H., and K. L. Tanaka, (1986), *U.S. Geol. Sur. Misc. Invest. Map, I-1802-A*; [5] Greeley, R., and J. E. Guest, (1987) *U.S. Geol. Sur. Misc. Invest. Map, I-1802-B*; [6] Craddock, R., and T. Maxwell (1993) , *J. Geophys. Res*., 98(E2), 3453-3468; [7] Craddock, R., and A. D.Howard, (2000) *J. Geophy. Res.*, 10.1029/2001JE001505; ; [8] Head et al, (1999) *Science, 286*, 2134-2137; [9] Tanaka et al, (2004) *J. Geophs. Res., 108(E4)*, 8043, doi:10.102/2002JE00 11908; [10] Boyce J. M. et al.,(2005a) *J. Geophys. Res.*, 110, E03008, doi:10.1029/ 2004JE002328.; [11] Garvin, J. B., et al., (2000), *Icarus, 144*, 329-352; [12] Stewart, S, and G. Valiant (2005) *Meteoritics and Plant. Sci*, in press.

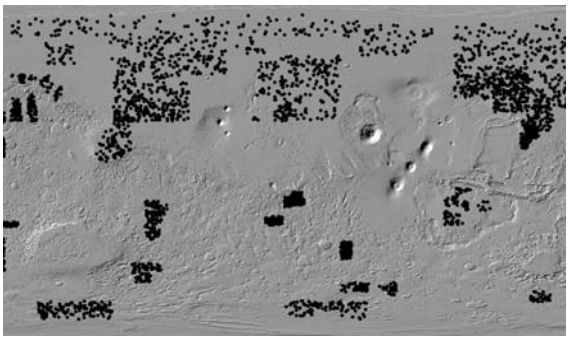

Figure 1. Global distribution of craters in this study.

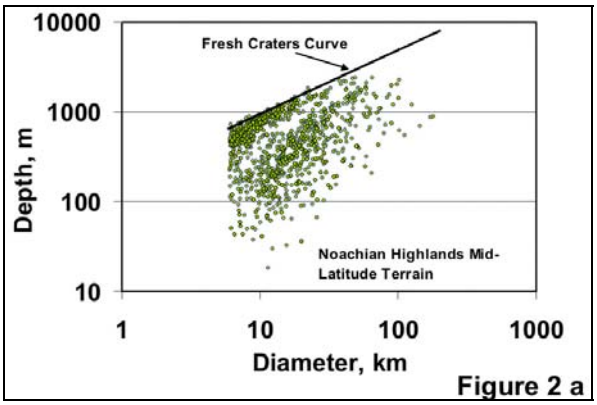

Figure 2 a

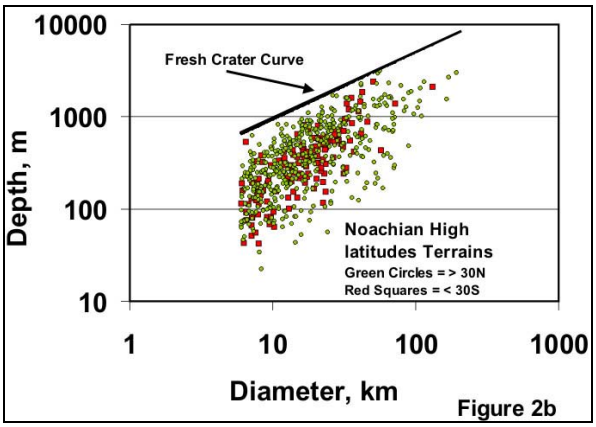

Figure 2b

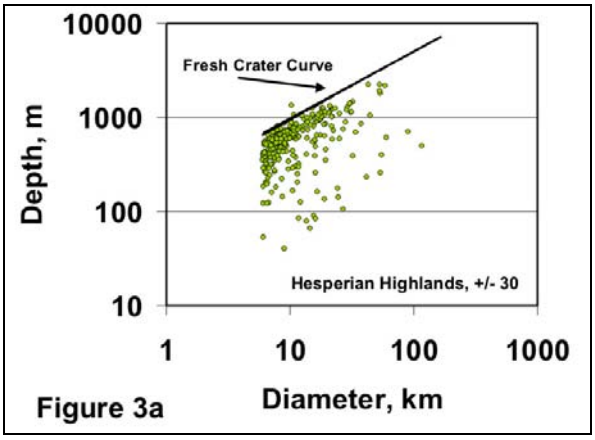

Figure 3a

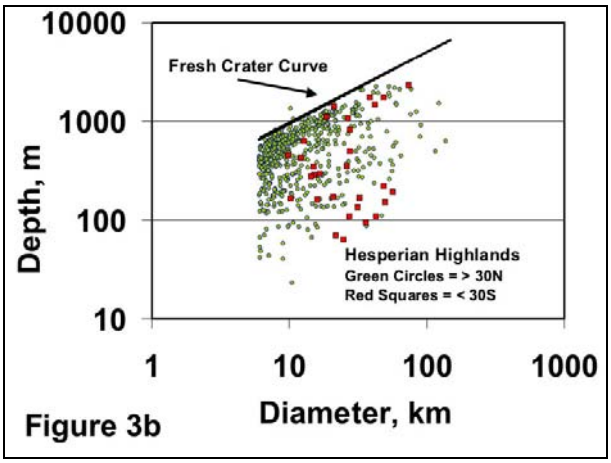

Figure 3b

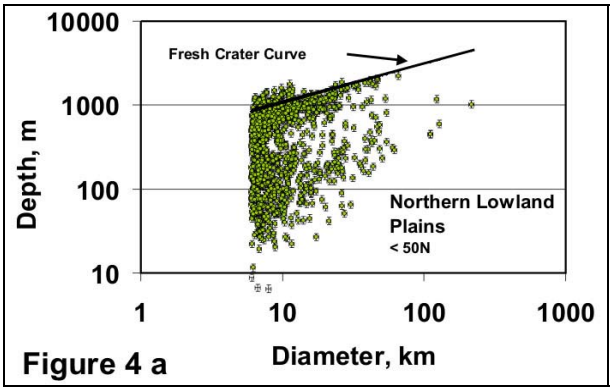

Figure 4 a

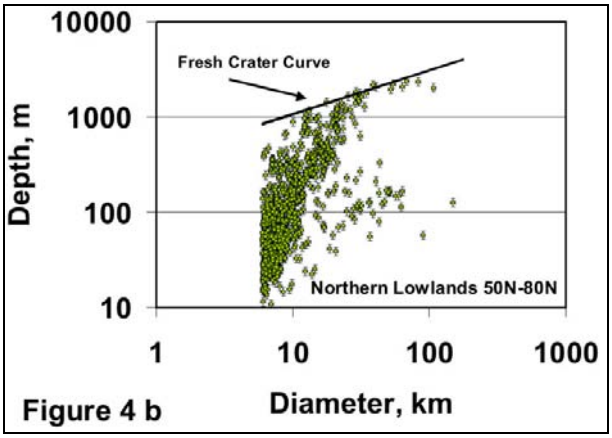

Figure 4 b

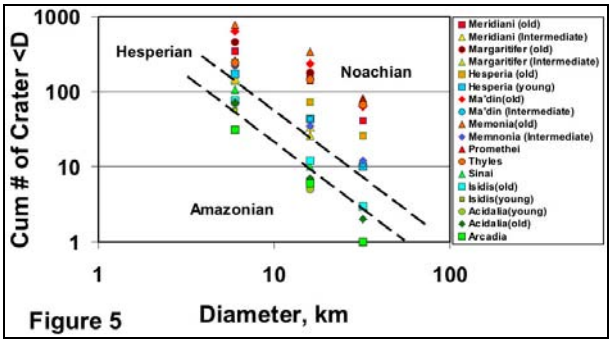

Figure 5