EVIDENCE FOR A THICK MANTLE OF VOLATILE-RICH MATERIALS IN THE UTOPIA BASIN, MARS, BASED ON CRATER DEPTH/DIAMETER MEASUREMENTS: Joseph M. Boyce[1], Peter J. Mouginis-Mark[1], James B. Garvin[2], and Harold Garbeil[1], [1]Hawaii Institute of Geophysics and Planetology, University of Hawaii, jboyce@higp.hawaii.edu, [2]Solar System Exploration Division, NASA Headquarters[2]

Introduction: This study focuses on the depth/diameter (d/D) relationships of impact craters within Utopia Basin (25°N-70°N, 88°W-150°W), Mars. In order to search for spatial variations in the study area, d/D values for a total of 1,430 craters have been grouped by sub-regions based upon their similar d/D characteristics. This has revealed a significant difference in d/D relationship for craters in north central Utopia basin compared with other parts of the basin, and withother areas on Mars. Preliminary measurements have also been collected in four additional test areas (Acidalia, Sinai, Sirenum, and south of Argyre) for comparison purposes.

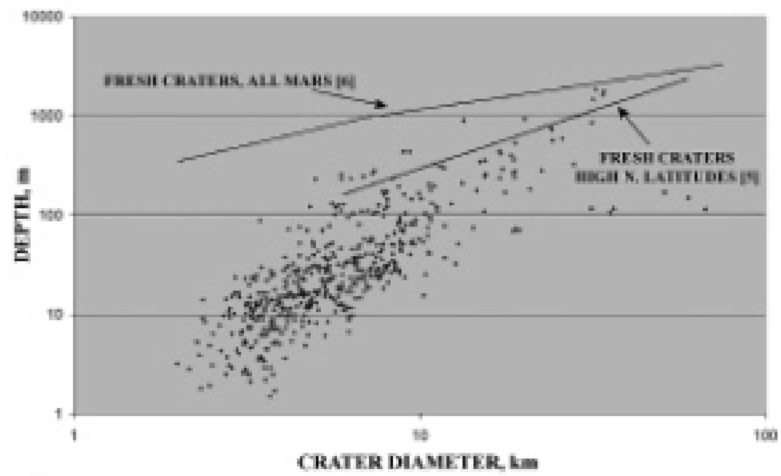
The technique described by [1] was used to measure d/D for all craters (ranging from ~2 km to 66 km dia.) in the study area. The gridded 1/64° MOLA data set was used for these measurements. Two different types of d/D were measured for each crater, as follows: 1) the difference in elevation between the crater floor and the rim (d_R/D), and 2) the difference in elevation between the surface surrounding the crater and the floor (d_s/D).

Background: Past studies of Martian impact crater geometry, which all measured only d_R/D [2, 3, 4, 5, 6], found that fresh craters follow the same general d_R/D trend found in fresh craters populations on all other terrestrial planets. These studies suggested that in a given area, each crater is initially produced with fresh crater d/D and subsequently changes shape (i.e., generally their d/D ratio decreases) as a result of modification by surface processes. Although the observed shallow depths of many Martian craters may be mainly due to erosion and deposition, it has also been suggested that the effects of volatiles on the cratering process may also have some initial effect [2, 5, 6]. It has been noted [5] that the fresh crater d_R/D relationship may be different for craters in the north polar region because of target material effects. Based on these studies, we assume that craters measured for this investigation initially formed with the fresh crater d/D, and that changes in geometry are due to the action of surface processes.

Results: The data show that the Utopia basin can be divided into three regions: <u>Region #1</u>, south of 45°N (848 craters); <u>Region #2</u>, N. Central Utopia (45° - 70°N, 514 craters); and <u>Region #3</u>, edges of the basin (45° - 70°N, 88° - 92°E and 130° - 150°E, total of 68 craters). In Regions #1 and #3, the d_R/D and d_S/D are similar to each other and to other regions at the same latitude. In Region #2, located in north central Utopia basin, d_S/D is markedly different from d_R/D or d/D in any other region. In Region #2, it was found that crater depth is not related to crater diameter, but that crater floors are at nearly the same elevation as the surrounding terrain (i.e., the exponent in the d_S/D relationship is zero), no matter what the size of the crater (Figure 1). In contrast, in Region #2 the d_R/D relationship is similar to other such relationships common to high-latitudes [5], where depth is a function of diameter (Figure 2).

Interpretation: In order for the type of anomalous d_R/D and d_S/D relationships to have developed in the north central Utopia basin (Region #2), we believe that our data support the hypothesis that the region is blanketed by a nearly continuous mantle of volatile-rich materials. Such a mantle must be thin enough to allow crater rims to stick through, but thick enough and continuous enough to cover both the crater floors and plains surrounding the craters. The mantle must also erode uniformly to maintain the elevation of crater floors at the same relative level as the surrounding plain throughout the region. This type of erosional behavior is diagnostic of deflation of volatile-rich sediments. With such a mantle, crater rim heights are still expected to be a function of crater size because the relative distance between floors and rims increases with increased crater size even though the floor elevation may remain constant. Evidence has existed since Mariner 9 observations for a heavily eroded mantled in the high latitudes of Mars [e.g., 7], the Utopia mantle is different. The heavily eroded, high latitude mantle is mainly found on crater floors and as isolated remnants on the surrounding plains, while the mantle in north central Utopia basin occurs inside craters and completely burying the surrounding plains. It is suggested here that these two mantles have different origins because of their difference in spatial distribution and vastly different thicknesses. The heavily eroded, high latitude mantle is thought to be caused by the effects of climate variations. We propose that the mantle in north central Utopia is ultimately a result of flooding of the type described by [8,9].

References: [1] Mouginis-Mark, P.J. et al., this volume. [2] Cintala, M. and Mouginis-Mark P. J. (1980) *GRL 47*: 4119-4121. [3] Pike, R. J. (1980) *Icarus 43*: 1-19. [4] Pike, R. J., and Davis, P. (1984) *LPSC XIV*: 645-646. [5] Garvin, J. B. et al. (2000) *Icarus 144*: 329-352. [6] Garvin, J. B. (2002) *LPSC XXXIII*: 1255-1256. [7] Soderblom, L. A. et al. (1973) *JGR 78*: 4117-4122. [8] Parker, T. J. et al. (1993) *Icarus 98*: 11061-11078. [9] Head, J. W. et al. (1999) *Science 286*: 2134-2137.



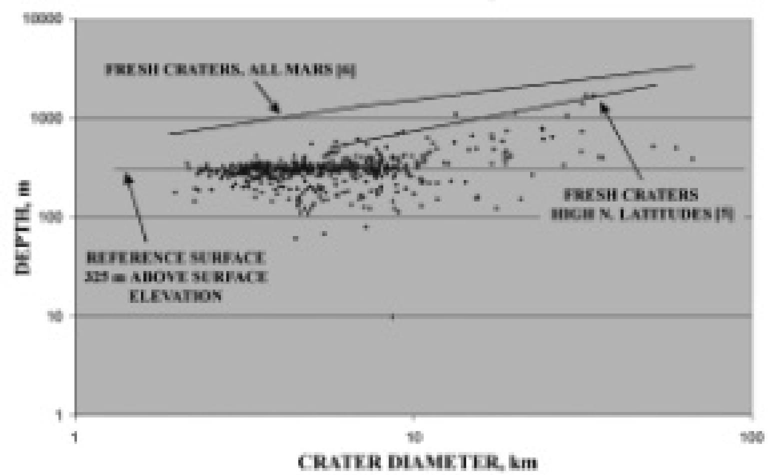


Figure 1 (Top): Plot of crater diameters against crater depths relative to crater rim. Lines represent d/D for all fresh craters from [6], and all fresh high latitude northern craters from [5]. Figure 2 (Bottom): Plot of crater diameters against crater depths relative to the surrounding surface. All depths have had 325 m added to their value to make all measurements positive. Lines are the same as in Fig. 1.