Deep Impact Craters in the Isidis and Southwestern Utopia Planitia Regions of Mars: High Target Material Strength as a Possible Cause, Joseph M. Boyce, Peter Mouginis-Mark and Harold Garbeil, Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, Hawaii 96822, and Livio L. Tornabene, Dept. of Earth and Planetary Sciences, University of Tennessee, Knoxville Tennessee 37996

Using THEMIS, MOC and MOLA data, we have found 120 craters in the diameter range 6 - 11.2 km that have unusually high depth/diameter (d/D) ratios (i.e., 0.0012) within southwestern Utopia Planitia and Isidis Planitia, Mars (Figure 1). Previous studies [1, 2, 3] noted a concentration of deep simple craters located mainly in SW Utopia Planitia suggesting that the deep simple craters could be caused by 1) layering in the subsurface, 2) differences in bolide characteristics, or 3) abnormal strength of the target materials conducive to enhanced excavation during crater formation. Layering by itself appears to be ruled out because there is also evidence for layering in many other places on Mars [e.g., 4, 5, 6, 7]] none of which show the same effects on their fresh crater d/D relationships as found in the study area [2, 3, 8] as would be expected if layering alone produced the deep craters. The restricted spatial distribution of the deep craters also appears to rule out bolide characteristics (e.g., strength, velocity] as a controlling factor. However, several lines of evidence suggest that the depth of the deep craters in SW Utopia and Isidis Planitia result from the effects of a regional rock unit that is composed of unusually strong (not weak) target materials: (1) the similarity of the d/D distribution of the deep craters in this study with simple craters (Figure 2); (2) the restricted geographic distribution of the deep craters; (3) their simple morphology (Figure 3); and (4) data from previous impact and explosion crater studies [9, 10, 11, 12, 13, 14, 15]. The effect of these strong target materials has been to delay gravity-controlled collapse of the cavities to large sizes. As a result, within Isidis Basin and Utopia Planitia, the simple to complex transition of the d/D distribution has been shifted to larger diameters, thereby producing craters that are over 50% deeper than predicted for fresh complex craters of the same diameter. In addition, a spectral unit, interpreted as an olivine-rich basalt, has been identified that is a reasonable candidate for these strong materials [6, 7, 16, 17]. The unit occurs around the edges of the Isidis basin and as part of the material exhumed and excavated by an 18 km diameter crater within the basin. This suggests that the olivine-rich basalt may dip toward the center of the Isidis Basin and is potentially tapped by craters throughout most of the basin.

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Figure 1: The location of craters measured by *Boyce et al.* [2005] and used in this study (~ 8.7 10^6 $km^{2)}$. Deep craters, (d/D ratios < 25% above fresh crater d/D ratios) are shown as triangles.

Figure 2: Depth to diameter relationships of craters in Isidis Planitia and southwestern Utopia Planitia. The d/D curve for freshest deep craters > 6 km (from this study) and the global fresh crater d/D curve (both simple and complex craters) from *Garvin et al*. [2003] have been include for comparison purposes. This plot shows that the freshest deep craters in the size range ~ 5.0 to 11.2 (dashed line) follow a relationship that is similar (i.e., has the same slope) to that of the global average of fresh simple craters (solid lines).

Figure 3. THEMIS images of a typical deep crater found in the study area. The crater is ~ 11.2 km diameter, and ~ 1950 m deep and located at 28.7°N, 119.9°E. This crater shows simple interior morphology and multi-layer fluidized ejecta blanket. Based on the d/D function of *Garvin et al.* [2003] the depth of crater (a) is predicted to be 1178 m. (THEMIS image V13938007).

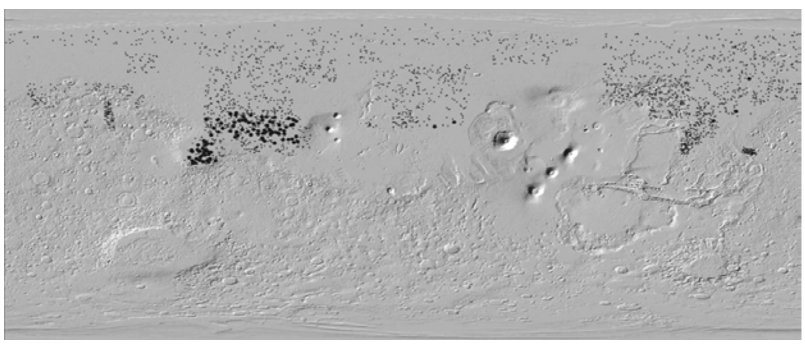

Figure 1

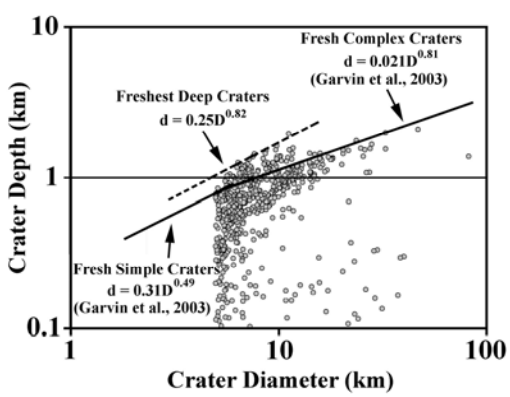

Figure 2

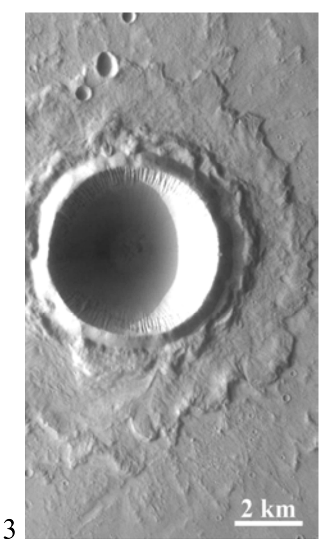

Figure 3