

**IMPACT CRATERING ON MARS: SEARCH FOR TARGET INFLUENCE ON MORPHOLOGY.** S. C. Werner<sup>1</sup>, B. A. Ivanov<sup>2</sup>, and G. Neukum<sup>1</sup>, <sup>1</sup>Freie Universität Berlin, Germany (swerner@zedat.fu-berlin.de), <sup>2</sup>Institute for Dynamics of Geospheres, Russian Academy of Science, Leninsky Prospect., 38-1, Moscow, Russia (baivanov@idg.chph.ras.ru).

**Introduction:** Within the framework of the project "Chronostratigraphy of Mars" the investigation of morphologies of differently sized craters superposed on different geological units has been started. The aim is to assess the role of the projectile nature (asteroid vs. comet) and the target properties (water or ice content) in the crater formation process and thus in the morphological appearance and size parameters of craters. Objects that may reflect the volatile content are craters with fluidized ejecta blankets (FEB) [1] varying in their morphology of interiors and some quantitative parameters such as crater depth/diameter, rim height/diameter ratios and additionally the diameter ratios of the crater cavities to their ejecta blankets. It is widely believed that FEBs manifest the presence of water or ice. Comparing crater morphology and morphometry for various FEB appearances may give us a key to the amount of volatiles in the target, crater scaling laws and, finally, the improvement of the absolute Mars cratering chronology transferred from the moon.

**Large Crater Morphometry:** We started with selected double ring craters such as Lyot, Lowell, Kepler, Galle and Flaugergues, all roughly 220 to 240 km in diameter. The goal is to compare crater morphometry of large craters in various geologic regions of Mars. The preliminary results show that they appear (if not filled by sediments as Kepler is) as rather deep depressions with distinct inner ring features. One of these craters, Lyot, in the south of the Northern Plains was earlier considered by [2] as a crater whose transient cavity penetrated into the global aquifer suggested in the hydrology model of Mars by [3]. However, these authors have not found anything morphologically indicative of the cavity penetrating to an aquifer and they did not analyze Lyot in relation to the above mentioned morphometric parameters. However, MOLA topography shows that being as deep as Lowell crater (~3 km), the inner rim of Lyot reaches the pre-impact level while the inner rim crest of Lowell (as well as in Kepler and Galle) situated ~1.5 km below the local pre-impact level (Fig. 1). This fact indicates that even for large craters some morphometric parameters may vary reflecting the target properties. This is a good starting point for numerical modeling of the influence target properties on large-crater formation.

**Smaller Crater Morphometry:** The starting set of craters with diameters ~30 km is compiled from Barlow's catalog to have 5 to 6 example craters for various morphologic classes: single, double, and mul-

iple lobated, and "dry" appearance of crater ejecta blanket. In addition several "unclassified" craters are investigated. The profiles for each crater are compiled from MOLA data for 4 directions through the crater center. Fig. 2 and 3 show the main morphometric parameters for the studied craters. Depth is not shown as many craters are partially filled with aeolian deposits. It seems that the central peak position below the target level and the average rim height are not very sensible to the change in target properties, reflected in ejecta blanket morphology (Fig. 2). The main difference found to date in the limited data test set is a weak tendency of craters with single lobe ejecta to have less steep inner walls (Fig. 3). We also note the systematic deviation of measured parameters from generalized relationships published by Garvin et al. [4].

**Numerical modeling of impact cratering:** The numerical modeling allows us to investigate impact crater formation from basic principles. The modeling gives information how the crater size and morphology depends on the projectile impact velocity, target strength etc [5]. In the current project we have started with modeling of the projectile type influence (2-km diameter asteroid at  $8 \text{ km s}^{-1}$  vs. 2-km diameter comet at  $15.5 \text{ km s}^{-1}$ ) on the crater diameter and depth. It resulted in the absence of any significant difference in the crater diameter (about 30 km), depth (1 km) and inner slope steepness (about  $15^\circ$ ), but the impact melt production and central peak morphology have been found to be different. We have compared our results with observational data from [4] and found a good fit for the crater depth, rim height and central mound width, but a poor fit for the central peak height, the computed peak came out too high. Modeling of the morphologic and morphometric characteristics of these craters will give us sets of model parameters like target strength and a key to understanding the influence of water in the target on the crater morphology and the mobility of ejecta.

Comparison with the numerical model of a crater similar in size shows that the model with the initial set of parameters allows us to reproduce the general crater morphology (central peak crater), and the crater depth. The variation of the model parameter set (Fig. 4) may be used to understand the dependence of the crater shape on material properties of a target.

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**References:** [1] Barlow N. and Perez C.B. *JGR* 108, E8, 4-1. [2] Russell & Head (2002) *GRL*, 29, 17, 8-1, 2002*M&PS*, 36, 371-380. [3] Clifford (1993) *JGR*, 98, E6 10973-11016. [4] Garvin et al. (2003) *6th Int. Conf. on Mars*, #3277. [5] Ivanov et al (1997) *International Journal of Impact Engineering* 20: 411-430 .

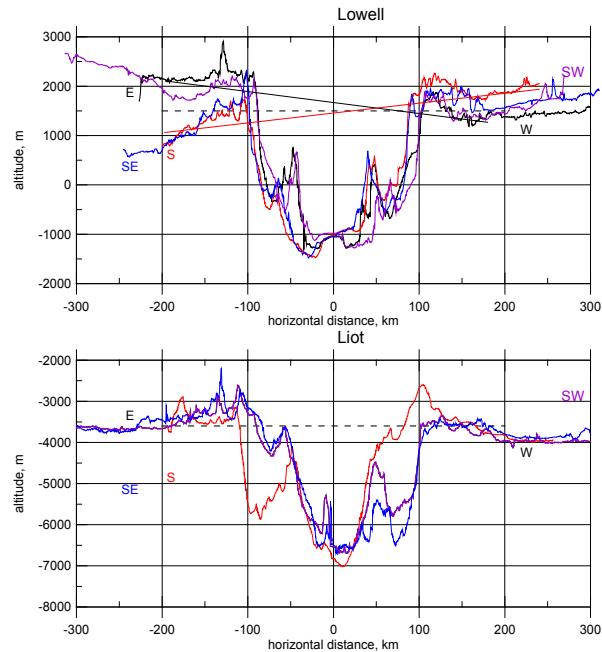


Fig. 1. Profiles of MOLA altimetry data across Lowell (top) and Liot (bottom) craters. Note the different depth of the inner rim crest – the inner rim in Liot reaches the pre-impact surface.

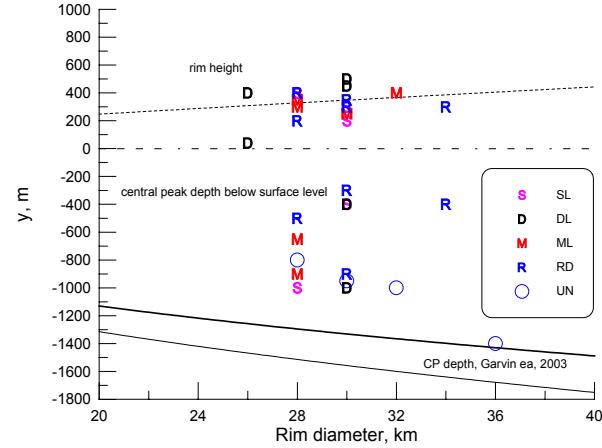


Fig. 2. Rim heights and central peak (CP) depth below the initial target level for craters with various types of ejecta blanket: single (SL), double (DL) and multi-(ML) lobed , radial (“dry”) deposits (RD), and unclassified cases (UN).

All data for CP depth are well above averaged relationships by Garvin et al. [4].

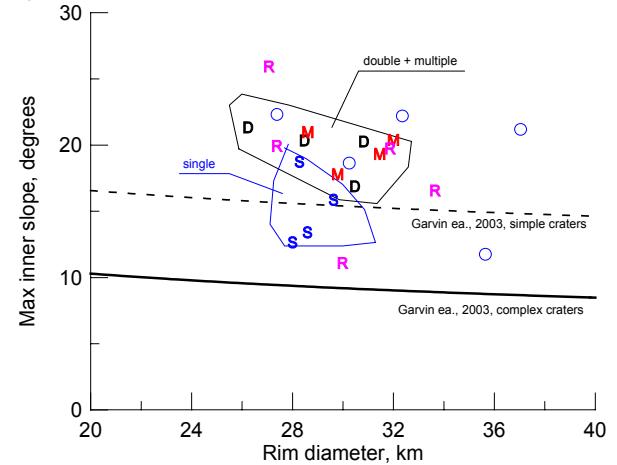


Fig. 3. Maximum slope for the same craters as in Fig. 2. Craters with SL ejecta tend to have less steep maximum slope of inner walls. All data are well above the average relationships from [4].

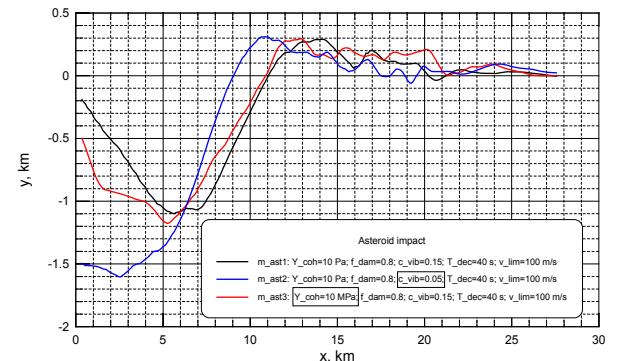


Fig. 4. Crater profiles for numerical modeling of the vertical asteroid impact (projectile diameter of 2 km at impact velocity of 8 km s<sup>-1</sup>). The starting run (black curve) produce the crater of ~28 km rim crest diameter with the central peak uplifted ~200 m below the preimpact surface. Changing of the model parameters (intensity of AF-model block oscillations – red curve – and the cohesion of damaged material – blue curve) results in a crater shape with smaller diameter and less developed central peak.