DEPTH/DIAMETER RATIO AND INNER WALLS STEEPNESS OF LARGE PHOBOS CRATERS

A. A. Kokhanov[1], A. T. Basilevsky[2], I. P. Karachevtseva[1], I. E. Nadezhdina[1], A. E. Zubarev[1], [1]Moscow State University of Geodesy and Cartography (MIIGAiK), MIIGAiK Extraterrestrial Laboratory (MExLab), Gorokhovskiy per., 4, 105064, Moscow, Russia, s_kokhanov@mexlab.ru, [2]Vernadsky Institute, Kosygin Str. 19, 119991, Moscow, Russia.

Introduction: Craters are the most abundant landforms on Phobos. They were described in numerous publicatioins since early observation by Mariner 9 and Viking Orbiter as generally similar to lunar craters and having all degrees of sharpness [e.g., 1, 2]. Quantitative characterization of Phobos craters morphology became possible since imaging of this body by Mars Express and working out its DEMs [e.g., 3, 4]. Further flybys of Phobos by Mars Express provided more images and allowed to work out better DEM with larger Phobos surface coverage [5]. This work is a continuation of the mentioned studies with concentration on craters ≥2 km in diameter.

Data and Analysis: We worked with the Phobos geodatabase [6] and new DTM produced at MIIGAiK [7] and products based on them including topographic profiles and hillshade images. Although the new DTM is global it includes structure lines (such as rim of craters or grooves) and in most paces its spatial resolution is between 50 and 100 m. But locally its spatial resolution is 1 x 2 km and even 1.5 x 3 km and the studied craters in these places can not be adequately characterized. On Phobos are observed 26 craters with diameter ≥2 km. Of then 3 are in the bad resolution places and could not be characterized so under study were 23 craters.

Topographic profiles provided to determine depth to diameter ratios (d/D) while hillshade images produced for different "Sun angle" over the horizon allowed to estimate steepness of inner walls of craters (see Fig. 1). On this figure is shown the 18 x 23 km area on Phobos with craters Stickney, Drunlo and Reldressal. Top is image mosaic, center is hillshade image produced for the "Sun angle" to be 25^o over horizon and bottom is hillshade image produced for the "Sun angle" to be 15^o. It is seen in the figure that at 25^o "Sun angle" inner walls of craters Drunlo and Reldressal show no shadows while inner wall crater Stickney does shows; at 15^o "Sun angle" inner walls of all these three craters do show shadows. The hillshade images used for his study were produced for the "Sun angle" to be 5, 10, 15, 20, 25 and 30^o over the horizon and illumination azimuth SE 135^o and NW 315^o. So we could estimate for each given crater if steepness of its inner slopes is larger or smaller than these angles. When even at the "Sun angle" being 5^o in the crater there was no shadow we arbitrarily were giving them the 2^o wall steepness.

Results of measurements of d/D and estimation the steepness of inner walls for the studied 23 craters are shown in Figure 2.

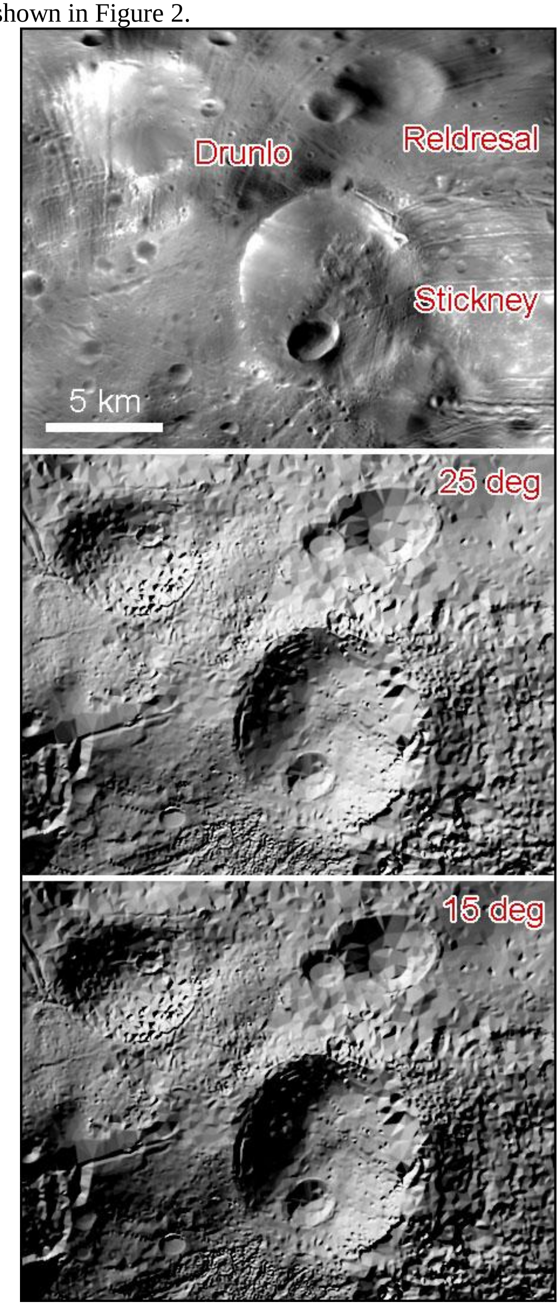

Figure 1. An example area on Phobos to demonstrate the technique to estimate steepness of crater inner walls based on presence/absence of shadows on the hillshade images produced for different "Sun angle" over horizon.

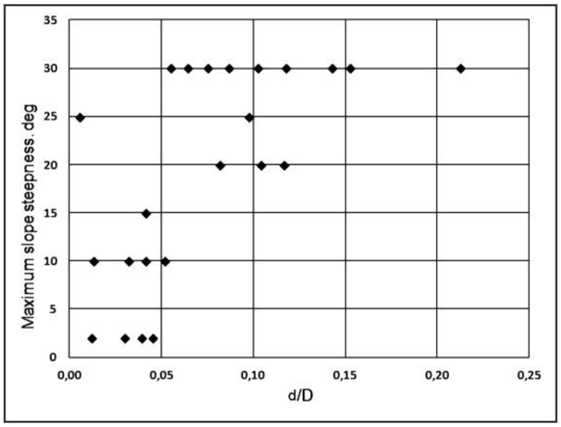

Figure 2. Correlation of the depth/diameter ratio and the inner wall steepness for the 23 craters of Phobos ≥2 km in diameter.

It is seen in the figure that, as expected, the d/D ratio and inner wall steepness show positive correlation which is partly violated by poresence of a few craters having inner slopes steeper than 30^o but relatively low d/D ratio (0.1).

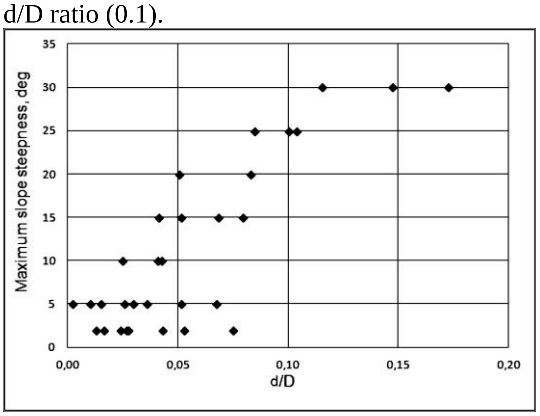

Figure 3. Correlation of the depth/diameter ratio and the inner wall steepness for the 31 lunar craters ≥2 km in diameter.

Figure 3 shows similar correlation of the depth/diameter ratio and the inner wall steepness for the 31 lunar craters ≥2 km in diameter located in the 62 x 25 km area of the lunar farside near 10^o N and 160^o W north of crater Korolev. This is the area shown on geologic maps as being of Nectarial age and free of clusters of secondary craters [8]. The crater outlines were taken from the LROC WAC mosaic and the DTM used in our study is GLD 100 which produced from LROC WAC stereo images [9].

It is seen in the figure 3 the depth/diameter ratio and the inner wall steepness of the 31 studied craters show good correlation with no cases typical for the Phobos craters among which there are ones having steep inner slopes but relatively low d/D ratio. This is probably because the background surface of the studied area of the Moon is close to horizontal while the Phobos background surface has the irregular topography with a few km range of altitudes.

Discussion: The results gained in this work is interesting to compare with ones published by [4] based on DEM for part of the Phobos surface [3]. In that work were produced topographic profiles for 6 craters from 1.8 to 8.6 km in diameter: Stickney, Reldresal, Drunlo, Clustril, Flimnap, Grilldrig (see Fig. 4).

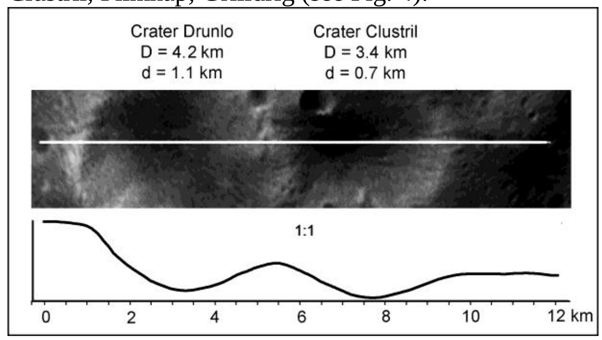

Figure 4. HRSC image of craters Drunlo and Clustril with the line of topographic profile and the profile through these craters.

That study showed that these six craters have steep inner slopes (up to 30-40^o). Locally as a result of addition with regional slopes they become to be 45-55^o. The ratio of the depths of the studied craters to their diameters varies from 0.15 to 0.24. In that work the studied craters of Phobos also were compared with lunar craters of the same size. Using Lunar Topographic Orthophotomap obtained by Apollo mission there were determined diameters and depths and their ratio for 244 craters located in the Gagarin crater area in the highland of lunar farside and for 7 craters located on the mare surfaces on the front side. It was found that the Phobos craters ratios are close to lunar mare ones and to the deepest (most preserved) craters of the highlands.

Summary: Using the new DTM of Phobos produced at MIIGAiK and products based on them including topographic profiles and hillshade images for 23 craters ≥2 km in diameter have been measured depth to diameter ratios and maximum steepnesses of the crater inner walls. These new results are in a good agreement with those taken for part of the Phobos area by [4].

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