MORPHOLOGICAL CHARACTERISTICS OF THE PHOBOS CRATERS AND GROOVES.

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Introduction: The Russian Mission PHOBOS-GRUNT is tentatively planned for a launch in 2009. It should deliver samples of Phobos' regolith back to the Earth. The successful landing and sampling of the regolith depend on the smoothness of the surface. So we analyzed the morphological characteristics of craters and grooves using the new data of Mars Express mission.

Background. In the August 2004 the High Resolution Stereo Camera (HRSC) of Mars Express obtained several high-resolution (7-14 m/pixel) images of Phobos surface [1]. These images made 5 stereo pairs (in the range of 160° – 360° W and 0° – 90° N). Photogrammetic processing of these data lead to consist two digital maps for about 1/3 of Phobos surface [2]. The first map (DTM-1) has resolution 80x80 m/pixel and accuracy 6 m of radius-vector's determination, but it has several gaps in data net. The second map (DTM-2) is the map of the same relief but smoother and without gaps. Its resolution is 240x240 m/pixel. These maps allowed getting calculated characteristics of relief f.e. declination of the surface features more than100-200 m across.

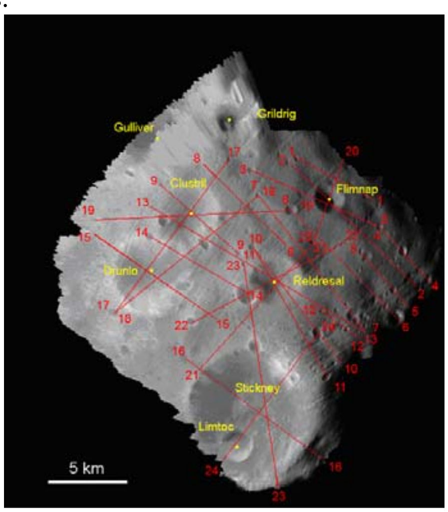

Fig.1. Topographic profiles on Phobos' surface on DTM-1 map.

Grooves. Using the DTM-1 map, we constructed 24 topographic profiles of Phobos' surface (fig. 1). And 17 of them cross the grooves at the angles between 45° and 90°, so we could measure the depths of the grooves. Altogether we measured 30 grooves: 27 of them have wide 150-300m and 3 – about 500m. Among 27 grooves 21 are not visible on the profiles so their depths are less than 10 m and 6 of 27 grooves have depths 15-30m. Two of 500m wide grooves have depth about 30m and one of them is less than 10m deep. So in general the grooves are not deep and have gentle slopes.

Craters. The most part of the profiles crossed the large craters, so we measured 6 craters from 1.8 to 8.6 km in diameter. All of them have the cup-form as the moon craters in the same range of diameters. The maximum angles of the inner slopes of these craters are observed in their upper parts in the range from 18° to 54°. Phobos is a small space body with irregular shape so almost all its craters are located on the regional slopes and so one of the inner slopes of these craters is as a rule steeper than another one. The ratio of the depths of the studied craters to their diameters varies from 0.15 to 0.24. We compared this parameter of Phobos craters to lunar ones of the same size. Using Lunar Topographic Orthophotomap obtained by Apollo mission we determined diameters and depths and their ratio for 244 craters located in the Gagarin crater area on the highlands on the back side of the Moon, and for 7 craters located on the mare surfaces on the front side. Fig. 2 shows that the Phobos craters ratios are close to lunar mare ones and to the deepest (most preserved) craters of the highlands.

To study the declinations of the inner slopes of the craters <1km in diameter we had used the HRSC image (7 m/px) from 0756 orbit and the Solar elevations map which was made on the base of DTM-1 with resolution 150-200m. There were identified 220 craters with diameters 80-100m and more on this image. For each crater diameters, the solar elevation at the crater location and presence of shadow were measured. There were selected six areas where the Solar elevation above the horizon was <5°, 10°, 15°, 20°, 25° and 30°and there were determined the squares of each of this area. Fig. 3 shows the cumulative crater frequency per 1 km^2 for all these areas and for all craters identified on HRSC image from 0756 orbit. The most similar are the craters from area between 16° and 20° solar elevations because their cumulative crater frequency is close or the same as lunar one

($N = 10^{4.9} D^{-2}$) [3, 4]. The crater frequencies for other areas (for upper and lower solar elevations) are lower because we could not see all craters in these cases. When the Sun is high the old craters are not seen, and when the angle between the Sun and horizon is low the most part of the surface is covered by a shadow. So we can select the area with optimal luminosity where all craters could be determined.

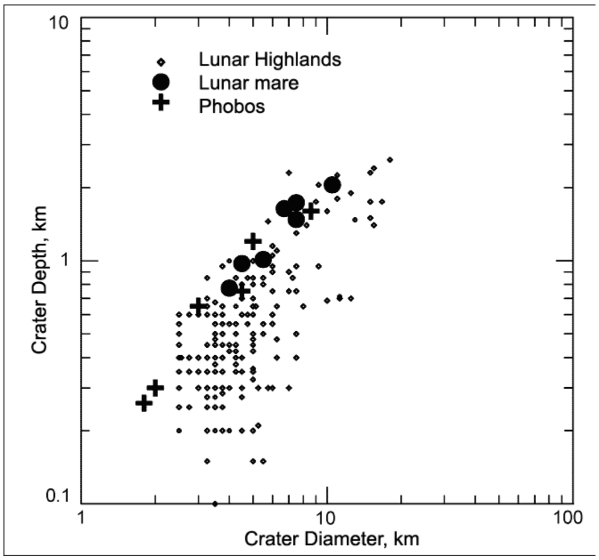

Fig. 2. *Crater depth/diameter correlation for Moon and Phobos.*

There is a correlation between the sizes and steepness of inner slopes for lunar craters [5]. The process of changing the crater morphology from B type to C type is longer for large craters comparing to small ones. So the most part of the large craters has steep inner slopes. To show this similarity between Phobos and Lunar craters we divided the craters from area with optimal luminosity in three groups by their diameters: 1) 90-200 m, 2) 200-400 m, 3) 400-650 m. In the first group of 18 craters only two (11%) have shadows inside. It means that their inner slopes have angles more than 15°. In the second group of 18 craters – 6 (33%) have shadows inside. And in the third group of 10 craters – 7 (70%) have shadows inside. So the larger the crater the steeper its inner slopes on the Phobos, too.

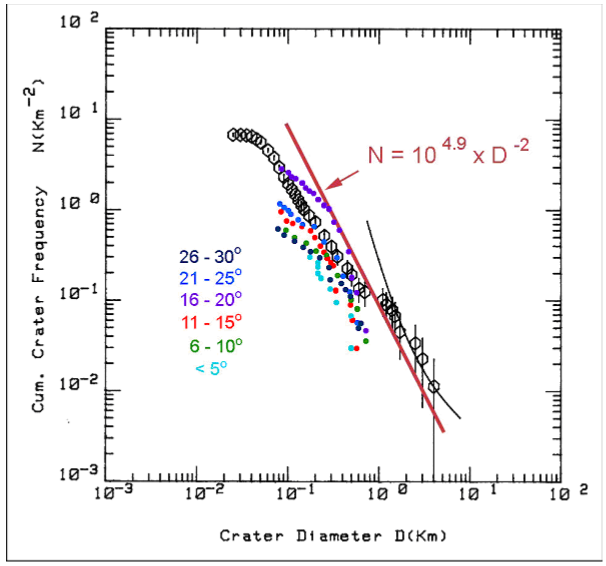

Fig. 3. *Size-frequency distribution of craters on the HRSC Phobos images (orbit 0756): in general and in the areas with different solar elevations.*

Conclusion. Morphological analyze of new HRSC images allowed to determine calculated characteristics of craters and grooves: their depth and inner slope steepness. The most part of grooves are not deep and have gentle slopes. The most part of large craters have steep inner slopes (up to 30-40°), with addition of the regional slopes they become 45-55°. The craters 100-200 m in diameter or less are very similar to lunar ones as in size so in shape. In spite of the fact that Phobos is a very small space body it is covered by the craters which are similar to the craters on the large planets.

References: [1] Neukum G. et al. (2004) In: *Mars Express: The Scientific payload. ESA SP-1240*. 17-36;[2] Giese B.et al. (2005) *Photogrammetry Fernerkundung Geoinformation*, 435-440; [3] Quaide W. L., Oberbeck V. R. (1969) *Earth Sci. Revs.*, 5 No 4; [4] Florensky K.P. et al. (1972) In: Modern knowledge about the Moon, Nauka, 21-45; [5] Basilevsky A.T. (1976) *Proc. Lunar Sci. Conf. 7th*, Pergamon Press, 1005-1020.