SATURN SATELLITE HYPERION: MORPHOLOGY AND GEOLOGY OF ITS SURFACE BASED ON RESULTS OF NASA MISSION CASSINI.

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Introduction: Here are considered surface morphology and geology of Saturn satellite Hyperion. This consideration is mostly based on results of recent cartographic-geodetic analysis of images taken by the NASA mission Cassini including new 3D model of this body [1, 2] with involvement of other Cassini results. Hyperion is rather small body of irregular shape (Fig. 1), which can be approximated by the 3-axes ellipsoid, with axes 355.2 km, 257 km and 213.2 km [2].

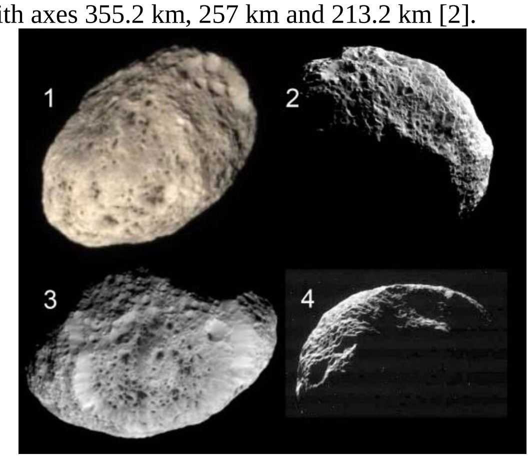

Fig. 1. Images of Hyperion taken by Cassini spacecraft; 1 – color image is mosaic of images taken by Cassini mission via red, green and blue filters at the distance 291000 km, 2, 3 and 4 – black-and-white images, obtained at the distances 90400, 244000, and 73000 km.

Hyperion orbits Saturn in retrograde way that indicates, that it could not formed in the protosatellite disk of Saturn, but is the captured body arrived from the outer region of circumsolar disk. Period of its orbiting is 21.276 days, semiaxis 1,481,009 km and eccentricity 0.123. It rotates around its long axis with average velocity 60.13 ± 16.4°/day [2]. Mean density of its material is 0.54 ± 0.05 g/cm^3 [3]. This suggests that it is composed mostly from water ice with some admixture of the "rocky" component that is supported by the spectroscopic observations [4]. The estimated Hyperion material porosity is ~0.46 [5]. Surface gravity is 0.017-0.021 cm/s^2, depending on the place [6]. Escape velocity is 45–99 m/s depending on the place. Albedo is - 0.3 [7].

Craters: It is seen in Fig. 1 that surface of Hyperion has the sponge-like appearance due to presence of numerous depressions, which are probably impact craters with diameters from less than 1 km to 20-30 km [8]. In Fig 1(3) is seen a planimetrically oval 200 x 250 km feature which probably is also impact crater. Its more detailed image is in Fig. 2.

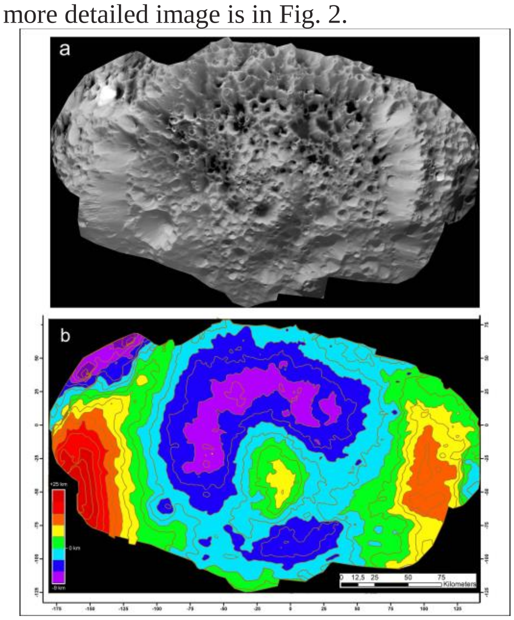

Fig. 2. Giant crater on Hyperion; a) mosaic of images taken by Cassini spacecraft; b) map of heights with color coding.

It is seen in Fig. 2 that this "giant" for this body crater has a central peak of about 100 km in diameter and about 5-7 km high over the floor level. This oval feature was mentioned as impact crater in [9, 10].

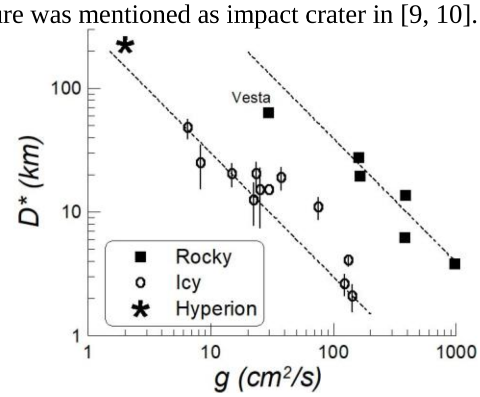

Fig. 3. The giant crater on Hyperion in comparison with simple to complex transition crater diameter after [12].

Mechanism of formation of this crater at a porous body, demands additional studies.

Also, it is seen in Fig. 2 that floor, central peak and rims of this giant crater are peppered by numerous craters with diameters from first kilometers to 20-30 km. They are absent or rare on the steep upper part of the inner slopes of the giant crater. So, it can be concluded that the giant crater was formed before the observed population of small craters was formed and that on Hyperion despite its small surface gravity the downslope material wasting is rather effective. In images shown in Fig. 4 are seen characteristics of craters with diameters from a few kilometers to 20-30 km.

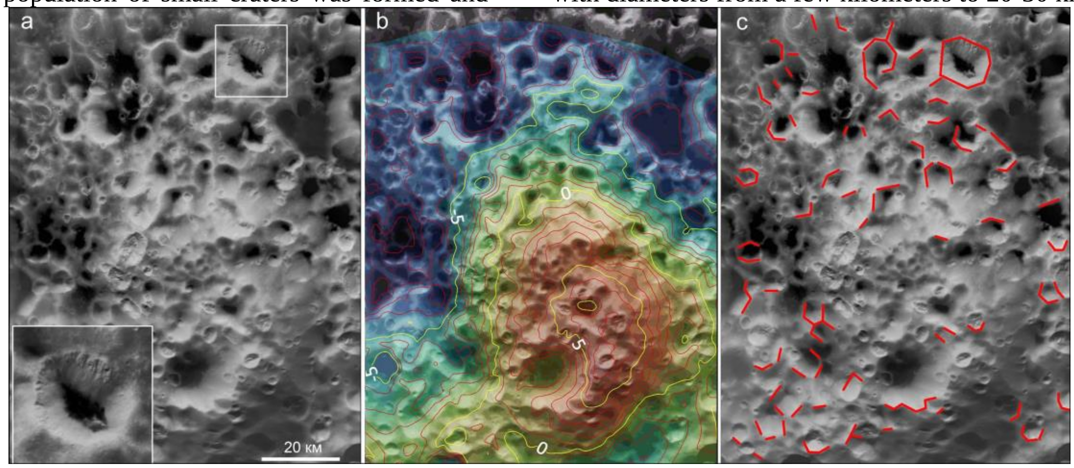

Fig. 4. Detailed view of the giant crater central peak. a) mosaic of images with 30 m/px resolution, inlet shows 14,5 x 12 km crater with dark material inside; b) the same with color coded heights and contour lines through 1 km relative to the surface of approximating ellipsoid; d) the same with shown in red the rectilinear parts of the crater rims.

It is seen in Fig. 4 km that small craters are locally superposed on each other that is typically for impact ones, but little evidence of crater ejecta is observed [5]. The latter may be due to high porosity of Hyperion material [8] and/or to enhance velocity of material leading to escape most of it from the body [13]. Many of kilometer-sized craters and a few observed those, which are 20-30 km in diameter, are not circular. Rims of them often are rectilinear (red lines in Fig. 4c). So, these craters are polygonal like many craters of Earth, the Moon and other bodies, suggesting that this is due to fracturing of the target material.

For 33 craters of Hyperion with diameters from 4.5 to 34 km we made measurements of their diameters *D* and depths *d* and calculated *d/D* ratios (Fig. 5). Our results generally agree with those in previous publications [e.g., 5, 9].

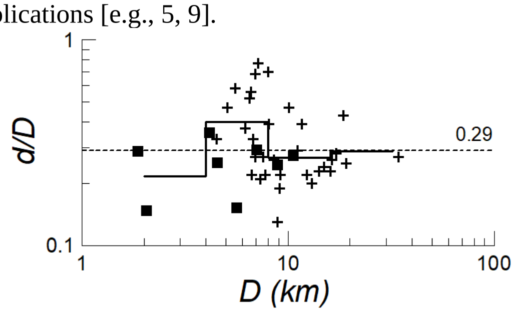

Fig. 5. Results of measurements of the crater depths and diameters, crosses – this work (using special stereo glasses with subpixel quality), black squares – [14].

General conclusions: The above consideration showed that Hyperion is a specific space body having characteristics intermediate between those of comets and icy satellites and deserves more studies, maybe special space mission.

Acknowledgments: Our study is based on the analysis of the NASA Cassini mission data.

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