CRATER-LIKE FEATURES ON THE SURFACE OF NUCLEUS OF THE COMET 67P CHURYUMOV-GERASIMENKO. S.S. Krasilnikov[1,2], A.T. Basilevsky[1,2], N.E. Demidov[1], N.A. Artemieva[3,4], U. Mall[2], H.U. Keller[5] , Yu.V. Skorov[2,5], S.F. Hviid[6], G. Michael[7]; [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, 119991 Moscow, Russia, zergovski@geokhi.ru; [2]Max-Planck-Institut für Sonnensystemforschung, 37077 Göttingen, Germany; [3]Institute of Dynamics of Geospheres, RAS, Moscow 117334 Russia; [4]Planetary Science Institute, Tucson, AZ 85719 USA; [5]Institute for Geophysics and Extraterrestrial Physics, TU Braunschweig, 38106, Braunschweig, Germany, [6]DLR Institute of Planetary Research, D 12489 Berlin, Germany; [7]Free University of Berlin, Berlin, Germany.

Introduction: On the surface of the 67P Churyumov-Gerasimenko comet nucleus are observed crater-like features [1,2] part of which could be modified impact craters. We have selected some of them using NavCam images [3] and built topographic profiles through them using the SHAP4S shape model [4] (Figures 1 and 2) to see the general form of the profiles and to measure the craters' diameters (D) and depth (d). The crater-like features (below we call them "craters") were given with names consisting of the region name and crater diameter in meters (first measurement): Hatmehit 1030, Hatmehit 171, etc.

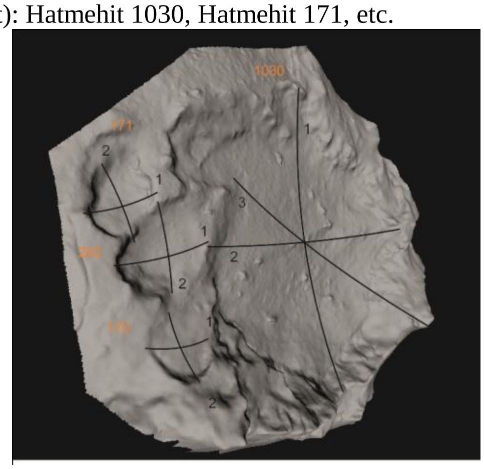

Figure 1. Profiles through crater-like features in Hatmehit region shown in the image made using the shape model.

The resulted measurements were compared with those produced by theoretical modeling of impact crater formation in the comet nucleus material [5].

Results: Below are shortly characterized craters of 8 regions: Ash, Atum, Babi, Hatmehit, Imhotep, Khepry, Ma'at, Seth [6]. In these areas we measured in total 45 features by building 75 profiles: from 1 to 3 for each feature. We constructed profiles by section by plane going through two surface points and the center of mass of the comet. The profiles length was measured along the surface model. From each profile we determined the crater diameter as distance between two crater rim crests and crater depth between the highest point of the profile and the floor. It is seen from Figure 3 that the considered craters vary in their D from 30 to ~1000 m and in their d/D from <0.1 to 0.9.

The crater images, both NavCam and those made from the shape model, show that often part of the crater rim looks as destroyed by some superimposed process. Theoretical modeling by [5] showed that for the comet material with porosity 60 - 85% and strength of 10 kPa the fresh formed impact craters should have d/D ~0.4-0.6. Superimposed erosion of the nucleus surface by sublimation could change the initial d/D, especially if the crater-forming impact changed the material propertied inside the crater and in its close vicinity. As a first approximation we assume that the d/D value may vary from 0.4-0.6 for fresh impact craters to ~0.1 for the eroded ones. Based on this we selected 19 features which could be impact craters modified at different degree by subsequent processes. They are listed in Table 1 and d/D (D) plot is shown in Figure 4.

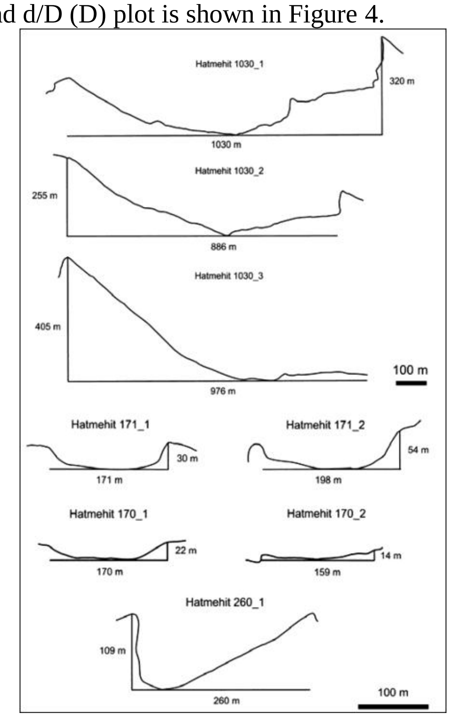

Figure 2. Profiles through crater-like features shown in Figure 1.

We make a rough estimate of the crater formation rate on the comet relative to the Earth's Moon using the lunar chronology system [7], the impact scaling equation of Ivanov [8], an 18.5x impact higher flux

Table 1. Craters of probable impact origin.

Name	Diameter, m	d/D
Imhotep_630	630	0,12
Imhotep_437	458±21	0,23
Atum_209	194,7±14,7	0.25±0,01
Hatmehit_1030	957±71	0,28±0,03
Ash_679	651,8±27	0,11±0,04
Ash_424	423	0.26
Ash_290	290	0.18
Khepty_182	182	0,2
Imhotep_55	55	0,07
Imhotep_47	49,5±2,5	0,1
Imhotep_45	48±3	0,09
Imhotep_44	44	0,06
Imhotep_43	38±5	0,06
Imhotep_36	34	0,3
Imhotep_35	35,5±0,1	0,14±0,02
Imhotep_34	32	0,08
Imhotep_30a	32	0,2
Imhotep_30b	30	0,1
Imhotep_25	22,5±2,5	0,16±0,05

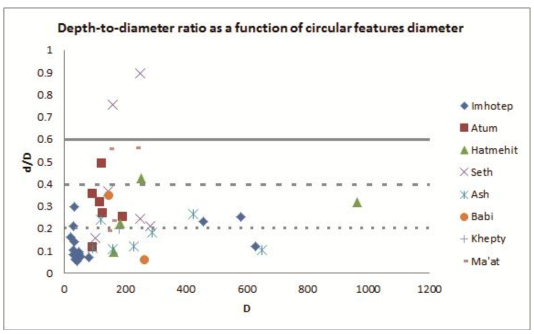

Figure 3. Plot of d/D v.s. D for 45 measured craters. Hatch line show modeling ~0,4 d/D for 60% porosity and line show modeling ~0,6 d/D for 85% porosity [5]. Point line show 0,2 d/D standard for Lunar craters.

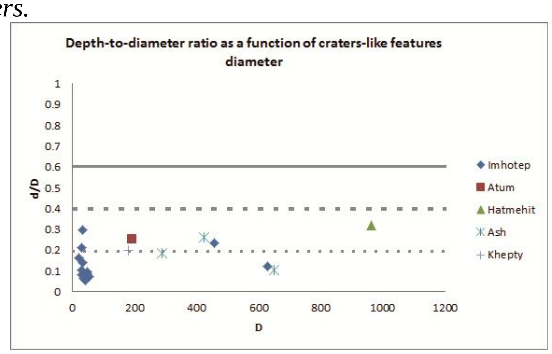

Figure 4. Plot of d/D v.s. D for 19 craters of probable impact origin.

with the following (mean) parameter estimates: lunar impact velocity: 14.1 km/s, projectile density: 2.5 g/cm^3, comet density: 0.47 g/cm^3, surface acceleration: 0.0005 m/s^2, impact velocity: 13.6 km/s. We find the expected accumulation period for the observed crater candidates on an area of 2/3 of the body's surface (32.8 of 49.2 km^2) (Table 2). We caution that the estimate applies to the comet's current high eccentricity orbit, which is known to have changed on timescales shorter than these periods.

Table 2. Estimated accumulation period for observed crater candidates

Projectile diameter	Impact rate, /km^2/yr	Crater diameter, m		Impact crater candidates	Expectated accumulation period, yr
		min	max		
10-30 cm	1.26×10^{-3}	10.8	32.3	4	97
30-100 cm	4.98×10^{-5}	32.3	107	7	4 300
1-3 m	1.25×10^{-6}	107	322	3	73 000
3-10 m	4.55×10^{-8}	322	1070	5	3 300 000
10-30 m	1.13×10^{-9}	1070	3200	-	-

Conclusions: The above consideration shows that part of crater-like features observed on the surface of nucleus of 67P comet could initially be formed by impact and then to different degree modified by superposed processes.

If these were craters on a normal planetary surface, we would expect the accumulation period to look similar for all the size ranges. That they differ so strongly suggests something unusual is happening. One possibility is that some or all of them are not impact craters. However, erosion – which might be expected on a comet – diminishes the population of smaller craters much faster than larger craters: this might also play a role.

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