Physical properties of craters on asteroid (21)Lutetia

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Introduction: On July, 10th, 2010, ESA spacecraft Rosetta en route to comet 67P/Churyumov-Gerasimenko flew by (21)Lutetia, the largest asteroid ever visited. The camera OSIRIS acquired more than 400 images that revealed a very interesting surface with complex geomorphologic features such as craters, boulders, landslides, and grooves. In this abstract we focus on the physical properties of craters and surface derived from the measurement of depth/diameter ratios for a large set of craters covering the whole northern hemisphere of Lutetia.

Technique: Craters were indentified in raw, sharpened images (unsharp masking with gaussian), and filtered images (Laplace filter). Diameters were measured by carefully selecting points at least 5 points on the craters edges, and fitting an ellipse to these points; the longest axis of the ellipse was taken as the real diameter of the crater. Depth was estimated through photoclinometric analysis: first, high-resolution images were projected on a low resolution shape model of the asteroid ([1]), then, knowing the solar elevation angle at each point of the surface, the depth could be derived from the slopes and the length of the shadows in the craters.

Results: We investigated different scales of craters, with diameters ranging from a few hundred meters to tens of kilometers. So far the results are in excellent agreement with what has been measured on other solar system bodies. The depth/diameter ratio varies from 0.05 to 0.35, with 80% of the craters being below 0.2 (see cumulative distribution on Fig.1). The distribution peaks at 0.12, as was observed for other asteroids (see [2], [3], [4], [5], [6]). Differences in ratios can be observed between what was identified as separated geological units, for instance craters are deeper in the shattered terrains than in less disturbed regions of the asteroid. Such measurements are useful to improve the statistics of craters physical properties on the solar system, but they have also indirect contribution to our understanding of the geomorphological processes at the surface of Lutetia. One example is the region surrounding the North pole, which appears very young with respect to the rest of the body, and clearly has been covered by a thick ejecta blanket. Some of the preexisting craters were almost completely filled and erased by this process but can still be detected in our images (Fig. 2). Therefore, knowing the depth/diameter ratio in similar terrains allows us to estimate the depth of these craters, derive the amount of material needed to fill them, and reconstruct the thickness of the ejecta blanket all around the polar region. Last but not least, we report on the detection of craters showing linear features on the inner flanks, characteristic of avalanches or dry granular flows similar in appearance to what as been observed on Mars and other planets, but seen here at a new scale on an asteroid. This brings new constraints on the gravity regime where such avalanches can occur.

References:

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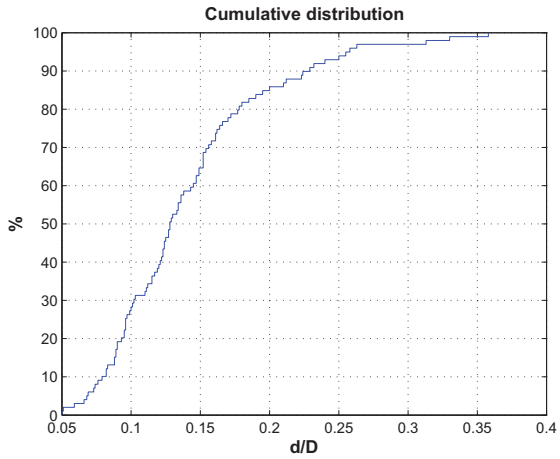

Figure 1: Cumulative distribution of the depth/diameter ratio measured for a sample of hundred crater in the northern hemisphere of (21)Lutetia.

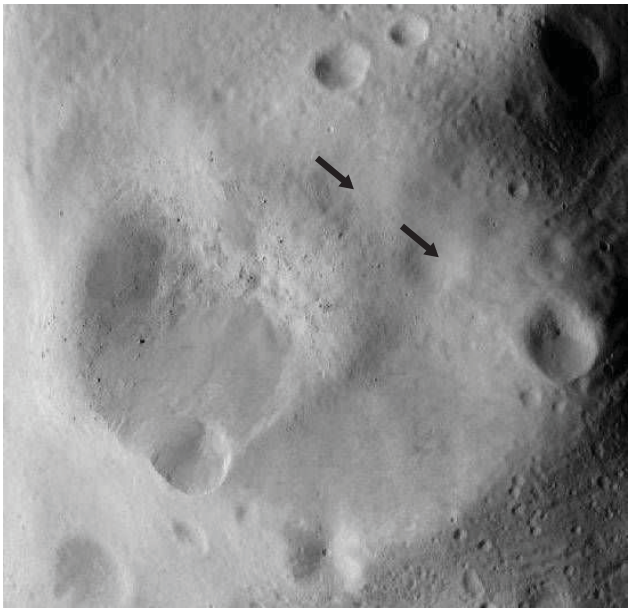

Figure 2: Close view of the polar region of (21)Lutetia. The black arrow indicate the presence of two buried craters. At these location the thickness of the ejecta blanket is estimated to be at least 500 m.

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