Geophysical Research Abstracts
Vol. 20, EGU2018-10420, 2018
EGU General Assembly 2018

Distribution of landforms at the Lunar North Pole

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Geomorphologic structures at Moon's North Pole (circular region of 60.6 km diameter centered at the pole) were considered based on a set of digital elevation models (DEMs) with grid spacing varying from 25 to 100 m. The DEMs were constructed from Lunar Orbiter Laser Altimeter (LOLA) data. Two groups of landforms at the surface in terminology of Shary (1995) were analyzed: regional landforms such as B-hills and B-depressions defined by close contour line; 12 main local landforms (MLLFs) defined by the signs of maximal, minimal, vertical, horizontal, difference and mean curvatures. The MLLFs describe the shape of the pure geometry of the surface and orientation of this surface in the gravity field. Such parameters as area, volume and depth/height are used for the description of the regional landforms. The size (in plan) of the MLLFs is governed by the grid spacing of the DEM. Every type of MLLFs is related to certain surface formation processes and the frequency of occurrence (FO) reflects the intensity of these processes.

Maps of regional landforms reveal distinct zones characterized by different types of impact craters. Hinshelwood is the largest crater in the quadrant 270-360 degrees; in the quadrant 90-180 degrees there is the Whipple crater. The lava field at the bottom of the Peary and one unnamed crater is well visible in quadrant 0-90 degrees. The quadrant 180-270 degrees is covered by structures formed by ejected material from the Peary, Hermite and Rozhdestvenskiy craters.

Our analysis shows that the correlation between volume and area of B-depressions/B-hills (backbone elements of the land surface) is stronger than between their area and depth/height. This finding can be used for the classification of craters (hills) based on deviation from the ideal trend for geometric figures. The deformation of the Hinshelwood and Whipple craters indicates that the pronounced hill between these craters consists of denser material than surrounding objects. The probability of a relationship between this structure and the rim of the Peary crater is low. With the help of curvature maps we have revealed many hidden structures in the surface morphology. The most important are the unique radial structures across the rim of the Hinshelwood crater. Such radial structures can be formed due to the specific character of the shock wave and the expanding gas cloud after impact. The FO of individual MLLFs is mainly similar to the FO of MLLFs at the hilly and mountain areas of Earth. Steep slopes (>20°) of large structures are relatively free of small craters. This effect is unclear and subject for future investigations. Either it is the result of erosion of the small craters on steep slopes or it is caused by specifics of the LOLA data.

Finally, we suggest two hypotheses: (i) the results of land transformation due to meteoritic bombardment can be comparable with the land formation due to tectonic down- and up- lift; (ii) the meteoritic bombardment has not eliminated the geomorphologic signal from autochthonous structures.

References:

Shary, P.A., 1995. Mathematical Geology, 27, 373-390.