Estimation of the state of matter in young impact craters on the Moon based on the orbital observations

Michael Shpekin[1*] and Ricardo Ferreyra[2]

[1] Kazan Federal University, 18 Kremlevskaya str Kazan Russia, MichaelS1@yandex.ru
[2] National University of Cordoba , Avda Velez Sarsfield 1611 Córdoba Argentina, Ricardo.Tomas.Ferreyra@unc.edu.ar

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The report examines the results of a 3D-survey of the relief in young impact craters based on high-resolution images obtained from lunar orbits. The craters examined included: the Tsiolkovsky and Aitken craters on the far side of the Moon, the Tycho and Ina craters of the visible hemisphere, as well as the Orientale Mare in the marginal zone of the Moon. To build 3D-models, orbital images of the Soviet spacecrafts "Zond-6,-8" and the American spacecraft "Apollo-17" delivered to Earth, as well as images transmitted to Earth from the Lunar Reconnaissance Orbiter (LRO) were used.

The survey of the relief using 3D-models allows us to study the structure of craters from different sides at different angles of view at different scales. This approach, in addition to analyzing single images, opens up new possibilities. In particular, on a 3D-model, it is often possible to detect relief details that are either not visible in single images, or are not clearly visible enough. So, looking through the images from the “Apollo-17” spacecraft, made on different orbit revolutions at different positions of the Sun, which provided different illumination conditions, we found a small volcano on the floor of the Tsiolkovsky crater, surrounded by an oval-shaped depression of soil about 25 km in size [1], which no one had paid attention to before. Further study of the object we found allowed the authors of the work to make an assumption about the presence of a magma chamber under the bottom of the crater. Another example of this approach is associated with the Aitken crater. Comparing our 3D-models of the central peak of Aitken crater with ultra-high resolution images from the LRO, we found a glacier-like tongue crawling out directly from the southwestern slope of the central peak to the crater floor [2]. It was possible for the first time to examine its structure and find similarities with similar objects on Mars. The report provides a detailed analysis of all 5 the above-mentioned objects.

Forthcoming lunar expeditions, creation of lunar bases and mining of minerals presupposes a certain level of knowledge about the lunar surface itself. The state of the matter of lunar craters, the structure of the elements of the lunar relief and the lunar interior is of particular interest in this regard. The results obtained play an essential role in understanding the crater formation process itself, as well as for studying the physics of the extreme state of matter. It is also important to note that the energy of crater-forming events is so high that it is unlikely that it will ever be possible to reproduce it in terrestrial conditions.

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