THE MODEL ESTIMATES OF THE CRATERS EJECTA THICKNESS IN THE SOUTHERN POLAR REGION OF THE MOON.

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Introduction: The South polar region of the Moon is considered by the Roscosmos corporation as the primary target for the Russian lunar program. Great interest in this region is linked with the enhanced concentration of hydrogen in the regolith and various geological processes associated with the possible presence of ground ice. The South Pole - Aitken basin (SPA), the largest and oldest known lunar impact basin, formed the relief and geological structure in the studied region. The SPA basin remnants have a high scientific potential, as the material of the ancient lunar crust, and possibly mantle, which is accessible for analysis in the South polar region. Ejecta of the larger craters that are younger than SPA are also of extreme interest because they can contain oldest material, excavated from beneath of the SPA ejecta.

On the Moon, the primary agent of the regolith re-distribution is impact process, which formed zones of contiguous ejecta, satellite and secondary craters, and rays around the primary craters. Here we present the results of the model estimates of the ejecta thickness for the Nectarian, Imbrian, Eratosthenian, and Copernican craters that occur in a region extending from $90°$ to $70°$ S. Our estimates are based on the new geological map of the southern polar region of the Moon compiled at 1:300,000 scale [1]. In our study, we did not consider the Pre-Nectarian craters because of their poor preservation state and overlapping of their ejecta by younger deposits.

Estimation of crater ejecta thicknesses: The geological map, which we used in our study, was compiled based on both the LOLA DTMs (60 m/px resolution) and the LROC WAC images (100 m/px resolution) The map allows identification of impact craters and their ejecta, which belong to different epochs of the geological history of the Moon. Along with the geological map, we used the catalogue of lunar craters with a diameter > 20 km [2]. The diameters of smaller craters were determined directly from the geological map.

In the past, five models have been developed to estimate the thicknesses of craters ejecta [3-7].

The McGetchin et al. model [3] was based on ejecta thickness's statistics for small-scale impact craters and craters, formed by nuclear tests. The results of these measurements were extrapolated for the impact structures of the larger diameter. McGetchin et al. have proposed the following formula for the ejecta thickness (T): $T=0.14*R*0.74*(r/R)^{-3}$. Here and thereafter, R is the crater radius, r is the distance from the crater center, all values are in meters. In his paper, Pike [4] severely critiqued the McGetchin's approach and proposed an alternative formula: $T=0.033*R*(r/R)^{-3}$. The Housen et al. model [5] was developed based on a theoretical modelling of a projectile's impact with specific velocity, diameter, and density. Their resulting formula is: $T=0.0078*R*(r/R)^{-2.61}$. Using new topographic data, collected by the LOLA instrument [8], Fassett et al. [6] developed a model that describes the variation of the ejecta thicknesses for the Orientale basin. Their formula is $T=2900(\pm300)*(r/R)^{-2.8(\pm0.5)}$, where R is the radius of the Cordillera rim. Finally, in the work of Sharpton [7], the new topographic data to describe the topology of relatively of small craters (2-45 km diameter) were used. The formula proposed by Sharpton is: $T=3.95(\pm1.19)*R^{0.399}*(r/R)^{-3}$.

Estimates of the ejecta thicknesses in the South polar region of the Moon: In order to estimate the thickness of the recognizable ejecta in the study region, we have selected the models of Hausen et al. [5] and Sharpton [7], because the formulae of McGutchin [3] and Pike [4] may either underestimate or overestimate the thickness estimates. The formula by Fassett et al. [6] is likely applicable for the largest impact structures such as basins (>300 km diameter). We applied the Housen et al. formula to the craters larger than 45 km. For the smaller craters, we used the formula by Sharpton.

The resulting map (Fig. 1) shows the ejecta thickness estimates. For each studied crater, the ejecta thicknesses in zones with different width are shown. The zone width depends upon the crater rim diameter and increases for the larger craters. The width is 2.5 km for craters <25 km dimeter, 5 km for craters 26-80 km diameter, 10 km for craters 81-130 km diameter, and 20 km for the larger craters.

The map of the model ejecta thickness provides the possibility to quantitatively estimate the contribution of impact events of different ages to the formation of the polar regolith, identify the sources of the material, the depth of its excavation, and its proportion in the regolith. This information is important for the selecting of a landing site and interpretation of the results of the future lunar missions.
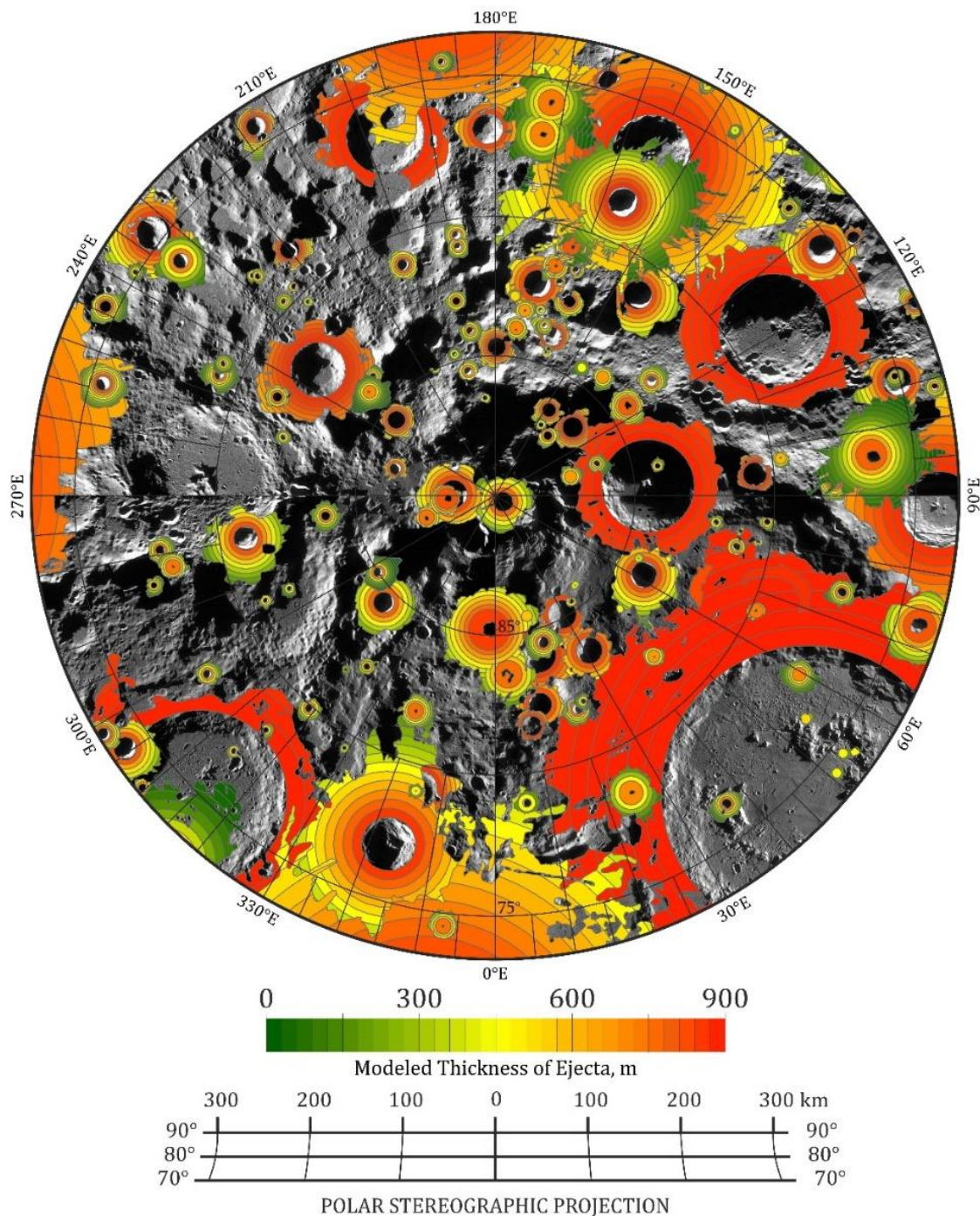
Fig. 1. The map of the model thicknesses of contiguous ejecta for craters of the Nectarian - Copernican ages in the southern polar region of the Moon.

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