CREATING THE MAP OF THE POLAR REGIONS OF THE MOON

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**Introduction:**

In the near future, several countries are planning flights to the Moon. In the southern polar region of the Moon [1]. More complex spacecraft will follow to the Moon: the Luna-26 lunar orbiter [2], the Luna-27 lander for studying frozen volatile components in lunar soil and studying its chemical and mineral composition, as well as thermophysical, physical-mechanical and electromagnetic properties [3], and the Luna-28 lander for the delivery of lunar soil to the Earth [4, 5, 6]. Soft landing of the Chandrayaan-3 module was carried out near the south pole of the Moon on August 23. Further, India is preparing, in cooperation with the Japanese JAXA, the Chandrayaan-4 mission also to the South Pole of the Moon, where India will provide the lander, and Japan the launcher and lunar rover. China also plans to search for frozen water near the Moon's South Pole. In 2024, the Chang'e-6 spacecraft will be launched to collect soil samples from the far side of the Moon, and then, in 2026, the Chang'e-7 spacecraft will land in the South Pole zone. CNSA believes that the flying vehicle, unlike traditional rovers, will be able to reach the bottom of the crater. Using a drilling tool, the probe will take a sample of ice, and the manipulator will move it to the apparatus for spectral analysis. The launch of the Chang'e-8 apparatus is scheduled for 2028 to conduct experiments on the use of lunar resources and create a basic model of the International Lunar Research Station. Japan hopes to perform a precision landing on the surface of the moon using an orbiter and land a lunar rover at the South Pole. The UK will launch its first lunar lander by 2024, with an orbiting probe to study regolith chemistry, provide communications and map the lunar surface. South Korea, together with ESA, intends to launch a lunar orbiter and lander in 2025. NASA will send several spacecraft to the Moon in 2024, including the new VIPER rover. The purpose of the device will be a detailed mapping of the distribution and concentration of water in the region of the South Pole of the Moon. The NASA Artemis program aims to land astronauts on the Moon, including the first female astronaut. The main goal of the program is to return people to the surface of the Moon and ensure a long-term human presence on the Moon.

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It became possible to process large amounts of data received by spacecraft in automatic mode and present them in the form of various overview and thematic maps [7, 8]. We used ESRI ArcGIS 10.1 software. The map of the circumpolar regions of the Moon was compiled on a scale of 1: 5,000,000 in a polar stereographic projection and is limited by + - 60 ° parallels. Particular interest in the circumpolar regions of the Moon is due to the fact that there is ice in permanently shaded places. The Kaguya and LRO laser altimeters determined the heights of the lunar surface with high accuracy. We used a digital terrain model built according to the laser altimeter (LOLA) data of the Lunar Reconnaissance Orbiter (LRO) spacecraft with an accuracy of 64 pixels per degree (0.5 km per pixel) [9]. The heights on the map are measured from a sphere with an average radius of 1737, 4 km. Detailed “hillshading” by the cut-off method was carried out by Grishakina E.A. The height scale includes 17 levels. The total elevation difference on the Moon is almost 20 km. During the development of a color scale for displaying heights on a map, the problem of showing characteristic landforms at all height intervals was solved. With the help of cartographic research methods, it was possible to determine the depth of craters and large basins located on the visible and far sides of the Moon. The South Pole–Aitken Basin turned out to be the deepest (the average depth of which is 9 km). The deepest 20 craters in the northern and southern subpolar regions are presented in Table 1. It follows from the table that the craters of the southern polar region are, on average, 1–2 km deeper than those in the northern polar region. In addition to the relief, the map shows the names of major moon formations in IAU Latin and in Russian. Named craters are indicated by dots in the center. New landing site for Chandrayaan 3 module showed on the map. The largest craters in the northern polar region are: Bel'kovich 215 km, Schwarzschild 211 km, Rozhdestvenskiy 181 km, Plaskett 177 km, W. Bond 170 km, and in the south: Schrodinger 316 km, Bailly 301 km, Zeeman 187 km, Haysen 163 km. There are several other large unnamed craters (see Table 1). It is interesting that the number of craters with a diameter of 10 km or more in the northern polar region is 2302 craters, while in the southern polar region there are only 1320 craters [11, 12, 13]. Figure 1 shows dependence of the number of craters on the ratio of depth to diameter in two polar regions. The structure of the distribution of craters is generally the same in both hemispheres, but differs in number.

**Table 1.** The deepest craters in the northern and southern polar regions of the Moon.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Northern Polar Region | | | | | Southern Polar Region | | | |
| N | Name | Diameter, км | Depth, км | h/D | Name | Diameter, км | Depth, км | h/D |
| 1 | - | 337,2 | 10,8 | 0,032 | Cabeus | 103,9 | 10,1 | 0,097 |
| 2 | Sommerfeld | 138,8 | 7,9 | 0,057 | - | 353,5 | 9,6 | 0,027 |
| 3 | Stebbins | 132,0 | 7,7 | 0,058 | Zeeman | 198,8 | 9,5 | 0,048 |
| 4 | Milankovic | 105,9 | 7,3 | 0,069 | Planck | 318,0 | 9,3 | 0,029 |
| 5 | - | 248.8 | 7,1 | 0,028 | Boussingault | 124,9 | 9,2 | 0,074 |
| 6 | - | 118,8 | 7,1 | 0,060 | Petzval | 110,0 | 9,2 | 0,083 |
| 7 | - | 158,6 | 7,0 | 0,044 | Sikorskiy | 98,7 | 8,7 | 0,085 |
| 8 | Rozhdestvenskiy | 177,7 | 6,9 | 0,039 | Drigalski | 173,5 | 8,7 | 0,050 |
| 9 | Schwarzschild | 212,8 | 6,8 | 0,032 | Amundsen | 104,5 | 8,5 | 0,082 |
| 10 | Cremona | 92,0 | 6,6 | 0,072 | Demonax | 128,4 | 8,3 | 0,065 |
| 11 | Hayn | 88,9 | 6,6 | 0,074 | Le Gentil | 115,2 | 8,1 | 0,070 |
| 12 | Belcovich | 215,0 | 6,3 | 0,029 | Casatus | 108,7 | 7,8 | 0,072 |
| 13 | Tikhov | 81,6 | 6,2 | 0,089 | Hausen | 182,5 | 7,8 | 0,043 |
| 14 | Avogadro | 127,3 | 6,2 | 0,048 | Ashbrook | 152,0 | 7,7 | 0,051 |
| 15 | Hayn F | 66,6 | 6,2 | 0,093 | Schrodinger | 313,8 | 7,7 | 0,025 |
| 16 | Poinsot | 68,3 | 6,2 | 0,091 | Antoniadi | 165,3 | 7,4 | 0,045 |
| 17 | Plaskett | 115,0 | 6,1 | 0,053 | Curtius | 101,4 | 7,4 | 0,073 |
| 18 | Seares | 109,7 | 6,0 | 0,054 | Malapert | 75,6 | 7,2 | 0,095 |
| 19 | Karpinskiy | 96,2 | 6,0 | 0,062 | - | 91,5 | 7,2 | 0,079 |
| 20 | - | 153,9 | 6,0 | 0,039 | Scheiner | 108,4 | 7,1 | 0,065 |



**Fig. 1.** Graphs of the dependence of the number of craters on the ratio of h/D in the northern and southern polar regions of the Moon.

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