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Cartography and Morphometric Analyses of the Lunokhod-2 Landing Site

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Abstract

Using GIS tools and high resolution LRO NAC images new mapping of the Lunokhod-2 area (which is about 172 sq. km) has been done. This provides new possibilities for geomorphology analyses of this territory with a high level of details, such as it had been done in our previous work on the analysis of the territory of Lunokhod-1. The obtained data can be used for large-scale mapping and surface studies of landing sites for future lunar missions.

1. Introduction

The Soviet spacecraft Luna 21 was launched towards the Moon in January 1973 and deployed Lunokhod-2, the second rover to explore an extraterrestrial surface. Until June 1973, Lunokhod-2 acquired about 80,000 TV pictures and 86 stereo images along its traverse. The history of the Soviet Lunokhods missions came back into focus recently, when the Lunar Reconnaissance Orbiter obtained high resolutions images (0.3-1 m/pixel). Using these data we mapped the landing site of Luna-21 and traverse of Lunokhod-2 based on GIS-tools.

2. Analyses of the Lunokhod-2 area

In the first step of work we orthorectified a set of LRO NAC images (Table 1) that covered the landing site. Rectification was done using the LOLA DEM (LDEM1024, 30 m/pixel) to MOON ME Coordinate System. Following methods developed earlier [5], Lunokhod-2 wheel tracks were mapped in the orthoimages. The full traverse was determined to be about 42 km long, in agreement with previous post-mission published data. Also, we digitized craters with diameters of more than 10 m in the Lunokhod-2 traverse area (Fig.1) using CraterTools for ArcGIS [3]. Crater catalog has been created as geodatabase which now consists of about 17,000 crater objects, with diameters of up to 300 m. The crater data allow us to calculate different statistical parameter of surface: crater cumulative (Fig. 2) and spatial densities (Fig. 3). The calculation results are preliminary, because our study has only just begun.

Table 1: List of orthoimages LRO NAC into the territory of Luna-21 landing site

Year	Name	Incidence, degree	Resolution, m/pixel
2009	M101971016R/L	83.2/83.0	1.50/1.49
2009	M106669064R/L	37.8/37.5	1.59/1.61
2009	M109039075R/L	27.4/27.4	0.52/0.53
2010	M122007650R/L	36.6/36.5	0.50/0.50
2010	M146783727R/L	75.5/75.5	0.65/0.65
2011	M165645602R/L	70.2/70.1	0.47/0.47
2011	M168000478R/L	47.6/47.6	0.41/0.42

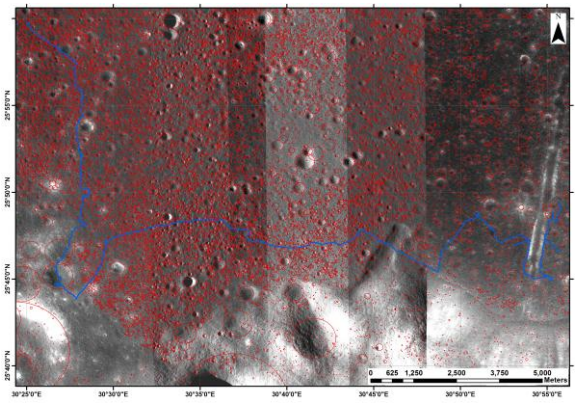

Figure 1: Orthomosaic showing the Lunokhod-2 traverse (blue) and crater geodatabase (red)

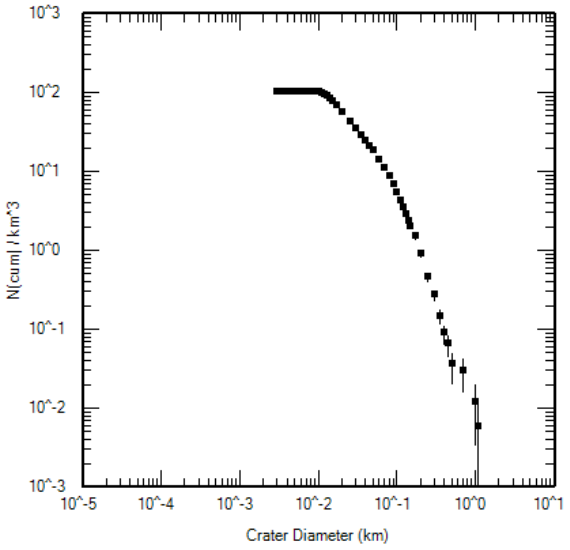

Figure 2: Crater cumulative density for Lunokhod-2 area

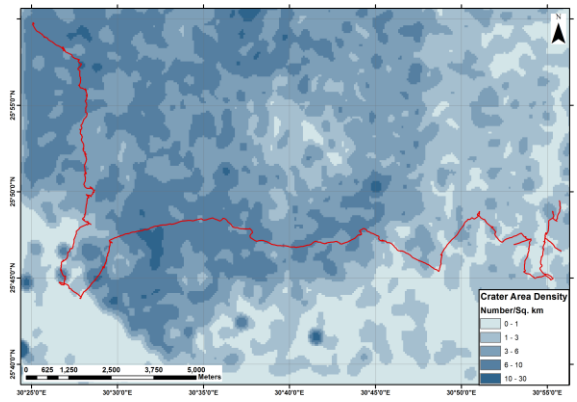

Figure 3: Spatial density map of Lunokhod-2 area

3. Terrain models

Using LDEM1024 we will calculate various morphometric parameters of the Lunokhod-2 area, including topographic roughness and slopes. Additionally we will use Kaguya DEM (7 m/pixel) for relief analyses of the region [6]. Recently, LRO has obtained a NAC stereo image pair covering the Lunokhod-2 site. We expect to derive a high resolution DEM based on methods as describe at [4] which will allow us to carry out geomorphological analyses of craters [1], including measurements of relative depth (ratio D/H). However, quality of imaging geometry and illumination for stereo processing remains to be seen. Also we hope that various DEMs with different resolutions give us possibilities for in-depth analyses of topography at the regional and local levels of details.

4. Conclusions

While new missions to the Moon are being planned, it is of utmost importance to identify and make available for access all Lunar surface data. We show that data from both Lunokhod missions [2] can be used for large-scale mapping and surface studies of landing sites for future lunar missions, for example LUNA-GLOB and LUNA-RESOURCE. Our work is in progress and any new results will be shown at the conference.

Acknowledgements

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