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GIS-ANALYSES OF THE LUNOKHOD-1 LANDING SITE USING LROC IMAGES AND HIGH RESOLUTION DEM

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Introduction: MIIGAiK is developing an automated GIS-oriented mapping technology for studies of planetary surfaces. Here we present the new results of the Luna-17 Landing Site large-scale mapping. In our study we used the high resolution orthoimages and DEM, which were previously obtained at DLR from the photogrammetric processing of LRO (Lunar Reconnaissance Orbiter) NAC (Narrow Angle Camera) stereo images (07350_M150749234, 07351_M150756018) with spatial resolutions of 0.5 m/pixel. Both data sets were used for landing site area and Lunokhod-1 traverse GIS analyses. The work carried out may prepare us for searching and assessing future landing sites of the LUNA-GLOB and LUNA-RESOURCE missions.

Lunokhod-1 area mapping and geoanalyses: We have studied the Lunokhod-1 area using large-scale maps. For analysis of surface morphology and e.g. for measurements of sizes of craters along the Lunokhod track, a DTM (derived by F. Scholten, DLR) was used. To improve the identification of the traverse (obtained by J. Plescia, Johns Hopkins University Applied Physics Laboratory), we used topographic plans (large-scale maps whose resolution varied from 1 to 2.5 m per 1 cm) derived from stereo-photogrammetry processing of the Lunokhod-1 surface image data [2]. We identified about 99% of the Lunokhod's traverse, which is approx. 9.5 km long, as measured in the GIS (Fig.1). About 1% segments of the traverse (150 m) could not be identified as these parts of the traverse was in shadow in the image we used. Integrating all types of data as described above we digitized craters in the Lunokhod traverse area and created a crater catalog as geodatabase in ArcGIS which now consists about 45 000 crater objects and includes their diameter and depth, obtained from the DTM. Using this information we calculated various parameters of the Lunokhod-1 area (about 8.75 sq. km), including spatial density for craters with diameter more 10 m entire all area of the Luna-17 Landing Site (Fig. 2), size-frequency distribution for all craters at the Lunokhod-1 traverse area (Fig.3). We calculated crater relative depths for the study area (ratio of crater depth to diameter: min=0,006; max=0,036, mean=0,06) and also slopes, roughness that demonstrated possibilities of high-resolution elevation data (that corresponds to the scale of 1:5000, 50 m per 1 cm) for distinguish local scale geomorphic units.

Lunokhod-1 surface image data: In addition to identifying the Lunokhod-1 track, we also used topographic plans, that had accuracy in the positions and heights of of 10 cm and 4 cm [2], respectively, for testing the possibility of using the LRO NAC data for large-scale mapping of purposed future lunar landing sites. Results of GIS measurements showed good agreement with the results of the large-scale mapping derived from Lunokhod-1 surface image data. For example, the difference between crater depths from lunar old topographic plans and new GIS measurements is from 20 cm to 1 m (Fig. 4). Slopes measured on topographic plan N3 have a value between 16° and 23° [2], which also shows good agreement with measurements in GIS (Fig 5). From the other side, these results attest to the very high quality work that had been done 40 years ago during Soviet lunar missions.

Conclusions: GIS mapping of the landing site Lunokhod-1 has been carried out using semi-automatic function for the crater detection and measurements from high resolution orthoimages and DTM. We show that these data can be used for large-scale mapping and studies of candidate landing sites for future lunar missions, for example LUNA-GLOB and LUNA-RESOURCE missions. `The purpose of our future work is computation of archived Lunokhod panoramas [2], [3,] [4] and assignment of these panoramas to their respective rover position along the track.

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Reference: [1] Abdrakhimov A.M. et al. (2011) Luna 17 / Lunokhod 1 and Luna 21 / Lunokhod 2 landing sites as seen by the Lunokhod and LRO cameras. *42nd LPSC* (#2220). [2] Barsukov V.L. et. al. (1978) Peredvijnaya laboratoriya na Lune Lunokhod-1, Volume 2. *Nauka*. (in Russian). [3] Vinogradov A.P. et. al. (1977) Peredvijnaya laboratoriya na Lune Lunokhod-1, Volume 1. *Nauka*. (in Russian). [4] http://www.planetology.ru/panoramas/

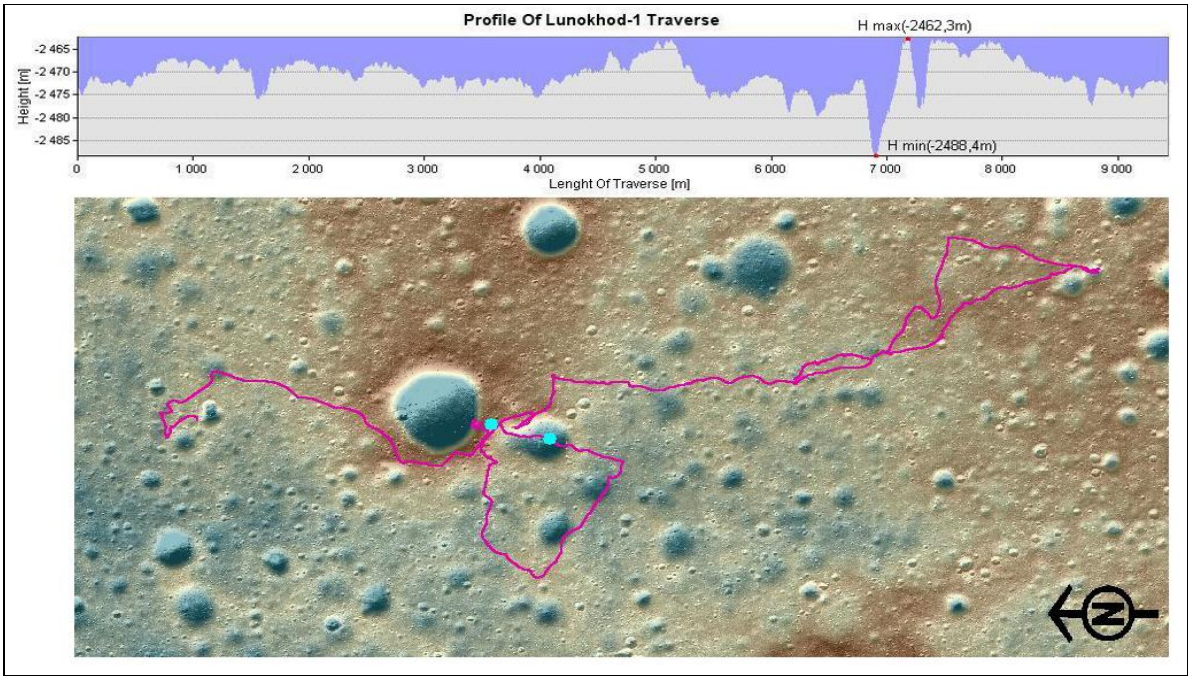

Fig.1 Lunokhod-1 traverse, digitized in GIS

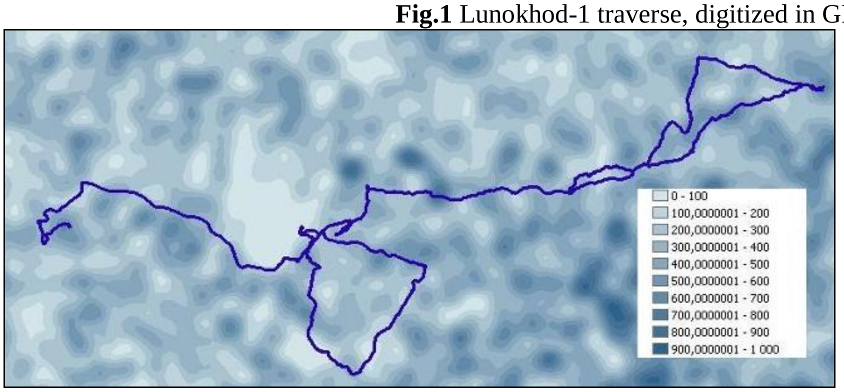

Fig.2 Lunokhod-1 area map of the spatial density of craters (Diam>10 m)

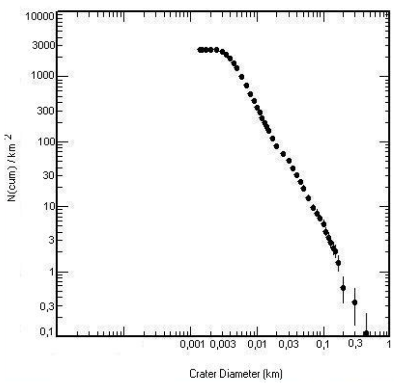

Fig.3 Size-frequency distribution for all craters at the Lunokhod-1 traverse area

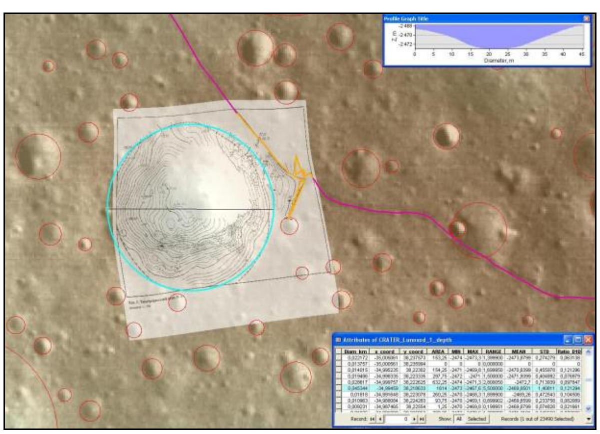

Fig.4 Lunokhod-1 surface large scale map and GIS-measurements

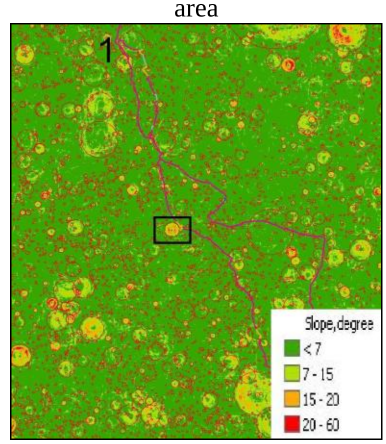

Fig.5 Slope map of Lunokhod-1 area