LUNAR PHOTOMETRY AND COMPOSITION OF EJECTA TERRAINS WITH AMIE/SMART-1.
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Introduction: Important scientific goal of the AMIE experiment to fly onboard the SMART-1 mission (ESA) [1] is to study, at low polar orbit, the South Pole regions of the Moon. We plan to use a new technique for remote sensing estimation of lunar surface structure in meter-scale (distribution of boulders, debris etc.) by means photometry method. On the other hand, a close relationship between the photometric characteristics of the surface layer and composition (thorium abundances) of the terrains is elucidated. The AMIE camera will observe the surface in nadir direction within a large phase angle interval, thus providing photometric investigation of selected regions, in particular the South Pole-Aitken basin.

Photometric behaviour of the Moon and local roughness: We proposed that information retrieved from the local surface photometric behaviour of the Moon could be used for guiding the remote sensing analyses of specific geological targets. It was shown that difference between the modelled and observed phase function for phase angle in range about 18° demonstrates a degree of the surface roughness in meter-scale [2]. The average integrated lunar indicatrix [3] was used as a background photometric model. The Saari and Shorthill catalogue [4] data were used as observed phase functions. The value of the difference of intensities mentioned above may be used as a photometric parameter ΔI of the surface roughness.

Surface Roughness and Thorium Contents: In a preliminary investigation, we have compared the Lunar Prospector thorium contents for some regions of the lunar near side with surface roughness estimated by means of the local photometric function. It was used data concerning thorium content in some regions on the visible side of the Moon [5]. In the areas under study, parameter of the surface roughness (which can vary between 0 and 1) varies from 0.05 (smooth mare surface) to 0.25 (crater Tycho and its ejecta). Interestingly, a good correlation (-0.985) is observed between the local thorium content and the photometric roughness parameter, indicating a possible association of Th-rich materials with the rough structure of the regolith disturbed by the emplacement of ejecta materials and could indicate the surface distribution of KREEP materials. Figure 1 represents the diagram of relationship between photometric roughness parameter and local thorium content in different lunar regions. The line shows a mean polynomial trend. The separate points represent areas of number of landing sites (Surveyor I, III, V, VI, VII, Lunokhod 1 and 2, Apollo 11 and 12), and an area in Sinus Media (Lunar Orbiter II high resolution pictures). It's nota -

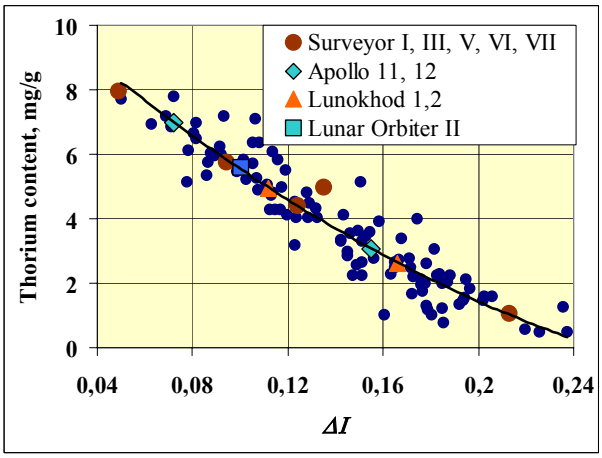

Figure 1. These data show the results of comparison of the local thorium content [5] and the photometric roughness parameter.

ble that data are divided into several groups. Possibly, each group cab be corresponded to the ejecta terrain with individual character of the surface distribution of KREEP materials. Using result of morphological analysis of separate regions a relation between the local thorium abundances and the number of particles per unit area has been established. The fragmental

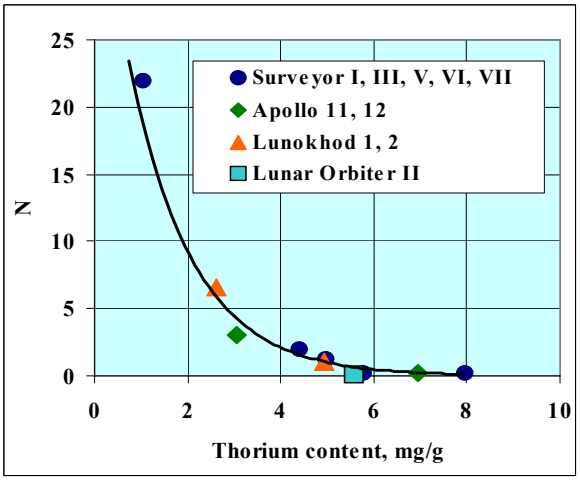

Figure 2. Comparative data for cumulative number of particles N per 10^4 m^2 and thorium content.

debris size-frequency was examined in terms of statistic data [6 – 11]. Figure 2 represents this diagram. The line shows a mean exponential trend. It's observed a good correlation (- 0.875) between N and the local Th-content.

Preliminary Interpretation: If correlation between the local thorium content and the photometric roughness parameter demonstrates a possible association of Th-rich materials with the rough structure of the regolith, comparison of photometric roughness and thorium content could show the depth of the local KREEP assimilation. We can consider crater Arago region as example. Figure 3 shows phase functions (modelled one and observed one) of crater Arago region. According to Lunar Prospector data the surface

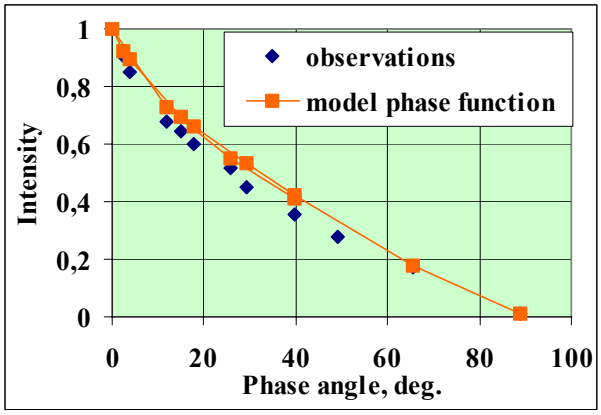

Figure 3. Phase function of crater Arago region.

layer of the terrain contents about 6.60 ppm of thorium [5] (KREEP-rich materials). On the other hand, this surface area has a low degree of roughness (ΔI =0.063,

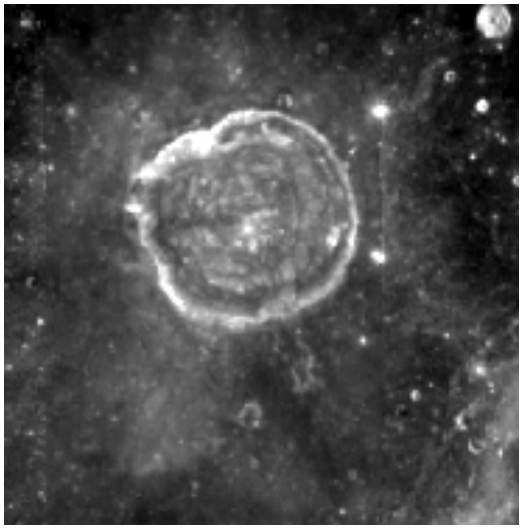

Figure 4. Image of the crater Arago (26 km, 6° N, 21° E. Clementine picture.

and calculated value of N is about 0.2). Observed coarse mounds on the crater floor probably produced by floor uplift. They were commonly ascribed to volcanic extrusions released or localized by the impact. Therefore, it may be assumed that volcanic processes prevailed in the area, and KREEP-rich materials were exposed on the crater floor. In contrast, crater Tycho region has very low thorium abundances (1.05 ppm) [5], high value of the photometric roughness parameter (0.213), and high value of the cumulative number of particles N per 10^4 m^2 (0.220). It suggests that KREEP-materials were not assimilated at depth in this portion of the Moon.

Conclusions and Future Work: Similar investigations conducted by AMIE/SMART-1 for other lunar regions such as the South Pole-Aitken basin would be an interesting and useful task. As it's mentioned above we can receive the photometric measurement for one phase angle only during orbital fly of SMART-1 to analyse by means of the roughness parameter ΔI selected lunar region. In particular two distinct regions with unique compositions were unambiguously identified: the Procellarum KREEP Terrane and the South Pole-Aitken. The South Pole-Aitken basin floor represents a large mafic anomaly on the far side, suggesting wide deposits of lower crust and possible mantle materials [12]. The northwest part of the South Pole-Aitken basin contains a high abundance of thorium anomaly. It's necessary that a more thorough study of the phenomenon should be performed.

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