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The possibility of the existence of volatile compounds in the area of the proposed mission landing sites Luna-25

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Abstract

The possibility of the existence of hydrogen-containing compounds in the area of the proposed landing sites of the Luna-25 mission is investigated.

1. Introduction

Currently, as the possible landing areas of the mission Luna-25 (Luna-Globe), three areas are selected, located in the southern polar region of the Moon: the landing ellipses 1, 4 and 6. The landing ellipse 1 with its center at the point (68.8° S, 21.2° E) is located south-west of the Manzinus crater (67.3° S, 26.2° E), the landing ellipse 4 (coordinates of the center: 68.6° S, 11.6° E), is located northwest of the Simpelius A crater (69.9° S, 16.1° E), and the landing ellipse 6 with the center at the point (69.5° S, 43.5° E) lies to the south of the Boussingault crater (70.1° S, 53.4° E).

The neutron spectrometer onboard probe Lunar Prospector (LP) has revealed the decreasing of epithermal flux from the surface in this region, which was interpreted as of enhanced abundance of hydrogen: 61,9 ppm, 56,7 ppm and 77,9 ppm at ellipses 1, 4 and 6 respectively [1], at the average abundance hydrogen in lunar regolith about 50 - 55 ppm [2]. These results were supported by data from neutron spectrometer LEND of probe Lunar Reconnaissance Orbiter (LRO), which also observed the enhanced abundance of hydrogen in these regions 0,15% for ellipses 4 and 6 and about 0,12 ± 0,15% for ellipse 1 [1]. Such, the abundance of hydrogen in the region of ellipse 4 is near to the average value for the lunar regolith, but the hydrogen abundance at the ellipses 1 and 6 regions above. Deposits of volatiles compounds were revealed in permanently shaded areas in Cabeo crater during the impact experiment of probe LCROSS [3]. The water content in impact vapor estimated as 1,5 - 4 % according to I.G. Mitrofanov et al. [4] or 5,6 - 2,9 % to A. Colaprete et al. [3]. In addition to water, a number of other hydrogen-containing compounds, such as H_2, NH3, H2S, C2H4, and CH3OH, were discovered in the crater Cabeo.

Time the existence of such deposits is determined by the rate of their evaporation, which is a function of temperature. Earlier we conducted a study of the temperature regime and insolation of these landing sites [5]. According to these results, there are no permanently shaded areas in these regions and diurnal temperatures are exceeding 300 K. As the calculation results show, in the area of the landing ellipses 1, 4 and 6, the maximum temperatures are too high, and the deposits of volatile compounds similar to those found in the area of the Cabeus crater, including water ice, cannot exist on the surface.

The neutron spectrometer of the LP probe has received data on hydrogen content ~~for~~ in the upper layer of regolith with a thickness of 0.4-0.5 m. Information obtained by the LEND neutron spectrometer refers to ~~a~~ the soil layer with a thickness of 1-1.5 m. Thus, it can be assumed that the deposits of water ice or other hydrogen containing compounds can be under a layer of regolith with a thickness of 0.4 to 1.5 m. If the hydrogen in the area of the landing ellipses is in the form of water ice, its fraction should be ~ 1.2 wt% for the landing ellipse 1, and ~ 1.3 wt% for ellipses 4 and 6.

We investigated the rate of evaporation of water ice and such hydrogen-containing compounds as NH3, H2S, C2H4, and CH3OH in the areas of landing ellipses. The sublimation rate of deposits of substances under a layer of silicate material was calculated from the model of Schorghofer N., et al. [6]. Regolith has been modeled as consisting of two layers, similar to how it has been in calculating the temperature conditions [5]. It was found, that for the layer with a thickness of ~~a~~ 0.4 m, the lifetime of such deposits does not exceed 1 million years for the area of the landing ellipse 1, and 10 million years for the landing ellipse 4. A longer existence of water ice and other compounds (> 100 Ma) is possible in the area of the landing ellipse 6 (in its northeastern part) (fig. 1).

If the thickness of the shielding layer reaches 1,5 m, the lifetime of existence of the deposits of hydrogen-

containing compounds increases to ≥ 10 million years in the area of the landing ellipses 1 and 4, and exceeds 100 million years in the area of the landing ellipse 6 (fig. 2).

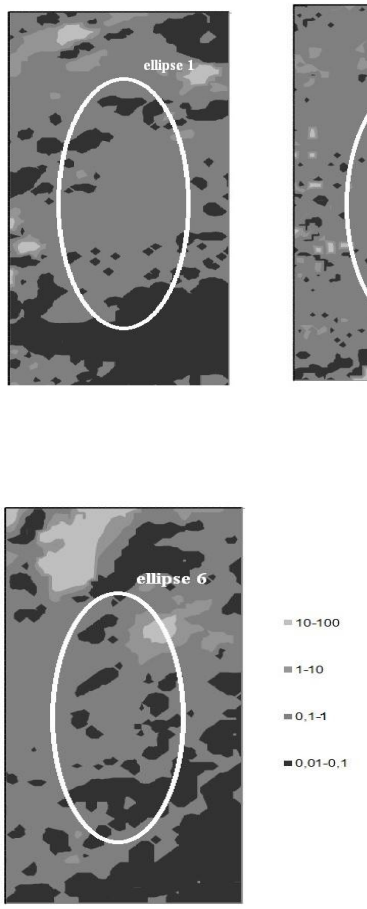

Figure 1. The time (in millions of years) of the existence of water ice deposits under a layer of regolith 0.4 m thick in the region of the landing ellipses 1, 4 and 6.

Summary and Conclusions

In this paper, we investigated the possibility of existence of the hydrogen-containing volatile compounds, similar to those found in the Cabeo crater, in the area of the proposed landing ellipses of the Luna-25 mission. We found that the existence of water ice and other hydrogen-containing substances is possible only in the presence of a shielding layer of regolith. The time of existence of such deposits does not exceed 10 million years for a layer of regolith with a thickness of 0.4 m and 100 million years for a layer of regolith 1.5 m thick.

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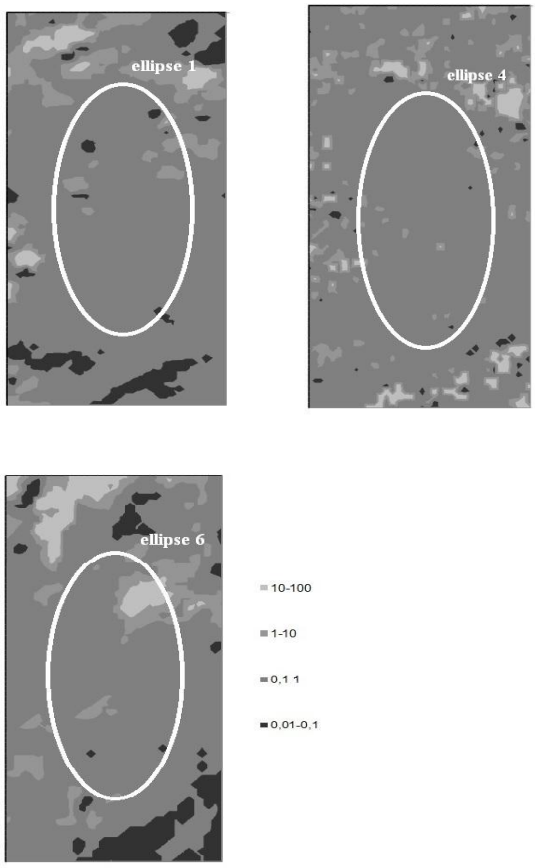

Figure 2. The time (in millions of years) of the existence of water ice deposits under a layer of regolith 1,5 m thick in the region of the landing ellipses 1, 4 and 6.

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