POTENTIAL LUNAR BASE ON MONS MALAPERT: TOPOGRAPHIC, GEOLOGIC AND TRAFFICABILITY CONSIDERATION

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Introduction:
Due to the near constant solar illumination and the potential presence of water ice in the regolith,polar areas of the Moon are candidates for construction of a lunar base [e.g., 1, 2]. The mountain Mons Malapert (MM) near the South Pole of the Moon (a massif that is part of the outer ring of the South Pole Aitken basin) is a key candidate for the location of such a base [e.g., 3, 4, 5]. MM is an ~ 30×50 km mountain elongated in a WNW-ESE direction with a NNE extension (Fig. 1). Its summit stands ~5 km above the 1838 km datum, has constant visibility from Earth and long periods of sunlight (87 to 91% of the year).

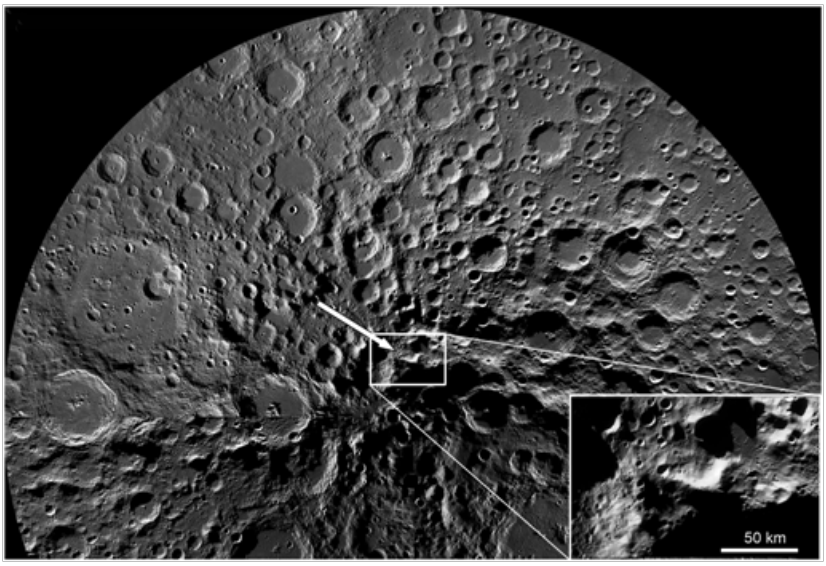

Fig. 1. Mons Malapert (arrow) seen in the LROC WAC mosaic P900S0000_032P of the lunar South Pole region (NASA/ASU).

In this analysis we consider the topographic, geologic and trafficability characteristics of Mons Malapert, which need to be taken into account in the further consideration of MM as a lunar base location. Potential landing sites for a lunar base in the Mons Malapertarea are discussed in [6].

Topography and Geology:
The topography and its derivatives of MM were studied using LROC WAC images and the LOLA-based DTM. South of MM lie the ~50-km craters

Haworth and Shoemaker whose floors are in permanent shadow and show a neutron spectrometric signature of high water-ice content [7] that may be a source of water for the base. The geology of the MM region is defined by its position on the rim of the South-Pole-Aitken basin, the largest and most ancient impact basin on the Moon [8]. The ancient age of this area is confirmed by crater spatial density which shows ages of ~4.2 Ga [9]. The MM slopes are mostly rather steep: from ~20 to 30°, while slopes on its summit and base are more gentle (Fig. 2).

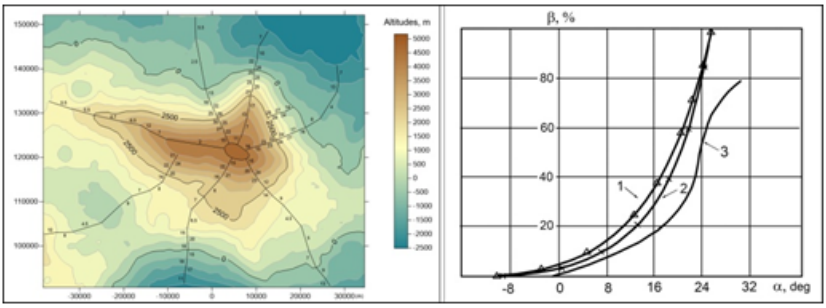

Fig. 2. Left — Topographic map of Mons Malapert based on the LOLA-based DTM LDEM80S20M_a1 alculated values of slope steepness shown. Right — Dependence of slip ratio (β) on steepness (α) of the slope on which the rover is climbing. 1 and 2 — Lunokhod 1 measurements on the Moon and on Earth analogs, correspondingly [10]. 3 — the Apollo Lunar Rover Vehicle measurements on terrestrial analogs [11].

LROC NAC images of this area show that while the summit and base of MM are covered by numerous small craters, its steep slopes show a deficit of craters and are complicated by low ridges approximately perpendicular to the downslope direction. These characteristics of the steep slopes suggest effective downslope movement of the regolith material that, in turn, suggests that the mechanical properties of the surface layer here are relatively weak.

Trafficability

The siting, building and operation of a lunar base implies activity not only at the base and in close proximity, but also traverses to other distant sites of interest for resources and scientific investigations. So planning the Mons Malapert base requires the detailed analysis of the trafficability of the region. To consider this issue we return to experience gained by the operations of Soviet Lunokhod 1, 2 and the US Apollo Lunar Roving Vehicles (LRV) [10, 11]. On the basis of new and evolving technology, rovers designed for the MM lunar base may significantly differ from earlier rovers, but consideration of trafficability of the earlier rovers is important for future planning. Our analysis shows that neither Lunokhods nor the Apollo LRV could successfully climb most of the slopes of Mons Malapert. The acceptable trafficability appears to be only possible along the WNW crest of the mountain. For emergency cases wheel-walking rovers may be considered. Mons Malapert seems to be a good locality for the lunar base but more studies are needed [12].

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