POTENTIAL SOUTH POLAR LUNAR BASE (MONS MALAPERT): TOPOGRAPHIC, GEOLOGIC AND TRAFFICABILITY CONSIDERATION. A.T. Basilevsky[1,2], S.S. Krasilnikov[1], M.A. Ivanov[1], M.I. Malenkov[3], G.G. Michael[2], T. Liu[4], J. W. Head[5], D. R. Scott[5], L. Lark[5], [1] Vernadsky Institute, RAS, Kosygin Str., 19, 119991, Moscow, Russia, atbas@geokhi.ru, [2]Planetary Sciences @ Remote Sensing, Freie Universitaet Berlin, Germany, [3]Space Research Institute, RAS, Moscow, Russia, [4]Institute of Geodesy @ Geoinformation, Technische Universität Berlin, Germany, [5]Brown University, Providence, RI, USA.

Introduction: Polar areas of the Moon are key candidate sites for construction of a lunar base [e.g., 1, 2] due to 1) near constant illumination conditions, and 2) the presence of water ice in the regolith of cold traps [e.g., 3-5]. The mountain Mons Malapert (unofficial name; we use MM as an abbreviation) near the South pole of the Moon [6,7] is a key candidate for the location of such a base (Figure 1).

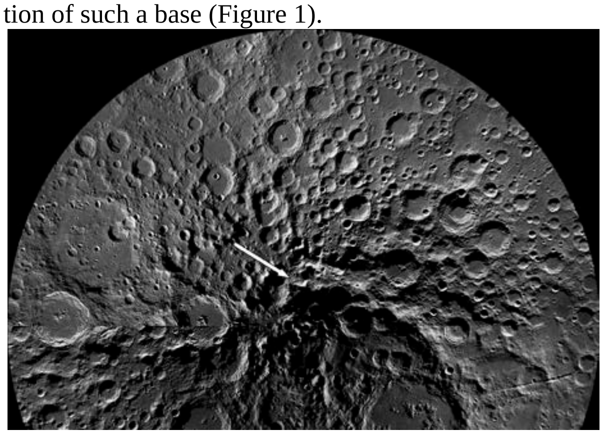

Fig. 1. Part of LROC WAC mosaic of the South Pole of the Moon 60-90°S, zero meridian is at the image top, arrow shows location of Mons Malapert.

The summit of this mountain, (~86°S, 0°E) stands ~5 km above the 1838 km datum and has constant visibility from Earth. It has long periods of sunlight (87 to 91% of the year [6]), an important factor for solar-electric energy production. In this analysis we consider the topographic, geologic and trafficability characteristics of Mons Malapert, which are need to be taken into account in further consideration of this place as a lunar base location.

Topography and its derivatives: Topography and its derivatives of Mons Malapert were studied using LROC WAC images and the LOLA-based DTM LDEM80S20M_a1 with spatial resolution of 20 m. MM is ~30 x 50 km mountain elongated in a WNW-ESE direction with a NNE extension. Its slopes are locally steep (up to 20-30°). South of MM lie the ~50-km craters Haworth and Shoemaker whose floors are in permanent shadow and show the neutron spectrometric signature of significant water ice content [5]. These craters may be interesting as a source of water for a potential MM base.

The geology of the MM region is broadly defined by its position on the rim of the South-Pole-Aitken basin, which is considered to be the largest and most ancient impact basin of the Moon [8]. The ancient age of this area is confirmed by crater density which shows ages of 4.1-4.2 Ga. The Mons Malapert topographic promontory resembles a giant massif being part of the basin rim structure and ejecta. Detailed study of MM is a critical factor in understanding the very beginning of the geologic history of the Moon and thus its exploration and sampling is an important goal for robotic and human geologic excursions and sampling.

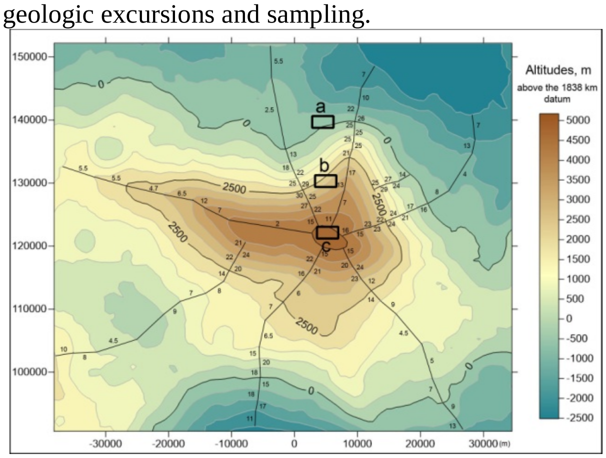

Fig. 2. Topographic map of Mons Malapert with calculated values of slope steepness shown, LOLA DTM. Letters a, d, c rectangles correspond to a,b,c parts in Fig.3.

It can be seen from Figure 2 that slopes of Mons Malapert are mostly rather steep: from ~20 to 25 and 30°, while its summit and its base are topographically more gentle. In reality the values shown should locally be even steeper due to presence of small craters.

Surface morphology: LROC NAC images of this area show that while the summit and base of Mons Malapert are covered by numerous small craters (meters to 10's – 100's m) consistent with the ancient age of the area, its rather steep slopes show a distinct deficit of craters. These slopes are complicated by low ridges approximately perpendicular to the downslope direction (Figure 3). The deficit of craters on the steep slopes of MM and the presence of the ridges suggest effective downslope movement of the regolith material. Active downslope material movement suggests that physical-mechanical properties of the surface layer are rather weak.

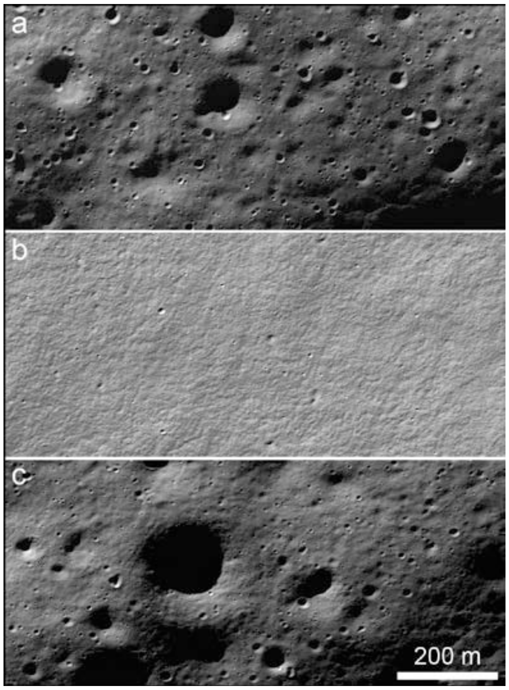

Fig. 3. Surface morphology of the northern foot of Mons Malapert (a), its northern slope (b) and the top (c). NAC image M137538218LC, see also Fig. 2.

Options for the base location: The siting, building and operation of a lunar base implies not only in-base and close proximity activity, but also traversing to other distant sites of interest for resources and scientific investigations. For example, the base could be sited on the mountain top with living-working shelters, solar power station, communications, and landing-launch facilities. From the base, geologic excursions and water-ice mining and supply will require visiting the places outside the summit of MM. Another alternative is to site only the solar power station and communication facility on the MM summit, while other base facilities are at the lower flanks or edges of MM. In this case traverses back and forth to the summit may be infrequent, but necessary. Thus, planning the Mons Malapert base requires detailed analysis of the trafficability of the region, particularly Mons Malapert.

Trafficability: To consider this issue we return to experience gained by the operations of Soviet Lunokhod 1 and the US Apollo Lunar Roving Vehicles (trim/roll sensor of Lunokhod 2 did not operate). On the basis of new and evolving technology, rovers designed for the MM lunar base may significantly differ from earlier rovers, but consideration of their trafficability is important for future planning.

Lunokhod 1 was robotic rover used for scientific studies in Mare Imbrium It had a mass of 756 kg, was 170 cm long, 160 cm wide, 135 cm high and had eight wheels 51 cm in diameter and 20 cm wide each with an independent suspension, electric motor and brake. There were two speeds, ~0.85 and 2 km/h [9].

The Apollo Lunar Roving Vehicle (LRV), used in expeditions of Apollo 15, 16 and 17, was a four-wheeled manually-controlled, electrically-powered and carried the crew and their equipment. The vehicle was designed to carry the two astronauts and a science payload at a maximum velocity of about 16 km/h on a smooth, level surface, and at reduced velocities on slopes up to 25^o. The LRV wheel base was 2.3 m, wheel width 23 cm, the rover length 3.1 m .

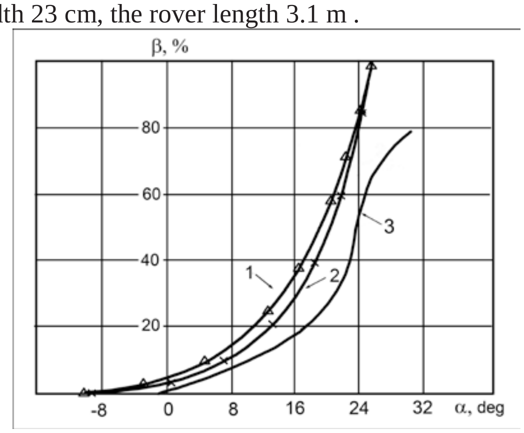

Fig. 4. Dependence of slip ratio (α) on steepness (β) of the slope on which the rover is climbing up [9]. 1 and 2 – Lunokhod 1 measurements on the Moon and on Earth analogs. 3 – the Apollo Lunar Rover Vehicle measurements on terrestrial analogs [10].

It is seen from comparison of Figures 2 and 4 that neither Lunokhods 1, 2 nor the Apollo LRV could successfully climb the 20-30^o slopes of Mons Malapert. On the basis of their demonstrated performance, acceptable trafficability appears to be only possible along the WNW crest of the mountain. For emergency cases wheel-walking rovers may be considered [e.g., 11].

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