SURFACE MORPHOLOGY INSIDE THE PSR PART OF LUNAR POLAR CRATER SHOEMAKER IN COMPARISON WITH THAT OF THE SUNLIT AREAS. A. T. Basilevsky[1], Yuan Li [2] and Li Gang Fang [2], [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Kosygin Str., 19, 119991, Moscow, Russia, atbas@geokhi.ru, [2]Suzhou Vocational University, SuZhou, 215009, China, YuanLi_SciRes@outlook.com.

Introduction: The bottoms of many near-polar lunar craters are permanently shadowed (abbreviation PSR). They are the cold traps for H_2O and other volatiles that makes them interesting for fundamental research and potentially this H_2O may be used for life support of lunar base(s) and as a fuel for distant spaceflights. This is why PSRs are goals for the future missions of several countries and space agencies. Most attractive for future polar missions is south pole of the Moon where the mentioned issue of trapped volatiles is added by possibility to study the rim of the largest and most ancient from known South Pole – Aitken impact basin. Object of our study is crater Shoemaker (Fig. 1, 88.1°S 44.9°E, D = 50.5 km, d = 2.5 km).

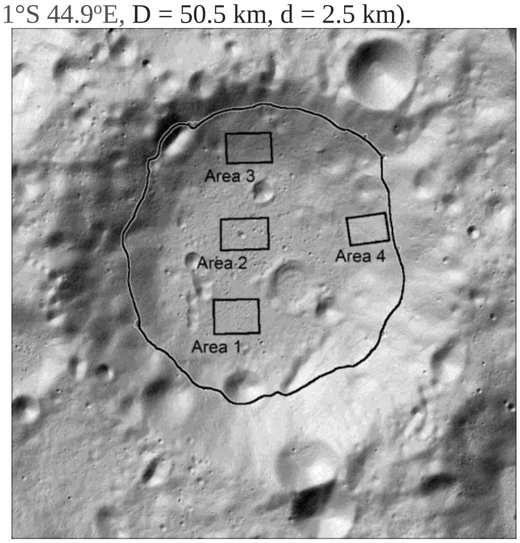

Fig. 1. The hill-shade image of crater Shoemaker with shown PSR boundary and four study areas, each ~ 4.5 x 6 km, – two on the floor and two on the lower parts of inner slopes.

PSRs have no the diurnal changes of the surface temperature, and inside them the regolith contains admixture of H_2O ice and ices of other volatiles. This may influence geological processes and thus the surface morphology. To progress in understanding these effects we are making photogeologic analysis of the hill-shade images based on LOLA DTMs [1] within the PSR part of depression of polar crater Shoemaker with resolution 5 m/px (Fig. 2) and compare these observations with those made in the area of work of Lunokhod-2 and Apollo 16 landing site, which have "normal" solar illumination.

Surface Morphology in the Study Areas: Below are shown hill-shade images of the study areas:

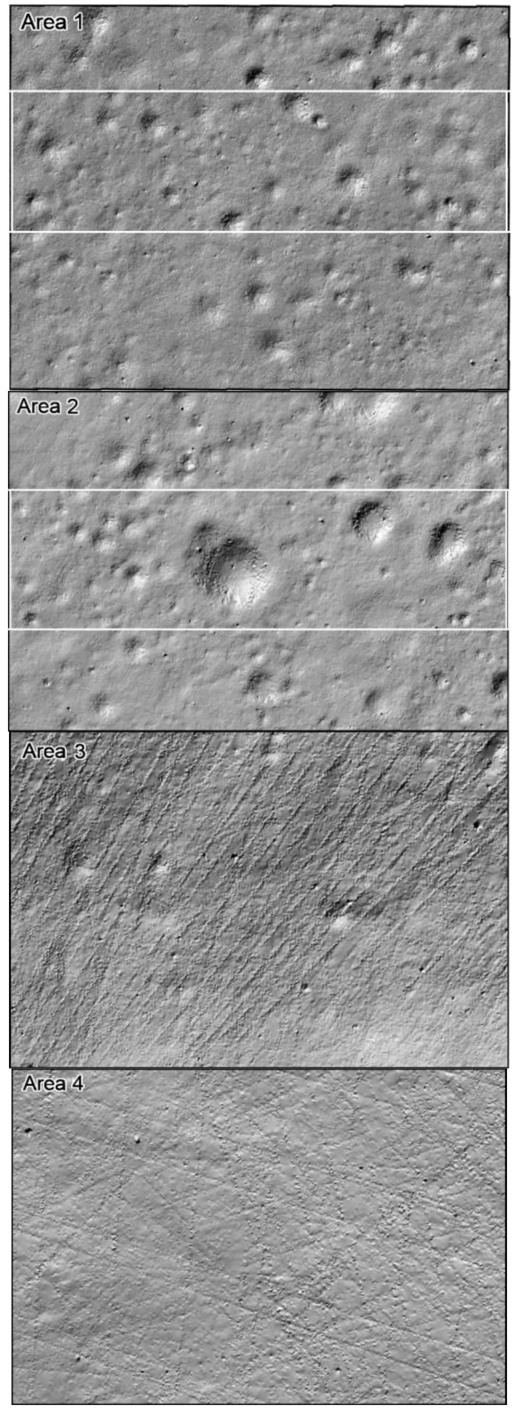

Fig. 2. Images of the study areas. White lines in images of Areas 1 and 2 outline areas shown in Fig, 3.

Figure 2 shows images of the study areas on the Shoemaker floor (areas 1 and 2) and its inner slopes (areas 3 and 4). The average slopes on the base of 200 to 1000 m for areas 1 and 2 are 1-3º, and for areas 3 and 4 – 23-25º and 28-30º, correspondingly [1].

Surface of the study areas 1 and 2 is covered by numerous craters with diameters up to several hundred meters. Their spatial frequency corresponds to absolute age of 3,6 ± 0,03 to 3,8 ± 0,04 Ga that agrees with earlier results by [2] – 3,46 ± 0,02 Ga. Images of the study areas 3 and 4 which are on Shoemaker inner slopes are complicated by the lines of LOLA tracks that worsens visibility of the surface morphology. Despite of this it is clear that on these surfaces there are craters with diameters up to a few hundred meters, but their quantity is significantly smaller comparing to the areas 1 and 2 and the apparent age there is 2,4 ± 0,06 and 0,17 ± 0,08 Ga. This is obviously partly due to bad quality of the images, but partly to acceleration of evolution/destruction small craters on the slopes [3, 4].

In the areas 1 and 2 inside craters and more rarely in intercrater space are seen rock boulders of 10-15 m (= 2-3 pixels that is limit of identification) to ~40 m across (Fig. 3). In areas 3 and 4 the boulders are not reliably seen. Preferrable association of rock boulders with small craters (inside and on crater rims) was found for equatorial areas of the Moon long time ago [e.g., 5] and observations of Lunar Reconnaissance Orbiter confirmed that this is the globe-wide characteristics [6].

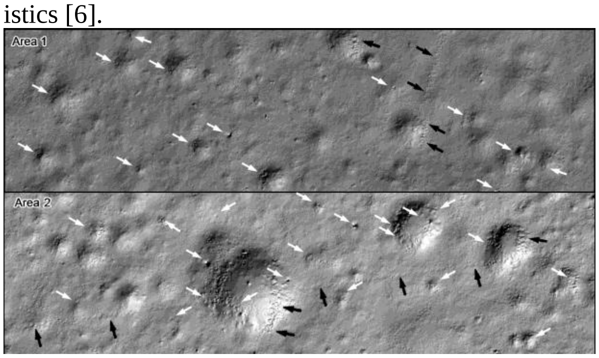

Fig. 3. Images showing location of boulders (white arrows) and the boulder-looking artefacts (black arrows).

Lunokhod-2 and Apollo-16 areas: Below are shown small subareas in the Lunokhod-2 work region and the Apollo-16 site:

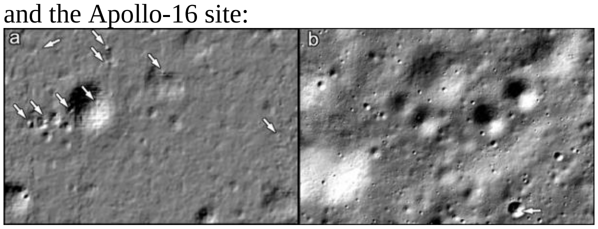

Fig. 4. Hill-shade images of selected 3 x 2 km areas in the Lunokhod 2 working region (a) and the Apollo 16 site (b). Arrows show rock boulders.

It is seen in Fig. 4 that both in the Lunokhod 2 region (age is 3.2 +0.06/-0.09 Ga) and in Apollo 16 site (~3.85 Ga) the surface is pitted by craters with diameters up to a few hundred of meters. In the image of the Lunokhod 2 region are seen the 10-20 m boulders associated with craters. In the image of the Apollo 16 site, boulders are seen only inside one looking fresh crater with diameter ~200 m. In association with presenting there several craters with diameter of several hundred meters no boulders are observed. This difference may be due to the higher mechanical strength of mare basalts comparing to that of highland fragmental breccias as it was described by [7].

Discussion and conclusions: The above consideration showed that surface morphology in permanently shadowed region (PSR) inside crater Shoemaker is generally similar to the morphologies of the sunlit areas as exemplified by the Lunokhod 2 work region and Apollo 16 site: (1) There is present population of craters up to several hundred meters in diameter. (2) On the Shoemaker inner slopes the abundance of these craters is significantly lower than on sub-horizontal areas of the Shoemaker floor. (3) On the Shoemaker floor inside some craters and more rarely in inter-crater space are seen rock boulders of 10-15 m to ~40 m across. (4) The boulder abundance on the Shoemaker floor is closer to that of Lunokhod 2 region than to Apollo 16 site that is probably because the mechanical strength of the Shoemaker floor bedrock is closer to that of mare basalts than to the highland fragmental breccias. So, the permanent shadowing and presence of ices in the regolith in concentrations up to a few percent by mass did not significantly influence the surface morphology and thus surface geological processes comparing to the areas of the Moon with "normal" solar illumination. But new studies are certainly needed.

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