LOCAL GEOLOGIC SETTINGS ALONG THE LUNOKHOD-1 TRAVERSE AS ANALOGS FOR CHARACTERISTICS OF THE CHANG'E 3 LANDING SITE. A. M. Abdrakhimov[1], A. T. Basilevsky[1], and J. W. Head[2], [1]Vernadsky Institute, Russia, 111538, Kosygina 19, AlbertAbd @ gmail.com, [2]Deptartment of Geological Sciences, Brown University, Providence, 02912, Rhode Island, USA.

Introduction: On December 14, 2013, Chang'e 3 (CE-3) successfully landed in Mare Imbrium (44.13°N, 19.50°W) on the rim of ~450-m bowl-shaped crater (Fig. 1) [1,2]. The CE-3 landing site is about 500 km NE from the landing site of Luna 17/ Lunokhod-1 [3].

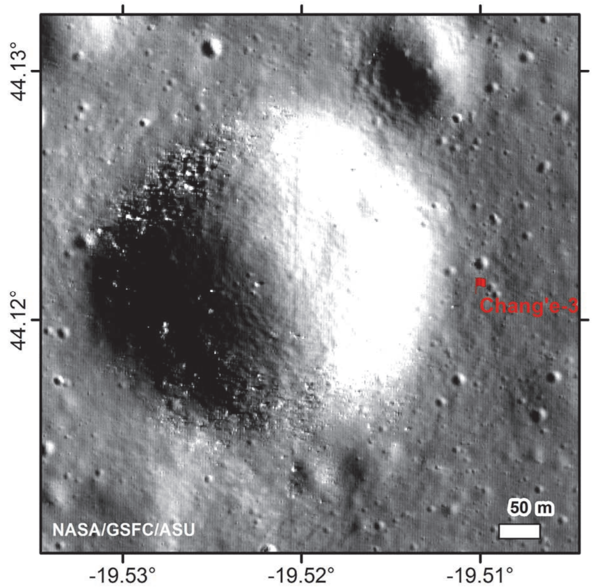

Figure 1. Fragment of LRO NAC M1811302794LE (NASA/GSFC/ASU) showing the crater on the eastern rim of which CE-3 landed [1,2].

The geologic setting of the CE-3 landing site, as it is seen in LROC NAC images [2], is close to that in the middle part of the Lunokhod-1 (L-1) rover traverse. The route here crossed the rim of similarly large bowl-shaped crater Borya (Fig. 2, 38.284 N, -35.007 W, D=470 m) [4]. The characteristics of this crater resemble those of 450-m crater of CE-3 landing site [2]. The inner slopes of the Borya inner wall are steep (reaching >20°) [5] and covered with rock boulders. The crater is characterized by a depth/diameter ratio h/D=0.12 [5]. These characteristics permit one to classify it as belonging to morphologic class B [6]. Several panoramas were taken by L-1 in this place [7]. Two panoramas were chosen to illustrate the geologic context as for L-1, which could be considered as some analog for the CE-3 landing site. These places we designate here as Site 1 and Site 2.

Site 1. On the inner rocky wall of crater Borya. The panorama shown here (Session 604, panorama 08) was taken inside the 470 m class B crater on April 11, 1971, during the 6th lunation of the Lunokhod-1 traverse (Fig. 3).

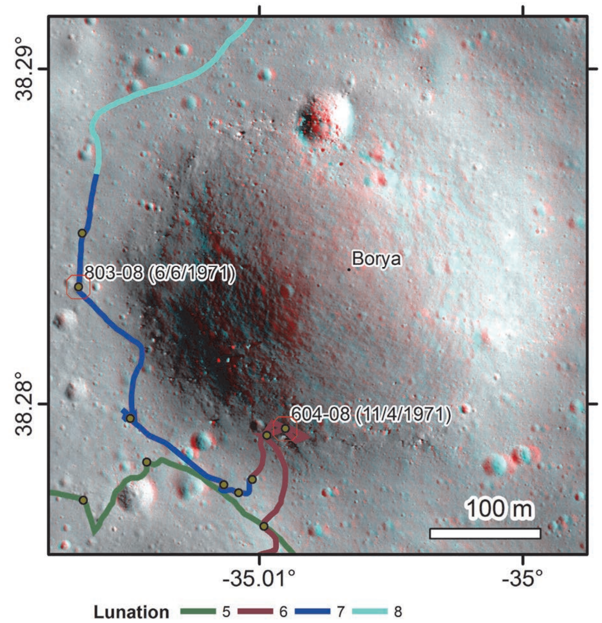

Figure 2. Anaglyph showing crater Borya and the route of Lunokhod-1 [4]. Composed of LRO NAC images M150749234LC and M166072850LC (NASA/GSFC/ ASU).

On the panorama a group of rock fragments is observed on the internal steep slope of the southern segment of the crater. The rocks are mainly of angular-rounded and irregular or pyramidal shape (a class 1-2, types I, II, III) [7, Fig. 5.19]. Their sizes vary within a few centimeters to ~0.5 m. A high density of rock fragments (10-50 rock fragments/sq.m) is observed here. The surface structure in between rock fragments looks cloddy. The L-1 wheel tracks are shallow.

Site 2. On the rim of Borya crater. On the panorama taken June 6, 1971 (Session 803, panorama 08), during the 8th lunation of the L-1 traverse the outside slope and the crest of the western part of the crater Borya rim are seen (Fig. 4). It can be observed here that as the distance from the 470-m crater increases, the spatial density of rock fragments is rapidly decreasing. On the left side of the panorama the intercrater surface of the mare plain is observed and on the right is seen the Borya crater northern inner slope covered with rock fragments. In the right-center part of the panorama ~2 m from the rover there is a small fresh crater about 1 m of class B with a sharp rim crest and steep internal walls. On the right, 3-7 m towards Borya crater, there are several prismatic and angular rocks of about 20-30 cm (class 1-2, type IV). Small rocks (less 5 cm, a class 2, type I-II) are observed in the surroundings, with the spatial density ~10/sq.m. Toward Borya crater the spatial density and sizes of rock fragments are increasing. The surface structure near the rover looks cloddy, with small, decimeters sized craters.

On the NAC image shown in Figure 2 a fresh-looking crater ~60 m in diameter superposed on the upper part of internal northern wall of Borya crater is seen. Several rock boulders of a few meters in diameter are observed in association with it.

Discussion: Sites 1 and 2 show two geologic settings associated with crater Borya: 1) the upper part of the crater internal slope and 2) the crater rim crest with a distant view of the northern inner slope of this crater. The major differences between them are the rather steep slope and the presence of numerous rock fragments in situation 1 and gentle-sloping to horizontal surface with rare and small rock fragments in situation 2. It is obvious that the elements of this crater formed simultaneously. If we apply the technique of [6], it has happened approximately 150-200 Ma ago and then the settings evolved due to ongoing surface processes.

One of the obvious surface processes – small-scale meteorite bombardment - had to be working in practically the same way in both situations. On the rim of crater Borya, which initially had to be very rocky (because it certainly penetrated through pre-existing regolith into the bedrock) the meteorite bombardment destroyed the rocks. According to estimates of [8] for the time 150-200 Ma more than 90% rocks of the initial population should have been destroyed.

The original population of rock fragments on the inner slope of crater Borya was exposed to the same destruction process and had to be destroyed too. The rocks which are now seen there are obviously those which were sitting safe from breakdown in the local regolith layer and were recently exposed by the regolith local overturn due to down-slope material movement.

Conclusions: We expect that rover Yutu will encounter the situation similar to that described for the Lunokhod-1 Site 1 and Site 2. In fact, the local settings in the Chang'e-3 landing site described by [2] are practically the same: rather steep rocky slope of the inner walls of the 450-m crater and much less rocky crater rim with superposed small craters, some of which excavate the rock fragments. The chemical analyses of outcropped rocks and regolith should provide the ground truth about compositions of local younger high-Ti basalts and, possibly underlying them, older low-Ti basalts [9,10].

References: [1] Robinson M. (2013) NASA/GSFC/ASU, LROC Report 30.12.2013. [2] Lu Y. et al. (2014) *LPS 45*, abs. #1116. [3] Florensky C.P. et al. (1972) *Space Research XII*, 107-121. .[4] Gusakova E. N. et al. (2012) *LPS 43*, Abstract #1750. [5] Gusakova E. N. et al. (2013), *LPS 44*, Abstract #1174. [6] Basilevsky A.T. (1976) Proc. *LPSC 7*. 1005-1020. [7] Barsukov V.L. et al. (1978) Lunokhod-1, a mobile laboratory on the moon. Volume 2. Moscow. Nauka press. 183 p.(in Russian). [8] Basilevsky A.T. et al. (2013) *Planet. Space Sci. 89*. 118-126. [9] Hiesinger H. et al. (2000) *JGR*, *105*. E12. 29,239-29,275. [10] Wu Y. Z. (2014) *LPS 45*, Abstract (in press).

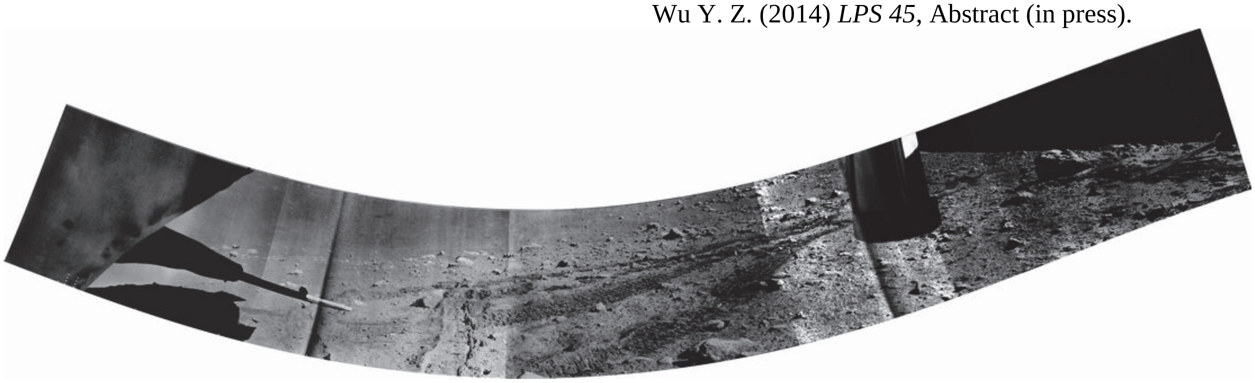

Figure 3. Lunokhod-1. Session 604. Panorama 08. April 11, 1971. Site 1. Inside Borya crater on its inner rocky wall.

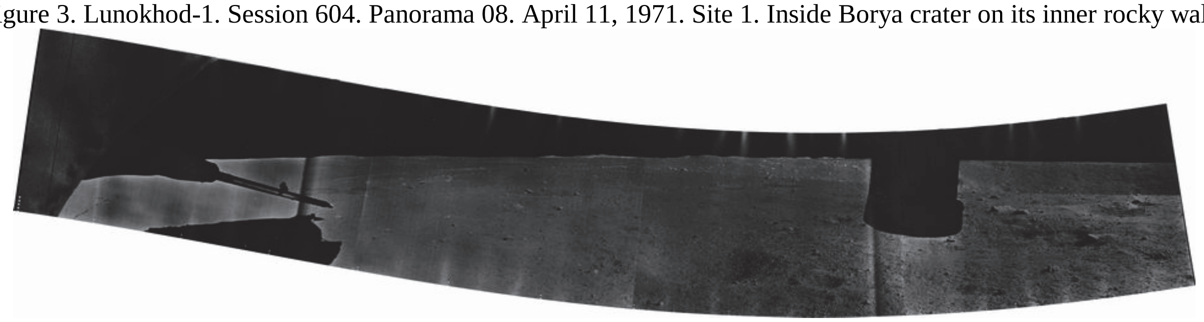

Figure 4. Lunokhod-1. Session 803. Panorama 08. June 6, 1971. Site 2. On the crest of the Borya crater rim.