STUDY OF THE ROCK DISTRIBUTION ON THE SURFACE OF EXOMARS 2020 OXIA PLANNUM LANDING SITE I.A. Agapkin [1], O.I. Turchinskaya [1], A.A. Dmitroskii [1], E.N. Slyuta[1]. [1] Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Moscow, Russian Federation.

Key words
Mars, ExoMars 2020; Martian geomorphology.

Introduction: As part of the ExoMars2020 project, it was necessary to choose the most successful spacecraft landing site. One of the selection criteria for the landing site was the absence of stones on the surface. Morphological features of the surface were evaluated using HiRISE ultra-high resolution images, 0.25 m / pixels.

The stones in the study were defined as isometric, free-standing, positive landforms in the range of diameters (0.75-10) m (Fig. 1). Unlike craters, stones are distributed on the surface in a nonrandom manner and are mainly found at the foot of slopes and in emissions of young impact craters. In some cases, stones are observed on flat terrain, unrelated to these situations and, probably, are relics of ancient emissions that are not completely covered by young sediments.

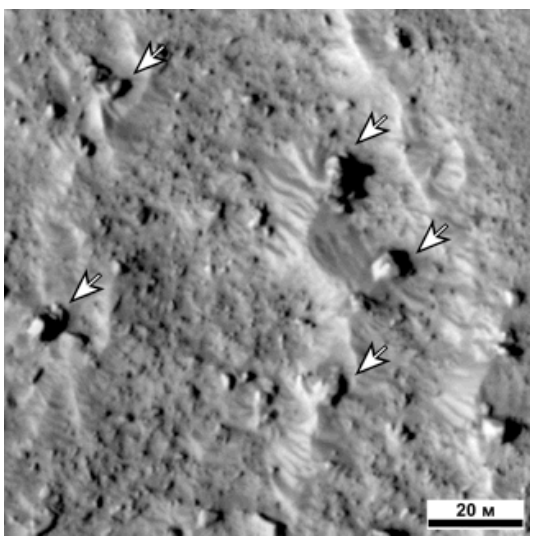

Figure 1 - An example of stone camber on the surface in the area of the landing of Oxia Planum. The largest stones are shown by arrows. Photobase - mosaic of HiRISE images, resolution 0.25 m / pixels.

In the area of the Oxia Planum landing, the spatial and frequency-size distribution of stones was studied using ultra-high resolution images (0.25 m / pixels) for ten lowland units: light plains (lbp unit), dark hilly material (dpj unit), dark emissions from the craters (ejd division), corroded covers (bem division), drift cones (dd division), bed bottom deposits (cd division), erosion remnants (me division), crater outliers (ed division), continental smooth plains (ups division) and emissions from ancient craters (uem division).

Spatial and frequency-dimensional distribution of stones using ultra-high resolution images

Within the dpj unit, stones are more common and their average density (for stones in the entire range of diameters (1-6) m) is about 737 stones per square kilometer or 0.18 stones on a 5x5 m site. It should be noted that the spatial distribution of stones on subdivisions of dpj are non-uniform and their clusters form clusters, where the average density of stones increases sharply to values (0.4-0.6) of stones at a site of 5x5 m.

Stones are rare in the light plains (lbp unit) and their average density is about an order of magnitude lower than in dark hilly material (dpj unit) and is about 65 stones per square kilometer or 0.02 stones on a 5x5 m site. Spatial distribution stones on the bright plains are also uneven and they form clusters (Figure 2.1.4.2b) near impact craters. In clusters of stones on the bright plains, their average density increases to 0.3-0.4 stones at a site of 5x5 m.

Within the ejd unit, stones are common and their average density (for stones in the entire range of diameters (0.75-2.79 m)) is approximately 1377 stones per square kilometer or 0.034 stones on a 5x5 m site.

Stones are also quite common within the drift cones (dd unit) and their average density (for stones in the entire diameter range (0.75-4.30 m)) is about 983 stones per square kilometer or 0.02 stones on a 5x5 m site.

In sections ed (for stones in the entire range of diameters (0.75-8.86 m)) and cd (for stones in the entire range of diameters (0.75-3.75 m)), the average density per square kilometer is approximately the same - 560 and 504, respectively, and on the site of 5x5 m, 0.14 and 1.12 stones.

Within the area with emissions from ancient craters (uem), the average density of stones is already lower (for stones in the entire range of diameters (0.75-5 m)) and amounts to approximately 164 stones per square kilometer and 0.0041 stones on a 5x5 m site.

Within the unit of corroded integument (bem) stones are less common. The density (for stones in the entire range of diameters (0.75-4.08 m)) is approximately 147 stones per square kilometer and 0.0037 stones on a 5x5 m site.

The density of stones (for stones in the entire range of diameters (0.75-5.76 m)) within the continental smooth plains (ups) is even less - 76 stones per square kilometer and 0.0018 stones on a 5x5 site.

In the me section, the density (for stones in the entire range of diameters (0.75-1.82 m)) is 25 stones per square kilometer and 0.0006 stones on a 5x5 m site.

It should be noted that the spatial distribution of stones in all units is uneven and their clusters form clusters.

Monte Carlo stone distribution analysis

Also, to assess the likelihood of stones meeting during the landing of the descent module, we analyzed the distribution of stones using the Monte Carlo method. The window diameter was chosen equal to 3914 mm, which corresponds to the diameter of the main part of the landing module. The probability of meeting stones during planting was evaluated separately for all types of terrain. In total, 50,000 model "landings" were conducted for each of these types of terrain. According to our estimates, the probability of stones meeting during landing on the light plains is 0.006, on the dark plains 0.048, on the dark emissions from the craters 0.0599, on the drift cones 0.058 (Figure 2.1.4.7), on crater outliers 0.0227, on bed bottom deposits are 0.502, on emissions from ancient craters 0.0092, on the continental smooth plains 0.0139, on erosion remnants 0.0027 and on corroded covers 0.0007.

Results

As a result of the analysis, it was found out that within the limits of dark bumpy material, stones are found most often and their density is approximately 737 stones per square kilometer. The lowest density was 25 stones per square kilometer in the area of erosive outliers.

Monte Carlo analysis of the distribution of stones showed that the least chance of meeting stones during planting is 0.0027 (erosive outliers).