LANDSCAPE AND SURFACE MATERIAL CHARACTERISTICS FOR THE MARS POLAR LANDER LANDING SITE: ANALYSIS AND PREDICTIONS. A. T. Basilevsky[1,2], H. U. Keller[2], W. J. Markiewicz[2], and N. Thomas[2], [1]Vernadsky Institute, 117975 Moscow, Russia, abasilevsky@glasnet.ru , [2] Max-Planck-Institut für Aeronomie, D-37191 Katlenburg-Lindau, Germany, keller@linmpi.mpg.de.

Introduction: Mars Polar Lander (MPL) should land on the south polar layered deposits consisting of mixtures of water ice and dust. This paper considers the landscape and surface material characteristics which will be a target for studies by Robotic Arm Camera and Stereo Surface Imager. We analyze the available images of southern and northern polar deposits taken by Mars Observer Camera (MOC) and published results on the surface material properties.

The landing site landscape: We have analyzed MOC images 7203, 7204, 9503, 9505 (45 m/px), 7306 (25 m/px), taken in southern spring, showing areas within and nearby the landing zone. Also we have analyzed MOC image 46103 (3.3 m/px) showing layered deposits of the northern polar region during early northern spring. Since the layered deposits of north and south are similar, image 46103 gives an idea of very detailed morphology of the MPL landing zone. Within the studied areas two major types of terrain are observed: 1) near-horizontal plains which are the outcropping upper surfaces of the layers; 2) slopes of scarps and planimetrically irregular troughs with laminated outcrops of the layers (Figure 1).

Plains surfaces are densely covered by gentle sloping knobs and pits. On images with resolution of 25 to 45 m/px they are seen as being typically a few hundred meters across. MOC image 46103 with resolution of 3.3 m/px shows knobs and pits of 15 to 30 m across with no prominent larger landforms of that sort. When resolution of this image was degraded by about an order of magnitude these small landforms disappear and instead larger scale knob- and pit-like forms become visible. This implies that the plains surfaces are covered by the knobs and pits hundred meters across whith slopes having morphologically similar knobs and pits of smaller size. These observations generally agree with observations reported in [5].

The knobbed and pitted surface is complicated by swarms of parallel lineaments which are seen on images with 25 to 45 m/px resolution as a few hundred meters wide and at least several kilometers long. On image 46103 the lineaments are seen as 10-15 m wide and a few hundred meters long. Sometimes these lineaments are dark strips locally superposed on the brighter layers. Sometimes they are gentle sloping grooves or chains of small depressions. The swarms trend mostly NNW-SSE and NNE-SSW, criss-crossing each other in places.

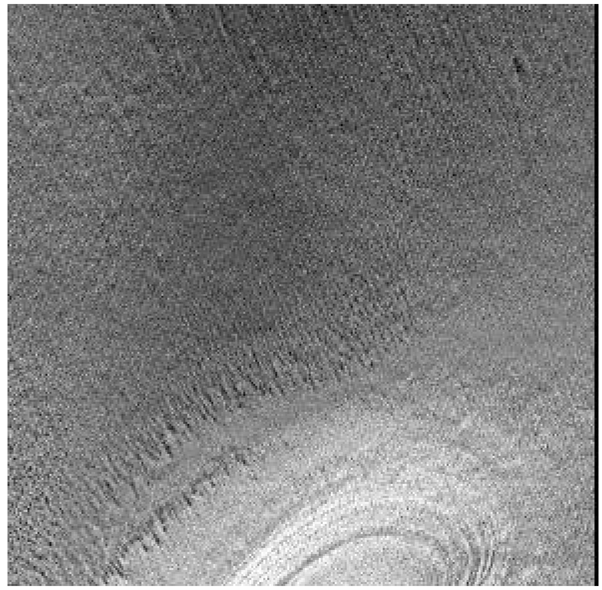

Figure 1. Knobbed-and-pitted plains with wind streaks and layer outcrops on the ovoid trough slopes. Fragment of MOC image 9503. Area 14 x 15 km.

Slopes with laminated outcrops of the layers show linear to sinouous outlines controlled by the topography. Apparent width of the outcrops vary from 50-100 m to 1-2 km on the images with 25 to 45 m/px resolution while on the image with 3.3 m/px resolution the outcrops as narrow as 10-15 m can be seen locally. Some layer outcrops look relatively dark, others are bright. Some have knobbed and pitted morphology, others look almost smooth. The layers keep these characteristics along all their visible lengths. Swarms of lineaments typical for the plains continue often onto the layer outcrops. Practically no evidence was found for any down slope material movement.

In none of the images could we identify any impact craters superposed on the layered deposits, although some of the observed pits could be remnants of the degraded craters which lost their elevated rim. We made a special study of MOC images of non-polar areas, where craters are not rare. We found that even at high Sun (no shadows in craters) we could recognize impact craters with the preserved rim if their diameter was at least 10 to 15 pixels. If such craters are present in the area we should identify them on the images with resolution of 45, 25, and 3.3 m/px if they are not smaller than 450-700, 250-400, and 35-50 m in diameter.

So the major component of the landscape seen by the Mars Polar Lander cameras will be numerous gentle sloping knobs and pits ranging in diameter from a few hundred meters to 15-30 m and maybe even less. Although presence of smaller-scale, potentially dangerous roughness can not be completely ruled out, the eolian resurfacing (see below) should probably effectively eliminate this possibility. The fact that degrading layer outcrops are different in their brightness is an evidence that eolian deflation strongly dominates here over the accumulation. If it would be the opposite, the layers should all become evenly dark with time due to accumulation of the residual dust. Difference of the layers in the presence or absence of the knobs and pits is evidently related to the layer properties to be more or less susceptible to the knob and pit formation. Hence, the knobs and pits on those outcrops are sculptured sublimation/deflation features rather than the relief of eolian accumulations. If knobs would be such accumulations they should cross the layer boundaries.

The swarms of parallel lineaments are evidently wind streaks formed by eolian erosion with some contribution of deposition. Their presence suggests also that smaller-scale eoilan activity probably occurs. Two dominant trends of the wind streaks suggest changes in the regional wind regime. Locally observed superposition of dark streaks on relatively bright layer outcrops suggests deposition of the darker material ontop of the brighter one. Although the general eolian balance in the areas under study is negative, some local deposition is evidently acting here.

The absence of recognizable impact craters in the studied areas may be interpreted in terms of rate of obliteration of the polar layered deposits. Combining results of [2] on crater counts and estimations of [8] on surface age of polar deposits with our observations we come to conclusion that the minimum estimate of the obliteration rate is about 2 m Ma^{-1}.

Surface material: Viking IRTM measurements and visual optical properties studied by [3, 7] show that the southern layered deposits are covered by red porous dust with thickness not more than 20 cm. In local lows darker material, supposedly sand, is present. It is broadly agreed that the polar layered deposits formed as a result of deposition of the airborn dust and ices. If so the lag deposits, left after sublimation of volatiles and partial deflation, should be the same dust, maybe modified by some *in-situ* surface processes. So the surface material at site should be close in its properties to the soils of other areas of Mars, including Viking and Pathfinder sites, namely drift and crusty-to-cloddy materials: fine (0.1 to 10 μm) dust with sand- and granule-sized clodlets, typical cohesion of 0.2 to 1.6 kPa, the internal friction angle typically 26 to 39^o, although 18^o is also possible [1, 6].

Sand-sized particles, which are believed to be a major component of the dark material seen in topographic lows [3], may also be present at the site. Aggregation of dust into larger particles may be due to processes similar to that described in experiments on vacuum sublimation of ice from ice-dust mixtures [9] and to meteorite bombardment as well. Centimeter sized meteorites accumulated due to negative mass balance of the surface material can also be expected.

When descending Mars Polar Lander will fire its rocket engines starting at the altitude of 12 m until touchdown. The rather strong and hot engine exhaust gas jets will effect the surface materials. Based on the Viking experience [4] we may expect soil erosion within 2-2.5 m from the engine with removal of upper 1-4 cm of the soil. The blowing out eroded soil will likely smear the last image taken by the Mars Descent Imager from the altitude of about 6 m. Some thermal effect on surface ice and frost is also expected.

Conclusions: The landscape at the MPL site will be dominated by knobs and pits of sublimation/deflation origin partly reworked by wind streaks. These knobs and pits are with gentle slopes of a few hundred to few tens meters across, possibly even smaller. Impressive landscape of the layered slopes has to be unfortunately avoided because of potential hazards to a successful landing. The surface material at the site is a lag deposit with an addition of wind blown material. The surface material will be affected by the descent engine exhaust gases. The material is expected to be mostly dust, sharing its characteristics with drift and crusty-to-cloddy soils of the Viking and Pathfinder sites. Presence of sand-sized particles originated from sublimation of ice-dust mixtures and/or impact bombardment as well as centimeter sized pieces of meteorites is expected too. The lag material layer is expected to be thin although eolian accumulation and small-scale down slope movement can locally increase it, thus making problem for sampling the subsurface ice.

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