MORPHOLOGY AND STRATIGRAPHY OF THE YOUNG HIGH-LATITUDE ICE-RICH MANTLE IN THE NORTHERN LOWLANDS OF MARS. M. A. Kreslavsky and J. W. Head, Department of Geological Sciences, Brown University, Providence, RI, 02912-2846, USA; misha@mare.geo.brown.edu, Astronomical Institute, Kharkov National University, Kharkov, Ukraine.

Introduction: The latitudinal trend of the subkilometer-scale topographic roughness of martian surface has been noted in [1]. It was suggested that smoothing at high latitudes is caused by a climate-controlled high-latitude surface mantle having a specific meter-scale surface pattern. [1, 2]. A specific dissected pattern interpreted as a result of desiccation of a several-meter-thick ice-rich deposit [3] has been observed in a latitude band at the peripheral part of the smoothed area. Recently, high concentration of hydrogen has been detected by Odyssey spacecraft at high latitudes [4-6]. These measurements refer to an uppermost layer of ~1 m thick. Thus the ice in the mantle material is responsible for the detected high ice concentration [7].

We continue our study of the statistical characteristics of kilometer-scale topography of the high-latitude ice-rich mantle using MGS MOLA profiles. We also carry out a systematic survey of the textures and features observed in the mantle in the northern hemisphere of Mars in the high-resolution MGS MOC images [e.g., 8]. In the northern hemisphere the mantle covers homogeneous, topographically smooth northern plains. These "boring" geological settings allow us to focus on intrinsic characteristics of the mantle itself, in contrast to the southern hemisphere, where in each place we encounter steep topography and a unique set of geological settings. We present here our preliminary results.

MOC images differ in resolution, illumination conditions and quality, and our ability to detect features and patterns is different for different images. We take this into account in the analysis of our survey results. All illustrations here are made with images with ~4.5 m/pixel resolution.

Morphology. In the northern plains the mantle has very typical decameter-scale surface textures seen in the high-resolution MOC NA images. Fig. 1 shows the most distinctive types of the textures. The basketball texture (A in Fig.1) is the most typical and wide-spread one. In some places the knobs forming the basketball texture are organized into a highly coherent linear structures (B) forming a regular basketball texture. The ripple-like texture (C) is also very common. The polygonal texture (D) occurs rarely and in relatively small patches (several km). Spatial scale of the textures differs from site to site, and often is smaller than shown in Fig. 1, and the texture is often hardly distinguishable in the images. Local variations of the patterns are often moderated by kilometer-scale topography. For example, more pronounced basketball texture tends to occur in local lows; the ripple-like texture on slopes of km-scale knobs has a radial orientation. There are latitudinal variations in the patterns, for example, the regular basketball texture and the polygonal texture occur at high latitudes (above 70°N) only.

In the peripheral part of the mantled region, the mantle is disrupted and probably undergoing erosion [2, 3]. Signs of erosion are observed at rare steep topographic slopes at high latitudes (an example is shown in Fig. 3). At high latitudes the steep slopes of any orientation are the warmest areas in the summer, and erosion of the mantle at the steep slopes is consistent with the ice as the material responsible for the mantle strength.

Statistical characteristics of kilometer-scale topography. Mantled high-latitude areas are characterized by lower hectometer-scale roughness in comparison to geologically similar unmantled terrains. Mantled areas have a higher Hurst exponent, which means weaker increase of roughness with decrease of scale. This means that the mantle preferentially smoothes down the subkilometer-scale topographic features. It is
interesting that the mantle has a positive median curvature [2], which means strong prevalence of concave topographic profiles. These characteristics are consistent with preferential emplacement of the smooth mantle in local hectometer- and kilometer-scale lows and concave areas. Morphological observations with high-resolution images confirm that this is the case. Fig. 3 shows an example of the mantle preserved in the concave area of kilometer-scale topography. Quantitative modeling of topography gives 1 - 2 m for a lower boundary for the mean mantle thickness. Smaller thickness of material cannot provide the smoothing observed. The morphological observations indicate a thicker mantle in many locations. Morphological observations also point to a gradual decrease of the mantle thickness toward the low-latitude margins.

Stratigraphy. The uppermost layer of the mantle is the most recent deposit in a vast area of the northern plains. This layer is mostly contiguous at higher northern latitudes and disrupted only by very rare small impact and collapse features. The paucity of impact features says that the mantle, at least its uppermost layer is very young geologically.

Deposition and removal of very thin films of bright fine dust by the dust storms and dust devils occurs at months-scale times. These processes have been documented in "real time" with the MOC images [8].

At the uppermost latitudes, in the surroundings of the polar cap, the mantle is overlain by wind-blown material. Fig. 2A shows one of the numerous examples of the dark barchan-like dunes that travel over the mantle. The barchan passage leaves no observable trace on the mantle, which says that the mantle is strong. It is not clear if movement of the dark dunes occurs at the present epoch. All attempts to identify such a movement during one martian year have failed [8]. In many locations the local lows in the dunes are filled with bright wind-blown material forming small ripples (e.g., Fig. 2B). This material is the youngest deposit in the circumpolar region.

The mantle itself has complex stratigraphy. This can be seen where the mantle is disrupted. Fig. 3, shows a clear example of at least two different layers; the surface of the uppermost layer has poorly developed basketball texture. In several cases, where individual MOLA profiles cross the layer edge, we obtained an estimation of the uppermost layer thickness. It turned out to be ~ 3 m.

Figure 3. Rim and southern outer wall of a crater at 69.5°N 86°W. Short arrows show edges of the uppermost mantle layer, long ones show that of the second layer. Fragment of MOC NA frame E04/00537, 1.8 x 1.8 km. Illumination is from lower left.

The roughness map [2] revealed several 10-km-scale craters that have high subkilometer-scale roughness, unlike the other craters in the mantled area (the crater in Fig. 3 is one of them). This indicates that these craters are younger than the major part of the mantle. However, the images show that these "young" craters bear some mantles (e.g., Fig. 3). This means that the whole set of mantles responsible for the observed topographic signature of the mantled region has been formed during a geologically long time in the Late Amazonian, while the uppermost layer is very young. It is not clear, whether the whole mantle is ice-rich, or only its uppermost youngest layer.