The comparative morphometric analysis of polygonal terrains on the Mars and on the Earth high latitudes areas.

R.O. Kuzmin 1, I.A.Komarov 2, A.H.Kozlov 2, V.S. Isaev 2, 1-Vernadsky Institute, Russian Academy of Science, Kosygyn st., 19, Moscow 117975, GSP-1, Russia. rok@geokhi.ru; 2-Laboratory of Planet Permafrost, Geological Department, Moscow State University, Vorob’evy Gory, Moscow, Russia, 119899. tpomed@garnet.ru

INTRODUCTION

Frost cracking process is widespread on the permafrost area on the Earth and is responsible to the formation of the ice wedges polygonal relief as the contraction cracks are repeated along the same fracture plane annually in the wintertime. The frost cracks is appears when the soil’s thermal tensions exceed the threshold durability of the soil (Lachenbruch, A. H. 1962, Kudryavcev, V. A. & Dostovalov B. N. 1978). Typical polygon sizes are in the range from 10 to 30 meters on the Earth. Their sizes are depended on the amplitude of the temperature fluctuations, and also from durability and physical-chemical characteristics of the frozen sediments. The maximum size of the frost-cracking polygons on the Earth was observed on the surface of low sea terraces, where they reaches of up to 70-100 meters in diameter (Shusherina, E. P. & Zaicev, V. N. 1976). The salinity of the sea terraces deposits was suggested as possible reason of such large polygon formation (Shusherina, E. P. & Zaicev, V. N. 1976).

The high resolution MOC images (Malin, C. M. & Edgett, K. S. 2001) shows wide multiple examples of the polygonal terrains. The terrains are located in the both hemispheres of Mars mostly on the latitudes higher than 40°, which is well consistent with the modal prediction where they could be formed on the Mars (Mellon, M. T. 1997). Preliminary analyses of the MOC images have shown that the morphology of the Martian polygonal features is very similar with terrestrial ice wedges polygons, while their size range (~ 20 - 200 m) is some wider (Kuzmin, R. O. et all. 2002. LPSC Abstract # 2030).

OBSERVATION

For comparison between Terrestrial and the Martian polygonal terrains we analyzed the images of the Yamal peninsula area (71°3N,67°E) (fig. 1 (a)), of the New Land archipelago (>73°N) (fig. 1 (b)) on the Earth areas, the region of Utopia Planitia (43.5°N,269.3°W) (fig. 4 (a), MOC image MO2-02863) and other area of northern plain on Mars (fig. 4 (b), MOC image MOC2-150).

The studied terrestrial area is characterized by following permafrost and geological conditions: upper part of frozen deposits is represented by sea loam-sandy loam sediments of middle and upper Pleistocene age which are recovered by sand (thickness of sand is > 10 m); the ice-wedges polygons have been observed everywhere and their pattern occurrence results to formation of multiple-wedge ice and polygonal ridge micro relief; predominant polygon size is 20-40 meters in diameter and till 80 meters for Yamal area (Kuzmin, R. O. et all. 2002. LPSC Abstract # 2030).
Polygons characterized by non-orthogonal and orthogonal form with three- and four-ray intersection of cracks. The orthogonal polygons with four ray intersection are more typical for areas close to the edge of the lake shore line, ravine and flood plain.

The example of orthogonal polygonal ice-wedge net is representing on the image of north part of South Island of New Land archipelago (Fig. 1(b), 2).

These are tessellation. It situates in ice-poor fine pebbles with sand-loamy sand filler on the second flood-land terrace. There are two wedge generation of different age.

Prevalent size of the first type is 3.0-6.0 m, the second type is 0.5-0.75 m, and the wedge width reaches 0.30 m (Fig. 1(b), 3). The ditch width exceeds the wedge width because of rock solifluction processes and wall collapses.

The Martian polygonal relief is located within the latitude range (>43°N), where water ice may to be stable in the surface regolith under modern climatic conditions of the planet (Fanale, F. P. et. al. 1986).

By the reason, the patterns may to be suggested as the ice wedge polygons(fig.4 (a), 4(b)). The polygonal terrains on Mars are seen mostly on the dark surface, where the mantle layer of an aeolian material (or other later formed sediments) apparently is less or absent.

The conducted comparative analyses of the polygons terrains on the Earth and Mars show that the features have very similar morphology, the size distribution trend and in the both cases they characterized by 3-ray and 4-ray intersections. The notable similarity of the polygonal terrains let us to suggest that the features on Mars apparently were formed mostly by frost cracking process in ice-reaching sediments with following growing of the ice wedges and in some places this processes is not finished. The calculation sizes values for the Martian polygon (on high longitude) show satisfactory conformity with values of polygon size, which are received from morphometric evaluations. The H₂O and CO₂ ice may to be as the main components for the ice wedge formation on Mars. It is probable that seasonal appearance of the salt solution in the upper surface layer (Kuzmin, R. O. & Zabalueva, E. V. 1999) could be serving as source of water filling the frost cracks in the summer season.

CONCLUSIONS.

The size of Martian polygons varies from 20 meters to 300 meters and their average size is close to 80-100 meters (Fig.5(a), 5(b), 6(b)). The geometry form of polygon patterns in the studied area is mostly regular orthogonal form and they have the intersections types like for the terrestrial ice wedge polygons (fig. 6(a)).

REFERENCES:
4-Kuzmin, R. O. et all. 2002. LPSC Abstract 2030