CONDITIONS AND MECHANISM OF MARS BIG HYDROLACCOLITHS FORMATION

Valeriy Yakovlev. Laboratory of Water Quality«PLAYA»
61001, 38, Kirova str., Kharkiv, Ukraine. Yakovlev_val@mail.ru

The introduction: On a surface of Mars in the low and average widths the structures like pingo with the diameters to several hundreds metres [1,2,3,4] and with the volume to 0,001 km^3 is widespread. It is practically undisputed that the origin of these structures is connected with the permafrost processes, namely with the water crystallisation at some depth. Considering the effect of expansion at water freezing (about 8,3 %), the volume of feeding tanks of undersurface water can make to 0,12 km^3. Such quantity of mineralized pore waters at the supposed permafrost capacity on Mars from 2,3-5 to 6,53-13 km [5,6] could be contained in the closed interfrost tanks. The question of «ice mountains» [7,8] and big hydrolaccolithe (BHL) [9] is taken less up in the literature. These structures have the characteristic pyramidal form and thanks to their sizes are well stand out in a relief of the flat lowered areas. An example of possibly active now structures is shown on Fig. 1.

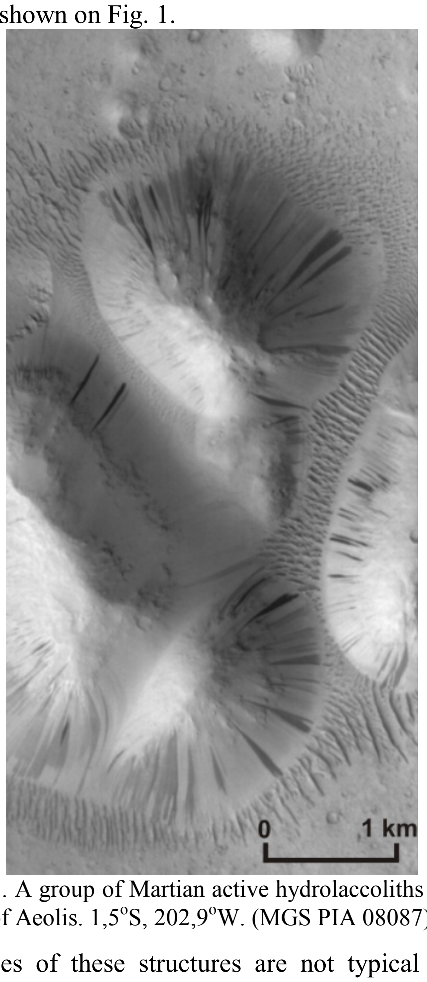

Fig. 1. A group of Martian active hydrolaccoliths is in the district of Aeolis. 1,5^{o}S, 202,9^{o}W. (MGS PIA 08087).

The sizes of these structures are not typical for the similar terrestrial forms - they reach more than 3 km in a diameter [9] and more than 0,5 km in height therefore the question on their origin is discussed. In case if it is really ice bodies, then following the above-mentioned reasoning, the volume of freezing water should make, at least, tens km^3, that it is difficult to place in the inter-frost tanks. The aforesaid can explain the activity of equatorial BHL shown on Fig. 1. At the same time the underfrost hydrosphere can theoretically be a source of such water volumes.

The preconditions for the ice injection structure formation: The water presence in the polar caps and in the underground layer in the high widths (Phoenix data), the wide spread occurrence of pingo, fresh gullies, channels and gigantic drain valleys, clouds of ice crystals indicate the presence of substantial water reserves on Mars. It is logical that water in the first fills the volume of the rock pore space. The depth of Mars cover destroyed by the asteroid impacts reaches 10 and more km [5, 10]. Taking into account a smaller gravity on Mars the porosity of breccia magmatic rocks, proluvial, alluvial and eolian granulated deposits at the depths of 5-13 km can correspond the analogous one on the Earth at the depths of 1,7-4,3 km and make no more than 10-12 % [11].The presence of liquid mineralized water at the certain depths being in a balance with the permafrost is possiple in a wide range of negative temperatures (depending on the water mineralization degree) - up to -55 C and lower [12]. It means, that potentially all thickness of the permafrost is permeable for the concentrated brines in low widths where the lowest temperature is at a surface (below a layer of seasonal temperature fluctuations) and makes - 50-60 C. The high mineralization of underfrost hydrosphere of Mars is the most probable condition of the last one as water of The Red Planet is in interaction with the rocks during billions of years, and there are no demineralization/desalination/freshening mechanisms of it in a stagnant zone under a layer of a frozen ground. Moreover, the water crystallization at the bottom surface of the frozen thickness leads to the replacement of salts and to the mineralization increase of residual water. Thus, at least, in the low and average widths of Mars there are conditions for the existence of liquid underfrost waters in the pore space of a sedimentary cover.

The assumed mechanism of BHL formation: Unlike smaller structures BHL pingo are located in areas with rather low marks, that indirectly specifies the possible relation of their formation with the underfrost waters. The assumed under frost tanks of water unlike interfrost interlayers and lenses are closed by only at top and from below they are limited by the dense crystal rocks. A simple calculation shows that BHL formation is impossible without involving of considerable volume of the underfrost waters of the surrounding territory. The average size of porosity of water containing rocks of Mars at depths from 5 to 10 km can be accepted not above 10 %. The phase transition of water into ice is accompanied by volume increase approximately on 8,3 %. Then the typical BHL formation - a cone with diameter of a basis 3 km and height 0,5 km (volume approximately 1,2 km^3) will demand involving 1,2/0,083*0,10 = 120 km^3 of the underfrost hydrosphere. A calculated value can be still increased if one assumes that in a freezing layer there is a formation of not continuous ice but with the interspersed nests of mineralized water. Thus, the area on which there is a phase transition of water in ice should be huge and consequently for the areas of BHL development it is necessary to speak about continuous development of underfrost hydrosphere. The phenomenon of the local BHL development in these conditions should be connected with the presence of local heterogeneity in permafrost thickness. The negative elements of a relief (for example a cavity of an impact crater) where the weight and durability of a frozen layer locally decreases or the presence of one or several higher located nests of salty water (see fig. 2) which also can reduce durability of thickness of frozen rocks can be such heterogeneity.

Conclusions: 1.Taking into account the aforesaid, the mechanism of BHL formation in water-encroached cover of sedimentary rocks of Mars can be presented in the sequence of processes: the formation of a continuous permafrost and mineralization increase of the undersrost pore water, the isolation of lenses of mineralized water in the permafrost thickness, the development of pressures in the underfrost hydrosphere, exceeding a surface of the lowered areas, the plastic deformation and damage of the continious frozen crust of Mars in the places of its smaller mechanical durability, the penetration of the mineralized waters in the nearsurface layers and the formation of BHL ice bodies2. The thermal conditions on Mars equator do not contradict the possibility of modern BHL formation at the expense of underfrost brines.

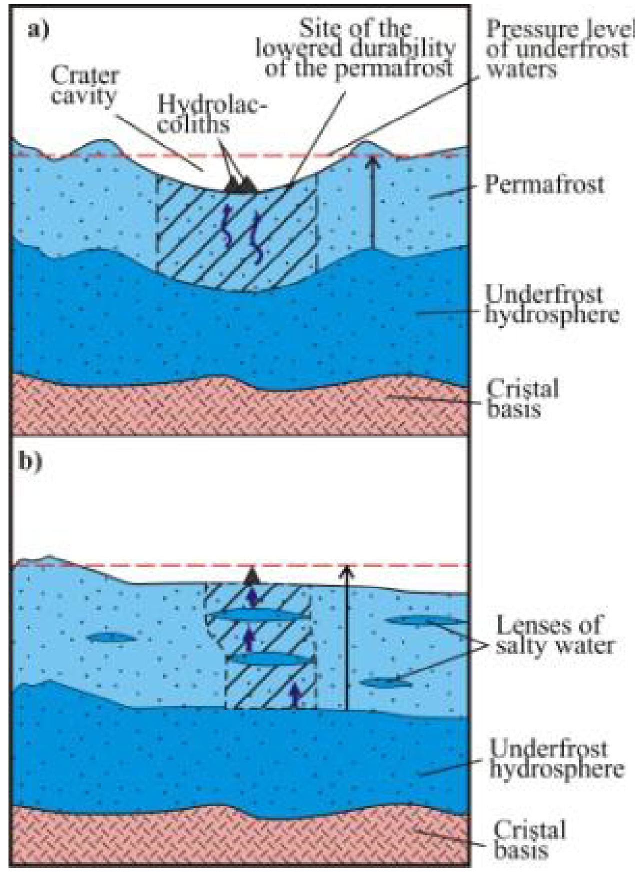

Fig. 2. Two variants of water penetration from the underfrost hydrosphere at big hydrolaccoliths formation: a) at impact excavation; b) in the presence of lenses of liquid salty water.

References: [1] de Pablo M.A. and Komatsu G. (2007) *LPS* XXXVIII, Abstract # 1278. [2] Soare, R. J et al. (2005) Icarus, 174, 373–382. [3] Dundas, C. M. et al, *JGR*, 35, L04201, doi:10.1029/2007GL031798. [4] Soare R.J. et al (2009) *LPS* XL Abstract # 1278. [5] Clifford S.M. (1993) *JGR, 98,* 10973-11016. [6] Clifford S.M. (2009) *LPS* XL Abstract # 2557. [7] Cabrol N. A., et al (2000), Icarus, 145, 91–107. [8] Farrand W. H., et al (2000) *JGR,* 110, E05005, doi:10.1029/2004JE002297. [9] Yakovlev V.V. (2007) European Mars Science and Exploration Conference: Mars Express & ExoMars. p.161. [10] Clifford, S.M. and T. J. Parker (2001) Icarus 154, 40-79. [11] Справочное руководство гидрогеолога. Т.1. Ленинград. «Недра» 1979. [12] Общее мерзлотоведение. МГУ,1978.