ON THE BASIS OF TERRESTRIAL ANALOGUE SITE STUDIES ARE THE DARK DUNE SPOTS REMNANTS OF THE CRYPTO-BIOTIC-CRUST OF MARS? Pócs T., (1) A. Horváth (2,3), T. Gánti (4), Sz. Bérczi (5), E. Szathmáry (4,6);
(1) Eszterházy Károly College, H-3300 Eger, Eszterházy tér 1. Hungary; (2) Budapest Planetarium of Society for Dissemination of Scientific Knowledge (planet@mail.datanet.hu), H-1476 Budapest Pf. 47, Hungary; (3) Konkoly Observatory, H-1525 Budapest Pf. 67, Hungary; (4) Collegium Budapest (Institute for Advanced Study), 2 Szentháromság, H-1014 Budapest, Hungary; (5) Eötvös University, Dept. G. Physics, Cosmic Mat. Sp. Res. Gr. H-1117 Budapest, Pázmány 1/a. Hungary (bercziiszani@ludens.elte.hu); (6) Eötvös University, Dept. of Plant Taxonomy and Ecology, H-1117 Budapest, Pázmány 1/a. Hungary, (szathmary@colbud.hu);

Abstract

We compared analogous sites on Earth to those Martian areas where a peculiar spotting phenomenon on the dark dunes occur. We found possibly candidates to these appearing and disappearing living organisms: those cyanobacteria which form the crypto-biotic-crust in hard terrestrial conditions.

Terrestrial spots with transient living conditions

According to Australian analogies (in the "Red Heart" of Australia, between Alice Springs and the Ayer's Rock) the Crypto-Biotic-Crust (CBC) regularly occurs and forms continuous, some hundred meter - kilometer sized spots with dark violet color on the wet plains between the hills or dunes, where the waters are collecting. After one-two months of active life period the dried CBC waits for the next wet season. The violet-black color is given to the surface by the scytonemin pigment of the cyanobacteria which play important role in this crust. This violet-black color pigment accumulates in the gelatinous cover of the cyanobacteria and it is protecting the living cell and its pigments for assimilation from the intensive UV radiation, and such way this layer makes possible the survival of the cells. Becasue the cyanobacteria are capable to survive in extreme cold or heat, and moreover dry conditions, it is probable that they also can survive the hard Martian conditions. Even those cyanobacteria were capable to awake to live which were in frozen state for millions of years in the Siberian permafrost. On the basis of these analogies we may suspect and assume that in the given Martian conditions the dark dune spots are resulted in from CBC consisting of cyanobacteria or other similar living organisms.

Martian spots with transient living conditions

These spots are named Dark Dune Spots (DDSs) and various hypotheses have been put forward for their origin and formation process, which fall into two main groups: geophysical and biological [1, 2, 3, 4, 5, 6 and 10].

Based on a detailed study of more than 400 MGS NA MOC images of Southern Polar Region of Mars we suggested a kind of biogenic origin of DDSs [2, 6], which is similar in many aspects to those life cycle, then that of the CBC organisms.

Characteristics of the Dark Dune Spots

Here we summarize the main characteristics of the DDS phenomenon in order to show the basic similarities to a CBC-type behavior.

The main morphological characteristics of DDSs are [6]: ○ diameter varies between a few dozen and a few hundred meters, □ on the flat areas the majority of the early DDSs are circular (Fig. 1a, 1b, 1d, Fig. 2), ○ circular shapes of DDSs are super imposed on the local small-scale topography, □ on slopes elongated DDSs develop (Fig. 1e), ○ elongation depends on the slope angle (from some spots extensions point downwards), ○ seasonal changes (Fig. 1a,b,c and Fig. 1d, 1e, 1f) and □ annual reappearance (Fig. 3a, 3b).

Fig. 1-The seasonal changes of the DDSs in the same places (a, b, c) of the Inca City (295°E, 82°S) and the different places (d, e, f) of the Pityusa patera (27°E, 66°S) areas from winter to summer. Arrows indicate lighter gray patches.

We observed [2, 5, 6], that the DDSs slowly changes in shape, extent, and number and reappears in the next year. We found the following time sequence of the morphological changes of DDSs: initially little gray fuzzy spots (or fields of spots) appear (Fig. 1a); the boundary of the gray fuzzy spots gradually becomes sharper and grayer (Fig. 1b, 1d, Fig. 2a, 2b).

Finally, the boundary extends, when all frost have sublimated (summer), lighter gray patches (LGP rings with darker central portion) remain at the site of the DDSs (Fig. 1c, 1f) and in next year about 70% of DDSs reappear in the same places [9].
ON THE BASIS OF TERRESTRIAL ANALOGUE SITE STUDIES ARE THE DARK DUNE SPOTS REMNANTS OF THE CRYPTO-BIOTIC-CRUST OF MARS?

Discussion: Current CBC on Mars?
The fact that extensions originate from some spots indicates some downward seepage or flow, i.e. transport of a fluid phase, which occurs below the frost cover (Fig. 1c).

We interpreted the DDS sequence of changes in the following way.
The bulk radial symmetry, (some outflow – seepage – patterns) and the defrosting beginning from bottom of the frosted layer means that a process begins at the frost-soil surface boundary.

DDSs gradually become holes in this process. In the DDS process – gray period – the frosted layer gradually becomes thinner and finally disappears. This may imply that the melting/evaporation process “eats up” the frosted layer. The DDS holes allow the light and atmosphere to make contact with the dark surface at the bottom where the DDS centers develop.

Fig. 3 The annual reappearance of the DDSs in the Inca City (a, b, [6]) from 1998 to 1999.

Summary
We suggested a CBC type terrestrial analogue process as a biological interpretation of the DDS phenomena [2, 6]. In this model we combined the sublimation processes with some kind of process are cyanobacteria type organisms which constitute the crypto-biotic-crust cover on terrestrial extreme surfaces [11]. If such CBC type crust of extremophile bacteria exist on Mars (earlier we called them Martian Surface Organisms - MSOs), they could live only below the surface ice, and they could survive the cold and dry (summer, autumn) periods, without the frost cover, in a dried state. When the frost layer is heated up by its absorption of sunlight, MSOs produce water from the frost, grow and reproduce through photosynthesis. This way CBC-MSOs can generate their own living conditions (liquid water and water vapor can also contribute to sustain this form of life). Activity of the MSO communities governs the defrosting/melting process on the top of the dark dune surface where the DDSs can be observed.

Acknowledgments
Authors thank for the use of MGS MOC images of NASA and Malin Space Science Systems [12].

References