COMPARISON OF SURFACE MINERAL CRUSTS AND CRYPTOBIOTIC-CRUSTS: HOW CAN THEY HELP LIFE SUPPORT MECHANISMS; IMPLICATIONS TO LIVING ORGANISMS ON MARS. ***T. Pócs** (1), **A. Horváth** (1,2), **Gánti T**.(1), **Sz. Bérczi** (1,3), **A. Kereszturi** (1,4), **A. Sik** (1,4), **E. Szathmáry** (1,6); (1)* Collegium Budapest (Institute for Advanced Study),, H-1014 Budapest, Szentháromság tér 2. Hungary, *(2)* Konkoly Observatory, H-1525 Budapest Pf. 67, Hungary, *(3)* Eötvös University, Dept. G. Physics, Cosmic Mat. Sp. Res. Gr. H-1117 Budapest, Pázmány 1/a. Hungary, *(4)* Eötvös University, Dept. Physical Geography, H-1117 Budapest, Pázmány 1/c. Hungary, *(5)* Eötvös University, Dept. of Plant Taxonomy and Ecology, H-1117 Budapest, Pázmány 1/c. Hungary (szathmary@colbud.hu)

Introduction: On MGS MOC images we studied *defrosting spotting process* at the Martian South Polar Regions. In the interpretation of the defrosting process we involved living organism activities of putative *Martian Surface Organisms (MSOs*) operating in the surface soil environment. In this study we compare the soil environment types of surface mineral and crypto biotic crusts in order to approach understanding the life support abilities and mechanisms.

Materials: Both mineral crusts and cryptobiotic crusts (CBC) are widely occurring on the surface of the soil or rocks. Various climatic conditions may contribute to their main characteristics and the constituent mineral and biotic components may give a double characterization for them. Many types of the crypto-biotic crusts (CBC) were summarized as candidate counterparts for the Martian life in 2003 by [1]. The surface mineral crusts (SMC) were overviewed in 2006 by [2]. The main purpose of this paper to compare them for common characteristics and markers.

CBC: On dark dunes characteristic, growing splotches, called *dark dune spots* appear at the end of the winter or in early spring [3]. We worked out an interpretation exclusively for the DDSs [4]. In a detailed sequence of interactions with the soil components we showed that development and characteristic features of these spots involve many kinds of materials where soil, water, snow coverings all serve the main actors, the MSOs. The seasonal water supply results in interrupted life cycle of MSOs. We focused the search on terrestrial counterparts with such interrupted life cycle and also with harsh climatic conditions. This way we found the CBC rusts as candidates.

For crypto-biotic crusts their interrupted life cycle, fitting to various environments, extreme conditions were the main reasons for selection as Martian Surface Organism counterparts on the Earth. The active life cycle of the CBC consortia in desert areas is restricted to the short wet season, when the water is present. After one-two months of active period the CBC dries out and waits for the next wet season (***Fig. 1***).

The terrestrial CBC in central *Australia* has violet-brown color. This is due to the *scytonemin pigment* of cyanobacteria, which are most important component of this crust. This dark pigment is accumulated in the gelatinous sheath of the cyanobacteria and it is protecting the living cells and its assimilating pigments from the overdose of intensive UV radiation, and in such a way makes the survival of the cells possible. *Scytonemin* is the most successful against the deteriorating effect of long UV-A radiation. The protective role of this pigment was studied mainly by [5, 6 and 7]. Other cyanobacteria (***Fig. 1***), especially those living in the CBC of rock surfaces, have another protective pigment too, gloeocapsin, with an intense reddish-violet color. In fact, cyanobacteria cells also have an internal protective system: *Mycosporin* like compounds (MAA), which are colorless, water soluble aminoacid derivates. The MAA is most effective, according to [8], against the shorter wavelength UV-B radiation.

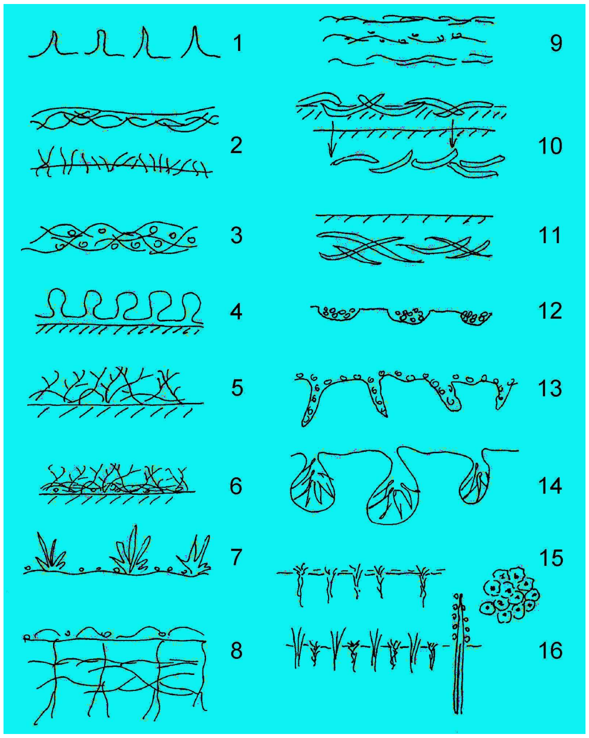

Fig. 1. Sketch of the main types of the cryptobiotic crusts. 1. Schizotrix Symploca, 2. Scytonema Lyngbya, 3. Scytonema Aphanocapsa, 4. Nostoc, 5. Stigonema, 6. Stigonema multilevel, 7. Calothrix Gloeocapsosis, 8. Tolypothrix – Nostoc – Lyngbya, 9. Tolypothrix – Crinalium – Symplocastrum multilevel assembly, 10. Microcoleus changing its position, level, 11. Microcoleus, 12. Gloeocapsopsis, 13. Chasmolitic Gloeocapsopsis, 14. Semiendolithic Hyellaceae et Symploca, 15. Circular network, 16. Antenna.

1. Schizotrix Symploca: Conical emerging cyanobacteria („erected fascicles”), the height of the cones can reach 1 cm! It forms fluffy green-blue surface visible by nacked eyes. Mainly on regions with great humidity (i.e. tropical forests), soils, rocks, crusts, and on leaves, too. Example: Schizothrix friesii (Queensland)

2. Scytonema Lyngbya: Filiform cyanobacteria with thick mucous sheath contain great amount of UV shielding pigments. They form continuous tissue on the surface. They live in loose soil in the depressions of the deserts in terrestrial conditions. Depressions became filled with water in the wet season, later they dry out, and salts are accumulated.

3. Scytonema Aphanocapsa: In the tissue of the filiform bacteria several coccoid species are mixed. They frequently live on perpendicular rocky surfaces. It is formed by Tolypothrix species with Gloeocapsa species. It is the layered type of Komáromy (1976) [9].

4. Nostoc:Spherical or pear shaped beds are embedded into a gelous sheath and are scatterred on the surface of the soil or form continuous cover.

5. Stigonema:They form continuous or intermittent bush cover on the surface of hard rocks. It is strongly filled with pigments. It is formed by various bush-formed Stigonematacea species. It occurs from the polar regions to the tropical regions, but not at the most dry regions. It is the branching type of Komáromy [9].

6. Stigonema multilevel:In the shadow of the various Stigonemtacea species nonpigmented gelous sheathed coccoid cyanobacteria may live in great masses. They occur mainly in the small depressions of the rocky surface (SMC) of granitic mountains. It does not occur in really tropical climatic conditions.

7. Calothrix Gloeocapsosis:Between the bushes of Calothrix or Dichotrix beds of the strongly pigmented Gloeocapsopsis species can live. They can occur on the granite rocks (SMC) of isolated mountains in temporary wet places in semiarid conditions. (Our colllecion site: Mount Franklin National Park, Australia.)

8. Tolypothrix – Nostoc – Lyngbya: The Tolypothrix threads penetrate into the deeper layers which contain water. There they can survive the dry season living together with Microcoleus species. Epi-endoterranean type, which fixates the loose, fine grained soil of the really desert regions. They live in depressions with wet soil for a short time, and where salts are accumulating (Our collection site: Middle-Australia, Sahara, Jerid).

9. Tolypothrix – Crinalium – Symplocastrum multilevel assembly:This is a community with 3 layers. The epiterrain layer level is ruled by Tolypothrix byssoidea, the subterrain is by Symplocastrum friesii, the lower endoterrain layer level is by Lyngbyella sp. In the middle level a characeristic species is the Crinalium epipsammum. Such communities can be found at the bottom of salty lakes which dry out seasonally. The layering is a defensive strategy and exhibits gradation from salt-tolerant, over dryness-tolerant and UV tolerant bacteria. (Our collection site: West-Australia: Barlee lake).

10. Microcoleus changing its position and level: Microcolueus paludosus and Microcolueus chtonoplastes takes part in this community. It occurs in sandy soils of deserts or on loess surfaces. This community is a good example of the seasonal adaptation strategy.

11. Microcoleus: It is the most general endoterrain type of the sandy soils of deserts or of loess surfaces. The Microcoleus species leave their gelous sheath and glue together the upper soil layer.

12. Gloeocapsopsis: Gloeocapsospsis dvorakii and its relatives etch their beds into the rocky surface (SMC) of the arid regions. They form mosaic-like groups. They are important pioneering factors in weathering of the rocks. The red-pigmented beds of this group occur even in the hottest desert rocks, too.

13. Chasmolitic Gloeocapsopsis: They occur in the fissures of the Arctic Canada dolomite rocks SMC (Our collection site: Houghton crater, Devon Island, Canada).

14. Semiendolithic Hyellaceae et Symploca: This community occurs in the limestones (SMC) of the Mediterranean and desert regions. It etches itself into the limestone. (Our collection site: on the limestone columns in the Pinnacles National Park, W.-Australia).

15. Circular network and 16. Antenna are two new types.

Because the cyanobacteria are capable to survive also in extreme cold or heat, and moreover dry conditions, it is probable that according to this analogous situation, they also can survive the hard Martian conditions as proposed by [10].

SMC: The mineral crust studying group focused their studies on the role of mineral components together with water as main supplies from the soil or rock surface. The role of water is: transporting solutes, (for mineral growing), containing dissolved ions as nutrients for living organisms, the previous two roles unified to entrap organic components. The mutual interaction between the water solutes and the supposed living organisms produces various processes to be studied. Climatic events allow to conclude the evidence of the presence of the various forms of water precipitates on the Earth and also on Mars (weathering products as surface mineral crusts, observation of the precipitating events as fog, snow and long staying frosted surfaces).

In the Houghton crater [2] describes various mineral crusts with carbonate, gypsum and iron rich crusts. On the carbonchain molecule content of these SMCs they conclude that the remnant molecules are characteristic markers of the cyanobacteria.

Discussion: Search for CBC and SMC crust types on soils contribute to the understanding the processes which may important in Martian life formation and preservation, moreover probably to the survival of the Martian life. Recent MER probes studied some SMCs along their pathway and revealed the weathering history of these surfaces. Joint effort of search both CBC and SMC crust types may emphasize the role of the living – mostly cyanobacterial – bacterial components in forming these crusts and these interactions may contribute to the development of new measuring methods of Martian life to. Till that epoch we must use the recent comparative possibilities in which water using, mineral (and biotic) crust forming living organisms act on soil and rocky surfaces. In this aspect the joint use of the CBC, SMC and MSO model data may give the best testifyable model.

Acknowledgments: Authors thank for the worthy discussions with professors I. Friedmann [10] and D. Möhlmann [11].

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