EPSC Abstracts
Vol. 8, EPSC2013-994, 2013
European Planetary Science Congress 2013

Endolithic microniches support habitability

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Abstract

Particular micro-niches on extreme environments give us some clues about the habitability potential under protected environments with important connotations from an astrobiological point of view [1]. The salts precipitation patters in extreme environments can contribute to biomineralization processes which could be of special interest for organics but also life preservation on environmental harsh conditions. These "oasys" for organics and/or life forms are of special astrobiological interest and should attract our attention in other planets and we should be looking for it during rover exploration missions. Endolithic micro niches in Rio Tinto salts precipitates determine controlled scenarios where phototrops develop under controlled conditions. Rio Tinto, 100 km river located at South West of Spain, is being taken as a well reported Mars analog due to the similarities in the mineralogy of the system which that reported by MER Opportunity Rover missions which landed in Meridiani Planum where sedimentary deposits have been identified in different craters [2]. Interesting multi layered salty deposits were identified in Rio Tinto source area where endolithic micro niches were settled [3]. Green layers appear included in brown stratified salt precipitates. The crust deposit was between 5 mm and 1 cm width. The layered structure is deposited over rocks or over man made structures as dam or mining tunnels walls but always in places with specific environmental characteristics. It appears in not direct Sun light exposed places (shadow side of walls) with thermal and pH stability.

1. Introduction

The existence of extinct or extant liquid water in Mars subsurface would increase its habitability potential. Evidence of extant water on Mars was reported by the Mars Express mission [4]. OMEGA near-infrared spectrometer reported the presence of phyllosilicates on the Mars surface. These water bearing minerals located on early Mars surfaces are solid proof of the existence of water in early Mars. Other authors have recently reported a wider diversity of phyllosilicate mineralogy using the Compact Reconnaissance Imaging Spectrometer (CRISM) on the Mars Reconnaissance Orbiter (MRO) [5]. Other evidence of a wet past of Mars come from the Opportunity rover at Meridiani Planum. The identification of hematite, goethite and sulfate rich deposits, such as jarosite [6], gave a possible scenario for a past aqueous acidic environment on Mars. The study on Extreme Environments on Earth has contributed tremendously to the understanding of habitability conditions on other planetary bodies. Mars surface conditions are harsh conditions for life to exist. The possibilities for life on such place increase if we consider the possibility of micro niches where life could be located and protected against the adverse conditions [7].

2. Methods and Studies

Samples of the multi layered salt deposits were studied using different techniques. Biomineralization processes are being studies using microscopic and molecular approaches.

2.1 Absorbance records

In acquiring the absorbance records along the diurnal hours, an Ocean Optics VIS-UV USB4000 fiber optic spectrometer was used. It covers a wavelength range from 200 to 850 nm with an optical resolution of 1.5 nm, providing a binary resolution of 16 bits.

2.2 X-Ray Diffraction (XRD) analysis

XRPD was performed using a PANalytical X'Pert PRO MPD system (PW3040/60) (PANalytical B.V., The Netherlands) with Cu Kα radiation (λ = 1.542 Å) and a divergence slit of 1°. Samples were scanned between 3° (2θ) and 40° (2θ) using a step size of 0.008° (2θ) and a count time of 2 s. Data were collected using X'Pert Data Collector and viewed

using X'Pert Data Viewer (PANalytical B.V., The Netherlands). The intact compact samples were placed directly on a flat aluminum sample holder. The powdered compact samples were packed into a standard aluminum sample holder and measured in the same way as the calibration samples.

2.3 Microscopic observation

Microbial population of the salty crust was followed by optical microscopy (Axioskop 2, Zeiss). Bio-mineralization processes over the microbes were identified and followed through the observation of different samples from different stations which showed different level of dehydration. The samples were fixed using critical point (Critical Point Dryer Ball-Tec CPD 030) and mounted onto conductive graphite stubs and sputtered and gold-coated in a Bio-Rad SC 502 apparatus for electrical conductivity and to prevent charging under the electron beam. Samples were examined with a SEM (Electron Scanning Microscope JEOL JSM-5600 LV) (Figs. 5, 8 and 10) using an acceleration voltage of 20 kV and a working distance of 20 mm.

2.4 Microbial diversity

Microbial diversity present in the samples was studied using molecular ecology techniques. Total DNA present in the sample was extracted and amplified by PCR using universal prokaryotes primers. The PCR products were directly sequenced.

3. Summary and Conclusions

Different microbial species to those present on the water column and sediments of the river were found inside the salty crust. Clear biofilm formations were identified. Not complex structures were observed as well as a low number in the species composition of the microbial population. Five different morphologies were identified in the SEM micro graphs. The number of the species was confirmed by molecular ecology techniques which rendered high similarities with eukaryotes as *Dunaliella* sp., *Cyanidium* sp., and others phototrophs. Some prokaryotes were also identified. The stability in pH and temperature seems to indicate a microbial adapted protected ecosystems what was confirmed when spectral analysis outside and inside the salts deposits were took.

Acknowledgements

The laboratory experimental procedures were supported by Grant **AYA 2010-20213** "Desarrollo de Tecnología para la identificación de vida de forma automática" from the Spanish Government.

References

[1] Gomez, F; Mateo-Marti, E; Prieto-Ballesteros, O, Gago, J., and Amils, R. Protection of chemolithoautotrophic bacteria exposed to Mars environmental conditions. Icarus **209** (2) 482-487, 2010

[2] Squyres S. W. and Knoll A. H. Sedimentary rocks at Meridiani Planum: Origin, diagenesis, and implications for life on Mars. Earth Planet. Sci. Lett. 240 (1), 1- 10, 2005

[3] Gómez, F., Rodríguez-Manfredi, JA., Rodríguez, N., Fernández-Sampedro, M., Caballero-Castrejón, F.J. and Amils, R. Habitability: Where to look for life? Halophilic habitats: Earth analogs to study Mars habitability. Planetary and Space Science 68 48–55, 2012

[4] Poulet, F., Bibring, J. P., Mustard, J.F., Gendrin, A., Mangold, N., Langevin, Y., Arvidson, R.E., Gondet, B., Gómez, C., and The Omega Team. Phyllosilacates on Mars and Implications for Early Martian Climate. Nature 438, 623-627, 2005

[5] Mustard, J F., Murchie, S L, Pelkey, S M, Ehlmann, B L, Milliken, R E, Grant, J A, Bibring, J-P, Poulet, F, Bishop, J, Dobrea, E N, Roach, L, Seelos, F, Arvidson, R E, Wiseman, S, Green, R, Hash, C, Humm, D, Malaret, E, McGovern, J A, Seelos, K, Clancy, T, Clark, R, Des Marais, D, Izenberg, N, Knudson, A, Langevin, Y, Martin, T, McGuire, P, Morris, R, Robinson, M, Roush, T, Smith, M, Swayze, G, Taylor, H, Titus, T, Wolff, M. Hydrated silicate minerals on Mars observed by the Mars Reconnaissance Orbiter CRISM instrument, Nature 454, 305 doi: 10.1038/nature07097, 2008

[6] Squyres S. W., Grotzinger J. P., Arvidson R. E., Bell J. F., III, Calvin W., Christensen P. R., Clark B. C., Crisp J. A., Farrand W. H., Herkenhoff K. E., Johnson J. R., Klingelhofer G., Knoll A. H., McLennan S. M., McSween H. Y., Jr., Morris R. V., Rice J. W., Jr., Rieder R. & Soderblom L. A. In Situ Evidence for an Ancient Aqueous Environment at Meridiani Planum, Mars. Science 306 (5702), 1709-1714, 2004

[7] Rothschild LJ. Earth analogs for Martian life. Microbes in evaporites, a new model system for life on Mars. Icarus 88:246-60,1990