Bacterial presence in cold perchlorates solutions: Implications for Mars

Laura García-Descalzo*†[1], Carolina Gil-Lozano[1], Victoria Muñoz-Iglesias[1], Olga Prieto-Ballesteros[1], Armando Azúa-Bustos[1,2], and Alberto G. Fairén[1,3]

[1]Centro de Astrobiología (CSIC-INTA) – Ctra. Ajalvir Km.4 28850 Torrejón de Ardoz, Madrid., Spain
[2]Instituto de Ciencias Biomédicas, Facultad de Ciencias de la Salud, Universidad Autónoma de Chile, Santiago. – Chile
[3]Department of Astronomy, Cornell University. – Ithaca 14853 NY, USA, United States

Abstract

The environmental conditions dominating on Mars early in its geological history (4.5–3.5billion years ago) are not precisely constrained, although climate models suggest that mean temperatures were generally below freezing. If the early Mars environments were "cold", the presence of liquid water can be explained because the freezing point of the aqueous solutions was decreased by a variable enrichment in dissolved salts [1] and high ionic solutions and brines has been suggested to be prevalent in a "cold and wet" Mars [2].
Here we evaluate the influence that the presence of microorganisms may exert on the physical properties of specific hygroscopic salts relevant to Mars, particularly perchlorates. To this end, we have cultivated bacteria in highly concentrated magnesium perchlorate solutions at sub-freezing temperatures. We studied their survivability as well as their interaction with the chaotropic perchlorates through a combination of techniques of molecular microbiology and aqueous geochemistry, recording the changes observed by Micro-Differential Scanning Calorimetry (μ-DSC) of the phases stability of the brine system.

Specifically we have analyzed the effects of the combination of cold and salty environmental conditions on microbial strains of *Rhodococcus* sp. JG3 and *Escherichia coli*, with the two fold aim of (1) better understanding whether halophile-psycrophile microorganisms can modify the freezing point depression in brines, and (2) extrapolating our results to constrain the limits of habitability on a "cold" Mars.

Recent studies suggest that some chaotropes might enhance the growth opportunities for life in hostile environments [3] and here we show that at some extent extremophiles are able to modify the chaotropicity of the solutions in which they inhabit, generating more hospitable microenvironments in cold ecosystems.

Moreover, by proteomic analyses we found differences in protein profiles between bacteria growing at optimal conditions and bacteria incubated in cold aqueous perchlorate solutions and those differences can provide clues about the potential role of some proteins as important players in the adaptability of life to cold environments. These molecules can be used as models for the search for biosignatures in planetary exploration.

*Speaker
†Corresponding author: garciadl@cab.inta-csic.es

We conclude that (1) if life ever existed in Mars, microbial communities may have contributed to enhance the habitability of salty aqueous solutions at freezing temperatures, therefore amplifying their own survivability limits on a "cold and wet" planet; and (2) calorimetric methodology is a very promising tool for the study of the influence of microorganisms on their environment.

References

Fairén, A.G. et al. (2009). *Nature* 459, 401.

Fairén, A.G. (2010). *Icarus* 208, 165-175.

Shcherbakova, V. et al. (2015). *Microorganisms* 3, 518-534.

Acknowledgements
Study in the framework of project "icyMARS", funded by the European Research Council, Starting Grant no. 307496.