Can Halophilic and Psychrophilic Microorganisms Modify the Freezing/Melting Curve of Cold Salty Solutions? Implications for Mars Habitability

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Abstract
We present the hypothesis that microorganisms can change the freezing/melting curve of cold salty solutions by protein expression, as it is known that proteins can affect the liquid-to-ice transition, an ability that could be of ecological advantage for organisms on Earth and on Mars. We tested our hypothesis by identifying a suitable candidate, the well-known psycrophile and halotolerant bacteria Rhodococcus sp. JG3, and analyzing its response in culture conditions that included specific hygroscopic salts relevant to Mars-that is, highly concentrated magnesium perchlorate solutions of 20 wt % and 50 wt % Mg(ClO4)2 at both end members of the eutectic concentration (44 wt %)-and subfreezing temperatures (263 K and 253 K). Using a combination of techniques of molecular microbiology and aqueous geochemistry, we evaluated the potential roles of proteins over- or underexpressed as important players in different mechanisms for the adaptability of life to cold environments. We recorded the changes observed by micro-differential scanning calorimetry. Unfortunately, Rhodococcus sp. JG3 did not show our hypothesized effect on the melting characteristics of cold Mg-perchlorate solutions. However, the question remains as to whether our novel hypothesis that halophilic/psychrophilic bacteria or archaea can alter the freezing/melting curve of salt solutions could be validated. The null result obtained after analyzing just one case lays the foundation to continue the search for proteins produced by microorganisms that thrive in very cold, high-saline solutions, which would involve testing different microorganisms with different salt components. The immediate implications for the habitability of Mars are discussed.

Author keywords
Calorimetry
Chaotropism
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