

An Experimental Assessment on the Effects of Variations in Sulfate Concentrations on Sulfate Reducing Bacteria in Simulated Martian Conditions. M. Silver¹; S. Mora², M. Ivey³, and V. Chevrier⁴, ¹Arkansas Center for Space and Planetary Sciences at the University of Arkansas. 332 N Arkansas Ave., Fayetteville, AR 72701. mmsilver@email.uark.edu, ²The University of Arkansas Department of Biological Sciences. 1 University of Arkansas, Fayetteville, AR 72701. slmosque@email.uark.edu, ³The University of Arkansas Department of Biological Sciences. 1 University of Arkansas, Fayetteville, AR 72701. mivey@email.uark.edu, ⁴Arkansas Center for Space and Planetary Sciences at the University of Arkansas. 332 N Arkansas Ave., Fayetteville, AR 72701. vchevrie@email.uark.edu

Introduction:

Significant sulfate mineral exposures have been identified on the Martian surface, [1][2] [3][4] including ferric sulfates[6][7], Ca sulfates, and Mg-sulfates. Liquid water in the form of brines may form and remain stable on the Martian surface or in the shallow subsurface for extended lengths of time [3] [8][9][10][11]. According to the second Mars Exploration Program Analysis Group (MEPAG) Special Regions Analysis Group (SR-SAG2), these sulfate brines on the Martian surface or shallow subsurface need to be considered “special regions”: regions where terrestrial organisms are likely to replicate and/or have a high potential for the existence of extant Martian life forms[12]. For these reasons, the replication capabilities of organisms which utilize sulfates as metabolic energy sinks (SO₄²⁻ as terminal electron acceptor) were investigated.

Experiment:

Organisms capable of enduring extreme temperatures and low water activities were chosen for study. Four extremophile sulfate reducing bacteria species representing psychrophilic, chemolithoautotrophic, heterotrophic, and sporulating organisms were investigated, *Desulfotalea psychrophila*, *Desulfobacter psychrotolerans*, and *Desulfotomaculum arcticum*, as well as an iron-reducing organism (*Desulfuromusa ferrireducens*) to test for the combination of iron reduction and sulfate reduction in ferrous/ferric sulfates.

Initial experiments were performed under optimal organism conditions (growth solutions, atmospheric composition, and temperature). Exponential phase cells were collected and inoculated into synthetic minimal media [13] supplemented with varying solutions of CaSO₄, MgSO₄, Fe²⁺SO₄, and Fe³⁺₂(SO₄)₃. Solutions were then incubated at the respective organism’s ideal growth temperature for 1 month.

Cultures were purified using a suite of MOBIO DNA Isolation Kits. PCR utilizing primers based on the 16s rRNA of six phylogenetic groups of sulfate-reducing bacteria was performed to amplify culture DNA concentrations. Gel electrophoresis was then performed to provide an initial, indirect molecular indication of cell number.

Results:

Gel electrophoresis of *D. psychrophila*, *D. arcticum*, and *D. ferrireducens* cultures subjected to media supplemented with varying sulfate concentrations has been inconclusive thus far: gels display inconsistent DNA banding of cultures. In most cases, cultures sampled for PCR and gel electrophoresis display a significant level of bioturbation, despite not consistently yielding DNA bands.

Conclusions:

The presence of bioturbation in cultures and intermittent DNA banding in gels indicates metabolic activity. A lack of DNA banding in PCR gels may be a result of 1) not enough DNA in PCR amplified samples subjected to gel electrophoresis, 2) insufficient DNA shearing during PCR amplification, 3) the use of inappropriate primers, or 4) slight variations in DNA purification and PCR processes.

Future Work:

Once control samples have been characterized, SRBs will be subjected to a suite of varying temperatures, water activities, pressures, and gas compositions to accurately replicate Martian surface and subsurface conditions. Cultures will be analyzed as described, as well as through X-Ray diffraction and Fourier transform infrared spectroscopy to investigate the morphology and semi-quantitative chemical composition of precipitates and to identify morphologies in biominerals that may form.

References:

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