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Microbial communities in subzero brine environments in the Canadian high Arctic.

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The primary targets for astrobiology investigations of other solar system bodies are Mars as well as Europa and Enceladus. Extremely cold temperatures characterize these targets, and as such, the best terrestrial analogues may be the Earth's polar regions; the Canadian high Arctic offers several unique cryoenvironments (cold saline springs, permafrost) that resemble the conditions that are known or are suspected to exist on Mars. This presentation will describe our recent research focused on detecting and examining microbial life in the unique cold sa-line/brine springs and permafrost habitats on Axel Heiberg Island (and Antarctica) with the overall goals of determining the low temperature limits of microbial life on Earth and if mi-crobial communities inhabiting such cryoenvironments (subzero habitats) are active at ambient subzero temperatures. Preliminary results will be presented for a permafrost isolate, Plano-coccus sp., capable of growing at the coldest temperature shown to date (-15 °C) at 18% salinity. Molecular adaptations to tolerating extreme salinity are also used for cryoprotection in this microorganism. The presentation will focus on the microbiology and geochemistry of the Gypsum Hill (GH) and Lost Hammer Spring (LH) sites (Perreault et al, 2008; Nieder-berger et al. 2010). These unique subzero (0 to -5ºC) hypersaline springs (7.5 to 23% salinity) are characterized by thick extensive permafrost in an area with an average annual air tempera-ture of -15°C and with air temperatures below -40°C common during the winter months. The presence of geomorphological features linked to water movement, such as fluvial valleys and flood channels on the surface of Mars signifies that water once flowed through the Martian landscape and thus, they could have been a potential abode for past or extant microbial life. These springs support viable microbial communities capable of activity at temperatures as low as -10ºC. The LH site also provides a model of how a methane seep can form in cryoen-vironments and presents a mechanism that could possibly be contributing to reported methane plumes on Mars. The GH springs sulfide (25-100 ppm) and sulfate (2300-3700 mg/L) abun-dant system serving as an analogue for the abundant sulfate deposits and potential sulfate-rich brines on Mars that may have originated in the presence of sulfur-rich groundwater. Gas composition (C1-C4 hydrocarbons, He, H2, O2, N2, Ar, & CO2) and stable isotope (d13C and d2H values using compound specific isotope analysis) analyses of the saline spring gas sam-ples has revealed the small amounts of hydrocarbons in gases exsolving from the Gypsum Hill springs (0.38 to 0.51% CH4) were compositionally and isotopically consistent with microbial methanogenesis and possible methanotrophy (Perreault et al. 2008) while the major gas emitted from LH spring is methane (∼50 %) with carbon and hydrogen isotope signatures consistent with a thermogenic origin (Niederberger et al. 2010). These hypersaline, cryo-systems present interesting testing grounds for hypotheses regarding microbial habitability and metabolism in subzero, brine environments.