HABITABILITY OF ANTARCTIC SUBSURFACE BRINES.

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Introduction: Extreme terrestrial environments inform our understanding of the potential habitability of other worlds. These locales provide insights into possible survival strategies, biosignature preservation and clean sampling approaches for extraterrestrial targets [1]. The McMurdo Dry Valleys of Antarctica have long served as a Martian analog site due to the extreme cold and dry desert conditions.

Fig. 1 Blood Falls (photo: P. Rejcek)

Blood Falls as a Putative Martian Analog: Blood Falls (Fig. 1) is a feature on the snout of Taylor Glacier where iron-rich brine episodically discharges to the surface from a deeper, extensive subglacial aquifer [2]. Here we focus on the attributes of the Blood Falls system that may be relevant to Mars: (1) Blood Falls provides access to a subglacial brine system for the testing of drilling and sampling technology, (2) samples of the brine allow for study of extremophiles living in cold, dark isolation, conditions that would exist in the Martian deep subsurface, (3) because contents of this subglacial brine are episodically released, they provide an opportunity to examine the fate of biosignatures from a subsurface microbial community as it becomes exposed to drastically different surface conditions.

Geophysical, Geochemical and Geomicrobiological Surveys at Blood Falls: Evidence suggests that the outflow brine at Blood Falls has derived chemically from cryoconcentration and/or evaporation of marine waters combined with extended (possibly over millions of years) of rock-water interactions [3, 4]. The result is a cold (-6 to -7 °C), suboxic (ORP= 70-90 mV), ferrous (3.4 mM Fe) and CO_2-rich (55 mM) brine (8% salinity) that seeps out from below the Taylor Glacier. Geochemical calculations suggest that the subglacial environment harbors ≥1 bar of CO_2(g). At the surface, salts precipitate from solution (Fig. 2), and iron in the brine oxidizes to produce the striking, red coloration of Blood Falls (Fig 1).

Despite the potentially challenging conditions beneath the Taylor Glacier, the calculated water activity (0.98) and ionic strength (1.7 mol kg^{-1}) of the brine is well within the limits for microbial life [5], and a stable microbial community persists and thrives. Molecular and geochemical results imply that this subsurface brine is chemosynthetic, deriving energy in part by cycling iron and sulfur compounds. Recent metagenomic analysis confirms the presence of numerous genes involved in oxidative and reductive sulfur transformations. Isotopic measurements indicate the presence of an active catalytic or 'cryptic' sulfur cycle linked to iron reduction [6]. Genes encoding key steps in several CO_2 fixation pathways are also detected, and brine samples showed measureable uptake of ^{14}C-labeled bicarbonate.

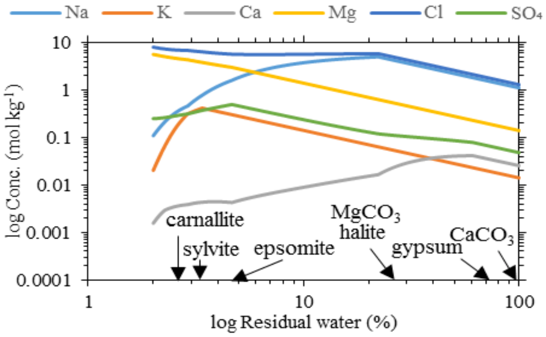

Fig. 2 Fractional crystallization of salts during evaporation of Blood Falls brine at 0°C. Modeled using FREZCHEM.

Conclusion: Evidence from the *Curiosity* rover supports the possibility of chemolithotrophic ecosystems on Mars [7]. Blood Falls in particular, and the widespread subsurface brines in the MDV in general, provide important, underexplored analogs for the study of potential Martian subsurface ecosystems.

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