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Introduction: Liquid water that likely exists at the interface of Martian glacial ice and bedrock has led to increased interest in the habitability of analogous subglacial systems on Earth. A key determinant capable of influencing the habitability of such systems is the availability of nutrients able to support microbial life. Due to the absence of sunlight in these systems, microbial communities are sustained through the process of chemosynthesis with nutrients derived largely via bedrock weathering. Glacial comminution of bedrock provides abundant fine-grained sediments but, at the low-temperatures that exist in subglacial systems, abiotic chemical dissolution rates are slow [*1*]. Together these factors result in relatively low concentrations of aqueous nutrients despite abundant fresh mineral surfaces.

Recent molecular-based characterization of subglacial sediment communities indicates the presence of an endogenous and surprisingly diverse microbiome [*2*] that appears to be supported primarily by oxidation of pyrite (FeS_2) found in the underlying bedrock [*3-6*]. Intriguingly, a geochemical mass balance on sulfate sources and subglacial outflow indicates that, in addition to aerobic FeS_2 oxidation, anaerobic FeS_2 oxidation must be occurring in the subglacial environment [*7, 8*]. However, there exists no known mechanism for abiotic, anoxic FeS_2 oxidation at the circumneutral pH of many subglacial waters. It follows that microbial processes are likely to play a key role in catalyzing FeS_2 oxidation under both oxic and anoxic conditions within the subglacial system. From an astrobiological standpoint these findings point to the ability of microbes to subsist off mineral driven chemosynthesis in low-temperature environments that lack molecular oxygen and sunlight.

Here we report the isolation of a novel bacterium from Robertson Glacier (RG), Alberta, Canada. This organism is capable of growing chemolithotrophically with thiosulfate ($S_2O_3^{2-}$) as an electron donor and nitrate, nitrite, or oxygen as an electron acceptor. Thiosulfate hydrolase (*sox*) and ribulose 1-5-bisphosphate carboxylase/oxygenase (*cbb*) genes from the genome sequence of this organism were among the *sox* and *cbb* transcripts recovered from RG subglacial sediments indicating this isolate grows autotrophically with $S_2O_3^{2-}$ in the subglacial environment. Moreover, we show that this bacterium is capable of enhancing the oxidation of synthetic, framboidal FeS_2 under oxic conditions, likely though the oxidation of $S_2O_3^{2-}$, a stable, reduced sulfur intermediate produced during abiotic pyrite oxidation at circumneutral pH. We also demonstrate its ability to oxidize framboidal FeS_2 via reduction of nitrate. Together, data describing aerobic and anaerobic, $S_2O_3^{2-}$ and FeS_2 driven chemosynthesis allow for a detailed assessment of the biotic mechanisms that enhance FeS_2 oxidation at low temperature. More broadly, we propose that this chemolithoautotrophic metabolism has the potential to support complex microbiomes and enhance chemical weathering in FeS_2 bearing, cold dark environments with variable oxidation potentials.

References: [1] S. N. Montross *et al.*, (2013), *Geol* **41**, 215. [2] T. L. Hamilton *et al.*, (2013), *ISME J* **7**. [3] M. Skidmore *et al.*, (2005), *Appl Environ Microbiol* **71**, 6986. [4] A. C. Mitchell *et al.*, (2013), *Geol* **41**, 855. [5] B. C. Christner *et al.*, in *Psychrophiles: from biodiversity to biotechnology*. (Springer, 2008), pp. 51-71. [6] E. S. Boyd *et al.*, (2014), *Appl Environ Microbiol* **80**, 6146. [7] M. Tranter *et al.*, (2002), *Hydrol Proc* **16**, 959. [8] M. Skidmore *et al.*, (2010), *Hydrol Proc* **24**, 517.