Ancient analogs for ultramafic-hosted vents: Water-rock-derived energy for deep subsurface chemosynthesis

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Microbial utilization of energy sources derived from ultramafic rock is not restricted to the marine environment. Recent studies demonstrate that deep fracture fluids in Precambrian Shield rocks in Canada, South Africa and Finland contain large quantities of hydrocarbon gases as well as up to 10mM dissolved H_2. Active H_2 consuming microbial communities are under investigation to identify agents of nutrient cycling and the manner in which these organisms interact with their local geological and hydrogeological environments. Understanding microbial characteristics that permit growth in these environments will help quantify subsurface contributions to nutrient cycling on Earth and also highlight suitable extreme environments for detecting subsurface biospheres in other regions of the solar system.

We collected samples from near 4,000 foot depth at the Birchtree Mine in Thompson, Manitoba. High water salinities resulting from extended periods of water-rock interaction reflect the isolation of these fracture systems from surface inputs. We deployed biofilm units, consisting of glass wool enclosed within a Teflon housing, into boreholes. Phospholipid fatty acids (PLFA) were harvested from the units after their retrieval and PLFA diversity indicated growth of a viable microbial community. Stable isotope ($\delta^{13}C$) composition of the PLFAs ranged from -28 ‰ to -24 ‰, minimally offset from the acetate composition (-26.7 ‰). We are assessing the role of acetogenesis in carbon cycling between the dissolved inorganic carbon ($\delta^{13}C$ of -15.0 ‰), lipid, and acetate carbon pools present within these isolated fracture systems.

A role for proteins in extracellular metal-sulfide and Selenium biomineralization?

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Our recent data point to a role for microbially derived proteins in extracellular zinc-sulfide (ZnS) and elemental selenium (Se^0) biomineralization by a natural community of *Desulfobacteraceae* sp. and pure cultures of *Geobacter sulfurreducens*, respectively. In the former case (Fig. 1), these proteins are associated with a biofilm growing under microaerophilic conditions, and may serve in a metal-binding capacity. In the latter case (Fig. 2), preliminary data suggest a role for sulfur redox proteins in mitigating the precipitation of Se^0. We will discuss possible roles for proteins and other organic macromolecules in mitigating the form and fate of aqueous and nanoparticulate metals in natural waters and sediments.

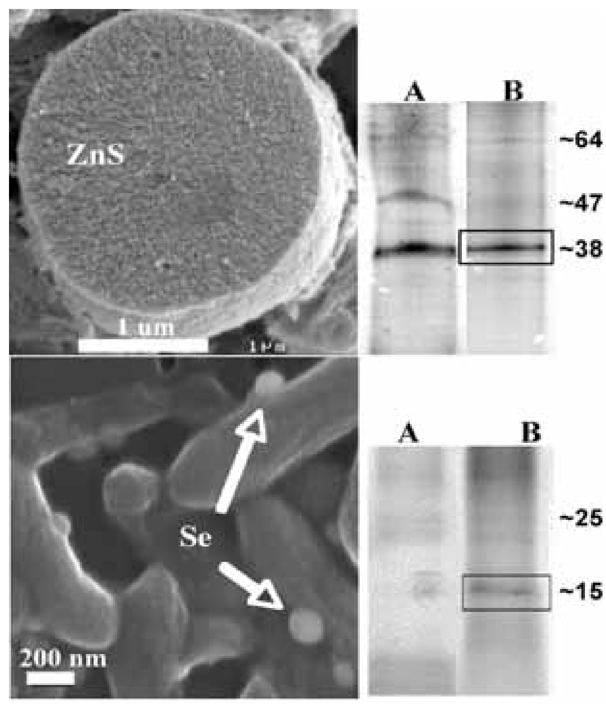

Figure 1: Natural aggregate of biogenic ZnS nanoparticles formed by biofilm sulfate-reducing bacteria (SRB). (**A**) SDS-PAGE gel image of proteins extracted from biofilm. (**B**) Gel image of proteins (box) extracted from ZnS.
Figure 2: *G. sulfurreducens* cells and biogenic Se^0 nanospheres. (**A**) SDS-PAGE gel image of proteins extracted from cells. (**B**) Gel image of proteins (box) extracted from Se^0.