Application of *in situ* Au-amalgam microelectrodes in Yellowstone National Park to guide microbial sampling

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To better understand the links between microbial activity and geochemical cycling, geochemical parameters and microbial ecology must be defined together in both space and time. This can be accomplished with the help of gold-amalgam microelectrodes that provide real time *in situ* data of a number of redox species, including species of Fe, Mn, O, and S, defining the microbes' natural environment as those microbes are collected for characterization.

In 2004 electochemical data and microbial samples were collected at Norris Geyser Basin, Gbbon Geyser Basin, and Brimstone Basin, in Yellowstone National Park, Wyoming, USA. Microbial samples were drawn through tubing attached to the working electrode, making sampling concurrent with electrochemical data collection. Electrochemical analyses from thermal springs such as Evening Primrose showed high concentrations of both thiosulfate and polysulfides (Figure 1).

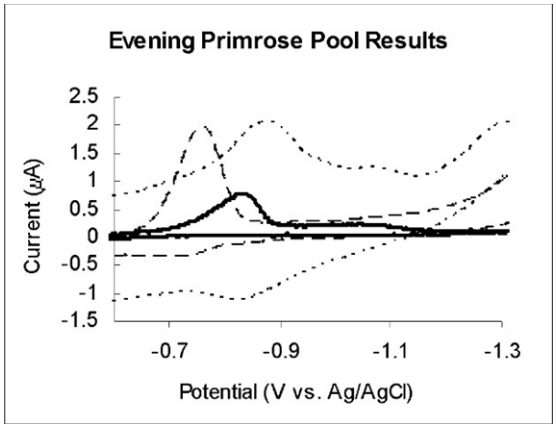

Figure 1: Voltammograms obtained at Evening Primrose pool (solid line), and in the lab using collected water spiked with H_2S (dashed line) and polysulfide (dotted line, formed by addition of S_8 and H_2S).

Effect of temperature on activity, growth, and structure of Fe(III) and sulfate reducing communities

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Microbial Fe(III) and sulfate reduction are important electron transport processes in acidic mining lakes and stimulation by the addition of organic substrates is a strategy to remove acidity as well as metals and sulfate. This principle was applied in a pilot-scale enclosure in acidic mining lake 111 in Brandenburg, Germany. Since seasonal variation of temperature may have a considerable impact on the performance of in situ experiments, the influence of temperature on Fe(III) and sulfate reduction was investigated in surface sediments from the enclosure in the range of 4 to 28°C. Fe(III) reduction was measured as potential rate in anoxic batch incubations and sulfate reduction rates were determined by the radiotracer-injection technique. Growth rates of acidophilic and neutrophilic Fe(III) reducers as well as sulfate reducers were estimated from MPN (Most Probable Number) readings during an incubation period of 70 days. Fe(III) reduction rates showed an exponential increase with temperature. Assays without molybdate did not consistently show higher rates, indicating that sulfate reducing activity under experimental conditions was of minor importance compared to variability of Fe(III) reduction. The effect of temperature was quantified in terms of apparent activation energy E_a measuring 42 and 46 kJ mol^{-1} for assays with and without molybdate, respectively. Sulfate reduction rates also increased exponentially with temperature and showed with E_a = 52 kJ mol^{-1} a slightly greater effect of temperature. In contrast, growth rates did not show an exponential increase with temperature. In case of the neutrophilic iron reducers and sulfate reducers highest growth rates were determined for incubations at 15°C. Analysis of MPN dilution series by SSCP (Single Strand Conformation Polymorphism)-fingerprinting based on 16S rRNA gene amplicons revealed that different incubation temperatures led to a shift in the bacterial community structure. Therefore, an increase of temperature will lead to an increase of the overall reducing activity, but microorganisms mediating these processes may change and with them their physiological properties and environmental requirements.