Thermodynamic characteriaztion of *Bacillus subtilis* spore-proton adsorption

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Bacterial surfaces are known to host adsorption reactions that can affect metal speciation and transport in geochemical systems. However, most research focuses on the surface reactivity of vegetative cells opposed to the reactivity of spores. Bacterial spores are a differentiated and dormant cell with a tough proteinaceous coat composed of macromolecules that are very different from those found in vegetative cells. To investigate spore surface properties we first grew and starved cultures of *Bacillus subtilis* to induce sporulation and chemically extracted the remaining vegetative cells. The percentage of residual vegetative cells within purified spore crops was quantified using cell counting software, CellC [1], in conjunction with manual cell counts from fluorescence and light microscopy images. We measured spore-proton adsorption via potentiometric titration and derived stability constants and site concentrations using surface complexation modeling. In addition, we measured heats of proton adsorption with isothermal titration calorimetry. By applying our surface complexation model describing proton adsorption to the calorimetric data we derived enthalpies and calculated entropies for site specific proton adsorption. The adsorption data generated in this research will support future studies regarding spore-metal surface complexation modelling and advance our understanding of bacterial influences on geochemical cycling.

[1] Selinummi, J., Seppälä, J., Yli-Harja, O., and Puhakka, J. A., (2005). *BioTechniques* **39**, 859-63.

Trithioarsenate degradation in geothermal waters by *Thermocrinis*

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Trithioarsenate ($AsOS_3^{3-}$) is the predominant arsenic species in alkaline sulfidic geothermal springs at Yellowstone National Park [1] and its transformation to arsenite and arsenate was suggested to be microbially catalyzed [2]. To determine the influence of a commonly encountered sulfide-oxidizing extremophile on trithioarsenate degradation, field incubation experiments were done at different sites of different drainage channels with brown-pinkish *Thermocrinis* streamers versus abiotic controls without biomass.

Generally, *Thermocrinis* accelerated trithioarsenate degradation (Fig. 1). Higher sulfide concentrations increased trithioarsenate stability and decreased the arsenate production, presumably because *Thermocrinis* preferentially use free sulfide over sulfur in thioarsenates. Sulfide spike experiments at Ojo Caliente also showed a time lag in microbial adaptation to higher sulfide concentrations with initially successive accumulation of dithioarsenate, monothioarsenate, and arsenite and a significantly slowed-down arsenate production. In abiotic controls higher sulfide concentrations at Conch Spring and Gibbon Geyser Basin compared to Ojo Caliente decreased trithioarsenate stability and increased the production of arsenite and arsenate. Thiosulfate added to test its effect as sulfur donor on the sulfur-oxidizing bacteria did not show any differences in arsenic speciation patterns or transformation rates.

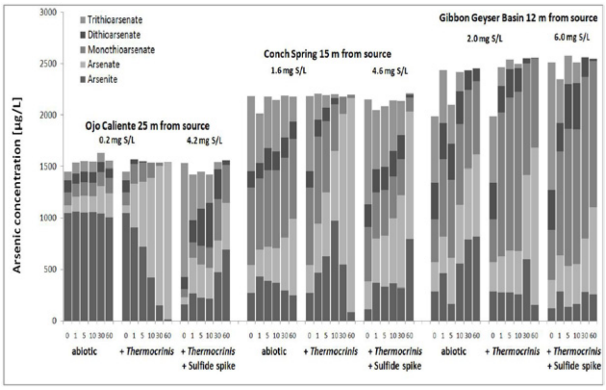

Figure 1: Arsenic speciation from incubation experiments

[1] Planer-Friedrich *et al*. (2007), *Environmental Science and Technology* ***41***, 5245-5251; [2] Planer-Friedrich *et al*. (2009), *Geomicrobiology* ***26***, 339-350