Mineral surface regulation of biological growth and distribution

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In most geologic settings, a significantly greater number of bacteria exist as surface-attached cells compared to unattached planktonic cells. The effects of the physical distibution of bacterial mass between the solid and aqueous phases of sediments may be significant to redox chemistry and geochemical reactions in porous sediments. Studies have shown physiological, structural, and metabolic differences between planktonic and surface-attached microorganisms. One recent study even suggested that the physical adhesion of bacteria to certain mineral surfaces may result in significant growth advantages to *Escherichia coli* and *Bacillus brevis*, excluding the effects of nutrient availability [1].

In this research we document the distribution of attached and unattached bacteria in a sediment core in equilibrium with artificial groundwater of varying chemistry. Growth rates of bacteria in sedimentary columns are also documented as a function of solution chemistry but not nutrient conditions. Several physical and chemical techniques of releasing bacteria from sediments have been tested. Bacterial populations were counted by most probable number and epiflourescence. Bacterial forces of adhesion as a function of artificial groundwater chemistry were measured using atomic force microscopy. The results underscore the significance of aqueous geochemistry on bacterial growth, distribution, and possibly function in geologic environments.

[1] Hong & Brown (2009) *Appl. Environ. Microbiol.* **75**, 2346–2353.

Determining mineral solubilities in simulated geothermal brines

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Mineral precipitation from geothermal fluids (scaling) poses serious problems for the operation of geothermal power plants. Scales reduce volumetric flow rates within a power plant, significantly diminishing energy production efficiency. The potential for the development of scaling is being investigated in the Na-Ca-Cl brine (265 g/L total dissolved solids) in the Groß Schönebeck (GrSk) enhanced geothermal system near Berlin, Germany. Using the available GrSk chemical data for deep fluids and PHREEQc calculations, we have identified over 30 minerals that may be oversaturated in the GrSk system. The reliability of these models, however, is called into question due to the inconsistency or lack of Pitzer parameters required to calculate the activity coefficients of species in high ionic strength fluids. We are, therefore, experimentally determining the solubilities of sulfate and carbonate minerals in Na-Ca-Cl brines (6M Cl^-) identified as as near saturation by the aforementioned PHREEQc models. Experiments are performed by deliberately oversaturating a solution with the components of the mineral under investigation and allowing precipitation reactions to come to completion. After the minerals precipitate, the fluid is analyzed via ICP-MS to establish the concentrations of solutes remaining in the solution. Solid phases are analyzed with XRD and XRF to determine the composition and structure of precipitants. These experiments are being performed in batch reactors at atmospheric conditions and from 50°C to 150°C at 10bar of pressure to simulate the conditions in the proposed GrSk power plant. Results from experimental solubility determinations are compared to with PHREEQc calculations to test their reliability for future modeling.