Novel approaches to investigate microbe-mineral interactions under flow conditions

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The interaction of microbes and biofilms with geological components has mostly been investigated in closed-system experiments. However, they do not allow the input of new nutrients and reactants, and export of geochemical products and microbial waste products. This severely limits the ability to link laboratory based geomicrobiological experiments with field scale processes in the natural environment [1]

The use of novel mineral-containing open-faced flat-bed flow reactors, which allow microbe-mineral interactions to be observed in real-time and at the individual cell resolution, provides a powerful tool to explore the hydrodynamic controls on geomicrobiological processes. This invited presentation will discuss the utility of such reactors for investigating the attachment and respiration of *Shewanella oneidensis* on hematite during dissimilatory iron reduction under natural-flow conditions.

[1] Geesey & Mitchell (2008) *Journal of Hydrologic Engineering* **13,** 28-36.

Microbially enhanced carbonate mineralization and the geologic containment of CO_2

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Geologic sequestration of CO_2 involves injection into deep underground formations including oil beds, un-minable coal seams, and saline aquifers with temperature and pressure conditions such that CO_2 will likely be in the supercritical state. Supercritical CO_2 injection into the receiving formation will result in elevated pressure in the region surrounding the point of injection, and may result in an upward hydrodynamic pressure gradient and associated “leakage” of supercritical to gaseous CO_2. Therefore mechanisms to reduce leakage and to mineralize CO_2 in a solid form are extremely advantageous for the long-term geologic containment of CO_2.

This paper will focus on microbially-based strategies for controlling leakage and sequestrating supercritical CO_2 during geologic injection. We will examine the concept of using engineered microbial barriers [1, 2] which are capable of precipitating calcium carbonate [3, 4] under high-pressure subsurface conditions. These “biomineralization barriers” may provide a method for plugging preferential flow pathways in the vicinity of CO_2 injection, thereby reducing the potential for unwanted upward migration of CO_2, as well as mineralizing injected CO_2. A summary of experiments investigating biofilm and associated calcium carbonate formation in porous media using a unique high pressure (8.9 MPa), moderate temperature ($\geq$ 32 °C) flow reactor will be presented, and the potential for biomineralization enhanced CO_2 sequestration discussed.

[1] Cunningham *et al.* (in review) *International Journal of Greenhouse Gas Control.* [2] Mitchell *et al.* (in review) *Journal of Supercritical Fluids.* [3] Mitchell & Ferris (2005) *Geochim. Cosmochim. Acta* **69**, 4199-4210. [4] Mitchell & Ferris (2006) *Geomicrobiol. J.* **23**, 213-226.