Geophysical Research Abstracts
Vol. 12, EGU2010-1698, 2010
EGU General Assembly 2010

Olivine dissolution in the presence of heterotrophic bacteria (Pseudomonas reactants) extracted from Icelandic groundwater of the CO2 injection pilot site

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This work is aimed at experimental modeling of the effect of heterotrophic bacteria on dissolution of important rock-forming mineral, olivine, at the conditions of CO2 storage and sequestration. Heterotrophic aerobic gram-negative bacteria were extracted from deep underground water (HK31, 1700 m deep and, t = 25-30°C) of basaltic aquifer located within the Hellisheidi CO2 injection pilot site (Iceland). Following this sampling, we separated, using culture on nutrient agar plates, four different groups of gram-negative aerobic bacteria. The enzymatic activity of studied species has been evaluated using Biolog Ecoplates and their genetic identification was performed using 18-S RNA analysis. The optimal growth conditions of bacteria on Brain Hearth Broth nutrient have been determined as 5 to 37°C and growth media pH varied from 7.0-8.2. Culturing experiments allowed determining the optimal physico-chemical conditions for bacteria experiments in the presence of basic Ca, Mg-containing silicates.

Olivine (Fo92) was chosen as typical mineral of basalt, widely considered in carbon dioxide sequestration mechanisms. Dissolution experiments were performed in constant-pH (7 to 9), bicarbonate-buffered (0.001 to 0.05 M) nutrient-diluted media in batch reactors at 0-30 bars of CO2 in the presence of various biomass of Pseudomonas reactants. The release rate of magnesium, silica and iron was measured as a function of time in the presence of live, actively growing, dead (autoclaved or glutaraldehyde-treated) cells and bacteria exometabolites. Both nutrient media diluted 10 times (to 100 mg DOC/L) and inert electrolyte (NaCl, no DOC) were used. Our preliminary results indicate that the pH and dissolved organic matter are the first-order parameters that control the element release from olivine at far from equilibrium conditions. The SEM investigation of reacted surfaces reveal formation of surface roughness with much stronger mineral alteration in the presence of live bacteria compared to experiments with dead biomass.

Overall, this work allows better understanding of microbially-affected silicate dissolution in basaltic aquifers and provides a firm methodological basis for constructing the mixed-flow reactors for studying the interaction of heterotrophic bacteria with rock-forming silicates at the environmental conditions of CO2-storage.