

## Does the presence of bacteria affect basaltic glass dissolution rates? 2: Live *Pseudomonas reactants*

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Calculations suggest that mineral sequestration of CO<sub>2</sub> is favored in basaltic rocks, but carbonation could be limited by slow basalt dissolution rates [1]. This project is aimed to determine if basalt dissolution rates and thus carbonation reactions could be accelerated through the use of bacteria. Heterotrophic aerobic gram-negative bacteria (*Pseudomonas reactants*) from well HK-31 of the Hellisheidi geothermal power plant in Iceland was selected for a series of dissolution experiments. Live-stock of *Pseudomonas reactants* was added to ~ 0.01 M MES and bicarbonate solutions and used in basaltic glass dissolution experiments performed in mixed-flow reactors at pH 6 and 8. The experiments were run under sterile conditions with: 1) no nutrients added to the inlet solutions and bacteria concentrations of 0, 0.9 and 6.5 gram humid/L, and 2) with 10% nutrient media added to the inlet solutions and bacteria concentrations of 0, 9 and 19 gram humid/L. Experiments were run in series. First basaltic glass was dissolved in bacteria free solutions, once steady-state was attained, bacteria was added to the inlet fluids. No change in Si release rates was observed when adding bacteria to experiments performed at pH 8. A slight decrease in Si release rates was observed when adding bacteria to experiments performed at pH 6. At both pH 8 and 6, Mg and Ca show a slight preferred release over Si, with dissolution rates of half an order higher than the rate for Si. A similar weak effect of dead *Pseudomonas reactants* on Si, Ca and Mg release from basaltic glass was shown in our previous work [2]. Al release is known to control the overall dissolution rate of basaltic glass [3]. However, the adsorption of Al on bacterial surface and Al complexation with bacterial exo-metabolites are likely to be negligible at these conditions (pH 7 to 8). Taken together results suggest that the effect of *Pseudomonas reactants* on the basaltic dissolution rates and thus CO<sub>2</sub> storage in basaltic rocks is negligible.

[1] Oelkers *et al.* (2008) *Elements* **4**, 333–337. [2] Stockmann *et al.* (2010) *EGU General Assembly 2010*, abstract. [3] Oelkers & Gislason (2001) *GCA* **65**, 3671–3681.

## Geochemical implications for sustainable utilization of low-arsenic aquifers in the Bengal Basin

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Arsenic concentrations in shallow aquifers of the Bengal Basin often exceed World Health Organization standards of 10 µg/L, resulting in increased utilization of deeper low-As aquifer zones for water supply. Pumping-induced transport of high-As groundwater could eventually cause As concentrations in the deeper aquifers to increase. Sustainable use of the deeper aquifers depends on local hydrologic and geochemical conditions as well as drilling and management practices.

Arsenic removal capacity of deeper aquifer sediments was evaluated at a site about 10 km west of Dhaka, Bangladesh. This site is similar to many As-contaminated areas in the Basin. Arsenic concentrations as high as 900 µg/L [650 µg/L As (III) and 250 µg/L As (V)] are present in the shallow aquifer (<40 m depth), which is geochemically reducing with sediments gray to black in color. At depths >40 m aquifer sediments are more oxic and reddish-brown in color because of ferric oxide coatings on the sediments; As concentrations in groundwater are <10 µg/L.

Laboratory experiments and field data were used to identify and quantify processes affecting transport of As and other constituents in shallow reducing groundwater as they move through deeper more oxic sediments. A combination of reactions between constituents in reducing groundwater and oxic sediments inhibit As mobility. Arsenic is significantly attenuated by sorption onto iron oxide minerals. As (III) is oxidized to the more strongly sorbing As (V) by manganese oxides. Results from these experiments were used to calibrate a geochemical model capable of simulating the reactions between constituents in As-contaminated groundwater and oxic sediments. The reactive-solute transport model PHAST [1], which couples hydrologic flow with geochemical reactions, was then used to simulate the potential rate of As transport through the oxic aquifer for a range of groundwater velocities. For an initial As concentration of 900 µg/L, the rate of As transport through oxic sediments ranged from 0.01 m/yr for an interstitial groundwater velocity of 3 m/yr, to 0.22 m/yr for a groundwater velocity of 30 m/yr.

[1] Parkhurst *et al.* (2004) U.S. Geol. Surv. Tech. & Meth. 6-A8.