Interaction of dissolved and sedimentary sulfur species in a contaminated aquifer: Insights from stable isotope analysis

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Background and Objectives

Sulfur transformation reactions in a contaminated aquifer partly control the efficiency of biodegradation processes. Detailed investigation of the sulfur cycling may therefore provide essential information on the estimation of the overall natural attenuation potential at the contaminated site.

The investigated sulfate rich urban aquifer is contaminated with a variety of different BTEX species. To reveal the details of the sulfur cycling and to prove the occurrence of bacterial sulfate reduction (BSR), isotope investigations of different dissolved (sulfate and sulfide) and sedimentary sulfur species (monosulfide, disulfide, elemental sulfur) were conducted.

Results and Discussion

The enrichment of both heavy sulfur and heavy oxygen isotopes in dissolved sulfate and the simultaneous decrease of sulfate concentrations at several sampling locations provide clear evidence for the occurrence of BSR in the aquifer [1]. The isotope distribution pattern of sulfate suggests a straightforward bacterial reduction process. However, the isotopic composition of dissolved sulfide indicates the occurrence of secondary processes superimposing BSR.

Primary or secondary pyrite is the dominating sedimentary sulfur species in the aquifer matrix. The ubiquitous occurrence of sedimentary monosulfide is further evidence for a significant relevance of BSR. However, the presence of elemental sulfur and the isotope distribution pattern of sedimentary sulfur species point to a temporal variability of the hydrochemical conditions at the site with the occurrence of secondary sulfur transformations such as partly re-oxidation and disproportionation. Nevertheless, isotope and hydrochemical data indicate an overall high natural attenuation potential of the investigated aquifer.

[1] Knöller et al. (2006) Environ. Sci. Technol. **40** (12) 3879-3885.

Comparison of the pyrite oxidation rates by *Acidithiobacillus ferrooxidans* with a low initial cell population

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Methods

A batch experiment of pyrite oxidation by *Acidithiobacillus ferrooxidans* was perfomed with a initial cell population of less then 10^5 cells/ml at 30°C and the results of this batch experiment were compared with those of Yu et al. [1] whose initial cell numbers were approximately 2×10^6/ml. The batch solutions were regularly sampled and analyzed for Si, Al, Ca, Fe(total), Fe(ll), K, Na, Cl, NO_3, PO_4, and SO_4 concentrations.

Discussion

The analytical results indicate that the transition from the lag phase to the exponential phase of the bacterial growth occurred after 400 hours elapsed from the bigining of the experiment, which is very close to what Yu et al. [1] showed. The oxidation rates calculated from the variation of SO_4 concentration were 9.9×10^{-3} mg pyrite/h and 3.2×10^{-2} mg pyrite/h during the lag and exponential phase, respectively. These rates were about four and 13 times faster than the oxidation rate in a sterile control flask. The oxidation rates by the microbes starting with much higher initial cell number of Yu et al. [1] were very colse to that of this study during the lag phase (9.6×10^{-3} mg pyrite/h), but approximately two times faster during the exponential phase (7.9×10^{-2} mg pyrite/h). It shows that the oxidation rates are not simply proportional to the starting cell numbers.

[1] Yu et al. (2001) *Chem. Geol.* **175**, 307-317.