Geophysical Research Abstracts
Vol. 14, EGU2012-10973, 2012
EGU General Assembly 2012

Colloid-Associated Phosphorus Transport in Heterogeneous Alluvial Gravel Aquifer Media

M. Lafogler (1,2), L. Pang (2), E. McGill (2), T. Baumann (1), and M. Close (2)

(1) Technische Universtität München, Institute of Hydrochemistry, München, Germany (mark.lafogler@mytum.de, 49 89 2180-78254), (2) Environmental Science & Research, Christchurch Science Center, Christchurch, New Zealand

Phosphorus is a fertilizer and commonly present in groundwater aquifers. Higher concentrations of phosphorus can lead to subsurface eutrophication and aid microbial growth. In former studies phosphorus was considered to be immobile. Recently, it was reported that phosphorus can be mobilized in the presence of colloids. In this study the impact of colloid-associated phosphorus transport is investigated in a heterogeneous porous medium using inorganic colloids (Kaolinite, Goethite) and E. coli bacteria to get a better understanding of phosphorus transport in aquifer media.

A 2 m column was filled with heterogeneous alluvial gravel aquifer material from the Canterbury Plains/New Zealand with a grain size in the range of 2-40 mm. Injected solutions contained a conservative tracer (Bromide), phosphate, and either Kaolinite, Goethite, or E. coli bacteria. Eight experiments were conducted at flow rates of 20 m/day and 40 m/day, respectively. The effluent of the column was collected and analyzed. To distinguish dissolved and colloid associated phosphorous, unfiltered and filtered samples were compared.

As recovery rates for the conservative tracer bromide we observed full recovery at the column effluent. For total phosphorus varying recovery rates were found depending on the type of colloid that was present in the solution. Together with Kaolinite we observed recovery rates of phosphorous of 42.5% at low flow conditions and 69.3% at high flow conditions. Together with Goethite we found recovery rates of 22.3% at low flow conditions and 57.6% at high flow conditions. With E. coli bacteria we documented recovery rates of 80.7% at low flow conditions and 61.0% at high flow conditions. For dissolved phosphorus the observed recovery rates were in general higher between 73.4% and 92.3%.

The breakthrough curves showed that a significant fraction of mobile phosphorus was attached to colloids. At low flow conditions this fraction was higher than at high flow conditions. For Kaolinite the highest fractions of colloid associated phosphorous were observed, Goethite showed the lowest effect on phosphorous mobilization.

By using CXTFIT parameters according to the velocity enhancement of the colloid-associated phosphorus transport were modeled. They showed that the velocity of colloids was 1.1 to 1.5 times higher than the conservative tracer.

During the experiments the pH was around 7. Here, the surface charge of the sediments, Kaolinite, and E. coli are slightly negative while Goethite colloids are slightly positively charged. Therefore, the adsorption of phosphate to Goethite is high and the attachment efficiency of Goethite at the sediment is high. Together, this explains the observed low recovery rates of phosphate in the presence of colloids.