Geophysical Research Abstracts
Vol. 15, EGU2013-11345, 2013
EGU General Assembly 2013

Effect of adsorbed extracellular polymeric substances (EPS) on colloidal mobility of nanoparticulate iron oxides

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Solubility and transport of nutrients and pollutants is affected by the presence of colloidal nanoparticles (CNP) which may act as mobile geosorbents. In soils and aquifers, pure and organically modified Fe- and Mn-oxy-hydroxides are of particular importance due to their ubiquitous presence and also due to their progressive use for environmental cleanup. Stability and aggregation behavior control the mobility of CNP and depend on pH, ionic strength, and the presence of monovalent or divalent anions. In natural environments, however, iron oxides are usually covered by organic matter. Such coverage will completely change the colloidal surface properties and impose additional control on the colloidal mobility. Important sources for natural organic coatings are extracellular polymeric substances (EPS), i.e., complex mixtures of biopolymers consisting of polysaccharides and proteins and variable amounts of lipids and nucleic acids.

The objective of our study was to quantify the effect of EPS coatings on the colloidal stability, mobility and reactivity of hematite by column experiments. Columns (10 cm $\times$ 5 cm) were filled with glass beads (0.25 mm ø) as porous medium and operated in sterile closed flow conditions. Nanoparticulate hematite was coated to different degrees by extracellular polymeric substances (EPS) extracted from, liquid cultures of *Bacillus subtillis*. The pH was kept constant at 7. The hematite particles exhibited increasing colloidal stability with increasing amounts of EPS. Critical colloidal concentration (CCC) of the particles increased from 95 mM NaCl for uncoated particles to 250 mM NaCl for coated particles. EPS coated hematite did not react with the porous medium and stayed mobile while the uncoated hematite was immobile due to adsorption to the glass beads. Also colloidally unstable hematite particles did not show any mobility. Thus the organic coatings enhanced the colloidal stability, which consecutively increased the mobility of the particles. Also, the reactivity of these particles to the porous medium is reduced due to the masking of the reactive hematite surface sites with EPS. EPS coated CNP may define the major part of mobile material in natural environments like soils, sediments and aquifers.