Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07874, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07874
EGU General Assembly 2008

Role of bacteria in the accelerated transfer of heavy metals in soils: Advantages for polluted soil bio-remediation

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Micro-organisms were recently identified as one of the vectors of metal dissemination in soils thanks to their high sorption capacity. This property appears useful for polluted soils bio-remediation. The aim of this work was to evaluate the ability of bacteria to detoxify heavy metals contaminated soils, through the identification of the main factors controlling heavy metal desorption from soil and sorption onto bacterial cells.

This was done with two heavy metals (Cd and Zn) *versus* two bacteria models: *Cupriavidus metallidurans* CH34 and *Escherichia coli* DH5α, chosen for their high metal sorption capacity (Guiné *et al.*, 2006, 2007). The bio-physicochemical factors potentially involved in situations where colloidal transport of heavy metals dominates dissolved transport, were identified and quantified using laboratory columns experiments. Cell concentration, ionic strength and composition of soil solution were shown to control bacterial mobility in columns, whereas pH and water flow appeared to play a rather minor role in our experimental conditions.

Results of simultaneous metals and bacterial transfer showed a higher affinity of metals for the bio-colloidal fraction than for the porous media, and evidenced a colloidal facilitated transport of heavy metals (colloidal transport up to 3 times faster than dissolved transport). These experimental results were correctly modelled by coupling a metal complexation model of bacterial surfaces and a bacterial transfer model using PHREEQC.

Moreover, detoxification experiments were conducted in columns filled with either Fontainebleau sand, previously spiked with the heavy metals, an agricultural soil polluted with Cu and a multi-polluted urban soil. The contaminated soils were leached with water leading to a low equilibrium concentration of the metals in the effluent. When bacteria were introduced into the soil columns, high metal concentrations were leached and a higher equilibrium concentration was attained in the effluent. This led to a dramatic increase (up to 12 fold) of metal removal as compared to the bacteria-free leaching experiments and, consequently, in the time needed to detoxify the soil. The increased metal leaching is assumed to be either an active transport (*E. coli* DH5α) or indirect *in situ* modification of the metal speciation (*C. metallidurans* CH34). Thanks to these experiments, we evidenced the ability of bacterial colloids to both enhance metal leaching and accelerate their transport in contaminated soils. Moreover, these results provide new insight into the process of accelerated transport of heavy metals in soils by bio-colloids

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