



Heavy metal mobilisation of salt affected soils and sediments: Assessing the role of chloride complex formation

Christoph Hinz (1), Brian Hafar (1), and Thomas Fischer (2)

(1) Brandenburg Technical University of Cottbus-Senftenberg, Hydrology and Water Resources Management, Cottbus, Germany (christoph.hinz@b-tu.de), (2) Brandenburg Technical University of Cottbus-Senftenberg, Zentrallabor, Cottbus, Germany

Terrestrial and aquatic ecosystems are increasingly exposed to high level of salt (NaCl) concentrations. Impacts of increased salt concentration on mobilisation of heavy metals have been shown for road side soils receiving de-icing salt, for sediments and soils exposed to salt water intrusions, and soils and aquifers receiving runoff from salt mines. In fact, this study was motivated by the impact of salt dumps on soil and groundwater observed for potash mines in the central part of Germany.

The objectives of this contribution is to asses the impact of NaCl concentration on heavy metal mobilization using speciation modelling. In particular, we focus on the effect of chloride complex formation in solution and how strongly this complex formation is “extracting” heavy metal cation from soil and sediments substrates.

As experimental data for speciation at very high ionic strength is not readily available and not easily measurable, we focus on PHREEQC modelling to assess NaCl concentration ranges up to 3 M, needing to employ Pitzer equation as the activity model. In order to determine the competition of surface reaction and complex formation in aqueous solution, we used three reaction models: i) surface complexation with a high and low affinity site for iron hydroxide, ii) a heterogeneous binding site model for humic acids and iii) ion exchange as described with Rothmund-Kornfeld equation We did a series of simulations for Zn, Cd and Pb. Species distribution for the aqueous phase and the solid surfaces where determined by increasing NaCl solutions for a given total heavy metal concentration.

In nearly all simulations conducted, the difference between simulations allowing chloride complexes to form and simulations where complexation is disabled, showed the emergence of a characteristic concentration range of NaCl for which the effect of chloride complexation reaches a maximum. In general, the range of highest sensitivity concerning mobilization occurs within the range of 1-3M NaCl for all simulations. At the lower end of this range shows the highest sensitivity to NaCl changes and is determined by several factors including the affinity to bonding sites and the speciation of an element along the salinity gradient. The peak of this curve is controlled by the point along the salinity gradient where the majority of heavy metal has been mobilized from the surface phase. One important outcome of this study is, that increasing NaCl background concentration behaves in a nonlinear way that is determined by the heterogeneity of the surface binding sites and that there is no simple way of assessing the mobilization potential of chloride complexation in soils and sediments.