



The role of iron (hydr)oxides for arsenic fixation, mobilisation, and transport - an evaluation by soil column experiments

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The distinct affinity of arsenic for iron (hydr)oxides is nowadays a well known fact and was proven on laboratory scale as well as in natural systems. Several studies confirmed that both the precipitation and dissolution of iron (hydr)oxides clearly affect the arsenic mobility. However, there was less focus on the carrier mediated arsenic transport by iron containing mobile particles. In this study we show the major impact of mobile iron particles on arsenic mobility on the basis of long-term soil column experiments.

The experiments were run in duplicate under saturated flow conditions. Contaminated soil material was taken from a non-calcareous top horizon of a floodplain soil near the Mulde river (Saxony-Anhalt, Germany). Multiple flow interrupts of different duration were carried out to mimic the effect of flooding.

We observed a distinct microbial reduction of iron (hydr)oxides which resulted in the discharge of Fe^{II} and CO_2 . Concurrently, As was mobilised with concentrations up to 10 mg L^{-1} . The effluent samples were then allowed to re-oxidise under atmospheric conditions. This led to the formation of Fe^{III} while Fe^{II} disappeared completely. Nevertheless, a visible iron(hydr)oxide precipitation took place only after flow interrupts of several days. Otherwise the total Fe^{III} content remained stable in the fraction $<0.45 \mu\text{m}$ for months. We explain this different behaviour of Fe^{III} with the current ionic strength and with a change in the quality of the effluent dissolved organic matter. This is supported by Dynamic Light Scattering measurements and UV-Vis spectra, respectively. Moreover, the presence of effluent Fe^{III} either in the size fraction smaller

or greater than $0.45\mu\text{m}$ was the primary criterion how the effluent As was distributed among these fractions. There, concentrations of Fe and As were found to be in entire coincidence. In contrast to this, As was not associated solely to iron(hydr)oxides in the bulk phase. Chemical extractions with pyrophosphate, oxalate and dithionite-citrate-bicarbonate suggested an arsenic fixation also on aluminium phases and manganese phases.

Concluding, our results emphasize the key role of mobile iron particles for As transport. The presence of these particles is considered to increase the long-term mobility of As remarkably. The question about the exact composition of these mobile iron particles - colloidal iron (hydr)oxides or Fe-DOC-aggregates? - is subject to further investigations.