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Arsenic mobilization and immobilization in paddy soils

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Arsenic is oftentimes of geogenic origin and in many cases bound to iron(III) minerals. Iron(III)-reducing bacteria can harvest energy by coupling the oxidation of organic or inorganic electron donors to the reduction of Fe(III). This process leads either to dissolution of Fe(III)-containing minerals and thus to a release of the arsenic into the environment or to secondary Fe-mineral formation and immobilisation of arsenic. Additionally, aerobic and anaerobic iron(II)-oxidizing bacteria have the potential to co-precipitate or sorb arsenic during iron(II) oxidation at neutral pH that is usually followed by iron(III) mineral precipitation.

We are currently investigating arsenic immobilization by Fe(III)-reducing bacteria and arsenic co-precipitation and immobilization by anaerobic iron(II)-oxidizing bacteria in batch, microcosm and rice pot experiments. Co-precipitation batch experiments with pure cultures of nitrate-dependent Fe(II)-oxidizing bacteria are used to quantify the amount of arsenic that can be immobilized during microbial iron mineral precipitation, to identify the minerals formed and to analyze the arsenic binding environment in the precipitates. Microcosm and rice pot experiments are set-up with arsenic-contaminated rice paddy soil. The microorganisms (either the native microbial population or the soil amended with the nitrate-dependent iron(II)-oxidizing Acidovorax sp. strain BoFeN1) are stimulated either with iron(II), nitrate, or oxygen. Dissolved and solid-phase arsenic and iron are quantified. Iron and arsenic speciation and redox state in batch and microcosm experiments are determined by LC-ICP-MS and synchrotron-based methods (EXAFS, XANES).