Iron mineralogy along redox gradients in an arsenic contaminated aquifer in Van Phuc, Vietnam

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Fe-minerals are highly reactive and largely control the transformation and retention of contaminants and nutrients in natural environments. Especially the behaviour of As in near surface aquifers is significantly affected by redox-sensitive local iron phases. In this regard, we investigated the Fe mineralogy along a redox gradient within the delta sediments of the Red River, which is known for its patchy distribution of dissolved As concentration.

Sediment cores (50 m) drilled through a redox transition zone at the site of Van Phuc show oxic (orange) as well as clearly reduced (grey) parts.

High-resolution mineralogical and geochemical investigations along the redox transition zone reveal the distribution of primary and secondary Fe-minerals with specific appearance of Fe(II), Fe(II/III) and Fe(III) phases.

Within the oxic part of the sediment, Fe(III) phases, such as goethite and hematite, dominate. Towards the reduced sediments, Fe(II) and Fe(II/III) phases, such as siderite, magnetite, pyrite and greigite occur. The diversity of newly formed Fe phases imply coupled biogeochemical processes. In addition, (amorphous) iron oxyhydroxide coatings and iron impregnated clay coatings on primary silicates form at the redox boundary. Weathering of ferrous phyllosilicates and ilmenites complement the iron dynamic leading to a fundamental reorganization of ferric and ferrous minerals along the redox transition zone.

The work gives new insights into iron cycling under redox changes and its coupling to contaminant dynamics and provides a better understanding of changes in natural near-surface sedimentary systems.