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Microbially-mediated transformation and mobilization of soil Fe-organic associations

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Soil organic matter (OM) has been proposed to be stabilized in the long term via sorption to iron((oxy)hydr)oxides under aerobic conditions. However, in an anaerobic environment, Fe-organic associations may be subject to microbial reduction and mobilization, which counteract the suggested stabilizing effect of Fe compounds. Desorption of OM can result in its microbial decomposition causing the emission of greenhouse gases (CO_2, CH_4, N_2O) or release of associated contaminants into the soil solution and groundwater.

While the reductive dissolution of pure iron((oxy)hydr)oxides by dissimilatory Fe^{III} reducing bacteria is well established, little is known about the influence of natural OM on microbially mediated mobilization of Fe-organic associations. Therefore, this study aims to elucidate the effect of adsorbed OM on microbial Fe^{III} reduction of Fe-organic associations with regard to (i) the composition of OM, (ii) the carbon loading, and (iii) surface coverage and/or pore blockage by adsorbed OM.

Mineral-organic associations with varying carbon contents were synthesized using several iron((oxy)hydr)oxides (Goethite, Lepidocrocite, Ferrihydrite, Hematite, Magnetite) and OM of different origin (dissolved OM extracted from the Oa horizon of a Podzol and Oi horizon of a Cambisol, extracellular polymeric substance extracted from *Bacillus subtilis*). Incubation experiments under anaerobic conditions were conducted for 16 days using two different strains of dissimilatory Fe^{III} reducing bacteria (*Shewanella putrefaciens*, *Geobacter metallireducens*). At five sampling points in time the solution phase was analyzed for pH, Fe_{total}, and Fe^{II}. The initial mineral-organic associations and post-incubation phase were characterized by N_2 gas adsorption, FTIR, XRD, and XPS.

The results indicate that the composition of OM and carbon loading significantly influence the rate and extend of microbial reduction of Fe-organic associations depending on the type of microbial strain and iron((oxy)hydr)oxide used.