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# Iron biogeochemical cycling in freshwater sediments

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Iron belongs to the dominant chemical elements in the Earth's crust and is therefore an important constituent in all environmental systems. Iron redox transformations and elemental cycling are strongly controlled by local geochemical conditions, as well as by the abundance and activity of iron-oxidizing and iron-reducing microorganisms. Applying a coupled geochemical-microbiological approach we attempted to determine the spatial distribution of the different iron transformation processes as a function of substrate, energy and electron donor/acceptor availability in profundal freshwater sediments. The distribution of readily available electron acceptors (O2, NO3-) and donors (FeII) for the metabolic activity of specific bacteria was determined in high resolution as a function of sediment depth. Cultivation-based quantification (most probable numbers, MPNs) of iron-converting bacteria showed that the microbial stratification of iron-oxidizing and iron-reducing bacteria follows the measured geochemical/redox gradients. In addition, the bioavailable fractions of ferriferrous minerals were determined as a function of the redox gradient following the depth profile. The combination of geochemical, mineralogical and microbiological data allowed a detailed investigation into the spatial structure of the iron cycling throughout natural redox gradients. Moreover, the quantification of the energy that is available to iron-converting microorganisms with respect to local geochemical gradients enhances the description of the reaction network the biogeochemical iron cycle is based on. In order to evaluate the impact of environmental variations, i.e. geochemical changes due to the seasonality, freshwater sediment cores were investigated before and after the annual algae bloom (increase in Corg input) in the overlying water column. In addition to the iron species, the distribution of the dissolved N-species was determined by microelectrode measurements. The microbial reduction of nitrate using ferrous iron as electron donor strongly couples the iron cycle to the redox-dependent turnover of N-compounds. The obtained data-set allowed the construction of a conceptual model describing the substrate and electron donor/acceptor flux between the areas of pronounced metabolic activity (i.e. different iron converting processes) in the elemental iron cycling throughout natural redox gradients.