Co-regulation of redox processes in freshwater wetlands as a function of organic matter availability?

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Wetlands have important filter functions in landscapes but are considered to be the biggest unknowns regarding their element dynamics under global climate change. Information on sink and source function of sulphur, nitrogen, organic matter and acidity in wetlands is crucial for freshwater regeneration. Recent results indicate that redox processes are not completely controlled by the sequential reduction chain (that is electron acceptor availability) but that electron donor availability may be an important regulator. Our hypothesis was that only sites which are limited in their electron donor availability low concentrations of dissolved organic carbon (DOC)) follow the concept of the sequential reduction chain. We compared the results of two freshwater wetland systems: 1) three forested fens within a boreal spruce catchment in a low mountain range in southern Germany (high DOC regime) and 2) three floodplain soils within a groundwater enrichment area in the Rhein valley in northwest Switzerland (low DOC regime). Micro scale investigations (a few cm) with dialyse chambers as well as soil solution and groundwater concentrations at the forested fens (high DOC regime) indicated simultaneous consumption of nitrate and sulphate with release of iron, manganese and methane (CH4) as well as an enrichment in stable sulphur isotopes indicating a co-existence of processes attributed to different redox gradients. Soil and aquifer gas measurements down to 4.6 m at the groundwater enrichment site (low DOC regime and carbon limitation) showed extreme high rates of metabolism with carbon dioxide (CO2), dinitrous oxide (N2O) and CH4 concentrations reaching fifty, thirty and three times atmospheric concentrations, respectively. Simultaneously, groundwater oxygen (O-2) saturation was between 50 and 95%. We concluded that independent of DOC regime the sequential reduction chain was not a suitable concept in our systems. Instead of electron acceptor or donor availability micro site variability might explain the co-existence of redox processes within our sites.

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