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Peatland ecohydrology and redox potential

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Anoxic conditions in soils cause microbial populations dependent on oxidation of organic carbon to subsitute alternate terminal electron acceptors (TEA) for oxygen to facilitate the reactions they acquire energy with. Most commonly available alternate TEAs include nitrate, manganese, iron(III) and sulphate, in descending energetic yield. Oxidation by reducing these TEAs offers the microbes more energy per reaction than methanogenesis, and thus they are in principle preferred over it. Different moieties in organic matter itself can also act as TEAs and support non-methanogenic anaerobic decomposition, the most widely known of these being quinones.

Each redox pair (comprising the oxidised and reduced species of a TEA) in principle supports a known electron activity (pe) in solution when they are present in roughly equal activities in the solution. Pe can be measured by an electrode and compared to a reference electrode comprising of a known redox pair, thus creating an electric potential known as redox potential (Eh, mV).

Continuous Eh measurements are emerging as a tool for ecosystem monitoring, particularly on peatlands and wetlands. Because redox conditions are intrinsically linked to environmental outcomes such as carbon dioxide, nitrous oxide and methane fluxes and phosphorus and iron leaching, there are great hopes that measurements and modelling of redox conditions will improve our understanding of and ability to predict processes in peatlands under sub- and anoxic conditions, and to model the changes in these processes under different management scenarios, such as drainage, restoration, continuous-cover forestry or paludiculture.

Here we present long-term Eh measurements from several boreal peatlands of varying ecohydrological characteristics (ombrotrophic pine bog-mesoeutrophic flark fen) and drainage state (pristine, forestry drained, agricultural). We see the differences in the Eh profiles and their

dynamics caused by the dominant water table level (WTL) and the nutrient status, but also that WTL is not sufficient to predict temporal changes in redox conditions. We further explore possible connections between Eh measurements and microform- and ecosystem-level flux measurements.

We also present results of a laboratory incubation experiment showing that iron is the most important mineral TEA in a range of boreal peatland types.