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Determination of natural organic matter and iron binding capacity in fen samples

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Natural organic matter (NOM) plays an important role in ecosystem processes such as soil carbon stabilization, nutrient availability and metal complexation. Iron-NOM-complexes, for example, are known to increase the solubility and, as a result, the bioavailability of iron in natural environments leading to several effects on the microbial community. Due to the various functions of NOM in natural environments, there is a high level of interest in the characterization of the molecular composition. The complexity of NOM presents a significant challenge in the elucidation of its composition. However, the development and utilization of high resolution mass spectrometry (HR-MS) as a tool to detect single compounds in complex samples has spearheaded the effort to elucidate the composition of NOM. Over the past years, the accuracy of ion cyclotron- or Orbitrap mass spectrometers has increased dramatically resulting in the possibility to obtain a mass differentiation of the large number of compounds in NOM. Together these tools provide significant and powerful insight into the molecular composition of NOM.

In the current study, we aim to understand abiotic and biotic interactions between NOM and metals, such as iron, found in the Schlöppnerbrunnen fen (Fichtelgebirge, Germany) and how these interactions impact the microbial consortia. We characterized the dissolved organic matter (DOM) as well as basic chemical parameters in the iron-rich (up to 20 mg (g wt peat)-1), slightly acidic (pH 4.8) fen to gain more information about DOM-metal interactions. This minerotrophic peatland connected to the groundwater has received Fe(II) released from the surrounding soils in the Lehstenbach catchment. Absorption spectroscopy (AAS), differential pulse polarography (DPP) and high resolution electrospray ionization mass spectrometry (HR-ESI-Orbitrap-MS) was applied to characterize the molecular composition of DOM in the peat water extract (PWE). We identified typical patterns for DOM illustrated by van Krevelen plots, which indicate the presence of different substance classes including condensed aromatics, lignins and tannins known to complex iron. Our results indicate a variety of potential Fe-DOM-complexes present in the PWE samples when iron is incorporated into the elemental composition search. Using DPP we determine the complexation capacity of iron in the natural matrix of the fen along with the identification of ligands in order to estimate the iron bioavailability for bacteria. As the microbial redox system of the fen is impacted by other metals in the environment, we perform comprehensive analysis of the entirety of metal ions and concentrations in the water samples. Dialysis chambers are currently installed in the iron-rich fen from which pore water samples will be collected at 1 cm increments between 0-20 cm depth to determine the depth profiles of Fe(II)- and Fe(III)-concentration and evaluate the influence of the depth profiles on the interplay between microorganism comprising the natural microbial redox system of the fen. We have shown that metal-DOM-pH interactions affect the bioavailable metal concentration in fen water systems. This information will pave the way for a better understanding of the bacterial recruitment of trace elements and microbial redox reactions.