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Linking the spectroscopic signature of dissolved organic matter in interstitial waters of a riverbank sediment and trace metals mobility

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Wetlands and periodically flooded riverbanks (RB) are essential biotopes for many environmental issues, e.g., global carbon cycle, mobility of (in)organic pollutants in terrestrial and aquatic systems, and mitigation of (ground)water pollution. They have a high capacity to accumulate trace metals (TM) due to strong interactions between their organic, microbial, and mineral compartments and dissolved TM, but conversely can act as chronic sources of TM through metalloorganic complexes dispersed in water. There is a lack of knowledge about the composition of dissolved organic matter (DOM) in RB sediments, which is a prerequisite for establishing a link between speciation and TM transfers. In this work, the composition of DOM in interstitial waters (IW) of a RB sediment and its potential role in TM transfers were addressed.

The RB system studied is located downstream the Fessenheim Nuclear Power Plant (France), in a wetland along the Rhine River. Methodology included RB sediment core sampling, collection of IW in the field or in the laboratory from sediment cores, and laboratory desorption experiments to identify the labile fractions. In situ/on-site parameters (e.g., pH, dissolved oxygen), TM compositions, spectroscopic signatures (recording of 3D excitation-emission fluorescence matrices, EEMs) of IW's DOM and labile DOM were investigated. Water samples from the Rhine were also collected and analysed.

Certain TM, including cobalt, have concentrations in IW that vary - from a few to several hundred ppm - with the dissolved/colloidal manganese and organic carbon contents, suggesting that these are the main vectors of TM mobility. EEMs provided valuable insights into the structures of the organic fluorophores. Labile OM desorbed from sediment exhibited fluorophores having structures of ligno-cellulosic derivatives, like for river water's DOM. In contrast, the spectroscopic signature of IW's DOM, dominated by fluorophores emitting in EEM regions caracteristics of proteic-like compounds and poorly oxygenated aromatic compounds, respectively, reflected a high microbial activity. Laboratory experiments using fluorescence spectroscopy analysis are in progress to elucidate the main organic structures of IW's DOM involved in the complexation of Co(II).

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