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Copper binding to natural organic matter studied through UV-Vis absorbance

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The bioavailability and ecotoxicity of trace metals (such as Cu, Cd, and Pb) in the environment is largely governed by sorption processes. Natural organic matter (NOM) serves as the primary sorbent in soils and aquatic systems. It is known that NOM binds trace metals through some of its functional groups, particularly carboxylates and phenolates. However, due to its heterogeneous and polydisperse nature, quantifying the speciation of metal binding to NOM remains challenging. Accessing this information would be favourable to model trace metal-NOM binding in natural systems.

UV-Vis spectroscopy is a powerful tool for studying the properties of NOM at environmentally relevant concentrations. In this study, copper binding to reference material leonardite humic acid (LHA) was investigated across varying pH and metal concentrations. A novel data processing approach was developed to deconvolve the absorbance signal across the UV-Vis range, separating contributions from carboxylic and phenolic functional groups. The response of LHA absorbance to changes in proton and metal concentration is separated into the contribution of proton- and Cu-bound carboxylic and functional groups. Simultaneously, the fractions of carboxylic and phenolic functional groups bound to Cu, protons, and deprotonated are obtained from this approach. Deconvolved speciation results were compared to the predictions of the commonly used geochemical model NICA-Donnan. This study provides a helpful and accessible tool to quantify the speciation of NOM functional groups in the presence of metals.

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