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Natural organic matter adsorption on iron oxides: surface composition as a function of time, pH and concentration

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Globally, soil organic matter is a large and important carbon pool. The stability of this pool is controlled by a range of biological and environmental factors. One important environmental factor in this respect is the interaction between organic matter and soil mineral surfaces (e.g. iron oxide and clay surfaces). These interactions may fractionate the complex mixture of soil organic matter and influence why some fractions are more recalcitrant than others. Consequently, it is important to study adsorption of organic matter on soil minerals in order to understand the interaction mechanisms and their consequences for organic matter decomposition and sequestration.

In our study we used in-situ infrared spectroscopy to study the interactions between dissolved organic matter and ferrihydrite and goethite mineral surfaces. The organic matter was water-extracted from organic forests soils, thus herein we have studied the more labile fraction of soil organic matter. We investigated the adsorption behavior at different time scales by conducting a series of systematic experiments at pH values from 4 to 9 and at different organic matter concentrations. IR spectra were collected as a function of time at fixed predetermined pH values, at a sub-minute time resolution. Two advanced chemometric tools, two-dimensional correlation spectroscopy and multivariate curve resolution, were applied to decompose the IR spectral data sets into spectral components displaying different adsorption kinetics. In addition to the IR spectra, the concentrations of dissolved organic matter was monitored.

Results will be presented showing that composition of the surface layers changes with time, pH and organic matter-to-mineral ratios. Depending on these factors, the organic matter selectively and sequentially adsorbed on the iron oxide surfaces. Thus, the major compound classes of the organic matter displayed different adsorption kinetics and pH dependent adsorption behaviour. The present study will contribute to the molecular scale insights about adsorption mechanism occurring at natural organic matter-mineral interfaces and give a new perspective on how these reactions determine SOM degradation.