

How redox dynamics modulate the coupling of Natural Organic Matter (NOM) and iron cycling in soils

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The biogeochemical cycles of iron and carbon are intricately linked in a complex set of processes strongly modulated by redox. Iron minerals are often discussed as potent sinks that can extend the residence time of carbon in soils through sorption and co-precipitation processes; while at the same time, studies illustrate iron minerals can promote the mineralization of organic matter to CO₂. The presence and concentration of NOM strongly influences the rates of Fe cycling and the susceptibility of Fe minerals toward transformation. This presentation will describe our lab's and our collaborators' work on unraveling the influence of NOM and Fe on their respective cycles through a series of lab and field experiments using soils and some model systems. Upon exposure to oxic conditions, we find the rates of Fe(II) oxidation, electron transfer and atom exchange, and characteristics of subsequent Fe(III) minerals formed are all impacted by the presence of both dissolved and solid phase organic matter in soils. Similarly, upon exposure to anoxic conditions, we find Fe(III) mineral composition and degree of association with NOM impacts rates of both Fe(III) reduction and the bioavailability and decomposition/mineralization of NOM. Combining these processes in redox dynamic systems with sequential oxic and anoxic cycles, we find that indeed the rate redox transitions, initial NOM and Fe mineral composition, as well as the microbial community characteristics all influence the trajectory of Fe mineral transformations and stability of NOM. By in large, we find that the coupled influence of NOM and Fe on their respective cycles can only be parsed when specifics of the system's redox dynamics are considered and understood.