

How Organic Matter Modulates Heavy Metal-Soil Mineral Interactions

The interactions between soil minerals and heavy metals are pivotal in biogeochemical processes. Soil minerals like clays and oxides have the ability to bind heavy metals, thereby influencing their mobility and bioavailability in the environment. Heavy metals undergo various processes such as aggregation, dissolution, complexation, and precipitation, which are regulated by solution conditions like pH, ionic strength, redox status, and organic matter content. Organic matter, consisting of a diverse array of organic compounds, often exhibits strong affinities to soil mineral surfaces. Coating of mineral surfaces by organic matter can either inhibit or enhance the reactivity of both the organic compounds and the soil minerals, impacting their interactions with heavy metals. Because organic compounds act as effective chelators for many heavy metals, this leads to complex interactions among soil minerals, organic matter, and heavy metals under environmental conditions. We will present several examples highlighting how the composition of organic matter governs the mechanisms and kinetics of heavy metal-soil mineral interactions, with a specific focus on ferrihydrite, an iron oxyhydroxide mineral, in both field and laboratory experiments. Utilizing micro- and nanoscale techniques such as TEM, XAS, Mössbauer spectroscopy, and XPS, we aim to characterize heavy metal speciation and bonding environment to elucidate their reactivity and environmental fate.