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Bioavailability of organic C in MAOM formed from co-precipitation of short-range-ordered iron and DOC

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Humid soils show a strong correlation between the abundance of short-range-ordered (SRO) iron and aluminum and organic carbon abundance. This likely stems in part from the association of organic matter and these metals in co-precipitates that readily form in these soils during the oxidation of ferrous iron. Using a variety of experimental setups, our lab has been examining the incipient formation of Fe-C co-precipitates via this oxidation mechanism and assessing the stability and the bioavailability of the organic C under oxic and anoxic conditions. Our experiments include both synthesized ferrihydrite(Fh)-based co-precipitates, as well as isotopically-labeled (57Fe and 13C) co-precipitates formed in soil slurries. Our general approach is to oxidize ferrous Fe (labeled if necessary) in the presence of DOC (labeled if necessary) and then examine the persistence of the co-precipitates after subjecting them to microbial incubations. From an overall net C balance, we find that the oxidative formation of Fe-C co-precipitates only conferred net protection to newly added organic matter and only under strict oxic conditions, whereas in treatments without added DOC or that were exposed to transient anoxia, the addition of iron stimulated net organic matter decomposition. In addition, to explore the influence of mineral transformation, we reacted some Fh—based co-precipitates with Fe(II). We find that the anoxic reaction with Fe(II) generated Fe-C co-precipitates that were capable of retaining more C during an aerobic incubation than the non-Fe(II) reacted controls. Collectively, these findings suggest iron redox dynamics will likely tend to enhance overall net organic matter decomposition in soils, but may also help generate a smaller portion of MAOM that is more persistent. These studies have specifically focused on localized iron dynamics and biogeochemical coupling with organic matter by using well-mixed systems. Spatial heterogeneity and soil structural features have yet to be evaluated and likely the generation of composite MAOM structures composed of SRO-Fe, crystalline-Fe, Al, and clays is a critical step in understanding OM persistence in soils.