

Stabilization of wetland organic carbon by the “iron gate”

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As a massive reservoir of soil organic carbon (SOC), wetlands are facing a major threat of water-table decline (WTD) or redox shifts under climate and land use changes. The fate of wetland SOC upon WTD is hence a heated research topic but remains highly uncertain. Previously using a mesocosm experiment, we have shown that oxidation of ferrous iron during wetland WTD may considerably reduce phenol oxidative activity and contribute to SOC (in particular, lignin) stabilization via promoting lignin association with the newly formed ferric iron (hydr)oxides. We therefore propose that redox-induced Fe transformation acts as an “iron gate” (versus “enzyme latch”) in regulating wetland SOC dynamics under WTD. Here we employ laboratory incubation experiments to test (1) the prevalence of “iron gate” in different types of wetland soils and (2) whether oxidation of added ferrous iron may facilitate SOC stabilization. We measure greenhouse gases, iron species, microbial traits, extracellular enzyme activities as well as iron-associated SOC and lignin phenols in soils from six different wetlands subject to repeated redox cycles with or without ferrous iron addition. We find that ferrous iron addition enhances SOC stabilization by increasing iron-associated SOC and decreasing greenhouse gas emissions (in terms of global warming potential) in wetland soils with a pH < 7 under redox fluctuation. However, the same treatment may increase SOC decomposition in *Sphagnum*-dominated wetlands with high SOC contents. This study lends support for the “iron gate” mechanism and further elucidates its operating conditions.