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## Fe(II)-catalyzed transformation of Fe (hydr)oxides in particle-size soil organic matter fractions from amended agricultural soils

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Redox-driven changes in Fe crystallinity and speciation may affect soil organic matter (SOM) stabilization and carbon (C) turnover, with consequent influence on global terrestrial soil organic carbon (SOC) cycling. Under reducing conditions, increasing concentrations of Fe(II) released in solution from the reductive dissolution of Fe (hydr)oxides may accelerate ferrihydrite transformation, although our understanding of the influence of SOM on these transformations is still lacking.

Here, we evaluated abiotic Fe(II)-catalyzed mineralogical changes in Fe (hydr)oxides in bulk soils and size-fractionated SOM pools (for comparison, fine silt plus clay, FSi+Cl, and fine sand, FSa) of an agricultural soil, unamended or amended with biochar, municipal solid waste compost, and a combination of both.

FSa fractions showed the most significant Fe(II)-catalyzed ferrihydrite transformations with the consequent production of well-ordered Fe oxides irrespective of soil amendment, with the only exception being the compost-amended soils. In contrast, poorly crystalline ferrihydrite still constituted *ca.* 45% of the FSi+Cl fractions of amended soils, confirming that the higher SOM content in this fraction inhibits atom exchange between aqueous Fe(II) and the solid phase. Building on our knowledge of Fe(II)-catalyzed mineralogical changes in simple systems, our results evidenced that the mechanisms of abiotic Fe mineral transformations in bulk soils depend on Fe mineralogy, organic C content and quality, and organo-mineral associations that exist across particle-size SOM pools. Our results underline that in the fine fractions the increase in SOM due to organic amendments can contribute to limiting abiotic Fe(II)-catalyzed ferrihydrite transformation, while coarser particle-size fractions represent an understudied pool of SOM subjected to Fe mineral transformations.