



## **Soil Organic Matter-Mineral interactions across different land uses: the importance of Fe-mediated stabilization**

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Carbon (C) cycling is linked to the buildup of soil organic matter (SOM) pools with long residence time. Iron (Fe) (hydr)oxide minerals have been suggested as an important phase for the stabilization of SOM. Although the quantitatively important role of SOM coprecipitation with Fe for the purpose of SOM buildup is well established, the molecular structure, species, hydrolysis, and stability of SOM precipitated with Fe(III) in different real-world soil systems have not been thoroughly examined.

In this study, we investigated Fe speciation and its role in the interaction between the soil mineral phase and SOM in physically fractionated SOM pools across different land uses. One fraction included the fine silt plus clay (FSi+Cl) portion of the soil, which was obtained by ultrasonic dispersion and wet sieving. The soil samples represented several distinct land uses, including coniferous forest soils, grassland soils, technosols, and agricultural soils, in order to understand how each influenced the reaction.

Each fraction was analyzed for total organic C and total N, and OC stability was assessed by thermogravimetric analysis (TGA). Fe K-edge extended X-ray absorption fine structure (EXAFS) spectroscopy was used to characterize soil Fe species. We employed attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) to assess the main C functional groups of different SOM fractions. The sorption processes of Fe at the molecular scale and information about C, Fe, and Si chemical states were also examined using X-ray photoelectron spectroscopy (XPS).

Our multi-technique approach helps to reveal how different SOM pools control Fe(III) speciation and improves our understanding of SOM mean residence time in different soil ecosystems and land uses.