ORGANIC CARBON CYCLING AND STABILIZATION IN PADDY SOILS PROBED BY FE K-EDGE X-RAY ABSORPTION SPECTROSCOPY

Danilo OLIVEIRA DE SOUZA
Elettra Sincrotrone Trieste, Trieste, Italy

Beatrice GIANNETTA
Department of Biotechnology, University of Verona, Verona, Italy

Paddy soils experience long-term redox alternations affecting the interactions between the biogeochemical cycling of iron (Fe) and carbon (C). Differences in particle aggregation and soil organic matter (SOM) turnover are likely to both affect and be affected by the trajectory of Fe mineral evolution/crystallinity with redox fluctuations. Evaluating the mechanisms for organic carbon (OC) stabilization in paddy soils still deserves attention particularly due to the complex interactions between C cycling and changes in the contents and mineralogy of hydrous Fe oxides in redox-active systems.

We evaluated the distribution of Fe species and organic C between different aggregate and particle-size fractions in topsoil (eluvial) and subsoil (illuvial) horizons of soils under long-term paddy and non-paddy management in NW Italy, as well as mineralogical changes in Fe phases by Fe K-edge Extended X-ray Adsorption Fine Structure (EXAFS) and X-ray Absorption Near Edge Structure (XANES) spectroscopy (Fig. 1).

Our findings [1] have shown that although paddy topsoils show higher contents of particulate OC in the coarser size-fractions with respect to non-paddy soils, most of the soil organic carbon is associated with the finer soil fractions, not only in the topsoil but also in the subsoil. This suggests that the management-induced differences in C stocks is not primarily due to the limited decomposition of crop residues under paddy management, but rather to the redox-driven changes in the association of OC with soil minerals. We show that OC stabilization through interaction with minerals is also affected by microaggregate stability. Paddy management may lead to microaggregate breakdown with a preferential release of clay-sized particles rich in both Short-Range Order Fe oxides and OC, while intra-microaggregate fine silt-sized particles may also serve as an important OC sink. Long-term alternating redox conditions generally resulted in paddy topsoil horizons that were depleted in pedogenic Fe with respect to non-paddy soils and led to a redistribution of Fe phases across different particle size fraction often as less crystalline phases (primarily ferrihydrite and Fe-OM associations). Nonetheless, the higher C contents indicate that higher C loadings can be achieved under these redox-dynamic environments. Moreover, illuvial horizons under paddy management were enriched in SRO hydrous Fe oxides and this contributed to enhanced microaggregate formation and C stabilization with respect to non-paddy subsoils.

REFERENCES

[1] Beatrice Giannetta, Danilo Oliveira de Souza, Giuliana Aquilanti, Luisella Celi, Daniel Said-Pullicino. Redox-driven changes in organic C stabilization and Fe mineral transformations in temperate hydromorphic soils. Geoderma **406** (2022) 115532.

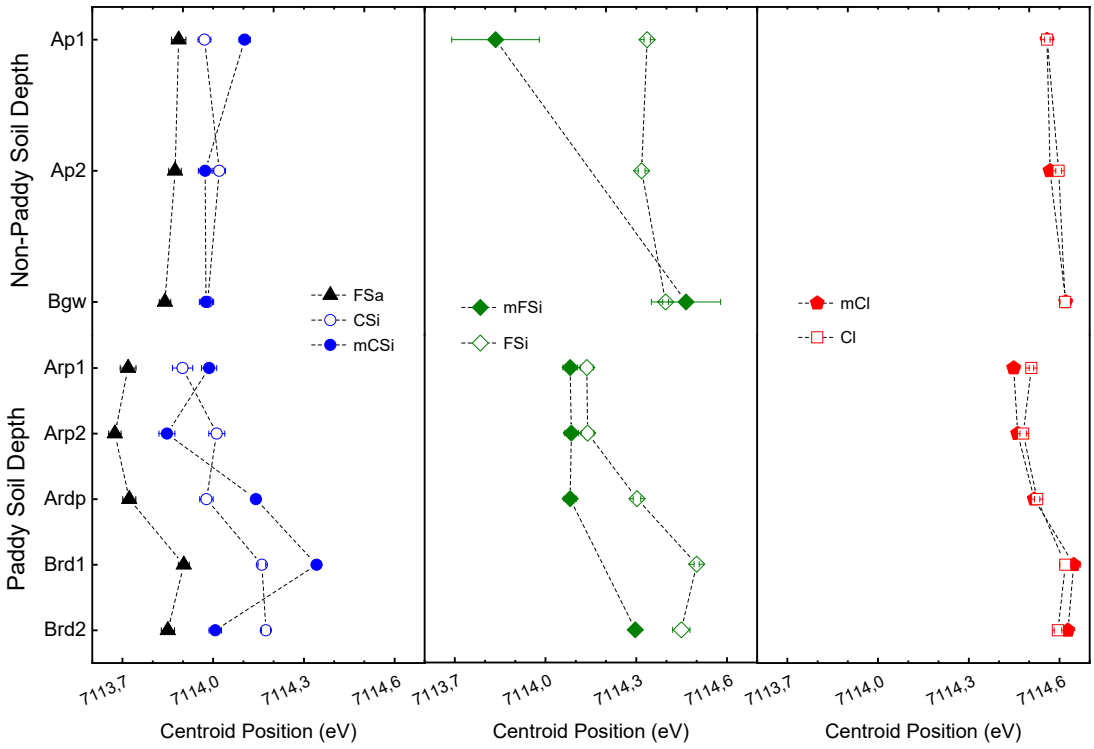

FIG. 1. Changes in average Fe oxidation state according to the pre-edge peak centroid position by fractions in paddy and non-paddy soil as function of soil depth.