GEOC: Division of Geochemistry

36 - Selective preservation of organic carbon species in amended field soils using multi-edge STXM coupled with XANES spectroscopy

View Session Detail

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Abstract: Soil systems preserve the largest C pool compared to other ecosystems such as the ocean and atmosphere. Acid soils occupy approximately 30% of the world's ice free land area and thus play a vital role in global C cycling. To overcome poor fertility of acidic soil due to Al toxicity, P deficiency etc., fly ash (FA) and red mud (RM), as alkaline industrial byproducts enriched with Ca and Fe minerals, respectively, have been widely used to amend acid soils to improve agricultural productivity. However, the impact of FA and RM application on the retention of organic carbon (OC) as well as the distribution and species of C and related mineral elements including Fe, Ca and Al in amended soils remain largely unknown both at the molecular level and sub-micro spatial scale. In this study, soil samples, collected from field plots with five-year application of FA and RM, were characterized by scanning transmission X-ray microscopy (STXM) coupled with X-ray absorption near-edge structure (XANES) spectroscopy. Our results indicated a significant decrease in total C in the clay fractions of FA- and RM-treated soils compared to the control soil. PCA coupled with cluster analysis indicated the C-enriched cluster was distributed separately from the Fe-enriched cluster in each of the three investigated soil fractions regardless of amendment; the distribution of the C-enriched cluster also differed from that of the Ca-enriched cluster in the FA-treated soil fraction. C K-edge XANES analysis of C-enriched clusters indicated carboxylic- (288.6 eV) and phenolic-C (286.3 eV) peaks were more evident in the control soil clay fraction, while amide-linked carbonyl-C (288.2 eV) and O-alkyl-C (289.7 eV) peaks were more prominent in RM- and FA-treated soil clay fractions, respectively. Lignin was the predominant constituent of soil organic carbon enriched with carboxylic- and phenolic-C, and amide-linked carbonyl-C and O-alkyl-C were generally assigned as protein-C and polysaccharide, respectively. Therefore, mineral amendments increased degradation of carboxylic-C and phenolic-C functional groups of SOM in the soil clay fraction, implying accelerated lignin mineralization after soil amending; the RM treatment enhanced protein-C accumulation, while the FA treatment contributed to polysaccharide stabilization in the investigated soil clay fraction. This study facilitate our understanding soil C dynamics and sequestration in acidic agricultural lands under RM and FA amendation.