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Dynamics of iron-bound organic carbon in the Changjiang Estuary

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Reactive iron (Fe_R) plays an important role in the preservation of organic carbon (OC) in soils and sediments, and yet the iron-bound OC (Fe-OC) characteristics in estuarine particles and the transformation of OC-Fe associations during transport and deposition remain poorly understood. The main goal of this work was to investigate the role of Fe_R in the preservation of terrestrial OC in suspended particulate matter (SPM) and surface sediments of the Changjiang Estuary and adjacent East China Sea (ECS) shelf. We examined OC and its carbon isotopic composition ($\delta^{14}C/\delta^{13}C$), sediment surface area (SSA), grain size composition, Fe_R, Mössbauer spectroscopy, Fe-OC, and isotopic signatures of Fe-OC ($\delta^{14}C_{Fe\text{-}OC}/\delta^{13}C_{Fe\text{-}OC}$). The bulk OC and Fe_R in SPM were significantly higher than those in surface sediments, with no significant differences between surface- and bottom-water SPM, indicating that the loss of OC and Fe_R mostly occurred at the sediment-water interface, due to rapid Fe cycling. The percentage of Fe-OC to bulk OC ($f_{Fe\text{-}OC}$) in SPM (6.7 ± 2.0%) was similar to that in mobile-mud sediments (8.8 ± 1.8%), but lower than in ECS shelf sediments (14.1± 3.3%). This suggests that iron reduction in estuarine regions may reduce Fe_R binding with OC. Both $\delta^{13}C$ and $\Delta^{14}C$ of Fe-OC were lower than bulk OC, indicating that Fe_R was mainly associated with aged terrestrial plant-derived OC, especially in estuarine SPM and mobile-mud sediment, possibly because Fe-OC has been protected from decay for a long time. The $\delta^{14}C_{Fe\text{-}OC}$ was significantly correlated with bulk $\delta^{14}C$, which suggests that association with iron oxides is a potential mechanism of OC aging in the Changjiang Estuary. The $\delta^{14}C_{Fe\text{-}OC}$ decreased with the increase of the ratio of hematite to (super)paramagnetic Fe^{3+}, demonstrating that aged Fe-OC was mainly associated with high-crystallinity iron oxides, and further indicating the synchronous aging of terrestrial OC with iron oxides. Our work supports that Fe_R plays an important role in the stabilization and transport of river-derived terrestrial OC.