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Distinguishing sediment organic matter bound to iron of varying reactivity

YUXUAN LIN[1] AND JIYING LI[1,2]

[1]The Hong Kong University of Science and Technology
[2]Center for Ocean Research in Hong Kong and Macau

Organic matter bound to iron oxides (FeOC) in sediments represents a significant carbon pool contributing to global carbon sequestration. Coastal sediments, owing to their proximity to terrestrial iron sources, are potential hotspots for FeOC burial. However, the timescale of this carbon preservation is closely linked to the reactivity of the associated Fe oxides. Amorphous Fe oxides (e.g., ferrihydrite) are more susceptible to anaerobic reduction and may therefore provide only short-term protection for the associated organic carbon, whereas more crystalline forms of Fe (e.g., goethite) can facilitate long-term carbon sequestration due to their stability. Thus, distinguishing between FeOC pools with differing reactivity is critical for evaluating carbon burial potential, yet existing methods do not allow for such differentiation. In this study, we develop and evaluate a sequential extraction method to separately quantify organic carbon bound to amorphous and crystalline Fe oxides using sediments from a range of coastal environments. Our results show that FeOC is predominantly associated with the more stable crystalline Fe oxide pools, indicating that iron-rich coastal sediments serve as important and stable reservoirs for long-term carbon sequestration.