

Mechanism of rare earth elements released from sediment in the Changjiang (Yangtze) river estuary

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Dissolved rare earth elements (REEs) serve as critical tracers for marine processes. For solving the problem that river and atmosphere input are insufficient to balance the global budgets, a hypothesis has been proposed recently that the sedimentary flux is the dominant source of ocean REEs (Abbott et al., 2015; Du et al., 2020, 2022; Haley et al., 2017). However, the mechanism of rare earth elements released from sediment is still poorly understood. The Changjiang (Yangtze) river is the largest river in the Asia which transfers large amount of sediment to the East China Sea annually. Riverine particles dissolution and benthic flux from sediment are important sources of dissolved REEs in the Changjiang river estuary (Che et al., 2022; Deng et al., 2022). Here, we integrate seasonal river monitoring (July 2020-June 2021), sequential leaching of surface suspended particles, flow-through time-resolved analysis (FT-TRA) and batch dissolution on surface sediments, to determine the dissolved REE composition of Changjiang river water and its seasonal variability and chemical phases involved with particles dissolution and the dynamic process of REEs release.

Our result reveal that the REEs concentration at Datong hydrological station varied from 144 to 258 ppt, with HREEs-enriched-pattern (PAAS-normalized). The REEs concentration in carbonate, Mn/Fe oxides fraction in the surface suspended particles along the salinity gradient has no linear correlation with the grain size. The release of REEs may correlated with the increasing pH and high turbidity in the Changjiang river estuary. The Mn/Fe oxides dissolution of suspended particles could be important sources of dissolved REE. Indicated by the LREEs/HREEs, MREEs/HREEs and LREEs/MREEs in Mn/Fe oxide fraction increasing with salinity, the released order is HREEs > MREEs > LREEs. The result of batch leaching and FT-TRA dissolution suggest that strong correlations in the release patterns of Fe with REEs. Additionally, LREEs showed enrichment in labile Fe oxyhydroxides, such as ferrihydrite. Labile Fe plays a dominant role in bonding and fractionating REEs in estuarine surface sediments, owing to its abundance and rapid reoxidation and coprecipitation. We propose that REEs associated with labile Fe have high mobility and could be pumped out under variable redox conditions.