Shallow bioturbation promotes benthic iron release more than deeper bioturbation

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Iron availability limits marine primary productivity in large parts of the ocean. Lithogenic iron is an important iron source for the ocean and can be delivered via dust deposition or transitional systems such as estuaries, rivers and fjords. As iron in oxic waters is highly insoluble, rapidly oxidized, and removed from the water column by settling to the seafloor, benthic iron recycling is a critical part of land-to-ocean iron transport. The activity of benthic fauna ("bioturbation") is known to promote benthic iron recycling in marine sediments and can be further divided into the up and downward transport of particles ("biomixing") and solutes ("bioirrigation"). The balance of these two processes controls the release of iron from the sediment and is ultimately determined by the faunal community present and their functional traits. How all these components are specifically linked to each other however remains largely unquantified and represents an important knowledge gap, preventing a reliable assessment of the role of benthic faunal communities in benthic iron cycling.[1-4]

To address this knowledge gap we investigated the benthic iron cycle and faunal activity in three fjord systems from southwest Sweden with different water-column oxygenation states (permanently oxic, seasonally hypoxic, permanently anoxic). Pore-water distributions of dissolved iron, dissolved iron efflux rates, and iron mineralogy were complemented by a quantification of faunal activity and qualitative assessment of the community composition. Our results confirm that faunal activity is crucial for benthic iron recycling and iron transport along the fjords. We found that benthic iron recycling and iron release are promoted by shallower biomixing activity rather than deeper biomixing, provided a sufficient upward transport through bio-irrigation is present in both cases. This suggests that the biomixing depth is critical for iron production and the benthic release of dissolved iron. Our results illustrate the need to differentiate different modes of bioturbation as ecosystem functions in relation to iron cycling and release from marine sediments.

References

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Keywords
Iron cycling; benthic macrofauna community; bioturbation; Swedish fjords