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Benthic Iron Redox Mobilization Via Iron Reductive Respiration in Low Oxygen Seas: The Case of The Sea of Marmara

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Marine iron dynamics play important roles in primary production and in the cycling of other important chemical species such as C, O, N, P, Mn, and S. The benthic component of the marine iron cycle, in particular, exhibits strong redox dependencies. According to research conducted over the last decade, iron release from marine sediments is favored within a narrow redox window, under conditions ranging from hypoxic to anoxic, but not sulfidic. However, further constraining this globally complex feedback is crucial in modern hypoxic and anoxic zones. Connecting the Mediterranean with the Black Sea, the Sea of Marmara is currently in a hypoxic state, especially in the basin's eastern part. Using multi-corer sampling, we investigated benthic iron species in porewaters and sediment solid phases for the first time between 2019 and 2022 to depict the iron dynamics of the mobilized and stored phases of iron. The results indicate that the Sea of Marmara is already in a denitrification and iron reduction state in its deep waters and the top layer of sediments. Iron reductive respiration recycles iron from the solid phase to porewater dissolved and colloidal phases, which results in high release rates from the sediments even at a scale comparable to major global oxygen minimum zones. The extent of bacterial respiration by iron versus total carbon respiration was estimated by the concentration gradients of dissolved iron in the sediment porewaters and was found to be around 10–30% at the study site. To investigate the relationship between the standing stock and recycled fractions of iron phases, the reactive iron and total iron fractions of the sediment solid phase were also analyzed. The results confirm that the recent hypoxia resulted in an iron release from the sediment via reduction and efflux into seawater. These results indicated that the Sea of Marmara is a significant area for further study of benthic iron dynamics, and the fate of released iron in the sea requires further attention to understand the full impact of benthic iron sources.