Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35763

Decoupled benthic nitrogen and phosphorus flux responses to oxygen variability in hypereutrophic Tokyo Bay

CHUANZHE SUN, YUXUAN LIN, XIAOTIAN ZHOU AND JIYING LI

The Hong Kong University of Science and Technology

Sediment recycling of nutrients is highly sensitive to redox variability, providing strong feedback to eutrophication-driven seasonal hypoxia. Quantifying this feedback is critical for coastal management. In this study, we characterize sediment porewater and solid-phase geochemistry and quantify fluxes of inorganic nitrogen and phosphate across the sediment-water interface in a hypereutrophic bay (Tokyo Bay, Tokyo) undergoing seasonal hypoxia. Despite similar organic matter remineralization rates in the sediments across the sampling sites (spanning 7 km), as indicated by total oxygen uptake (~21 ± 0.1 mmol m^{-2} d^{-1}), we observe orders of magnitude differences in the effluxes of key nutrients, including NH_4^+, PO_4^{3-}, and Fe^{2+}. Our analysis suggests that this variability is largely caused by slight differences in oxygen penetrations that strongly affect the sediment redox zonation. Although slightly higher organic matter availability (POC content: 4.23% vs. 3.16%) can provide more reduced substrates, a slight deepening of the oxic barrier at the topmost sediment can instantly oxidize Fe^{2+}, inhibiting the fluxes of dissolved Fe and PO_4^{3-}. Conversely, a slightly thinner oxic layer that can substantially suppress nitrification and promote PO_4^{3-} release via the reduction of P-binding Fe oxides. Incubation experiments further show that under deoxygenated overlying waters, as typically occurs during the hypoxic season, PO_4^{3-} and Fe^{2+} effluxes increase by three orders of magnitude relative to normoxic conditions. Surprisingly, NH_4^+ flux switches from efflux (from sediments to the water column) to influx (into sediments), suggesting NH_4^+ removal rather than recycling under hypoxia. These results demonstrate a striking decoupling of N and P flux responses to deoxygenation, highlighting the need for refined nutrient management in seasonally hypoxic, eutrophic coastal systems.