

Tungsten Isotope Dynamics across Redox Gradients in the Baltic Sea

RUIYU YANG¹, OLAF DELLWIG², COREY ARCHER³,
TRISTAN BONGARTZ¹, FRANK WOMBACHER¹ AND
CARSTEN MÜNKER¹

¹University of Cologne

²Leibniz Institute for Baltic Sea Research

³ETH Zurich

The stable tungsten (W) isotope system has recently gained attention as a promising proxy for past redox conditions in ocean floor sediments [e.g., 1,2]. However, its broader application remains restricted by a limited understanding, particularly regarding W isotope behavior across redox gradients. Key issues are the mechanisms controlling W isotope fractionation in oxic, hypoxic and euxinic environments.

In this study, we analyzed seawater, sediments, and pore-water samples from two contrasting sediment cores in the Baltic Sea. The cores are from the currently euxinic Gotland Basin (GB), one of the deepest basins in the central Baltic, and from the oxic, strongly freshwater-impacted Bothnian Bay (BB) in the northernmost part of the Baltic. These contrasting redox conditions provide an ideal framework to explore how redox gradients control stable W isotope behavior.

Our results reveal distinct patterns in W and its isotopic behavior between the two sites. At the GB site, sediments and pore-waters exhibit high levels of W concentrations, accompanied by a progressive increase in $\delta^{186/184}\text{W}$ values with depth. In contrast, sediments deposited under an oxic water column at site BB show lower W concentrations, with heavier surface $\delta^{186/184}\text{W}$ values that decrease downcore. Pore-water W concentrations increase with depth in both cores but are consistently higher at the GB site compared to the BB site. Additionally, pore-waters from the BB site display $\delta^{186/184}\text{W}$ values comparable to or slightly lighter than those of the overlying water column, whereas euxinic pore-waters exhibit significantly lighter $\delta^{186/184}\text{W}$ values relative to the corresponding water column.

These findings demonstrate that W isotopes in sediments and pore-waters respond distinctly to Mn and Fe cycles under redox gradients. Our data provide critical insights into W isotope behavior under contrasting redox regimes and highlight the potential of $\delta^{186/184}\text{W}$ as a paleo-redox proxy.

[1] Kurzweil et al. (2021) *PNAS* **118** (18), e2023544118

[2] Yang et al. (2023) *Geology* **51**(8), 728-732