Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35232

Decoupling of Zn and SiO_4^{4-} in a North Pacific marginal sea driven by boundary exchange

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In the global ocean, dissolved Zn generally exhibits a distribution pattern similar to that of dissolved SiO_4^{4-}, showing a positive correlation [1]. In coastal areas or marginal seas, however, the distribution of Zn is strongly influenced by external inputs as well as various complex biogeochemical cycling processes. This study examines the distribution patterns and behaviors of dissolved Zn in the East/Japan Sea (EJS), a semi-enclosed marginal sea in the North Pacific. While Zn concentrations in the North Pacific Ocean typically exhibit a nutrient-type distribution pattern vertically [2], with maximum values showing in intermediate waters and relatively uniform concentrations in the deep layer, Zn in the EJS exhibits elevated concentrations in the intermediate water but a depletion pattern in deep waters. In addition, an unusual decoupling between Zn and SiO_4^{4-} concentrations is observed in the EJS, with positive correlation showing in the surface-to-intermediate layer (< 500 m) and negative correlation appearing at water depths > 500 m. This decoupling of Zn-Si is likely due to the notable shelf inputs at the intermediate layer as well as the removal of Zn in the deep layer. The fractionations of rare earth elements ($(Nd/Er)_{PAAS}$ and Ce/Ce* ratios) are used in this study to trace the scavenging processes and the input of water mass. This study provides new evidence for Zn–SiO_4^{4-} decoupling in the EJS and demonstrates that boundary processes can significantly influence the cycling of trace elements and reshape their distribution patterns.

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