

The potential impact of lithogenic particulates on zinc isotope compositions of the Western Pacific pelagic deep-sea sediment

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Pelagic deep-sea sediment is an important isotopically light sink balancing oceanic Zn budgets. However, despite the significant role of lithogenic particulates within the pelagic realm, their impacts on Zn isotope variations are not fully understood. Here we performed Zn isotope investigations in two Western Pacific sediment cores experiencing different extents of dust and volcanogenic particulates accumulations. Leaching experiments were conducted targeting both labile and silicate fractions. Combining with literature data of surrounding sediments, the appearance of volcanogenic particulates facilitates authigenic silicate formation (phillipsite/smectite with K enrichment), which preferentially incorporates light Zn isotopes (residual $\delta^{66}\text{Zn}_R = 0.02 - 0.28\text{‰}$) and contributes up to 25% of authigenic Zn. Meanwhile, Fe-Mn-(oxyhydr)oxides dominate authigenic Zn enrichment, evidenced by good correlations between Zn and Mn in both bulk sediments and labile fractions. Notably, lithogenic pathways introduce excess Zn relative to Mn to pelagic deep-sea sediment beyond authigenic pathways, resulting in lower labile $[\text{Mn}/\text{Zn}]_L$ (46 – 100) and $\delta^{66}\text{Zn}_L$ ($0.14 \pm 0.06\text{‰}$) in GC02 core receiving more dust. Conversely, much higher $\delta^{66}\text{Zn}_L$ (up to 0.57‰) and $[\text{Mn}/\text{Zn}]_L$ (up to 180) are observed in GC06 core with lower sedimentation rates (more authigenic Co), approaching those found in Fe-Mn crust and nodules. Our findings highlight that the precipitation and alteration of lithogenic particulates significantly perturbate oceanic Zn cycling, promoting the removal of isotopically lighter Zn from seawater. Meanwhile, the $\delta^{66}\text{Zn}$ of the operationally defined sedimentary labile fraction in our study can be a good proxy reconstructing the changes of Zn biogeochemical processes in the (paleo-)ocean.