Scavenging of zinc and zinc isotopes onto sinking biological material in the upper ocean

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Zinc (Zn) and cadmium (Cd) are important biologically active trace-metals in the ocean. To date, the marine distributions of these elements have been understood primarily in terms of biological assimilation by growing phytoplankton and regeneration of sinking biological material. Initial studies of Zn and Cd concentrations and stable isotope ratios (δ^{66}Zn and δ^{114}Cd) have therefore focused on their use as simple tracers of assimilation and regeneration in the oceans. However, these two processes are insufficient to explain new data on the marine distribution of Zn and δ^{66}Zn from the US GEOTRACES North Atlantic Zonal Transect.

Here, using the first high-resolution paired marine depth profiles of Zn, Cd, δ^{66}Zn and δ^{114}Cd, we suggest that scavenging of Zn onto organic matter plays a major role in the marine cycling of Zn. This hypothesis is supported by culture experiments examining the release of Zn, Cd, and P from degrading phytoplankton. We find that all three elements are released at roughly the same rate during degradation, however Zn alone is rapidly scavenged back onto organic matter. We also find that adsorbed Zn is isotopically heavier than the dissolved phase by 0.58‰. In contrast, very little Cd or phosphate was scavenged and Cd isotopes were not significantly fractionated during degradation. Our hypothesis is further supported by one-dimensional modeling, which reproduces observed marine δ^{66}Zn profiles with < 1% of Zn adsorbed to particles.

Understanding how Zn cycling in the oceans is a balance between assimilation, scavenging, and regeneration is necessary in order to investigate δ^{66}Zn as a tracer of marine productivity. We anticipate that paired analyses of δ^{66}Zn and δ^{114}Cd will prove to be valuable new tools in constraining patterns of global primary productivity, providing key information for the marine carbon cycle during periods of past and present global climate change.