Isotopic insights on the marine zinc cycle in the North Atlantic Ocean

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Zinc (Zn) is a marine micronutrient, utilised by phytopkanton in enzymes such as carbonic anhydrase. In the oceans, zinc displays nutrient-type profiles, similar to silicate, with the highest concentrations found in the deep Pacific. Zn stable isotope ratios (δ^{66}Zn) are a relatively new oceanographic parameter which offers new insights into the biogeochemical cycling of Zn. The handful of previous studies of δ^{66}Zn in the ocean have shown the deep ocean in the North Pacific, North Atlantic and Southern Oceans to be rermarkably homogenous[1-3], and heavier (~0.5‰) than any of the known marine sources of Zn (crustal is ~0.3‰).

Here, we present the first high-resolution oceanic section of [Zn] and δ^{66}Zn, through the North Atlantic Ocean. Data from 21 open-ocean stations as part of the US GEOTRACES North Atlantic Transect, from Lisbon to Woods Hole via Mauritania, provide a large dataset for us to draw new insights into the cycling of Zn and Zn isotopes in the ocean. In the surface ocean, biological uptake and release of light Zn isotopes, together with scavenging of heavy Zn isotopes complicates the picture. Below 1000 m, however, consistent with previous studies, the deep ocean δ^{66}Zn is remarkably homogenous (mean 0.50±0.14‰; 2SD). However, the high resolution nature of this study allows us to observe small scale variability within the deep ocean.

Close to both North America and Spain, sediments are a source of isotopically lighter Zinc (-0.2 to +0.2‰), likely reflecting remobilisation of ZnS or non-remineralised biological Zn. The Mid-Atlantic Ridge is a source of isotopically light Zn (-0.1 to -0.2‰), but this signal does not persist far from the vents. There is a transition from fully 'oceanic' profiles in the western basin, (mean +0.47±0.08‰; 2SD) to those which show a broad excursion to higher δ^{66}Zn values (+0.6 to +0.7‰) between 1000-2500 m depth, close to Africa. These δ^{66}Zn signals are heavier than any known Zn source to the ocean, and so we suggest they could represent a water-column sink for isotopically light Zn associated with oxygen minimum zones. This sink may be repsonsible for the isotopically heavy steady-state deep ocean Zn reservoir.

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