The cycling of Zn and Cd isotopes in multiple sectors of the Southern Ocean from the Antarctic Circumnavigation Expedition

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The marine dissolved distributions of the bioactive trace metals Zn and Cd show strong correlations to dissolved macronutrients throughout the oceans. Both trace metals also exhibit a 'kink' in their relationship with phosphate, which has been attributed to a combination of biological uptake under Fe-limitation in the Southern Ocean and physical circulation [1,2]. Measuring dissolved stable isotope ratios of Zn (δ^{66}Zn) and Cd (δ^{114}Cd) can inform understanding of the processes cycling these metals through the oceans, help trace their influence on phytoplankton ecology, and better understand how regional cycling of these metals in the Southern Ocean influences their global distributions.

Here, we present high-resolution water column profiles of dissolved δ^{66}Zn and δ^{114}Cd from the uppermost 1000 m of the Pacific and Atlantic sectors of the Southern Ocean, using samples from the recent Antarctic Circumnavigation Expedition during the Austral Summer of 2016/17. At depth (>300m), both, δ^{66}Zn and δ^{114}Cd are controlled by upwelling of nutrient-rich deep water, characterised by homogeneous isotope signatures (+0.45‰ and +0.25‰ respectively). At shallower depths, however, δ^{66}Zn and δ^{114}Cd show contrasting patterns: δ^{114}Cd is characterised by significantly heavier values in surface waters (up to +0.9‰), due to fractionation during biological uptake, with shallow remineralisation in subsurface waters generating a pronounced shift towards lower values (+0.1‰). In contrast, and despite the intense uptake of Zn by diatoms in the surface Southern Ocean, δ^{66}Zn is only slightly higher at the surface (up to +0.6‰), and subsurface variations in δ^{66}Zn do not follow the same pattern as δ^{114}Cd. These differences point to distinct processes influencing the isotope systematics of Cd and Zn in the Southern Ocean that in turn profoundly affect the global isotopic distributions.

[1] Quay P. *et al. GBC* 29, 830-841 (2015).
[2] Vance *et al. Nat. Geosci.* 10, 202-206 (2017).