The oceanic biogeochemical cycle of zinc and its isotopes: The dominance of diatoms and the Southern Ocean

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Zinc (Zn) is the most abundant trace metal in the phytoplankton that dominate vertical carbon export in the oceans, the diatoms [1]. But the strong relationship between the distributions of dissolved Zn and the silicon (Si) that makes up the hard parts of diatoms represents a long-standing puzzle. Zn is overwhelmingly co-located with phosphate in the organic matter of diatom cells, not with Si in opal [1], and is regenerated with phosphate in the upper ocean, not with Si in the deep [2]. The resolution of this apparent paradox is key both to an understanding of the global oceanic cycling of Zn, and to the rates and mechanisms by which biologically-assimilated trace metals are returned to the photic zone.

Here we compile new and published [3] data to show that oceanic dissolved Zn exhibits significant isotopic variation in the upper ocean that is consistent with vertical cycling. However, we suggest that the isotopically homogeneous global sub-thermocline Zn pool is set by diatom-dominated biological cycling in the Southern Ocean, and advected northwards in Antarctic-derived deep and intermediate water masses. The leads to a new view of the global oceanic cycling of this important trace metal, one that is consistent with the unique physiology of Southern Ocean diatoms [1], the strong coupling of Zn and Si in the global deep ocean, and the emerging paradigm for global ocean nutrient dynamics (e.g. [4]). Our data and interpretation imply a small Zn pool that is biologically cycled in the upper ocean, but is to a great extent decoupled from the much larger Southern Ocean-dominated deep and intermediate pool.

[1] Twining, B.S. & Baines, S.B. (2013) *Ann. Rev. Mar. Sci.* **5**, *191-215*. [2] Twining, B.S. et al. (2014) *Limnol. Oceanogr.* **59**, 689-704. [3] Conway, T.M. and John, S.G. (2014) *Glob. Biogeochem. Cycles* **28**, 1111-1128. [4] Sarmiento, J.L. et al. (2003) *Glob. Biogeochem. Cycles* **21**, B1S90, 10,1029/2006GC002720.