Zinc isotopes in deep-sea corals

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Zinc (Zn) is a bioessential element, and the behaviour of Zn and Zn isotopes in the oceans might therefore be expected to reflect biological uptake and remineralisation. In fact, the oceanic distribution of Zn and its isotopes in the sub-surface can be understood largely in terms of the physical ocean circulation, with a key role for Southern Ocean diatoms in setting water mass endmember compositions [1]. The Southern Ocean today is Fe-limited, and this unusual ecology is critical to the physiology of modern day diatoms, which grow with very high Zn/P and high Si/N ratios [2,3]. Alleviation of Fe-limitation in the past, or a change in the physical ocean circulation, may thus have had substantial implications for past ocean nutrient distributions. To this end, we seek an archive of past ocean Zn and Zn isotopes.

To date, a reliable archive for past ocean Zn isotopes has been lacking, because Zn is present at high concentrations in potential contaminating material, e.g., lithogenic or authigenic (e.g. Fe-Mn oxide) phases. Deep-sea coral skeletons provide an exciting new possibility. Their size and global distribution, combined with an ability to assign precise ages to individual specimens [4], give corals distinct advantages over more traditional palaeoclimate archives. Their size is a particular advantage for trace elements such as Zn, which are present at low concentrations in carbonate.

Here, we present the first data for Zn isotopes coupled to metal/Ca ratios for a small suite of deep-sea corals from the Southern Ocean. We carry out a series of physical and chemical cleaning experiments, which demonstrate that thorough physical cleaning alone is effective at removing >90% of the Fe-Mn coating, with cleaned coral Zn/Ca ratios in the range 0.5-0.8μmol/mol. Isotopic data indicate that Zn in the coral skeleton may indeed reflect the isotopic composition of the seawater in which it grew, although more work is required to isolate the respective roles of adsorption onto Fe-Mn oxides organic phases and incorporation into coral aragonite.

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[2] Sarmiento et al. (2014), Nature 427, 56-60.
[3] Twining B.S. et al (2004), Limnol. Ocean. 49, 2115-2128.
[4] Robinson, L.F. et al. (2014), DSR Part II 99, 184-198.