Exploring Pb isotopes in deep-sea corals: Measurement by TIMS and application to the deglacial Southern Ocean

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Lead (Pb) isotopes have been widely used to track anthropogenic inputs through space and time and to trace transport pathways within the modern oceans, with new evidence now emerging from the GEOTRACES programme. While they also hold promise as a paleoceanographic tracer, being sensitive to both weathering inputs and ocean circulation, that potential remains to be fully exploited.

Here we explore the suitability of deep-sea coral aragonite for reconstructing the Pb isotope composition of the past (i.e., pre-anthropogenic) oceans. This archive benefits from absolute dating and the potential for centennial resolution and multi-proxy paleoceanographic studies, but low Pb concentrations in the aragonite matrix and the potential sensitivity to diagenetic or anthropogenic contamination represent significant challenges to application of the Pb isotope system.

We present methodological developments for Pb isotope measurements, including the low-abundance ^{204}Pb, using a ^{207}Pb-^{204}Pb double spike on a ThermoFinnigan Triton TIMS. By employing a 10^{12} Ω (in place of a 10^{11} Ω) resistor to measure the ^{204}Pb ion beam, we improve the internal precision on ^{20x}Pb/^{204}Pb for a 2 ng load of NIST SRM 981 Pb from ~420 ppm (2 s.e.) to ~260 ppm (2 s.e.), and the long term reproducibility from ~960 ppm to ~580 ppm, thereby aiding measurement of low-concentration carbonate samples.

Coral cleaning experiments point towards heterogeneous Pb concentrations in deep-sea corals, and indicate the need for both physical and chemical steps to remove an ubiquitous anthropogenic Pb contaminant. After cleaning, in most but not all cases, we recover a Pb isotopic composition that is consistent with nearby ferromanganese crusts, suggesting the preservation of past seawater signatures in this archive. By applying our method to a series of deglacial corals from the mid-depth Southern Ocean near Tasmania, we assess the robustness of the approach and its paleoceanographic potential, in particular the complementary evidence provided by comparing Nd and Pb isotope time series.