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Cd isotopes under extreme euxinia: Tracing productivity and redox in palaeo-oceans

SOPHIE K. GANGL[1], CLAUDINE H. STIRLING[2], DON PORCELLI[3], MATT DRUCE[2] AND MALCOLM R. REID[2]

[1]Heidelberg University
[2]University of Otago
[3]University of Oxford

Cadmium (Cd) displays nutrient-like behaviour in the modern ocean and its isotope composition has emerged as a valuable tracer for primary productivity and carbon burial. Phytoplankton preferentially take up lighter Cd isotopes under a wide range of oceanic conditions, resulting in surface waters that are relatively enriched in heavier isotopes. This biologically driven fractionation forms the basis for using Cd-isotope ratios to trace nutrient availability and the intensity of primary productivity in both modern marine environments and ancient oceans.

However, Cd-isotope distributions are also strongly affected by redox conditions. Specifically, in euxinic settings, the formation and removal of isotopically light Cd sulphides can significantly alter Cd-isotope signatures. Consequently, it remains uncertain to what extent sedimentary Cd-isotope records accurately reflect processes occurring in the overlying water column under such conditions.

Here, we present new Cd-isotope measurements from both the water column and sediments of Framvaren Fjord in Norway, the most strongly reducing modern marine basin. Framvaren Fjord provides a modern analogue for the intensely euxinic conditions that characterised parts of the ocean during past extreme climate events. Importantly, the redox boundary between oxic and anoxic waters lies within the photic zone, close to the depth of peak biological productivity. We observe Cd-isotope variations across the redox zone, which reflect various processes including biological uptake and Cd sulphide formation. The data also enable us to assess how these signals are transferred to and preserved in the sediment record.