

Biogeochemical cycling of the uranium, iron and cadmium isotope systems during oceanic anoxia: A case study of the Black Sea

J. M. ROLISON¹, C. H. STIRLING¹, E. GEORGE¹,
R. MIDDAG¹, M. GAULT-RINGOLD^{1,3},
M. J. A. RIJKENBERG² AND H. J. W. DE BAAR²

¹Department of Chemistry, University of Otago, Dunedin, New Zealand, cstirling@chemistry.otago.ac.nz

²Royal Netherlands Institute for Sea Research, Den Burg, The Netherlands

³ACE CRC, University of Tasmania, Hobart, Australia

Trace metals play many important roles in the biogeochemistry of the oceans, but their distributions are significantly influenced by the concentration of dissolved oxygen. Crucially, future climate system projections imply significant increases in the size of oxygen depleted zones (ODZs) in the oceans due to global warming. Therefore, it is desirable to understand the influence of expanding ODZs on the distributions of trace elements and their isotopes (TEIs). Furthermore, the utilization of TEIs as tracers of the redox conditions in the ancient oceans, especially under 'super-greenhouse' conditions, requires a firm understanding of the behaviour of trace metals in modern ODZs.

The Black Sea is the world's largest euxinic (anoxic and sulfidic) basin and it is therefore an ideal natural laboratory to study the reduction and oxidation reactions of trace metals. Deep water in the Black Sea is characterized by high hydrogen sulfide concentrations due to permanent anoxic conditions below the redox interface.

The GEOTRACES (GA04N) expedition to the Mediterranean and Black Seas in 2013 provided an opportunity to examine the biogeochemical cycling of a suite of trace elements under low- and zero-oxygen conditions. Using multiple-collector inductively coupled plasma mass spectrometry (MC-ICPMS) combined with double spiking techniques, we report the isotopic composition of U, Fe and Cd for the entire water column and underlying sediments of the Black Sea across oxic-anoxic-euxinic transitions. These data are also interpreted in the context of the dissolved concentration gradients of a suite of other redox-sensitive and particle-reactive trace elements (Al, Sc, Ti, V, Mn, Fe, Ni, Zn, Ga, Y, Zr, Cd, La, and Pb) across the redox transition zone. These new data will help elucidate the mechanisms driving the uptake and removal of redox-sensitive metals from the dissolved phase and their export to the solid phase across a gradation of changing redox settings from oxic to anoxic and ultimately euxinic.