Chromium biogeochemistry and stable isotope distribution in the Southern Ocean

J. RICKLI[1,2], D. J. JANSSEN[1], C. HASSLER[3], M. J. ELLWOOD[4] & S. L. JACCARD[1]

[1]University of Bern, Institute of Geological Sciences & Oeschger Center for Climate Change Research
[2]ETH Zurich, Institute of Geochemistry and Petrology
[3] University of Geneva, Department F.-A. Forel for Environmental and Aquatic Sciences
[4] Australian National University, Canberra, Research School of Earth Sciences

Despite the potential of stable Cr isotope compositions as a proxy to unravel past changes in oceanic redox conditions, a detailed understanding of the processes that govern its spatial distribution in the modern ocean are still lacking. Here, we report seawater Cr isotope compositions and concentrations from the uppermost 1000 m of the water column in the Southern Ocean. The survey includes a cross-frontal transect from Tasmania to Antarctica, sites near the Antarctic ice-edge and in the vicinity of the Balleny Islands, as well as sites in the Drake Passage.

Although a coastal influence is clearly visible in other parameters at the stations neighbouring the Balleny Islands, close to the Mertz Glacier and adjacent to the western Antarctic Peninsula, seawater $\delta^{53}Cr$ and Cr concentrations remain largely unaffected. As at the coastal sites, Cr removal and isotopic shifts are minimal in Antarctic and Subantarctic Surface Waters of the open ocean. Biological uptake of Cr, or scavenging of Cr onto sinking particles, is insufficient to induce substantial water column variability in this environment characterised by strong vertical mixing. Contrasting with the subdued variations in $\delta^{53}Cr$ and Cr concentrations at each site, there are systematic meridional changes in $\delta^{53}Cr$ and Cr from the Subantarctic across the Polar Frontal into the Antarctic Zone. The spatial pattern is consistent with the mixing of Southern Ocean sourced Cr with an isotopically heavier Cr pool at the level of Subantarctic Mode Water and at shallower depth. The heavy signature of the northerly Cr pool could either result from Cr cycling in the Subtropical Gyre or originate in oxygen minimum zones.

Southern Ocean data support previous work demonstrating a consistent relationship between seawater Cr concentrations and $\delta^{53}Cr$ globally. The processes that drive this relationship are not fully constrained to date.