Biological control of $\delta^{53}Cr$ in the surface ocean

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In natural waters, Cr exists primarily as the particle-reactive Cr(III) and the relatively inert Cr(VI) species, with reduction of Cr(VI) accompanied by isotope fractionation. Due to redox control of Cr concentrations and stable isotope composition ($\delta^{53}Cr$), $\delta^{53}Cr$ has been employed as a powerful paleoproxy for the oxygenation of the early earth[1]. However, in the modern oxic ocean, the processes governing Cr distributions are less well constrained. We present total dissolved Cr and Cr(III) concentrations ([Cr], [Cr(III)]), $\delta^{53}Cr$ and net community productivity from the North Pacific, highlighting a biological role in the oceanic distribution of Cr. Productive surface waters are enriched in Cr(III) and are isotopically light, while lower levels of Cr(III) are found in isotopically heavy oligotrophic waters. This suggests a connection between removal of Cr(III) and enrichment in heavy isotopes in the residual dissolved pool, a process for which we calculate a similar isotopic offset as observed for the global [Cr] and $\delta^{53}Cr$ relationship[2]. Surface waters show a depletion in [Cr] relative to deeper water, which can be explained by export of Cr with biogenic carbon. These data demonstrate a link between carbon export, [Cr] and $\delta^{53}Cr$ in the global ocean. Consequently, $\delta^{53}Cr$ may serve as a paleoceanographic proxy for biological productivity in the oxic ocean, and the primary control of $\delta^{53}Cr$ in the ocean's more recent past may be biological productivity rather than oxygen availability.

[1] Frei et al. (2009) *Nature* **461**, 250-253. [2] Scheiderich et al. (2015) *EPSL* **423**, 87-97.