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Influences of environmental conditions on Cd isotope fractionation by phytoplankton uptake: implications for marine biogeochemical cycling of Cd isotopes

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The biogeochemical cycling of cadmium (Cd) and its isotopes provides vital information for oceanic biological productivity because of the significant Cd isotope fractionation in the surface seawater induced by phytoplankton uptake[1]. Although the variations in Cd isotope fractionation induced by phytoplankton uptake under changing marine conditions have been reported, evidence from laboratory phytoplankton culture is lacking[1, 2].

In this study, the diatom, *Thalassiosira weissflogii*, was cultured under different initial Cd concentrations, temperatures, biomass, salinity and pH levels to systematically investigate both the direction and magnitude of Cd isotope fractionation driven by phytoplankton. The results show that $\triangle^{114/110}Cd_{diatom\text{-}initial\ solution}$ = -0.296 ± 0.069‰ to -0.823 ± 0.030‰ and $\triangle^{114/110}Cd_{cultured\ solution\text{-}initial\ solution}$ = -0.020 ± 0.051‰ to 0.309 ± 0.094‰. It reveals that lighter Cd isotopes are preferentially taken up by diatom, resulting in heavier residual Cd isotopes in the cultured solution. Except the salinity, other environmental conditions all exert influences on Cd isotope fractionation induced by diatom uptake. A larger extent of Cd isotope fractionation between the cultured solution and diatom is presented at higher percentages of uptake Cd.

With the decrease in initial Cd concentration or increase in biomass, an increasing enrichment in heavier Cd isotopes in the cultured solution is observed (Fig. 1). It provides vital experimental evidence for similar variations reported in the Southern Ocean and suggests that heavier Cd isotope signatures occurring at lower Cd concentrations and/or higher biomass levels probably result from increased Cd utilization by phytoplankton[1].

Cd isotope compositions of the cultured solution become heavier as the temperature rises (Fig. 2). This observation offers experimental insights into the constraint of temperature on biological Cd isotope fractionation reported in the Northwestern Pacific Ocean[2]. These findings help to understand the biogeochemical cycling of Cd in the oceans.

[1] Abouchami, Galer, de Baar, Alderkamp, Middag, Lann, Feldmann & Andreae (2011), *Earth and Planetary Science Letters* 305, 83-91.

[2] Yang, Zhang, Sohrin & Ho (2018), *Geochimica et Cosmochimica Acta* 233, 66-80.