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Using silicon isotopes in oceanography: What can we learn from a high-resolution transect in the Southern Ocean?

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The isotopic composition of silicic acid and biogenic Si along the WOCE SR3 transect (142-144˚E; spring 2001) was analysed by MC-ICP-MS, following Cardinal et al. (2003). We sampled the Subantarctic Zone (SAZ), the Subantarctic Front (SAF), the Polar Front Zone (PFZ), the Interpolar Front Zone (IPFZ), the southern Antarctic Zone (AZ-S) and the Seasonal Ice Zone (SIZ). More than 90 seawater samples from the whole water column, including silicic acid depleted surface waters, were analysed (Cardinal et al., 2005). Furthermore, for the area between the PFZ to the SIZ we also acquired the isotopic composition of 30 surface size fractionated biogenic Si samples ($>$0.4μm, 20-70μm and $>$70μm).

No systematic isotopic fractionation was observed related to size fraction, giving confidence in the proxy. Biogenic Si, surface, and mesopelagic waters, display a clear latitudinal gradient of isotopic compositions becoming lighter southward of the PFZ. This gradient is much steeper for biogenic Si (0.8 p.mil variation in d29Si) than for silicic acid (0.2 p.mil). In the SAZ, surface and mesopelagic waters do not exhibit a heavier isotopic composition than in the PFZ-IPFZ, in contrast to what was expected from a global modelling study (Wischmeyer et al., 2003). By taking into account these latitudinal changes, and by applying a simple multi-box open system model we estimate a fractionation factor, which differs from a previous estimate for the Southern

Ocean (Varela et al., 2004), but is well in accordance with the one reported for cultured tropical diatoms (De La Rocha et al., 1997). Only the southernmost station in the SIZ behaved differently and it is suspected that release of sea ice diatoms might have disturbed the isotopic signal.

Silicic acid isotopic signatures in the deep-water column are generally homogeneous, except at the southernmost station where the imprint of newly formed Antarctic Bottom Water, off Adelie Land, is recorded.

Overall, our results reflect latitudinal variability in mesopelagic signatures, surface ocean complexity of the isotopic composition vs. concentration relationship for silicic acid and some differences with earlier studies. This underlines the use of caution when applying the silicon isotope proxy tool in paleoceanographic studies and stresses the need for further systematic efforts to better understand the modern variations in Si-isotopic compositions.

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