Coupling between the Silicon Cycle and the Oxygen Minimum Zone off Peru: Insights from Silicon Isotopes

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The upwelling area off Peru is characterized by exceptionally high rates of primary productivity, dominated by diatoms, which require silicic acid [DSi] to build up their valves. Therefore the marine silicon (Si) cycle in this region is closely linked to the carbon (C) cycle and exerts a strong control on C export from the atmosphere, directly impacting climate in the present as well as in the past.

Silicon isotopes (δ^{30}Si) have proven to be a powerful tool to better understand the Si cycle, as the silicon isotope composition of seawater (δ^{30}DSi) carries information about [DSi] utilization in surface waters, subsequent dissolution of sinking biogenic material as well as water mass mixing.

Here we present a comprehensive data set for [DSi] and δ^{30}DSi recovered in the Eastern Equatorial Pacific (EEP), where one of the globally largest Oxygen Minimum Zones (OMZs) is located. The samples were obtained during cruises with R/V Meteor in 2008/2009, 2012 and 20016 during austral summer to identify sources and sinks in this region and discuss the spatial and temporal variability of [DSi]. Surface waters show a broad range in δ^{30}DSi (+1.7 ‰ to +4.4 ‰) directly reflecting upwelling intensity, horizontal mixing by eddies as well as [DSi] utilization. Below the upper oxycline, subsurface [DSi] strongly increases coupled to the release of light δ^{30}DSi. Samples within the coastal OMZ with oxygen concentrations below 5 µmol/kg are charcaterized by δ^{30}DSi ranging between +1.1 ‰ and +1.5 ‰, which mainly reflects the dissolution of diatoms from the Mixed layer and admixture with [DSi] from benthic fluxes with lighter δ^{30}DSi. Our δ^{30}DSi data and model results imply that anoxic marine sediments, characterized by high [DSi] fluxes are an important source for isotopically light δ^{30}DSi (+0.8 ‰).

The comprehensive data set of [DSi] and δ^{30}DSi sampled during several expeditions with different prevailing upwelling intensities, shows a strong coupling between the Si Cycle and the extent and intensity of the OMZ in the coastal upwelling region off Peru.