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Silicon and Nitrogen Cycling in the Upwelling Area off Peru: A Dual Isotope Approach

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The tropical Oxygen Minimum Zones (OMZs) are key regions of very low oxygen in today's ocean. Recent investigations have shown that the oxygen content of the global ocean is decreasing and OMZs are expanding, and the future ocean may experience significant shifts in nutrient cycling, strongly affecting the biological productivity in surface waters. Besides phosphate (PO4) and nitrate (NO3-), silicate (SiOH4) is the main nutrient in coastal upwelling systems driving the primary productivity. A change in the availability of these nutrients induced by changing oxygen concentrations and/or circulation can therefore either enhance or diminish productivity. How actively changes in ocean circulation can affect primary productivity is documented during intense El Niño events when weak upwelling leads to reduced primary productivity.

Over a time period of nearly ten years, we intensively studied the Si and N cycle in the upwelling area off Peru. To improve our understanding of their biogeochemical cycling in the present as well as in the past, we used stable Silicon (Si) and N isotopes in seawater (δ30dSi, δ15N) as well as particulate material (δ30bSi, δ15PON). We observed a tight coupling between the Si and nitrogen N cycle. During strong upwelling waters on the shelf showed high Si(OH)4 concentrations accompanied by diminished NO3- concentrations as a consequence of intense remineralization of bSi, high Si fluxes from the shelf sediments, and N-loss processes such as anammox/denitrification within the OMZ. In contrast, week upwelling and a deepening of the thermocline leads to diminished Si(OH)4 concentrations in surface waters. The shift in N:Si ratios was reflected by the stable isotopes and exert significant control on the phytoplankton communities. The combined approach of Si and N isotope data, as well as the comparison with core-top sediment data, helped to significantly improve our understanding of paleo records in upwelling areas.

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