Bioavailable iron in the Southern Ocean

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Abstract

Biological export of carbon lowers surface ocean carbon dioxide levels, resulting in a net uptake from the atmosphere that influences Earth's climate. Phytoplankton fix carbon via photosynthesize in the presence of light and critical nutrients, such as nitrogen, phosphorus, silicon and iron. Iron is an essential nutrient for many enzymatic pathways, with nitrogen fixation, photosynthesis and respiration among the most critical; however, Fe is a scarce micronutrient in the modern open ocean because of its insolubility under oxic conditions. The Southern Ocean provides a critical link in large-scale ocean circulation, heat transport, deep-water ventilation and carbon and nutrient cycling. A complex interplay of physical, biological and biogeochemical processes makes the Southern Ocean accountable for more than 40% of the global anthropogenic CO_2 uptake today. Iron, an essential micronutrient for primary producers, has a strong hold on Earth's carbon cycle through its fertilizing effect on global marine ecosystems. Using cores from ODP Leg 177, we reconstructed Fe reactivity delivered to the Southern Ocean using a state-of-the-art extraction scheme to determine the concentration of Fe that was actually available for primary production during the Cenozoic and upper Cretaceous. Our data capture changes in distributions of total Fe (FeT) and bioavailable Fe (FeHR) over glacial-interglacial intervals. At our site, there are only small variations in dust flux over those times scales and continental dust inputs from the Patagonian region seem unlikely to be responsible for observed Fe fluctuations. Further, barium data used to reconstruct paleoproductivity show no significant down-core variation. Previous studies, typically lacking detailed Fe speciation, claim increased iron supply during glacial periods linked to greater aeolian dust fluxes, with the net effect of increased primary productivity. Our data from Leg 177 are not consistent with these conclusions. Thus, further studies are needed to unravel the Fe cycle and inferred atmospheric inputs to the Southern Oceans, and that future research should include mineralogical considerations of the Fe present.

Keywords: Southern Ocean, Iron, Carbon Cycle

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