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Fe(II) as an integral component of the iron cycle in oxygen minimum zones

Iron (Fe) is an essential nutrient for all known life. Its low concentration in seawater limits primary production across much of the ocean surface, including most of the eastern tropical South Pacific. For the biological component of deoxygenation to continue to fuel the expansion of the ocean's oxygen minimum zones (OMZs), shelf supplied Fe must be advected laterally offshore and continue to facilitate primary production at the surface. A key uncertainty in our modelling of future OMZ changes is how this lateral Fe supply changes in response to intensifying deoxygenation over shelf regions.

Fe is a conceptually difficult nutrient to model because of the rapid scavenging that follows any Fe addition to seawater and because of its diverse speciation. Dissolved Fe, the main bioavailable fraction in seawater, is normally defined as consisting entirely of Fe(III)-organic ligand species. Despite the validity of this assumption across most of the ocean by volume, this assumption is invalid in the surface ocean due to the presence of dissolved Fe(II) as a result of photochemical process and in OMZs due to the pronounced release of benthic Fe(II) into the water column. Fe(II) is a highly labile form of dissolved Fe and formation of Fe(II) thus expands the bioavailable Fe pool. Resolving the separate biogeochemistry of Fe(II)/Fe(III) within regions affected by OMZs is critical to understanding how Fe sources and sinks, and thus Fe bioavailability in both shelf and offshore regions, will change in response to shelf deoxygenation.

Here we report the concentration of Fe(II) along the Namibian (November/December 2015) and Peruvian (October 2015 and April 2016) shelves, both regions occupied by pronounced OMZs. In both regions a strong benthic and a weaker photochemical source of Fe(II) was evident. Both vertical profiles of Fe(II) and spiked pelagic incubation experiments under low O₂ conditions (1-20 μM) suggested that the dominant removal process of Fe(II) was not oxidation by dissolved O₂. We therefore explore alternative hypothesis concerning the fate of Fe(II) within OMZ regions and the significance of these removal processes for the relationship between intensification of deoxygenation on the shelf and lateral supply of Fe offshore.

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