Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19666

The response of N_2 fixation to deglacial changes in shelf nitrogen loss along the western Pacific margin

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The tropical and subtropical western Pacific is bounded by broad and shallow continental shelves, where marine fixed nitrogen is removed by benthic denitrification. Past changes in sea level may drive significant changes in the rate of benthic denitrification, implying a strong compensation by marine N_2 fixation to stabilize the balance of marine N inventory in ocean margin regions and the global ocean. A published record using the foraminifera-bound $d^{15}N$ (FB-$d^{15}N$) in the South China Sea suggests that losses of N in the margins are compensated by N_2 fixation on glacial/interglacial time scales. However, the South China Sea might represent a special case, being particularly strongly influenced by the extensive marginal shelves that surround it. Here, we present two new foraminifera-bound $d^{15}N$ records from the Western Pacific, including the Okinawa Trough at the eastern boundary of the East China Sea and in Kuroshio Current of the open North Pacific Subtropical Gyre. The $d^{15}N$ changes in the Okinawa Trough shows a glacial-to-interglacial $d^{15}N$ decline that closely resembles the $d^{15}N$ decline in the South China Sea. This similarity argues that N_2fixation throughout the region responded to a sea level-paced deglacial increase N loss along the tropical east Asian margin. In contrast, FB-$d^{15}N$ from the North Pacific Subtropical Gyre is consistently low and largely invariant over the last 30,000 years, suggesting that N_2 fixation activity has remained relatively constant within the gyre. Taken together, these records suggest that the east Asian shelf sedimentary denitrification changes elicit a N_2 fixation in the near-margin waters that fully compensates for the shelf N loss. As a result, no excess P (N deficit) is available to be mixed laterally into the surface waters of the Kuroshio Current or the North Pacific Subtropical Gyre that it bounds. Such strong local compensation of N_2 fixation for denitrification-driven N loss implies that the western North Pacific's N:P ratio will be stable over time.