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Seasonal variations in nitrogen isotopic composition from Okinotori coral in the tropical Western Pacific: A new proxy for marine nitrate dynamics

Atsuko Yamazaki (1), Tsuyoshi Watanabe (1), Nanako Ogawa (2), Naohiko Ohkouchi (2), Kotaro Shirai (3), Mitsuhiro Toratani (4), and Mitsuo Uematsu (5)

(1) Graduate school of science, Hokkaido University, Sapporo, Japan (zaki@mail.sci.hokudai.ac.jp), (2) Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan, (3) Graduate school of science, The University of Tokyo, Tokyo, Japan, (4) School of High-Technology for Human Welfare, Tokai University, Numazu, Japan , (5) Ocean Research Institute, The University of Tokyo, Tokyo, Japan

Coral skeleton could be a high resolution recorder of past nutrient dynamics in open ocean with decades to millennia time scales. Nitrogen isotope of organic matter in the coral skeleton could vary with that of nitrogenous sources, and it has a potential to record nitrogen isotopes in marine nitrate continuously. We determined the nitrogen isotopic composition of *Porites lobata* coral collected from Okinotori Island, south western Japan, to demonstrate the utility of coral skeletons as a recorder of nitrate dynamics in the surface ocean.

Okinotori island is isolated in tropical western pacific and far from any terrestrial sources. Surface nutrient concentrations are therefore determined by vertical mixing, upwelling, nitrogen fixation, and atmospheric dust deposition. Nitrogen isotopic compositions in Okinotori coral were determined at 800 μm intervals ($\sim$1 month resolution) along growth direction and compared with skeletal carbon isotopic composition, barium/calcium ratios (Ba/Ca), and Chlorophyll-a concentration (Chl-a), respectively.

Nitrogen isotopes varied between +0.8 and +8.3‰ and oscillated with sea surface temperature (SST); higher nitrogen isotope (+5‰ $\sim$) in lower SST period and vice versa. Skeletal Ba/Ca, the proxy of upwelling, and Chl-a were also high during low SST season. These results suggested that vertical mixing supplied nitrate from deeper layer (+5$\sim$+6‰) into sea surface during low SST. The largest nitrogen isotope value of +8.3‰ was caused by ; 1) isotopic fractionation by phytoplankton in euphotic zone, 2) denitrification in oxygen depleted water, or 3) trophic δ^{15}N enrichment in coral feeding. Any of these possible events mean that primary production was enhanced. Coral Ba/Ca also had sharp positive peaks in transient typhoon upwelling. The typhoons formed in equator area often come across Okinotori Island toward East Asia and trigger upwelling. Variation of nitrogen isotope in coral could not detect this events, however, coral nitrogen isotopic values were extremely low (+0.8$\sim$+2.0‰) after four months from last typhoon even in low SST season. Nitrogen fixation at sea surface and coral symbionts occurred in non typhoon season, which decreased nitrogen isotopes in coral. Nitrogen isotope value of fixed N_2 is close to atmospheric N_2 (0‰). Coral carbon isotopes synchronized with nitrogen isotopic variation, suggesting that nitrate concentration in surface water could control zooxanthellae photosynthesis. Nutrient supply enhanced coral symbiont photosynthesis with increasing nitrogen assimilation.

Our results suggested that nitrogen isotope in coral skeletons was a potentially useful proxy for marine nitrate dynamics such as the transport to the surface ocean and estimation of nitrate origins in the tropical and subtropical oceans.