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Nitrogen isotope of coral skeletons: A new proxy for nitrogenous nutrients in subtropical and tropical ocean

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Coral skeleton could be a high resolution recorder of past nutrient dynamics in tropical and subtropical ocean with decades to millennia time scales. Nitrogen isotope of organic matter in the coral skeleton could vary with that of nitrogenous sources and be a potential to capture nitrogen isotope changes in marine nitrate. However, nitrogen isotope of coral skeletons had problems to be a paleoenvironmental proxy. Reef corals uptake various nitrogen compounds such as (1) dissolved inorganic nitrogen (DIN) assimilated by zooxanthellae, (2) coral consumption of particle and dissolved organic nitrogen (PON, DON), and (3) nitrogen fixation of symbiotic cyanobacteria. In this study, we developed a new method for coral nitrogen isotope analysis and demonstrated which nitrogen sources controlled nitrogen isotope in coral skeletons. For nitrogen isotope analysis of coral skeletons, each 28 mg powder samples were decalcified. Then, all of organic matter in coral skeleton resolved to nitrate and converted into nitrous oxide to introduce into continuous-flow isotope ratio mass spectrometry. The standard deviation of sample measurements was less than 0.2 permil (1sigma). We compared distribution of coral nitrogen isotope with that of nitrate nitrogen isotope in Shiraho coral reef, Ishigaki Island. We sampled the coral cores from five coral colonies distributed from the mouth of Todoroki River that flow into the coral reef to the reef edge. Seawater samples for nitrate were taken at 50 m intervals along the parallel line of coral sampling. Distribution of coral nitrogen isotope was decreasing from +8.6 permil to +3.0 permil toward off-shore. Nitrogen isotope of nitrate was also decrease from +9.0 permil at river mouth to +2.3 permil at reef edge, which showed similar trends with coral nitrogen isotope. Nitrogen isotope of nitrate near the river mouth was originated from nitrate in river water (nitrogen isotope: +8.2 permil). This result suggested that nitrogen source for reef corals was mainly DIN in reef water, and coral skeleton recorded nitrogen isotope of nitrate. Time series of coral nitrogen isotope has a possibility to reconstruct seasonal to interannual variations of nitrate sources to coral reef such as land-derived nitrogen, nitrogen fixation, and upwelled nitrate. In this presentation, we also introduce application examples of a nitrogen isotope proxy to corals alive in coastal reef and open ocean.

Keywords: coral skeleton, nitrogen isotope, nitrate, terrestrial input, nitrogen fixation, upwelling