Reconstruction of anthropogenic carbon dioxide uptake on the Kuroshio region using carbon isotopes of coral skeletons

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The Kuroshio Current and its extension are the sinks for carbon dioxide in the North Pacific, cooled by the northward flow of water masses with low carbon dioxide partial pressures. The release of carbon dioxide with low carbon isotope ratios from fossil fuels has reduced the carbon isotope ratios of DIC in seawater (Suess effect), and carbon isotope ratios of skeletons of reef corals and sclerosponges have been used to capture changes in the ocean uptake of anthropogenic carbon dioxide into the ocean.
The Kuroshio Current in the North Pacific and the Gulf Stream in the North Atlantic have been reported to be associated with nutrient streams (high nutrient zones). In Yamazaki et al. (2016), the nitrogen isotope ratios of organic matter in the reef coral skeletons were used to reconstruct Kuroshio current volume over the past 150 years. The nitrogen isotope ratios in coral skeletons changed with the current volume, mixing nitrate up by the turbulence generated at the northern margin of the Kuroshio Current. In this study, the same coral cores are used to analyze carbon isotope ratios of the carbonate skeleton, with the aim of determining the evolution of carbon dioxide uptake in the Kuroshio region.
The annual bands in the coral cores were observed by soft X-ray imaging. The powder samples were collected by cutting along the maximum growth axis at 0.2 mm intervals using a micro-drill. The powder samples were analyzed for oxygen and carbon isotope ratios using a stable isotope ratio mass spectrometer connected to the carbonate device. The seasonal variations in oxygen isotope ratios and annual bands determined the chronology of coral cores.
The carbon isotope variations in coral skeletons from Tatsukushi Bay were obtained over the past 70 years. The carbon isotopes in coral skeletons decreased by -0.5‰ from the late 1920s to the early 2000s due to the Suess effect. The amplitude of carbon isotope ratios varied significantly on a multi-decadal scale. The interannual variation of nitrogen isotopes suggests that the Kuroshio volume fluctuates on an approximately 25-year cycle and that carbon dioxide uptake may oscillate with the Kuroshio volume similarly. Comparison of the interannual variation of nitrogen isotopes with the anomaly variation of carbon isotopes, which removes the Suess effect, shows that carbon isotopes tend to decrease when the Kuroshio volume increases. This suggests that sub-surface water is supplied when Kuroshio volume increases and that nutrient supply and carbon dioxide absorption may occur simultaneously.

Keywords: Coral skeletons, Kuroshio, carbon isotopes, nitrogen isotopes, CO2 sink

