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BBG020-P01 Room:Convention Hall Time:May 24 14:00-16:30

Tropical Northwest Pacific pH Variability Inferred from Boron Isotope Composition in Annually-banded Coral Skeleton

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Ocean acidification has been accelerated due to adsorption of increasing anthropogenic carbon dioxide emissions from the atmosphere since the Industrial Revolution [Intergovernmental Panel on Climate Change, 2007], probably causing a serious decrease in surface ocean pH in the future [Zeebe et al., 2008 Science]. This issue may bring critical threat to calcifying organisms and coral reef ecosystems [e.g., Orr et al., 2005 Nature]. Our current knowledge of ocean acidification is mainly the result of model simulation studies [e.g., Cao and Caldeira, 2008 Geophys. Res. Lett.]. In the Pacific Ocean, a continuous observation of sea surface pH has been conducted only at the offshore site of Hawaii (Hawaii Ocean Time-series: HOT), which shows a decrease trend of seawater pH during the last 2 decades, in accordance with an increase in surface water partial pressure of carbon dioxide followed by the atmospheric carbon dioxide rise [Takahashi et al., 2006 J. Geophys. Res.]. However, the actual long-term trend and variability of seawater pH for the last several centuries remains unknown.

Massive Porites sp. corals, one of the most informative archive for past ocean environments, precipitate annually-banded aragonite skeletons and grow rapidly, which can allow accurate chronological control and high-resolution sampling. Due to isotopic fractionation between the two dominant boron species in seawater, boron isotopic systematics in marine carbonates provides a potential proxy for pH of ancient oceans [e.g., Hemming and Hanson, 1992 Geochim. Cosmochim. Acta]. Up to now, there are a few studies conducting reconstruction of seawater pH using boron isotopic composition of modern and fossil corals. Only the two previous studies [Pelejero et al., 2005 Science; Wei et al., 2009 Geochim. Cosmochim. Acta] reported boron isotope composition time series of long-lived Porites corals from the Great Barrier Reef that showed significant paleo-pH variability at sea surface in the southwestern Pacific Ocean for the last 300 years. Nevertheless, unlike seawater temperature and salinity records, no coral-based reconstruction of long-term pH variability in the North Pacific Ocean has been reported yet. To better understand natural variability of the ocean pH and predict its future trend more accurately, long time series of pH proxy records during periods before the instrumental data accumulation are needed.

Here, we present annually resolved boron isotope composition time series of a modern Porites coral from Guam and reconstruct interannual variability and trend of sea surface water pH in the tropical northwest Pacific Ocean since 1940. The pattern of reconstructed time series for Guam coral is significantly different from those reconstructed from the Great Barrier Reef corals, which appears to reflect regional variability on response to ocean acidification together with the El Nino events-associated fluctuation.

Keywords: coral skeleton, boron isotope composition, pH, ocean acidification, tropical North Pacific Ocean

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Monitoring, assessment and impacts of the seasonal and spatial sedimentation patterns/rates around coral reef ecosystems

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Seasonal and spatial patterns and rates of sedimentation; total mass flux, sediment types, size grades, physical and chemical characteristics (total/organic carbon, total nitrogen and carbonate) contents, have been monthly monitored around the coral reefs of southern Japan Marine Park Areas (MPAs), using sediment traps deployed in the ocean bottom around coral reefs in the coral moat and reef slope in the MPAs of the Ryukyu islands (Ishigaki, Iriomote, Kohama and kuro) during a one year monitoring project. The traps monthly retrieved and analyzed for their sedimentation rates, size grades, physical and chemical characteristics.

The total mass flux ranged between 0.54 to 872 gm-2d-1, and showed a pronounced seasonality (high in summer-autumn and low in spring) at each site, which was consistent with the rainfall and typhoon regime. On the reef flat (Todoroki South and North; Ishigaki), values obtained in July-August (872 gm-2d-1) and August-September (800 gm-2d-1) indicate the high terrestrial discharge from Todoroki River. The size distribution of trapped sediments revealed mostly uni-modal fine sand to mud in the reef flat and gravelly to coarse sand in the reef slope. Trapped sediment particles consist of CaCO3 (1.2-27.1%) and a non-carbonate fraction (98.8-72.9%), which contains total carbon (4.9-26%), carbonate carbon (CO2-C) (0.2-3.1%) and non-carbonate carbon (NC-C) (7.9-25.6%). Total nitrogen content was in the range 0.02-0.48%. TN is contained mainly in the carbonate fraction and NC-C may be contained in the non-carbonate fraction. The low TN/OC ratio of the trapped sediments suggests that they were mostly of terrestrial origin and that both fractions migrated. The high total mass flux derived from Todoroki River exceeded the threshold at which a lethal effect on coral community is caused (Ismail et al., 2005).

Mass mortality of some coral species was markedly recorded around Todoroki River mouth in the moat area. Mortality percentages were estimated along transect lines in the study area using scuba diving and manta tow technique, then plotted on satellite images. The coral mortality correlated with the measured sea water physical, chemical and oceanographic characteristics as well as the prevailed measured meteorological parameters during the course of study. Using time series analysis techniques, the results showed a strong correlation of the coral mortality with the prevailed high sedimentation rates, turbidity, low tide, rainfall, and high water temperature. The study revealed the importance and the role of using sediment traps in the monitoring around the coral reef ecosystems health, reef management and conservation.

Keywords: Monitoring, assessment, impacts, sedimentation, coral reefs, southern Japan