Reconstruction of paleoceanography during mid to late Holocene recorded in fossil corals in Kikai Islands

Yuta Kawakubo[1]; Yusuke Yokoyama[2]; Atsushi Suzuki[3]; Mayuri Inoue[4]; Hiroyuki Matsuzaki[5]; Mamito Koizumi[6]; hodaka kawahata[7]

[1] Earth Science, Tokyo Univ.; [2] ORI, Univ. Tokyo; [3] GSJ/AIST; [4] ORI; [5] MALT, Univ.Tokyo; [6] EPS,Tokyo Univ.; [7] GFS and ORI, U of Tokyo

North Western Pacific is an important area to understand East Asian monsoon (EAM), which is linked to the global climate variability during the Holocene. However, reconstructions of past changes in seasonality of climate have not yet sufficiently conducted. As an archive of paleoclimate, fossil corals are suitable for this purpose because they have potential for recording seasonal variations of climate. Samples for this study were massive fossil Porites corals collected from Kikai Island, the Ryukyu Islands, Japan. Its present climate is mainly affected by EAM, together with Kuroshio Current (KC), which has high sea surface temperature (SST) and sea surface salinity (SSS). The purpose of this study is to clarify paleo-ocean environment by reconstructing paleo-SST and SSS from fossil corals and discuss EAM and KC variability during mid to late Holocene.

First, X-ray diffraction analysis was conducted on fossil corals to determine the degree of diagenetic alteration. Only samples that contained no secondary calcite were used for 14C dating and isotope analysis. The 14C ages were measured by a tandem AMS at the Micro Analysis Laboratory Tandem Accelerator (MALT), The University of Tokyo. In this study, five 14C age-dated samples (3063,3824,4200,4382,4613 cal year BP) were used for analyzing chemical compositions. Skeletal oxygen isotope ratio d18O) was analyzed by an automated carbonate device (Multiprep, Micromass Co. Ltd.) coupled with a Micromass Optima mass spectrometer. Trace elements (Ca, Sr, Mg, U, Ba) in coral skeleton were analyzed by an Inductively Coupled Plasma Mass Spectrometer (ICP-MS; Hewlett Packard, HP-4500) at the National Institute of Advanced Industrial Science and Technology (AIST).

Coral skeletal d18O is controlled by SST and d18O in ambient seawater. Surface water d18O is mainly controlled by evaporation-to-precipitation ratio, which relates to SSS, since eustatic sea level was almost stable during the Holocene. It is widely known that Sr/Ca ratio of coral skeletons is mainly controlled by SST. So, by subtracting the SST contribution to d18O of fossil corals, as estimated from coral Sr/Ca ratio, one can obtain d18O of surface water and then convert them to paleo-SSS changes. We reconstructed paleo-SST and SSS during the Holocene in Kikai Island by using the equations proposed by Morimoto et al. (2007). The SST inferred from 4613 cal year BP coral was only higher than that of present and SSTs from other fossil corals (3063, 3824, 4200, 4382B cal year BP) were lower than present So, supposing that SST around Kikai Island has been an indicator of the strength of KC during the Holocene, KC appeared to be weaker than the present. This result is consistent with a previous report that KC shapely weakened at 4.6 ka (Jian et al., 2000). Weakening of KC should have produced low salinity. But, fossil corals from Kikai Island showed a different result. Estimated SSS during the Holocene was constantly higher than that of the present, suggesting that SSS may have been controlled by other factors than KC and presumably the EAM is a dominant factor. The EAM was intensified due to greater summer insolation during mid Holocene than at present (Dykoski et al., 2005). In summer, intensified EAM resulted in a higher evaporation-to-precipitation ratio over the grater precipitation over the East Asian continent. On the other hand, the intensified EAM transfers a cold and dry wind to the East China Sea (ECS) from the Siberian High in winter. As a result, annual evaporation from the ECS was strengthened. Consequently, the higher salinity observed around Kikai Island can be concluded as a result from intensified EAM during the mid Holocene.