Summary of Doctoral Dissertation

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Title of Doctoral Dissertation

The 80 years geochemical records in Porites coral from Con Dao island, Viet Nam as an indicator for Mekong river discharge and monsoon climate variability
（ベトナム Con Dao 島のハマサンゴ骨格の地球化学指標に記録される過去 80 年間のメコン川の流出とモンスーン気候の変動）

The Mekong River is one of the most important river systems in the world, politically, economically, and environmentally. It is originated from Tibetan Plateau, flow through six countries, China, Myanmar, Laos, Thailand, Cambodia, and Viet Nam before reaching to Mekong Delta in East Sea Viet Nam (ESVN). Mekong River and ESVN are strongly dominated by the seasonal reversing of East Asian Monsoon (EAM) which causes strong seasonal climatic variations. Instrumental records of past climate variations and paleoclimatic history of Mekong river are temporally short (20–30 years), and geographically constrained, limiting our ability to examine long-term climate fluctuations. In order to resolve and reconstruct past climate variations, EAM variabilities and Mekong River discharge, the geochemical records of marine carbonates such as scleractinian corals can be used. The coral cores were collected from the colony of Porites sp. alive at ~20m water depth on the southwest side of Con Dao island, south of ESVN and about 90 km distance from Mekong river mouth. We measured Sr/Ca and Ba/Ca ratios using inductively coupled plasma atomic emission spectrometry (ICP-AES) and oxygen and carbon stable isotope ratios using an automated carbonate preparation device (Kiel IV) coupled to stable isotope ratio mass spectrometer (Thermo scientific MAT 253) installed at Hokkaido University. All geochemical proxies were measured in monthly resolution during the period 1924 – 2005.

The results showed the high correlation between Sr/Ca and instrumental SST ($r = 0.90$; $P < 0.01$). The differences between the reconstructed and observed SSTs were 0.45, -0.89 and -0.33 °C for annual maximum, minimum and mean values, respectively. The reconstructed SST in period from 1924 to 2005 is quite stable and the standard deviation of residuals of the regression was determined to be 1.45 °C due to differences in ocean conditions and SST between observation site and sampling site. For determining ENSO variability and its impacts to ESVN, I compared between coral Sr/Ca and Nino 3.4 index. I found that coral Sr/Ca ratios from 1924 to 1990 showed significantly correlation with Nino 3.4 index with correlation coefficient $r = 0.516$ and $r = 0.725$ corresponding to winter and summer, respectively. This result suggested that interannual variability SST around Con Dao island is strongly influenced by ENSO. From 1990 to 2005, relationship between Nino 3.4 index and summer Sr/Ca are almost opposite due to influence of Mekong river discharge or the eruption of Mount Pinatubo, Philippines.

The time series of Ba/Ca is characterized with intra-annual double peaks, the first large one in March during the dry season and relatively small one in August during the wet season. Coral Ba/Ca record in Con Dao Island could reflect the sediment discharge from the Mekong River. The maximum discharge of freshwater from the river reached our coral site in summer (from May to November), however the sediment discharge model of the Mekong River indicated that the amount of suspended sediment influencing on Con Dao Island was high in winter (from December to April) because of the influence from the seasonal migration of the Asian monsoon and ocean currents. Coral Ba/Ca ratios can be used as reflection of the suspended sediment discharge from Mekong river in period 1924 to 2005 and divided into 3 stages: Before war (1924 to 1945), Indochina war (1946 to 1975) and After war and hydropower dams construction (1976 – 2005). The variability of Ba/Ca can be explained by human activities such as: land-use changes, hydropower dams construction and Indochina war.

On the other hand, coral Ba/Ca ratio and $\delta^{18}O_{sw}$ could be used as indicators of flooding from the Mekong Delta. During the period from 1980 to 2005, the difference in seasonal characteristics of geochemical signals in flood years and no-flood years was detected. During the flood years, in the warm/wet season, the Ba/Ca ratios and $\delta^{18}O_{sw}$ data significantly increased and decreased,

respectively. These results reflect the increase in the Mekong River freshwater discharge and the sudden increase of precipitation when floods occurred in warm/wet season. In period from 1980 to 2005, the averaged value of Ba/Ca ratios in summer months (May to November) of flood years was calculated as 3.6 µmol/mol. Based on this, 11 flood events can be detected by averaged value of Ba/Ca in summer months similar or higher than 3.6 µmol/mol in 1926, 1930, 1933, 1935, 1948, 1952, 1960, 1961, 1975, 1976, and 1978, especially expected big flood events in 1948 and 1960 with averaged Ba/Ca is 4.23 and 4.25 µmol/mol, respectively.

Ba/Ca ratios and δ18Osw recorded by Porites coral in Con Dao island can be used as proxy for northeast and southwest monsoon, respectively. δ18Osw showed a high correlation with δ18O in coral from Koshiki island which is also influenced by East Asian Monsoon. I found the significant correlation between δ18Osw and Pacific Decadal Oscillation (PDO) index, suggested that climate of ESVN was teleconnected with decadal variation of Pacific Ocean during the last 80 years. High correlation between summer δ18Osw and winter PDO index during 1924 to 1990 indicated that EASM may be a possible driving force of winter PDO variability. The no correlation between summer δ18Osw and winter PDO index from 1990 to 2005 corresponds with cooling event showed in the results of Sr/Ca variation.

In conlusion, the geochemical data from Porites coral of Con Dao island, Viet Nam provided a better understanding about interannual variability of sea surface conditions, Mekong river discharge and flood events determination during period from 1924 to 2005. Moreover, the interaction between ENSO and East Asian monsoon and their impacts to East sea Viet Nam were also clarified partly.