



Title	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 [an abstract of dissertation and a summary of dissertation review]
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Doctoral Dissertation Evaluation Review

Degree requested Doctor of Science Applicant's name Phan Thanh Tung

Examiner :

Chief examiner, Specially Appointed Professor Noriyuki Suzuki

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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)

Results of Evaluation of the Doctoral Dissertation (Report)

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. However, instrumental records of past climate variations and paleoclimatic history of Mekong river are still very limited.

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 could be used. A *Porites sp.* coral was collected on the southwest side of Con Dao island, southern of ESVN and about 90km distance from Mekong river mouth, at ~20m water depth. The Sr/Ca and Ba/Ca ratios using inductively coupled plasma atomic emission spectrometry (ICP-AES) and oxygen stable isotope ratios were analyzed by using an automated Kiel carbonate preparation device (Kiel IV) coupled to Finnigan MAT 253 at Hokkaido University. All geochemical proxies were measured in monthly resolution during the period between 1924 and 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.

Ba/Ca time series 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 $\delta^{18}\text{O}_{\text{sw}}$ 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 ratio and $\delta^{18}\text{O}_{\text{sw}}$ 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 $\mu\text{mol/mol}$. Based on this record, 11 flood events could be detected by averaged value of Ba/Ca in summer months similar or higher than 3.6 $\mu\text{mol/mol}$ in 1926, 1930, 1933, 1935, 1948, 1952, 1960, 1961, 1975, 1976, 1978, especially expected big flood events in 1948 and 1960 with averaged Ba/Ca is 4.23 and 4.25 $\mu\text{mol/mol}$, respectively.

Ba/Ca ratio and $\delta^{18}\text{O}_{\text{sw}}$ recorded by *Porites* coral in Con Dao island can be used as proxy for northeast monsoon and southwest monsoon, respectively. $\delta^{18}\text{O}_{\text{sw}}$ showed a high correlation with $\delta^{18}\text{O}$ in coral from Koshiki island used for revealing PDO variability, which is in same ocean conditions with Con Dao islands. I found the significant correlation between $\delta^{18}\text{O}_{\text{sw}}$ with PDO index, suggested that the PDO was teleconnected in the ESVN during the last 80 years. High correlation between summer $\delta^{18}\text{O}_{\text{sw}}$ and winter PDO index during 1924 to 1990 indicated that EASM may be a possible driving force of winter PDO variability in this region. The opposite between them from 1990 to 2005 corresponds with the difference between Con Dao island's coral Sr/Ca and Nino 3.4 index.

In conclusion, the results conducted by the author is important key to reconstruct the past changes of Mekong river and to understand its role on regional scale environmental changes in east Asian region with global climate change in the future. Therefore, we acknowledge that the author is qualified to be granted a Doctorate of Science from Hokkaido University.