Title of Project : **Reconstruction of atmospheric carbon dioxide concentration during the last 6 million years and the study of the interaction between atmospheric carbon dioxide and climate**

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【Purpose and Background of the Research】

Ice cores have provided a highly valuable archive of past CO_2 levels spanning the past 800 ka. Beyond ice core records, marine sediment archives using foraminifera $\delta^{11}B$ and alkenone $\delta^{13}C$ proxies have been used for CO_2 reconstruction, but they do not yield high resolution records sufficient to resolve orbital-scale cycles. Blue ice provided spot data at 1 Ma and 2.7 Ma. There has been no continuous high resolution CO_2 record beyond 800 ka (Fig. 1).
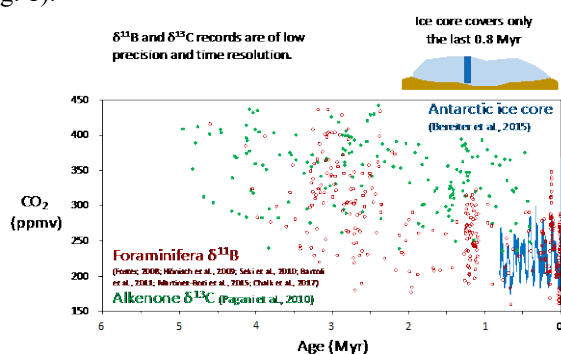

Fig. 1. Limitation of atmospheric CO_2 reconstruction.

In this study, we analyze the $\delta^{13}C$ of long-chain n-fatty acids ($\delta^{13}C_{FA}$) in sediments from International Ocean Discovery Program (IODP) Site U1445 on the Indian margin, Bay of Bengal, to generate a 1,700-year resolution record of CO_2 spanning the last 6 Myr. Based on reconstructed CO_2 record, we estimate climate sensitivity in the Pliocene, and understand the mechanisms of CO_2 variation and the interaction between CO_2 and climate.

【Research Methods】

We estimate CO_2 concentration from 6 ma to 1.5 Ma, estimate climate sensitivity in the Pliocene, discuss the mechanisms of CO_2 variability, the origin of glacial-interglacial cycles, and the cause of global warming around 5.6 Ma. Samples are the sediments taken from Site U1445 in the Indian margin of the Bay of Bengal. The $\delta^{13}C$ of long-chain n-fatty acids is analyzed to estimate the CO_2 concentration of the past. The $\delta^{18}O$ of benthic foraminifera is analyzed to create the age-depth model of Site U1445.

【Expected Research Achievements and Scientific Significance】

Interaction between CO_2 and climate is a key process in climate changes. However, robust CO_2 records are available only during the last 800 ka. The reconstruction of CO_2 concentration before 800 ka will be highly significant, enabling us to discuss the interaction between CO_2 and climate based on robust evidence.

Climate sensitivity is necessary to be determined to project future warming trend. The warmer Pliocene period (3 Ma) is now a target to determine climate sensitivity in the warmer Earth. The reconstruction of CO_2 concentration during the Pliocene should increase the accuracy of the climate sensitivity, which contributes to the projection of future climate.

Glacial-interglacial cycles became significant around 2.7 Ma. CO_2 decrease is a candidate of this trigger, but this is not proven by paleoclimte evidence. The high resolution CO_2 record enables us to discuss how carbon cycles were involved in the beginning of glacial-interglacial cycles.

Global warming occurred from 5.7 Ma to 5.5 Ma. This warming was a unique warming in the general cooling trend during the last 10 million years. The CO_2 record in this period enables us to discuss how CO_2 concentration was related to this global warming.

【Publications Relevant to the Project】

None

【Term of Project】 FY2019-2023

【Budget Allocation】 155,500 Thousand Yen

【Homepage Address and Other Contact Information】

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