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Variations of atmospheric components over the past 720,000 years deduced from Dome Fuji deep ice core

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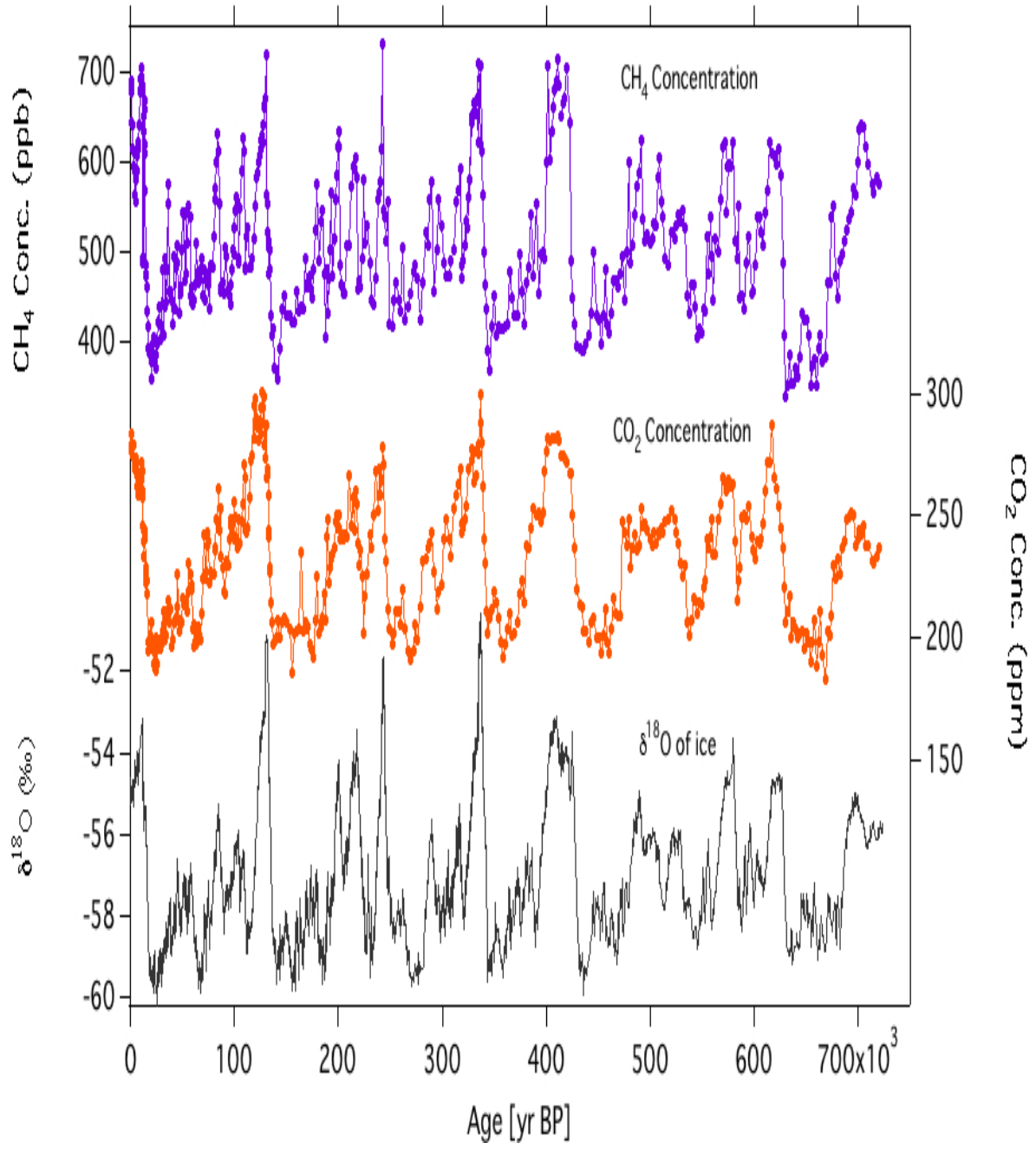

In order to reconstruct variations of atmospheric constituents over the past 720 kyr, a 3040 m deep ice core drilled at Dome Fuji, East Antarctica was analyzed for concentrations of CH4, N2O and CO2, Delta 15N of N2, Delta 18O of O2 and Delta (O2/N2) in the atmosphere, as well as total air content in ice, by using a wet extraction method. Total number of ice cores used for this study was 495. The DFO O2/N2 age scale was adopted throughout the ice core. The age difference between ice and air (Delta age) were estimated by a model calculation. Based on these analytical and model studies, precise concentration variations of CH4, N2O and CO2, Delta 15N of N2, Delta 18O of O2 and Delta (O2/N2) with time resolutions of about 1.1 and 2.0 kyr were deduced for the respective periods of 0-330 kyrBP and 330-720 kyrBP. Dole effect, which is a proxy of terrestrial and marine production, was also deduced from atmospheric Delta 18O and Delta 18O of seawater from the deep-sea core. Among various results obtained in this study, only those of CH4 and CO2 concentrations are summarized as follows:

CH4 concentration has varied between ~340 and ~730 ppbv through glacial and interglacial periods for the last 720 kyrBP. During the glacial-interglacial transitions, the CH4 concentration increased rapidly from 360-420 to 700-730 ppbv for the period of 0-450 kyrBP and from 340-400 to 620-650 ppbv for the period of 450-720 kyrBP, respectively. After the interglacial period, the concentration decreased rapidly to 450-500 ppbv and then gradually toward the lowest value in the glacial maximum, showing a number of fluctuations with amplitudes of more than 100 ppbv. The CH4 concentration variation was found to be concomitant with the temperature variation, which suggests that natural CH4 sources especially in the region from the tropics to northern latitudes were affected by climate change. The temporal variations of CH4 concentration obtained from Dome Fuji core showed similar variations to those from other Antarctic ice cores. However, detailed comparison with the Dome C records revealed that small but systematic differences in concentration could be seen in some periods of the last 400 kyr. It was also found that almost all prominent concentration peaks seen in the Dome Fuji CH4 record of the last glacial period were identified in the Taylor Dome record. Based on the measured CH4 concentrations, CH4 source was found to be stronger in the glacial maximum at around 240 kyrBP by 13 % than in other glacial maxima. It was also found that CH4 emission sometimes occurred in the region from the tropics to northern high latitudes, being independent of climate change in southern high latitudes.

Temporal variations of CO2 concentration obtained from Dome Fuji core for the last 720 kyr are almost similar to those obtained from other Antarctic ice cores using dry extraction methods, although the wet extraction method is generally thought to be inadequate for the determination of the CO2 concentration. Comparison between the CO2 and Ca2+ concentrations deduced from Dome Fuji core suggests that calcium carbonate emitted from lands was mostly neutralized in the atmosphere before reaching the central part of Antarctica, or that only a small part of calcium carbonate was involved in CO2 production during the wet extraction process. The CO2 concentration for the past 720 kyr deduced from Dome Fuji core varies between 190 and 300 ppmv, showing clear glacial-interglacial variations similar to the results of Dome C and Vostok ice cores. However, for some periods, the concentration values of Dome Fuji core are higher by up to 20 ppmv than those of Dome C and Vostok cores. There is no clear indication that such differences are related to variations of chemical components of Ca2+, microparticle and acidity of Dome Fuji core.

Keywords: Dome Fuji, ice core, atmospheric constituents, CH4 concentration, CO2 concentration