STABLE CARBON ISOTOPE ANALYSIS OF LIGNIN IN CALIFORNIA SEDIMENT: CONTRIBUTION CHANGE IN C4 PLANTS BETWEEN INTER- AND GLACIAL

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Introduction

How contributions of C3 and C4 plants changed between interglacial and glacial? Oxygen stable isotope ratio analysis of Greenland ice sheet core revealed that the rapid climate change such as Dansgaard-Oeschger (D/O) cycle in which sudden temperature rise and moderate temperature drop repeatedly occurred in a cycle of several hundreds to several thousand years (Dansgaard et al., 1993; North Greenland Ice Core Project members, 2004). In California region, paleo-temperature indices of benthic foraminiferal oxygen isotopic values and alkenone surface seawater temperature revealed rapid climate changes as seen in the ice core, implying that these climatic changes recorded in the Greenland ice sheet core occurred in the northern hemisphere scale (Kennett et al., 2000; Seki et al., 2002). These climate changes affected not only the atmosphere and marine systems but also the marine organisms and terrestrial biota.

In southern California vegetation, the sedimentary pollen records suggest that gymnosperm are suitable for dry climate i.e less precipitation and grow during cold intervals such as stadials and the Last Glacial Maximum, while angiosperm plants grow with rainfall increase during warming intervals such as the Holocene (Heusser, 1998). In these drying/wetting climate sequences, vegetation of C3 and C4 plants might have changed. In general, C4 plants live in a dry environment and C3 plants grow in a humid environment, and their carbon stable isotope values are significantly different by their carbon synthesis circuits (C4, -19‰; C3, -34‰; Rieley et al., 1993). Therefore, carbon isotope records that are derived from these plants in sediments can be useful tracers for C3 and C4 plants input.

An analysis method of carbon isotope ratio of lignin phenol using tetramethylammonium hydroxide (TMAH) method and HPLC showed that it is possible to measure the isotope values with an analysis error less than 0.2-0.9‰ (1σ) (Sonoda et al., 2005). In this study, we applied to measure lignin isotope ratio analysis in sediment using this method.

Results and Discussion

We analysed isotope of lignin phenols recorded in California sediment (Ocean Drilling Program Leg 167, Hole 1017E) and attempted to reconstruct paleo-vegetation change in southern California region by comparing glacial, interglacial and postglacial age of when the large atmospheric temperature change had occurred. Lignin phenols of vanillyl, syringyl, and cinnamyl were detected from the sediment throughout analysed ages. Measured those isotope data were different between glacial and interglacial and postglacial (e.g., Sa: ca. -30‰ [glacial], ca. -40‰ [interglacial]). From this trend, using two end members considered as their sources, a contribution rate between C3 and C4 plants was estimated. The data showed that C4 plants contribution relatively dominated (< 70%) from 41.7 to 41.1 ka and decrease from 40.53 ka and the Holocene with increasing C3 plants contribution (ca. 30-90%).

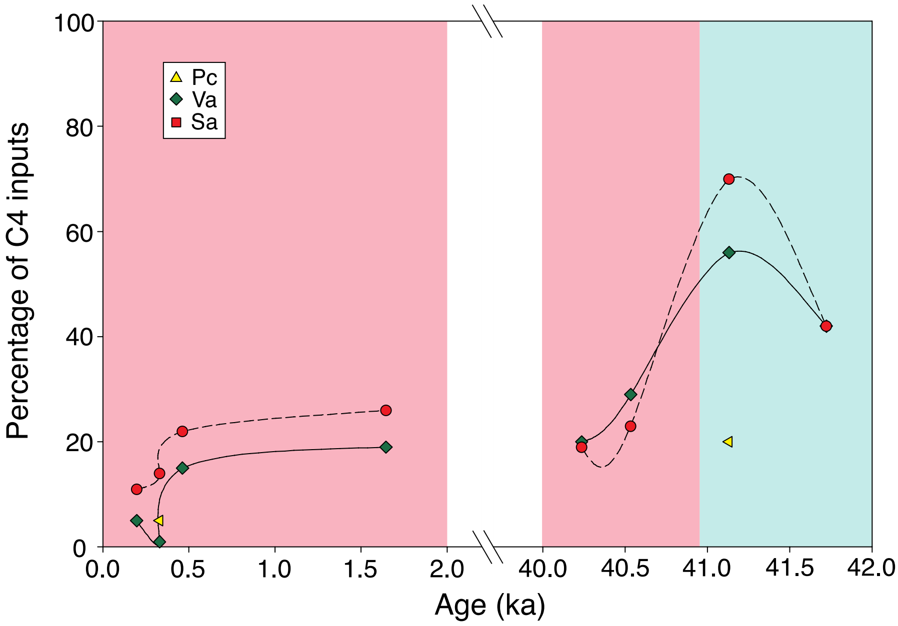

Figure 1 *Percentage changes in C4 plants calculated from each lignin phenols. End members of C3 are -38.7‰ (Va), -44.5‰ (Sa), and -27.9‰ (Pc). End members of C4 are -21.9‰ (Va), -21.6‰ (Sa), and -11.4‰ (Pc) (End member values are obtained from our laboratory [unpublished]). The area colored red and blue indicate interglacial and glacial, respectively. The age model was obtained from Kennett et al., 2000.*

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