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The variations of stable carbon isotope ratio of land plant-derived *n*-alkanes in deep-sea sediments from the Bering Sea and the North Pacific Ocean during the last 250,000 years

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Abstract

Two piston cores, one located far from the continents (The North Pacific Ocean: ES core), and another located comparatively closer to the continents (The Bering Sea: BOW-8a core) were investigated to reconstruct environmental changes on source land areas. The results show significant contribution of terrestrial organic matter to sediments in both cores. The $\delta^{13}C$ values of n-C_{27}, n-C_{29}, and n-C_{31} alkanes in sediments from the North Pacific ES core show significant glacial to interglacial variation whereas those from the Bering Sea core do not. Variations of $\delta^{13}C$ values of land plant n-alkanes are related to the environmental or vegetational changes in the source land areas. Environmental changes, especially, aridity, rainfall, and pCO_2 during glacial/interglacial transitional periods can affect vegetation, and therefore C_3/C_4 plant ratios, resulting in $\delta^{13}C$ changes in the preserved land plant biomarkers. Maximum values of $\delta^{13}C$ as well as maximum average chain length values of long chain n-alkanes in the ES core occur mostly at the interglacial to glacial transition zones reflecting a time lag related to incorporation of living organic matter into soil and transportation into ocean basins via wind and/or ability of C_4 plants to adapt for a longer period before being replaced by C_3 plants when subjected to gradual climatic changes. Irregular variations with no clear glacial to interglacial trends in the BOW-8a core may result from complex mixture of aerosols from westerly winds and riverine organic matter from the Bering Sea catchments. In addition, terrestrial organic matter entering the Bering Sea could originate from multiple pathways including eolian, riverine, and ice rafted debris, and possibly be disturbed by turbidity and other local currents which can induce re-suspension and re-sedimentation causing an obliterated time relation in the Bering Sea biomarker records.

Keywords: Bering Sea; Pacific Ocean; *n*-alkanes; Stable carbon isotope; Deep-sea sediments; Higher plants; Average chain length

1. Introduction

Time series sediment samples from marine cores are often utilized to reconstruct paleoclimatic and paleoceanographic environments. In addition to organic matter derived from marine organisms, ocean sediments also contain terrestrial organic matter. Long chain *n*-alkanes and fatty acids are common biomarkers found in ocean sediments (Meyers, 1997; Hu et al., 2002;

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Pelejero, 2003; Ratnayake et al., 2005) and aerosols (Conte and Weber, 2002; Simoneit et al., 1977). These biomarkers are abundant components of land plant epicuticular waxes (Cranwell, 1973; Rieley et al., 1991), occurring as protective coatings on plant leaves. Wax particles are easily lost from the surfaces of leaves by wind ablation, and can become airborne (Conte and Weber, 2002). In addition, decomposing plant organic matter in soils can be airlifted during dust storms and carried by wind. Plant-wax lipids are therefore even found in dust above deep ocean areas, i.e., the North Pacific (Gagosian et al., 1981), the South Pacific (Gagosian et al., 1987), the eastern Atlantic (Simoneit et al., 1977), and western North Atlantic (Conte and Weber, 2002). The eolian fraction in the ocean basins depends mostly on the climate of the source area, and partially on the strength of winds, the distance from source area, and the number of transport episodes within the year.

Among various parameters for the reconstruction of environmental change on land, compound specific stable carbon isotope ratios ($\delta^{13}C$) are of great interest. Compound specific $\delta^{13}C$ values can refine the interpretation of bulk $\delta^{13}C$ data and further strengthen the reconstruction of paleoenvironmental changes (Bird et al., 1995; Huang et al., 1999). The $\delta^{13}C$ values of leaf wax biomarkers can be applied to evaluate relative contribution of C_3 versus C_4 plants. The C_4 plants are favoured in arid environments to adjust into water limitations resulting in less isotopic fractionation than the C_3 plants. Leaf waxes from C_4 plants usually have $\delta^{13}C$ values of about $-23‰$, whereas C_3 leaf waxes have $\delta^{13}C$ values of about $-34‰$ (Freeman and Colarusso, 2001). The $\delta^{13}C$ values of land plant waxes such as long chain *n*-alkanes in marine sediments have been used to determine vegetational contributions by C_3/C_4 plant type organic material to marine sediments (Bird et al., 1995; Kuypers et al., 1999; Huang et al., 2000; Hughen et al., 2004).

The present study focuses on the relationship between the variation of the land plant $\delta^{13}C$ values of *n*-C_{27}, *n*-C_{29}, and *n*-C_{31} alkanes and glacial/interglacial changes over the past 250,000 years. We obtained two piston cores from seamounts in the North Pacific Ocean and the Bering Sea. Organic matter from these sediments was analysed for the $\delta^{13}C$ of land plant *n*-alkanes. The results provide an insight into glacial/interglacial changes in the Northeast Asia and Bering Sea catchment.

2. Study area and samples

Sampling of the sediment cores was carried out during Cruise KH99-3 of the R/V Hakuho Maru from June 25 to August 25, 1999. This cruise was organized by the Ocean Research Institute of the University of Tokyo to reconstruct the high-resolution glacial/interglacial paleoceanographic changes during the Late Quaternary in the Bering Sea and the North Pacific Ocean. Two piston cores were collected from representative sites (Fig. 1) in the Bering Sea (core BOW-8a from Bower Ridge) and the North Pacific Ocean (core

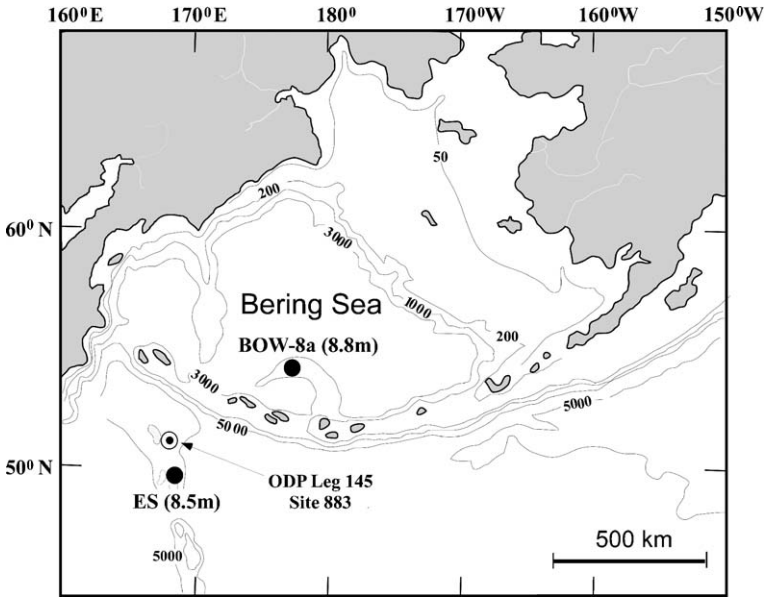

Fig. 1. Locations of piston cores from the North Pacific Ocean (ES) and the Bering Sea (BOW-8a), Cruise KH99-3 and Site 883, ODP Leg 145.