Occurrence of oxygen-poor NPIW during warm periods inferred from d15N records of the Chikyu Shimokita cores

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Hydrographic observations during the past 50 years in the Subarctic North Pacific clearly show that there are decadal changes in the dissolved oxygen (DO) and phosphate contents in the North Pacific Intermediate water (NPIW) (e.g., Ono et al., 2001; Andreev and Watanabe, 2002; Takaya et al., 2007). Because these changes are correlated with the North Pacific Index (Ono et al., 2001; Andreev and Watanabe, 2002), one could infer that oceanic ventilation of the NPIW and/or the mixing ratio of the Okhotsk Sea Water and the Western Subarctic Gyre Water are sensitively modified by the atmospheric circulation changes in the North Pacific. Interestingly, similar but more drastic DO changes occurred in the North Pacific in the past. The evidence for the abrupt decreases in DO concentration is shown by laminae preservation (i.e., originally formed sedimentary structures) from the sediment cores taken from sites shallower than ˜1000 m in the western North Pacific, indicating that the water mass had less than 5 micro-mol O2/kg. These DO decreased periods have been documented two times before and after Yonger Dryas from core MD01-2409 off Shimokita (water depth =975 m) (Narita et al., 2005). It is also shown that these DO decreased events coincided with DO decreased events in the eastern Pacific (e.g., van Geen et al., 2003), showing the basin-scale synchronous DO decreases in the North Pacific. Some researchers have proposed that the primary cause for the DO decreased events was increased productivity in the western north Pacific, others have proposed that ventilation changes in the NPIW may attributed to the phenomenon. However, a consensus has not yet been reached, and so the aim of this study is to seek the potential causes of DO decreased events in the North Pacific and whether the phenomenon in the western North Pacific is developed in response to Dansgaard-Oeschger events.

In this study, I present new d15N and total nitrogen records off Shimokita Peninsula back to the 90 kyrs. The samples (C9002A and 2B; 71 m long) were taken at 1179 m water depth, and were measured at intervals of approximately 10 cm (thickness: 1-2 cm). Given an average linear sedimentation rate at this site of ˜80 cm/kyr, this spacing yields a temporal resolution of the order of ˜125 years per sample. The cores C9002A/B are bioturbated throughout the core, but core MD01-2409 at 975 m water depth represents the laminae during the periods of Pre-boreal (PB) and Bolling/Allerod (B/A).

An age model for the cores C9002A/B has not yet been established at this stage (07/02/07), but it might be developed until the presentation. Therefore, I show a part of the results as a figure (vs depth). The data show double peaks of d15N values around 1000 cm depth, which might correspond to PB and B/A. At same time, there is laminae preservation at the shallower MD site. These evidences lead a possible explanation that an upstream region of the NPIW, probably Bering Sea, had experienced water column denitrification during PB and B/A. If so, phytoplankton might have utilized isotopically heavier nitrate in the NPIW, resulting in higher d15N values during PB and B/A. Recently, Cook et al (2005) have revealed two laminated intervals with higher export production in the Bering Sea during PB and B/A. Laminated sediments occur when the DO at the sediment-water interface is too low for burrowing macrofauna ([O2] less than 5micro-mol). If [O2] in the water column in the Bering Sea is less than 10micro-mol, water column denitrification will occur. Therefore, the high d15N records from Shimokita cores could be indicative of water column denitrification in the Bering Sea (thus formation of oxygen-poor NPIW in the source region). In the presentation, I discuss results over the past 90 kyrs and nutrient status in the oxygen-poor NPIW in details.