Changes in eolian dust source and transport path to the Japan Sea based on ESR signal intensities of eolian quartz

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Hemipelagic sediments of the Japan Sea contain significant amount of eolian dust derived from dry areas in inland Asia. The grain size of eolian dust is mainly controlled by the intensity of the transport wind and distance from the source area. In order to reconstruct millennial-scale changes in atmospheric circulation of East Asia, we have focused on eolian dust within the Japan Sea sediments. In our previous study, we demonstrated that grain size of the eolian dust in the Japan Sea sediment cores (KT94-15-PC5; approximately 150 km west of Akita, IMAGES MD01-2407; approximately 200 km north of Tottori) oscillates in association with glacial-interglacial cycle and Dansgaard Oeschger Cycles (Nagashima et al., in press). We also demonstrated that the grain size difference between northern (KT94-15-PC5) and southern (MD01-2407) part of the Japan Sea also changes in associated with these cycles. Namely, eolian grain size was larger at northern site than southern site during glacial maximum and glacial stadial periods, and vice versa during interglacial and glacial interstadial periods. This result may imply two different dust source areas and/or transport wind systems corresponded to each mode of the DOC.

To examine the possibility of the changes in dust source area and transporting wind system, we estimated source areas of the eolian dust based on Electron Spin Resonance (ESR) measurement of eolian quartz within the Japan Sea sediments. Naruse et al. (1997) measured ESR signal intensities of the sediments in Japan and loess samples in China to reconstruct source areas and transport paths of eolian dust deposited in the Japan islands. Because there is a rough correlation between the original source rock ages and ESR signal intensities (Toyoda et al., 1992), ESR signals of northeast Asian Pre-Cambrian rocks show higher intensities (11-17; arbitrary unit after Naruse et al., 1997), and that of Chinese Loess and desert, which seems to have been supplied mainly from Paleozoic-Mesozoic rocks, show lower ESR intensities (6-8). Under the assumption that the ESR signal intensities of eolian quartz reflect those of the quartz in the source area, their intensities give us the information on the source area and transport path of the eolian dust (Naruse et al., 1996, 1997; Toyoda and Naruse, 2002).

Based on this idea, we measured ESR signal intensity of detrital quartz in the sediment cores KT94-15-PC5 and MD01-2407 to specify the sources of the eolian dust and its transport paths during the last 150 ky. From bulk samples, organic matter, carbonate, and biogenic opal were removed, then the treated samples were irradiated by gamma-rays and heated at 300 degree for 15 min, and measured by ESR spectrometer. The measured signal intensities were calibrated by quartz content estimated by X-ray diffraction using the internal method. The calculated ESR signal intensities show lower values (6-10) for samples from interglacial and glacial interstadial intervals, whereas higher values (12-17) are observed for samples from the intervals corresponding to glacial maximum and glacial stadials.

This suggests that eolian dust was supplied to the Japan Sea from central Asia through wesrerly during interglacial and glacial interstadial periods, and it was supplied to the Japan Sea from northeast Asia through winter monsoon during glacial maximum and glacial stadial periods. Thus, glacial-interglacial and millennial-scale variabilities of eolian grain size and its north to south difference reflect switches in dust-transport wind system between the westerly and the winter monsoon. Namely, westerly was the main dust-transport wind system during interglacial and glacial interstadial periods while winter monsoon was the main dust-transport wind system during glacial maximum and glacial stadial periods.