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Evidence of millennial-scale oscillations of westerly jet axis and East Asian winter monsoon intensity during the last 80 kyr from the Japan Sea sediment

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The evidence of millennial-scale variation in Asian summer monsoon and its probable association with Dansgaard-Oeschger Cycles (DOC) was demonstrated by the speleothem oxygen isotope record recovered from the southern China (Wang et al., 2001). However, the record mainly reflects summer monsoon variability, and variability of Asian winter monsoon as well as westerly jet and the associated dynamical mechanisms are poorly known. The purpose of this study is to examine the nature of atmospheric circulation variability in East Asia during the last glacial period and its possible linkage with variations in Asian monsoon based on provenance and grain size changes of eolian dust in the hemipelagic sediments of the Japan Sea, and discuss the possible origin of those variations.

The Japan Sea is located at downwind of Asian winter monsoon and beneath westerly jet that passes over dried areas in the Eurasian continent, and receives significant amount of aeolian dust derived from these arid areas. In that sense, the hemipelagic sediments of the Japan Sea are expected to record continuous aeolian dust accumulation, which may provide the information on the past variations in Asian winter monsoon and westerly jet.

In this study, we analyzed the sediment core MD01-2407 recovered from the southern part of the Japan Sea. We measured grain size distribution of fine silt fraction of detrital material for more than four hundred samples which cover the last 80 kyr with the

average time resolution of approximately 200 yr. We also measured Electron Spin Resonance (ESR) signal intensity and crystallinity index (CI) of quartz in fine silt fraction for more than two hundred samples which cover the last 80 kyr to investigate their provenance. Our previous study demonstrated that the silt fraction of the detrital materials in Japan Sea sediment is composed dominantly of aeolian dust (Nagashima et al., 2007 in press), so grain size and provenance of fine silt fraction of the samples of core MD01-2407 is considered as representing properties of eolian dust falling over the Japan Sea.

Grain size of aeolian dust shows millennial-scale variations in harmony with DOC. Provenance of aeolian dust, which was characterized by ESR signal intensity and CI of quartz, also shows millennial-scale variations probably in harmony with DOC. Namely, the aeolian dust shows larger grain size with the probable source of Mongolia-Siberia for the samples of glacial stadials, whereas the aeolian dust shows smaller grain size with the probable source of deserts in northern and western China (Tengger, Badain Juran, or Taklimakan) for the samples of glacial interstadials. Millennial-scale variations in grain size of aeolian dust are considered to represent either changes in dust-transport distance due to the advance or retreat of the aeolian dust source area or changes in the intensity or system of dust-transport wind. Because there is rather clear positive correlation between eolian dust provenance and ESR signal intensity (a proxy for provenance), changes in dust-transport wind system are more likely. Those millennial-scale variations in grain size and provenance of aeolian dust may suggest north (south) shifts of the westerly jet axis together with weakened (intensified) winter monsoon during interstadials (stadials). The N-S shift of the westerly jet axis is possibly accompanied by the millennial-scale variation in summer monsoon rains around eastern China area due to the N-S shift of northern limit for the summer monsoon front whose position is also controlled by the position of the westerly jet axis.