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Provenance Changes of Eolian Dusts in East Asia on various Time Scales

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Reconstruction of the past atmospheric circulation is a crucial part of paleoclimatic studies. Yet it is far more difficult compared to reconstruction of the past ocean circulation because there are no well-established proxies developed to reconstruct past atmospheric circulation. Eolian deposits are the only media that potentially record atmospheric activities in the past, and provenance of eolian dust provides key information to reconstruct past atmospheric circulation pattern. However, previous efforts to extract provenance information from eolian deposits are of limited success because 1) comprehensive data base for provenance study that cover entire East Asia did not exist, 3) grain size dependence of the parameters was not well taken into account, and 3) many of parameters used for provenance studies are susceptible to alteration during weathering and/or burial diagenesis processes.

We developed a new approach to specify eolian dust provenance that utilized a combination of ESR signal intensity of heat-treated E_1' center of quartz (= ESR signal intensity) and crystallinity index of quartz (= CI). We focused on quartz because it is highly resistant to alteration and is the major component of eolian dusts. We extracted the two parameters from quartz, by which we can avoid the differential effects of sorting and chemical alteration on the two parameters. The ESR signal intensity reflects ages of the source rocks, whereas CI reflects temperature and speed of crystallization. Thus, the they give basically independent information on the source rocks.

We first examined ESR signal intensity and CI of quartz in <16 μm fraction of surface samples collected from 9 deserts and dry lands in inland China and Mongolia (Sun et

al., submitted). The result suggests that 8 out of 9 deserts are clearly distinguishable on the ESR signal intensity vs CI diagram. The result further suggests that provenance of the <16 μm fraction in the surface samples from these deserts can be explained by mixing of local sources including Taklimakan, Tengger, Badain Juran, Gurbantunggut, and Mongolian Gobi deserts, whose ultimate sources could be Kunlun-Tien Shan, Qilian, Altai, and Gobi Altai mountains.

We then analyzed samples from loess-paleosol sequence covering the last 2.6 My at Lingtai section in the south-central part of Chinese Loess Plateau (Isozaki et al., in preparation). The result suggests distinct changes in dust provenance between loess (glacials) and paleosol (interglacials) samples. In general, loess samples are characterized by northerly source(s), whereas paleosol samples are characterized by westerly or north-westerly source(s). In addition, there are distinct changes in provenance approximately at 2.4, 1.1, and 0.3 Ma, which may reflect switches among the local sources mentioned above. These changes in provenance could reflect either tectonic uplift events or climatic changes and consequent changes in distribution of dry areas, precipitation and river erosion, or dust transporting wind systems.

Finally, we analyzed samples from the hemipelagic sediments of the Japan Sea covering the last 150 ky (Nagashima et al., in press). First, we demonstrated that quartz in fine silt fraction of the hemipelagic sediments of the Japan Sea is mostly derived from Asian continent (Nagashima et al., in press). With this knowledge, we examined temporal changes in provenance of eolian quartz in orbital and suborbital time scales. We found distinct dust source switches between Mongolia-Siberia during the summer insolation minima and Western deserts in China during the summer insolation minima. In addition, we found dust provenance switches in association with the Dansgaard-Oeschger Cycles [DOC] between Mongolia-Siberia during the stadials and Western deserts in China (Tengger, Badain Juran, or Taklimakan) during the interstadials of the DOC. This strongly suggests that westerly jet axis oscillated to the south and north over the Japan Sea in association with the DOC.