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Temporal change of the sources of aeolian dust delivered to East Asia revealed by ESR signals in quartz

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Change of atmospheric circulation system in the past is an important issue for studies of paleoclimate. Aeolian dust, fine particle suspended in air and brought by wind, is a clue to know the wind direction and the strength in the past. Historical record of aeolian dust accumulation in Japan will give important information on this issue as well as on the climate change in the arid source regions in China. Various features, such as grain size distribution, mineral compositions, and isotope compositions, have been investigated for loess sequence for this purpose. In the present study, we would like to propose that ESR signals in quartz are other good proxies as well.

Electron spin resonance (ESR) detects unpaired electrons in minerals, trapped at lattice defects and impurities. In quartz, we observe the signals due to the E_1' center, an unpaired electron trapped at an oxygen vacancy, the Al hole center, an electronic hole at aluminum impurity atom replacing a silicon, the Ti centers, and the Ge center. It was shown previously that, by measuring the number of oxygen vacancies, the precursor of the E_1' center, in loess sequence, the aeolian dust source in Holocene was different from that in LGM (Toyoda and Naruse, 2002). Later, the crystallinity index was found to be another proxy for such studies. Temporal change of the origins of the eolian dust accumulated in the Sea of Japan was found to be correlated with the climate change by using these proxies (Nagashima et al., 2007).

The dust samples taken at meteorological observatories in Japan since 1960's were examined by the same method. It was found that finer grain fractions contain more dust component of Chinese origin than coarser fractions and that the ratio of the Chinese component varies year to year.

The number tends to decrease with time (1964-1990) with some variation from 9 to 1.5 (1.3×10^{15} spins/g) in June and from 3 to 1.8 in March. The number in June is higher than the one in March in the 1960s while it is opposite in the 1970s. The decrease of the number of oxygen vacancies can be due to change in sources of dust in China.