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『石英の ESR 信号強度を利用した砕屑物の供給源推定と東アジアの古気候復元』

Palaeoclimatic reconstruction of East Asia deduced from provenance changes of detrital material based on ESR signal intensity of quartz

王可[#,A), 多田隆治[A), 入野智久[B), 松崎賢治[A), 関有沙[A), 佐久間杏樹[A)

Ke Wang [#,A), Ryuji Tada [A) , Tomohisa Irino [B), Kenji Marc Raymond Matsuzaki [A), Arisa Seki [A), Aki Sakuma[A)

[A) Graduate School of Science, the University of Tokyo

[B) Faculty of Environmental Earth Science, Hokkaido University

The uplift of Himalaya and Tibetan Plateau (HTP) exerted a great impact on the establishment and intensification of East Asian monsoon (EAM). Land-Ocean linkages over orbital and millennial timescales under the influence of the EAM also attract our attention. According to Rea et al. (1998), North Pacific dust flux increased gradually between 25 and 3.6 Ma and then increased rapidly at 3.6 Ma. Previous studies on the Japan Sea sediments revealed that onset of millennial-scale variability of East Asian summer monsoon (EASM) at 2.7 Ma, and amplification of millennial-scale variability of EASM at 1.5 Ma (Tada et al., 2016). EASM shows distinct millennial-scale variations, which has been associated with changes in the dust provenance probably reflecting changes in Westerly Jet (WJ) path (Nagashima et al., 2007, 2011). Discrimination of the Asian dust source areas based on electron spin resonance (ESR) intensity and Crystallinity Index (CI) of quartz has been reported, which classify the provenance of dust source as from Taklimakan desert, Mongolian Gobi and sandy deserts in Northern China (Sun et al., 2013). Here, we examine dust provenance of the Japan Sea sediments at IODP U1425, central Japan Sea using ESR signal intensity and CI of quartz in fine silt fraction (4-32 μm) of the sediments to specify the source(s) of eolian dust to the Japan Sea.

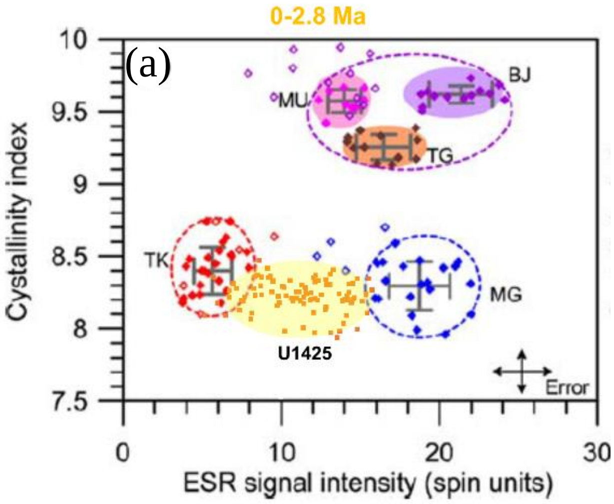
Prior to ESR signal intensity measurements, 2g of pretreated samples were irradiated with γ-radiation (total dose of 2.5 kGy) using a ^{60}Co source at the Takasaki Advanced Radiation Research Institute, National Institutes for Quantum and Radiological Science and Technology, Takasaki, Japan, according to the method of Toyoda and Hattori (2000). After irradiation, 1g each of pretreated samples were heated at 300 °C for 15 minutes to convert the oxygen vacancies of quartz to E_1' centers (Toyoda and Ikeya, 1991). ESR signal intensity measurements were conducted with JEOL JES-FA100ESR spectrometer at the University of Tokyo at room temperature under 0.01 mW of microwave power, 0.1 mT magnetic field modulation (100 kHz), 5 mT scan range, 2 minutes of scan time, and time constant of 0.03 seconds. The reproducibility of ESR signal intensity was ±1.0 spin units.

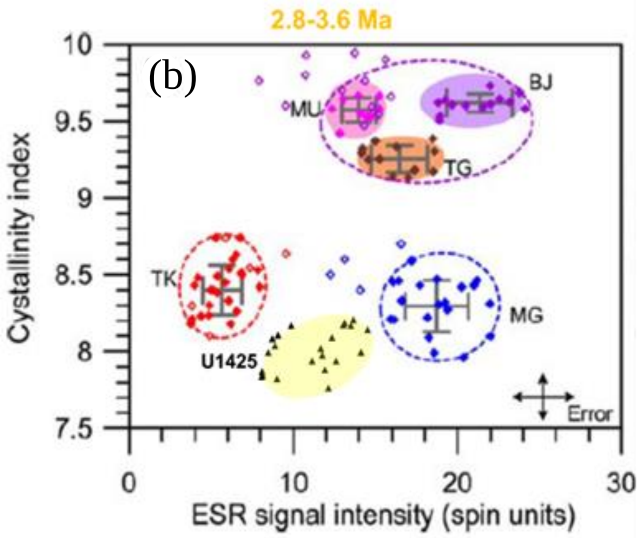
The crystallinity index (CI) of quartz was originally

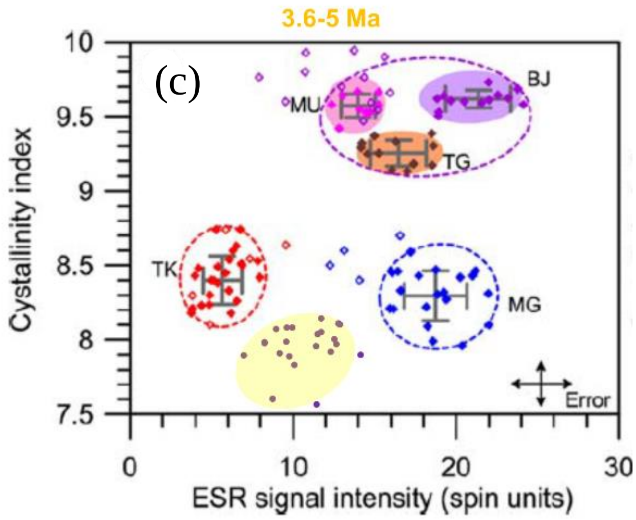
[課題番号 17006]

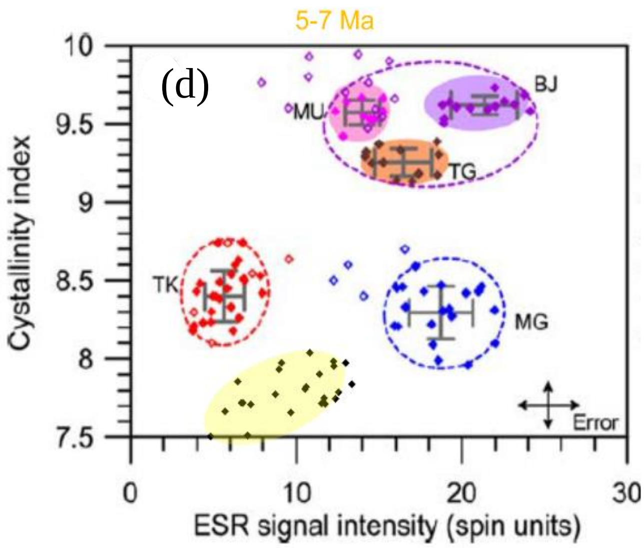
defined by Murata and Norman (1976) on the basis of the degree of resolution of the d (212) reflection of quartz at 1.3820 Å on the XRD profile. CI of quartz reflects physical conditions during quartz formation and is typically the highest in quartz that was formed under high temperatures and/or low crystallization rate. In this study, measurement of CI of quartz was conducted using PANalytical X'Pert PRO X-ray diffractometer (XRD) at the University of Tokyo with CuKα beam generated at voltage of 45 kV and current of 40 mA with divergence slit of 1.52 mm in width and anti-scatter slit of 3 mm in width. The CI values were calculated as the degree of the quartz peak split at 67.74° 2θ, based on the definition of Murata and Norman (1976).

The result is shown in Figure 1. Our result suggests that provenance of the dust in the Japan Sea sediments was different before 3.6 Ma. Namely, in addition to the contribution from Taklimakan Desert and Gobi, input from Japanese Islands was significant, whereas after 3.6 Ma contribution from Japanese Islands became negligible after 3.6 Ma. The North (larger relative contribution of dust from the Taklimakan Desert)-South (larger relative contribution of dust from Mongolian Gobi) shifts of westerly jet seems to be paced by 405-kyr-long eccentricity cycles.









[課題番号 17006]

Figure 1 Comparison of ESR signal intensity and CI of quartz in fine silt fraction of the sediment from U1425 core with those of desert sediments from Taklimakan Desert (TK), Mongolian Gobi (MG), BJ, TG, and MU during 0-2.8 (a), 2.8-3.6 (b), 3.6-5 (c), 5-7 (d) Ma, respectively.

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