電子顕微鏡を用いた中国レスにおける土壌化起源磁性ナノ粒子の観察

Microscopic observations of pedogenic nanoparticles causing magnetic enhancement in Chinese loess deposits

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Paleoclimatic signals have been recorded in various ways in Chinese loess-paleosol sequences. Magnetic susceptibility has been used as a reliable proxy for reconstructing Asian summer monsoon intensity because its enhancement is exactly related to paleorainfall through neoformation of magnetic nanoparticles during pedogenesis. However there are no observations which can interpret either formation process or form of such pedogenic nanoparticles exactly.
To investigare this problem, scanning electron microscope (SEM) observations were conducted after some rock magnetic experiments including magnetic susceptibility measurements, IRM composition analysis and thermomagnetic measurements, and we divided bulk samples into three subsamples with different grain size bands (D1: >10 μm, D2: 10~1 μm, D3: <1 μm) in advance so that we can obtain significant informations on grain sizes of pedogenic nanoparticles which may help the microscopic observations. Bulk samples used in this study include less-altered loess and mature paleosol showing extremely low (29 $\times 10^{-8} m^3 kg^{-1}$) and high (116 $\times 10^{-8} m^3 kg^{-1}$) magnetic susceptibility respectively and were selected as specimens from a sequence of loess L8 to paleosol S8 from Lingtai on central part of the Chinese Loess Plateau.
From results of IRM composition analysis and thermomagnetic measurements, pedogenic nanoparticles turned out to be magnetite or maghemite. Besides, results of magnetic susceptibility and its frequency dependence (FD) showed that D2 has the dominant contributions amounting to over 60 % to enhanced magnetic signals in paleosol. Considering FD indicates the total amount of super-paramagnetic (SP) particles whose grain sizes are tens of nm, we can suggest that the detritus grain size band in which pedogenic nanoparticles including some SP particles are concentrated is D2 and such ultra-fine particles exist in detrital particles in the form of inclusions. Based on these results and hypothesis, magnetic extractions were conducted on D2 of both loess and paleosol. A certain amount of particles was obtained from paleosol while particles were hardly obtained from loess, and these magnetically extracted particles from paleosol D2 were subjected to SEM observations. Energy dispersive X-ray spectroscopy (EDS) showed that such magnetically extracted particles include a lot of detritus silicates like chlorite, muscovite and quartz even they are non-magnetic minerals. Watching surface of these silicates with SEM carefully, nanoinclusions of iron oxide were observed. Further results including X-ray diffraction analysis and TEM observation will be shown on the poster.

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