Exploration of pedogenic nanoscale particles causing magnetic enhancement in Chinese loess deposits

*佐野 拓郎[1]、兵頭 政幸[1,2]、松本 恵[3]、瀬戸 雄介[1]
*Takuroh Sano[1], Masayuki Hyodo[1,2], Megumi Matsumoto[3], Yusuke Seto[1]

1. 神戸大学 理学研究科 惑星学専攻、2. 神戸大学 内海域環境教育研究センター、3. 神戸大学 研究基盤センター
1. Department of Planetology, Kobe Univ., 2. Research Center for Inland Seas, Kobe Univ., 3. Center for Supports to Research and Education Activities, Kobe Univ.

Based on magnetic enhancecment in paleosols, magnetic susceptibility (χ) and its frequency dependence (χ_{fd}) are widely accepted as reliable proxies of paleorainfall, and thus often used for estimation of the East Asian Summer Monsoon intensity in the Chinese Loess Plateau (CLP). In spite of its paleoclimatic importance, pedogenic particles causing magnetic enhancement have never been detected. We challenged this problem, using three sets of loess and paleosol samples from Lingtai and Xifeng in the central CLP. Each bulk sample was divided into three subsamples with different detrital grain size ranges (D1: > 10 μm, D2: 10–1 μm, D3: < 1 μm), all of which were subjected to rock magnetic experiments including χ and χ_{fd} measurements, isothermal remanent magnetization (IRM) composition analyses and thermomagnetic analyses. The paleosol bulk samples show high χ values ranging from 116–177 $\times 10^{-8}$ m^3 /kg, which are 4.0–6.1 times higher than loess bulk samples, and 49.6–66.2 % of the magnetic enhancement is contributed by grains in D2 subsamples. Besides, values of χ_{fd} are also increased by 4.0–5.7 times for all paleosol bulk samples, and the enhanced χ_{fd} is dominantly contributed by D2 subsamples (61.0–77.0 %). The rock magnetic experiments reveal that pedogenic particles causing magnetic enhancement are magnetite and maghemite. Based on these results, scanning electron microscope (SEM) and trans electron microscope (TEM) observations were conducted on magnetic extracts from D2 subsamples. As a result, we found nanoscale magnetite inclusions in weathered muscovite particles. These magnetite inclusions are secondarily produced through elution/oxidation of Fe compounds in muscovite during pedogenesis. The inclusions can explain the facts that the magnetic enhancement partly caused by superparamagnetic grains is mostly contributed by D2 size grains, and the main magnetic extracts are not detrital magnetite/maghemite grains but silicate minerals. Hence, we conclude the magnetite inclusions in weathered muscovite particles are the most likely candidate for pedogenic particles causing magnetic enhancement.

キーワード：中国レス、土壌化、磁気増大
Keywords: Chinese loess, Pedogenesis, Magnetic enhancement

