American Mineralogist, Volume 95, pages 64–72, 2010

A mineral tracer toward high-resolution dust provenance on the Chinese Loess Plateau: SEM, TEM, and sulfur isotopes of sulfate inclusions in biotite

Gi Young Jeong[1,*] and Kwang-Sik Lee[2]

[1]Department of Earth and Environmental Sciences, Andong National University, Andong 760-749, Korea
[2]Korea Basic Science Institute, Daejeon 305-333, Korea, and Graduate School of Analytical Science and Technology, Chungnam National University, Daejeon 305-764, Korea

Abstract

The most important terrestrial archive of the Quaternary climate is the Chinese Loess Plateau (CLP) distributed over a vast region peripheral to the deserts of Inner Asia. Numerous paleoclimatic studies have examined magnetic, chemical, and isotopic proxies from deep loess-paleosol sections. However, the highly uniform mineralogy of the CLP has made it difficult to track the provenance, transportation, and deposition of dust particles. Here, we report that the micrometer-scale mineralogical heterogeneity of the loess particles has a significant potential in determining high-resolution loess provenance. Scanning and transmission electron microscopy of the Chinese loess reveals that biotite particles commonly have microinclusions of Ba-Sr sulfates displacing the micaceous layers along cleavages. Chemical compositions varied widely from barite to celestine within the same biotite grain. The Ba-rich sulfates precipitated first, followed by an overgrowth of Sr-rich sulfates. The frequency of sulfate-bearing biotite varied greatly over several loess sections, implying a specific source and sedimentation process. Their abundance on the western CLP and sulfur isotopic composition support their derivation from porous sedimentary sequences reacted with hypersaline solutions, e.g., arkosic sandstone, probably located west of the CLP covering the Qilian Mountains, Qaidam Basin, and surrounding mountains of the Tibetan-Qinghai Plateau. The sulfate-bearing biotite is the first microscopic mineral tracer in the CLP, provoking further search for other microscopic heterogeneities of the Chinese loess and their equivalents in the source regions.

Keywords: Barite, biotite, celestine, loess, provenance