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Identification of interstratified mica and pyrophyllite monolayers within chlorite using advanced scanning/transmission electron microscopy

Guanyu Wang[1,2], Hejing Wang[1,*], and Jianguo Wen[2,*]

[1]School of Earth and Space Sciences, Peking University, Beijing 100871, China
[2]Center for Nanoscale Materials, Argonne National Laboratory, Lemont, Illinois 60439, U.S.A.

Abstract

Interstratified clay minerals reflect the weathering degree and record climatic conditions and the pedogenic processes in the soil. It is hard to distinguish a few layers of interstratified clay minerals from the chlorite matrix, due to their similar two-dimensional tetrahedral-octahedral-tetrahedral (TOT) structure and electron-beam sensitive nature during transmission electron microscopy (TEM) imaging. Here, we used multiple advanced TEM techniques including low-dose high-resolution TEM (HRTEM), high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) imaging combined with energy-dispersive spectroscopic (EDS) mapping to study interstratified layers in a chlorite sample from Changping, Beijing, China. We demonstrated an interstratified mica or pyrophyllite monolayer could be well distinguished from the chlorite matrix by projected atomic structures, lattice spacings, and chemical compositions with advanced TEM techniques. Further investigation showed two different transformation mechanisms from mica or pyrophyllite to chlorite: either a 4 Å increase or decrease in the lattice spacing. This characterization approach can be extended to the studies of other electron-beam sensitive minerals.

Keywords: Chlorite, interstratified layer, HRTEM, STEM