Change in Layer Charge of Smectites and Smectite Layers in Illite/Smectite during Diagenetic Alteration

Tsutomu Sato[1], Takashi Murakami[2,†] and Takashi Watanabe[3]

[1] Department of Environmental Safety Research, Japan Atomic Energy Research Institute, Tokai, Ibaraki 319-11, Japan
[2] Department of Earth Sciences, Ehime University, Matsuyama, Ehime 790, Japan
[3] Department of Geoscience, Joetsu University of Education, Yamayashiki, Joetsu, Niigata 943, Japan

[†] Present address: Mineralogical Institute, Graduate School of Science, The University of Tokyo, Hongo Bunkyo-ku, Tokyo 113, Japan.

Abstract: The changes in amount and location of layer charge during diagenetic alteration have been investigated for smectites and smectite layers of illite/smectite interstratified minerals (I/S) by X-ray powder diffraction analysis with various expansion behavior tests: 1) ethylene glycol (EG) solvation (XRD); 2) K-saturation and EG solvation; 3) Li-saturation, heating at 250 ° C and glycerol or EG solvation (Greene-Kelly test); and 4) alkylammonium saturation. In the course of low-temperature diagenesis but before the onset of illitization, mean layer charge of smectites continuously increases from approximately 0.56 to 0.73 per $O_{20}(OH)_4$ with increasing depth, and tetrahedral charge also increases continuously from approximately 0.21 to 0.38 per $O_{20}(OH)_4$ (beidellitization). The continuous increase in tetrahedral charge without change in peak intensity and shape suggests that the solid-state Al for Si substitution mechanism appears to predominate within beidellitization. After illitization, the content of the beidellitic layers continuously decreases, while the mean layer charge of expandable layers and the content of illite layers in I/S increase. This suggests that the conversion of a beidellitic layer to an illitic layer preferably occurs during early illitization. Thus, before illitization, beidellite-like layers are formed from precursor smectite, and during the early stage of illitization, the high charged beidellitic layers are probably consumed to form illite layers.

Key Words: Beidellitization • Charge Location • Diagenesis • Greene-Kelly Test • Illite/Smectite • Layer Charge • Smectite

Clays and Clay Minerals; August 1996 v. 44; no. 4; p. 460-469; DOI: 10.1346/CCMN.1996.0440403

Clay Minerals Society (www.clays.org)