Characterization of Illitization of Smectite in Bentonite Beds at Kinnekulle, Sweden

Atsuyuki Inoue[1], Takashi Watanabe[2], Norihiko Kohyama[3] and Ann Marie Brusewitz[4]

[1] Geological Institute, College of Arts and Sciences, Chiba University, Chiba 260, Japan
[2] Johetsu University of Education, Johetsu, Niigata 943, Japan
[3] National Institute of Industrial Health, The Ministry of Labor Nagao, Tama-ku, Kawasaki 213, Japan
[4] Geological Survey of Sweden, Box 670, S-75128 Uppsala, Sweden

Abstract: Structure, morphology, and chemical composition of illite/smectite (I/S) containing 30–50% smectite layers (% S) from Kinnekulle bentonites, Sweden, of diagenetic origin were examined using X-ray powder diffraction (XRD) and transmission electron microscopy (TEM). Interlayer arrangements of I/S changed from random interstratification to short-range ordered at about 40% S. The transition from random to ordered structure proceeded continuously as reflected by the gradual decrease in probability of two smectite neighbors (P_{ss}) towards zero.

TEM observations of water-dispersed samples that had not been cation-exchanged showed that the I/S consisted dominantly of flakes coexisting with laths having a length/width ratio of about 4, regardless of % S. The thickness of the I/S particles ranged from 30 to 100 Å, and no systematic variation in thickness was detected with decreasing % S. The chemical composition of the I/S also changed continuously with decreasing % S. These observations suggest no dissolution of smectite layers and no recrystallization of illite layers during the formation of the I/S in these bentonites; rather, cationic substitutions occurred within a smectite precursor (termed a solid-state transformation mechanism). A comparison of interlayer order, particle texture, and chemistry of the I/S from various types of rocks suggests that the mechanism of smectite-to-illite conversion in the range 100% S-30% S was related to the porosity and permeability of original rocks. The solid-state transformation mechanism appears to have predominated in rocks of low porosity and permeability.

Key Words: Bentonite • Diagenesis • Illite/smectite • Illitization • Transmission electron microscopy • X-ray powder diffraction

Clays and Clay Minerals; June 1990 v. 38; no. 3; p. 241-249; DOI: 10.1346/CCMN.1990.0380302