Investigation of a K-Bentonite by X-ray Powder Diffraction and Analytical Transmission Electron Microscopy

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Abstract: The < 0.1-μm size fraction of an Ordovician K-bentonite from northern Kentucky was characterized by X-ray powder diffraction (XRD). Using A.I.P.E.A. criteria for interstratification nomenclature and Reynolds' computer algorithm the dominant clay mineral proved to be an R2 ordered illite/smectite. The best fit of observed and calculated XRD tracings was obtained using 12 > N > 5, where N is the number of layers within a diffracting domain.

Sections of the K-bentonite were prepared by ion-beam milling and examined in an analytical transmission electron microscope (ATEM). One-dimensional lattice images observed parallel to the a – b plane showed subparallel packets, about 50 – 100 Å thick, each of which consisted of about 10-Å thick unit layers. Somewhat thicker unit layers (as much as 14.5 Å) were also seen. The former are presumed to be illite, whereas the latter may be partially collapsed smectite. Selected-area electron diffraction patterns suggested simultaneous diffraction from several packets, each containing at least five layers. Both *h*0*l* and 0*kl* spacings were usually present, indicating that the stacking of the subparallel packets was random. Quantitative analysis by AEM and electron microprobe show the clay to be low in tetrahedral Al but high in octahedral Mg, the latter presumably contributing largely to the interlayer charge responsible for K fixation. The TEM data are broadly reconcilable with the accepted XRD interpretation of a two-component, mixed-layer clay. Alternatively, the TEM images may be interpreted as a single phase having numerous packet boundaries, the latter being responsible for swelling behavior. These two interpretations will not be fully reconciled until greater analytical precision and resolution permit individual packets to be studied. This work suggests that mineral definitions based purely on XRD interpretations may have to be reconsidered as more electron microscope data become available.

Key Words: Analytical transmission electron microscopy • Bentonite • Illite • Interstratification • Potassium • Selected area diffraction • Smectite • X-ray powder diffraction

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