Chemical and Morphological Evidence for the Conversion of Smectite to Illite

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Abstract: The continuous conversion of smectite to illite in samples from the Shinzan hydrothermal alteration area of Japan has been examined by X-ray powder diffraction (XRD) and transmission (TEM) and analytical transmission electron microscopy (AEM). TEM shows that randomly interstratified illite/smectite (I/S) containing 100-50% expandable layers exhibits a flakey shape, whereas regularly and partially ordered interstratified I/S having 50-0% expandable layers exhibits a lath-like habit. An early- formed lath of regularly interstratified I/S is typically <35 Å in thickness and 300 – 500 Å in width; these dimensions gradually increase with decreasing percentage of expandable layers. XRD shows that the lath-shaped I/S has a 1*M* polytype mica structure. AEM shows that the interlayer K content of flakey I/S increases monotonously with decreasing percentage of expandable layers in the range 100-50% expandable layers, whereas the interlayer K content of lath-shaped I/S increases along a different trend from that for the flakey I/S in the range 50-0% expandable layers. These observations suggest that randomly interstratified I/S is fundamentally smectite that is undergoing K-fixation and dissolution and that regularly and partially ordered interstratified I/S are immature illite which is still growing. Consequently, they suggest a mechanism for the hydrothermal smectite-to-illite conversion that is based on the K-fixation in and dissolution of smectite and the precipitation and growth of thin illite particles. Furthermore, these data suggest that the kinetics of smectite dissolution and illite growth are the most important factors controlling the smectite-to-illite conversion.

Key Words: Diagenesis • Expandable layers • Illite • K-fixation • Smectite • X-ray powder diffraction

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