Transmission Electron Microscope Observations of Illite Polytypism[1]

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Abstract: Transmission electron microscopy (TEM), including selected area electron diffraction (SAED), has been used to identify polytypes in illite, phengite and muscovite from samples representing a wide range of diagenesis and low-temperature metamorphism. Samples include Gulf Coast sediments, sediments from the Salton Sea region, California, the Martinsburg Formation at Lehigh Gap, Pennsylvania, the Kalkberg Formation at Catskill, New York, Otago Schists from southern New Zealand, pelites from the Gaspé Peninsula in Quebec, Canada, shales and slates from Wales, sediments from the Barbados accretionary complex, and synthetic hydrothermal illite.

Samples from rocks of lowest grades, including those representing a range of sedimentary diagenesis, invariably give SAED patterns with few, complex non-00*l* reflections which are diffuse and ill-defined and that represent largely disordered stacking sequences. Corresponding XRD patterns are consistent with $1M_d$ polytypism. The term $1M_d$ is therefore retained for this material. Higher grade samples, including those in which slaty cleavage is developed, and detrital grains in low-grade sediments invariably give diffraction patterns of well-ordered 2- or 3-layer polytypes. Of all samples and localities studied, only one diffraction pattern, from a sample in the Gaspé sequence, was found to be predominantly 1*M*. In none of the other sequences included in this study were any 1*M* or predominantly 1*M* electron diffraction patterns obtained for illite grains.

Where illite is in its original state of formation, it is consistently $1M_d$, whether it originates as a result of direct crystallization from solution or as a replacement of smectite. Where illite has apparently undergone subsequent change, presumably through dissolution and crystallization representing an Ostwald-step-rule-like change, it occurs as a well-ordered 2-layer (inferred to be $2M_1$,) or, less commonly, a 3*T* polytype. On the basis of this limited survey, the state of polytypism appears to directly identify illite as either being in, or changed from, its initial state of formation.

Key Words: Illite • Polytypism • Transmission electron microscopy

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