Periodic and Nonperiodic Stacking in Biotite from the Bingham Canyon Porphyry Copper Deposit, Utah

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Abstract: Fine-grained biotite crystals within primary actinolite from a quartz monzonite body of the Bingham Canyon porphyry copper deposit, Utah, consist of 1M, $5M_1$, and $1M_d$ polytype structures. HRTEM images directly show the stacking sequences of ordered biotite polytypes, stacking faults in ordered polytypes, and stacking sequences in disordered polytypes, if the stacking vectors for the 2:1 layers involve only 0 ° and ± 120 ° rotations. The most common type of stacking fault in the 1M biotite is a layer with −120 ° rotation, followed by a layer with +120 ° rotation, which corresponds to one unit cell of the $2M_1$ polytype inserted in the 1M structure. Disordered (or semi-random) biotite is composed primarily of thin domains of the 1M and $2M_1$ polytypes, with stacking faults. The structure of a new 5-layer ($5M_1$) polytype has been determined from SAED and HRTEM results. The stacking sequence of the polytype is [02022].

A model of structural oscillation among 1M, $2M_1$, and 3T structural states is proposed to interpret nonperiodic stacking sequences in biotite crystals formed during non-equilibrium crystallization. The model also provides qualitative insights into the structure of complex long-period polytypes and may help to explain intergrowths of ordered and disordered polytypes that form during crystallization far from the equilibrium state.

Key Words: 5-Layer mica polytypes • Biotite • Transmission electron microscopy • Structural oscillation

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