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TEM investigation of Lewiston, Idaho, fibrolite: Microstructure and grain boundary energetics

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Abstract

High-resolution transmission electron microscopy (HRTEM) revealed that a sample of fine-grained Lewiston, Idaho, fibrolite is predominantly fibrolite with trace amounts of poorly crystalline layer silicates. The fibrolite consists of aggregates of acicular grains where the *c* axis of each grain is parallel to the elongation direction. Widths of 195 grains were measured: The average is 0.41 μm, the mode is 0.29 μm, and the range is 0.05–1.57 μm. No stacking faults or other extended defects were observed in any of the grains. Grain boundary energies were calculated using the symmetrical dislocation tilt wall theory (SDTW) and measurements of misorientation between the *c* axes of neighboring fibrolite crystals. The angles of misorientation range from 1° to 11°, yielding grain boundary energies ranging from 310 to 967 ergs/cm^2, respectively, with an average energy of 610 ergs/cm^2. Modeling the fibrolite grains as infinitely long cylinders and using the experimentally measured average grain diameter, an average molar grain boundary energy of 320 J/mol was calculated. This excess grain boundary energy could correspond to a shift of as much as +140 °C in the andalusite-sillimanite boundary and +30 °C in the kyanite-sillimanite boundary. Typical fibrolite grain boundaries adopt relatively high-energy configurations. We attribute this to fibrolite nucleation at pre-existing low-angle grain boundaries in layer silicates, preserving misorientations, and conferring a fine-grained texture.