HRTEM and SAED investigations of polytypism, stacking disorder, crystal growth, and vacancies in chlorites from subgreenschist facies outcrops

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ABSTRACT

Selected-area electron diffraction (SAED) combined with experimental and computed high-resolution transmission electron microscopy (HRTEM) images were used to investigate polytypism, stacking disorder, mixed layering, and vacancies in chlorites from subgreenschist facies outcrops of the Taveyanne Sandstone from the Helvetic nappes, Switzerland. SAED patterns reveal increased ordering of the stacking sequences in chlorite with increasing metamorphic grade. However, semi-randomness and rotational faults occur even if the SAED photographs imply a regular ordered stacking sequence. In diagenetic ($T = 210$–250 °C, $P = 2.1$–2.2 kbar) and anchizonal-grade outcrops ($T = 270$–300 °C, $P < 5$ kbar) the polytypes Ibb and IIbb of chlorite were found, whereas in epizonal-grade samples ($T = 300$–360 °C, $P < 5$ kbar) the exclusive polytype is IIbb. Based on SAED and HRTEM images, a polytypic evaluation in one epizonal sample indicate that the monoclinic polytype IIbb-2 (55%) occurs as frequently as the triclinic polytype IIbb-4 (45%). Our samples suggest that by far the most important influence on polytypism and stacking disorder is temperature.

Vacancy clusters occur in the octahedral cation positions within the talc-like layers and brucite-like sheets. The M1 and M2 positions in the talc-like layers are affected more by the cation deficiencies than the M3 and M4 positions in the brucite-like sheets. We suggest that octahedral vacancies are a substantial feature in natural chlorites in rocks of the Taveyanne Sandstone.