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Chemical control of 3*T* stacking order in a Li-poor biotite mica

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Abstract

The microstructural features of a biotite (Mg-rich annite) crystal from dacite rocks of Džep, Serbia, were studied by X-ray diffraction topography (XRDT) and high-resolution and analytical transmission electron microscopy (HRTEM and ATEM, respectively). The average chemical composition, obtained by electron microprobe analysis (EMPA) and secondary-ion mass spectrometry (SIMS) data, is

$$(K_{0.87}Na_{0.05}Ca_{0.01})_{\Sigma=0.93}(Fe^{2+}_{1.36}Mg_{1.25}Ti_{0.22}Al_{0.14}Mn_{0.03}Li_{0.01})_{\Sigma=3.01}(Si_{2.84}Al_{1.16})_{\Sigma=4.00}O_{10}[(OH)_{1.53}O_{0.35}F_{0.10}Cl_{0.02}]_{\Sigma=2.00}.$$

Inhomogeneous regions from either different polytypes or twins were mapped by XRDT, and these images were used to guide sampling for TEM analysis. Three stacking arrangements, each belonging to subfamily-*A* of mica polytypes, were identified by selected area electron diffraction (SAED) patterns and HRTEM images: (1) dominant semi-random $1M_r$-*n*(120°), including an occasional repetition of long-period inhomogeneous stacking sequences belonging to the 3*T* structural series; (2) highly faulted $2M_1$, sometimes with short-range-ordered long-period inhomogeneous sequences based on the $2M_1$ structural series; and (3) perfectly ordered 3*T* stacking repeating over long distances (several micrometers). ATEM data revealed that the microchemical composition of 3*T* differs from that of the host matrix. The 3*T* is enriched in interlayer cations (K and Na), and depleted in Si and octahedral cations. No evidence of Li was detected. Compositional control on the stability of 3*T* stacking is suggested.

Keywords: Polytypism, biotite, electron microscopy, chemical analysis