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Deformation-controlled cation diffusion in tourmaline: A microanalytical study on trace elements and boron isotopes

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Abstract

Plastic deformation of variable intensity has modified primary textures, composition, and element distribution in tourmaline from a mylonitic pegmatite from the NW Argentinean Sierras Pampeanas. The primary concentric tourmaline zonation has been overprinted and partly destroyed by synkinematic cation diffusion that occurred under amphibolite-facies *P*-*T* conditions. Textural changes include bending of crystals, formation of subgrains, and subgrain rotation, leading locally to recrystallization of tourmaline. Some parts of deformed crystals were less affected or unaffected by plastic deformation and secondary cation diffusion.

Two principal processes, intracrystal trace-element diffusion and matrix exchange of trace-elements, caused the compositional variations in deformed tourmaline domains. Intracrystal diffusion partly or completely destroyed the primary trace-element zonation by cation diffusion from zones of high to low concentration. Small cations occupying the Y-position are readily mobilized even by weak deformation, whereas large cations on the X-site require higher deformation intensity to be mobilized and show less pronounced or no homogenization of the primary zonation. Matrix exchange between tourmaline and co-existing solid or fluid phases generally leads to trace-element loss from deformed tourmaline domains. The extent of the matrix exchange is primarily controlled by the compatibility of mobilized cation species with matrix phases during mylonitization.

In contrast, the B-isotopic compositions in deformed and undeformed crystal domains are uniform, indicating absence of significant B diffusion and isotope fractionation during crystal growth and plastic deformation; i.e., the activation energy to move B in tourmaline must be too high even for intense plastic deformation to overcome.

Keywords: Plastic deformation, compositional homogenization, matrix exchange, LA-ICPMS, SIMS