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Using cathodoluminescence to identify oscillatory zoning of perthitic K-feldspar from the equigranular Toki granite

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Abstract

For the first time, cathodoluminescence (CL) was used to show oscillatory zoning in perthitic K-feldspars from the equigranular Toki granite, central Japan. Based on the CL patterns, two types of zoning are identified: single core oscillatory zoning (SCOZ) and multiple core oscillatory zoning (MCOZ). The SCOZ is defined by oscillatory zoning around a single-crystal core within the K-feldspar crystal, whereas the MCOZ depicts two or more such crystal cores. The crystal cores displayed in CL images reflect the nucleation parts of magmatic K-feldspar. The existence of MCOZ patterns in K-feldspars indicates multiple nuclei. CL patterns reveal crystal growth behavior of magmatic K-feldspar in the equigranular Toki granite. CL intensities are positively correlated with titanium and barium concentrations, indicating that the CL variations depend on two factors: (1) titanium concentration as a CL activator and (2) density of Al-O^{-}-Al structural defects. The analysis of CL images revealed that albite-rich phases in microperthite and patchperthite with low-luminescence intensities cut across the CL bands of the oscillatory zoning, indicating that the oscillatory zoning in the orthoclase-rich host phase of K-feldspar was not perturbed by the formation of microperthite and patchperthite in the post-crystallization stage. The luminescence intensities of albite-rich phases in patchperthite are lower than those in microperthite, which is due to the differences in titanium and barium concentrations between them. In the post-crystallization stage, the mass transfer of titanium and barium occurred during the formation of microperthite and patchperthite. Therefore, the difference in the luminescence intensities between microperthite and patchperthite lamellae reflects their different formation mechanisms between exsolution coarsening and dissolution-precipitation coarsening. In summary, CL analyses can be used for the evaluation of the nucleation and growth not only of anhedral K-feldspar crystals in equigranular granite but also of K-feldspar phenocrysts/megacrysts in porphyritic granite. It can reveal the spatial extent of element partitioning between the melt and crystal, along with that of mass transfer from the melt into crystals during the magma evolution. Moreover, the CL analyses can also be used for the interpretation of K-feldspar textural development during the post-crystallization stage.

Keywords: Cathodoluminescence, K-feldspar, oscillatory zoning, microperthite, patchperthite, granite