Cathodoluminescence study of apatite crystals

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ABSTRACT

Cathodoluminescence (CL) spectrometry represents a promising technique for the analysis of trace-element concentrations and distributions in minerals. However, a higher precision and a standardization of the recording conditions are required to use CL spectral data quantitatively. A significant step towards a more quantitative treatment of CL spectra is presented in this study.

A procedure to correct the spectra for the various efficiencies as a function of the wavelength of the CL detector is proposed using low-pressure mercury-vapor and quartz-iodine lamps. CL spectra presented in this study are thus corrected for the system response. Apatite CL spectra, which are commonly composed of two broad bands centered at 3.5 and 2.2 eV, are deconvoluted to isolate component bands and determine their areas. The crystallographic control by prismatic or basal sections of apatite on spectral intensities is significant and only prismatic sections should be used. Signal decrease associated with electron bombardment (electron beam aging) is exponential and appears drastic in the first hundred seconds but continues even after 15 minutes of beam bombardment.

All observed CL bands could be correlated with a specific activator [rare earth elements (REE) or manganese]. The 3.5 eV band is composed of three bands at 3.59 eV, 3.29 eV, and 2.87 eV. Ion microprobe results and comparison between CL and photoluminescence data support Ce^{3+} activation for the origin of these bands.

The relationship between CL band intensity and REE concentration measured by ion microprobe analysis demonstrates that CL also can provide semi-quantitative data for Gd^{3+}, Ce^{3+}, Dy^{3+}, and Sm^{3+} when recording conditions are strictly controlled.