

Multispectral Imaging in Cathodoluminescence Microscopy

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Introduction

Cathodoluminescence (CL) microscopy using cold cathodes and optical microscopes is a common tool in geology and particularly in the sedimentology of carbonates (see Pagel *et al.* (Eds.), 2000). Basically, petrologists take advantage of variations in colour in order to distinguish different mineral species and to interpret different mineral paragenetic sequences characterised by different fluid compositions. Colour contrasts may be generated in some favourable cases by chemical contrasts of only a few ppm in activator elements such as Mn²⁺, REE, Fe³⁺, Ti⁴⁺, etc.

Although CL observations are widely used, quantitative analysis of emission spectra are still poorly documented (Mitchell *et al.*, 1997). Imaging of selected spectral bands may open the way to a better understanding of crystallochemistry, compositional zonings and growth conditions of minerals.

Materials and methods

A CL equipment from CITL (model CCL 8200 mk3) mounted on an Olympus BX 60 microscope has been used for this study. The imaging device is a PCO SensiCam camera with a Peltier cooling stage allowing for a continuous adjustment of the integration time (exposure) from 1 millisecond to 1000 seconds. The connection tube between the PCO camera and the microscope is fitted with a rotating wheel holding nine different 25mm Ø filters. Interference filters with a 10 nm bandwidth have been chosen with reference to known excitation bands such as 360nm (Ce³⁺), 390nm (Nd³⁺), 410nm (Eu²⁺), 560nm (Mn²⁺), etc.

Multispectral Imaging

Due to very low light levels imposing long exposures, optimal imaging conditions may be hard to achieve. By taking advantage of the binning capabilities of the camera, it is possible to combine the photonic response of neighbouring cells and to obtain reasonable refreshing rates (ex. one image every two seconds) at a reduced spatial resolution. Figure 1 displays images of zoned apatite crystals taken at 489nm, 591nm and 692nm. We see that the zoning is better put forward by the image at 591nm which displays the higher luminosity contrast. This is interpreted to result from variable amount of Mn²⁺.

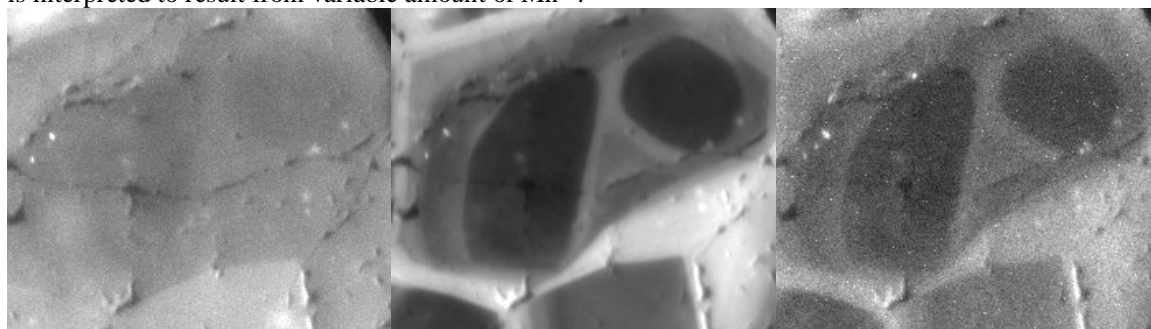


Fig. 1. Cathodoluminescence images of apatite crystals taken at 489nm, 591nm and 692nm

Perspectives

Multispectral imaging of CL emissions in contrast to RGB colour imaging open the way to quantitative image analysis of selected bands. Although microchemical data are not available at the moment to calibrate the CL emission intensities of these apatites, the next step will be to map variable Mn and REE concentrations in apatite crystals.

References

- Pagel M., Barbin, V., Blanc, P. & Ohnenstetter, D. (Eds.), 2000. *Cathodoluminescence in Applied Geosciences*. Springer-Verlag, Berlin, 2000.
- Mitchell R.H., Xiong J., Mariano A.N. & Fleet M.E., 1997. Rare-earth-element-activated cathodoluminescence in apatite. *Canadian Mineralogist*, 75: 979-998.