Hyperspectral cathodoluminescence mapping of calcite and feldspar

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Introduction

Hyperspectral mapping is a very powerful technique for determining the cathodoluminescence (CL) emission characteristics and chemical compositions of materials over relatively large areas and at micron to sub-micron spatial resolutions (Lee *et al.* 2005). Using a Cameca SX100 electron probe at Strathclyde University, which is equipped with a silicon CCD spectrograph and energy- and wavelength-dispersive X-ray detectors, we have investigated spatial and spectral variations in the CL properties of meteoric calcite cements from the Upper Permian of the UK and perthitic alkali feldspars (Na- and K-rich intergrowths) from the Precambrian Klokken syenite, Greenland.

Results

Calcite and feldspar were studied because they both have two main emission bands, one in the near-UV/blue and the other at orange to near-IR wavelengths. Hyperspectral images reveal that the calcite cements show oscillatory zoning that is developed at both UV-blue and orange-red wavelengths. Zones seen in the UV-blue do not correspond exactly with those developed at longer wavelengths and show more fine-scale detail. Spatial variations in emission intensities at orange-red wavelengths correlate closely with differences in Mn concentrations whereas there is no clear correlation between emission intensities at blue wavelengths and trace element compositions.

By contrast, the feldspars show well developed and very fine-scale oscillatory zoning at UV-blue wavelengths but irregular variations in luminescence intensities in the red/near-IR. Surprisingly, zones developed in the UV-blue can be traced uninterrupted between intergrown Na- and K-rich feldspar. Growth-related differences in defect density is the most common explanation for zoning in feldspars at blue wavelengths, but such an explanation is hard to reconcile with the very fine-scale zones that can be traced between minerals.

We conclude that hyperspectral CL mapping in combination with trace element geochemistry can provide a wealth of new insights into the CL properties of materials and the factors that control luminescence activation.

Reference

Lee, M.R., Martin, R.W., Trager-Cowan, C. and Edwards, P.R. (2005) *Journal of Sedimentary Research A* (in press).

Zoning patterns in metasomatic minerals from the North Qôroq centre, South Greenland: Insights and significance from cathodoluminescence

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The North Qôroq nepheline syenite centre is a multi-phase intrusion that forms part of the Proterozoic Gardar Province of southern Greenland. Fractional crystallisation within the intrusion has resulted in residual magmatic liquids of peralkaline composition. These fluids were enriched in REE, Zr and Nb, and resulted in the localised crystallisation of eudialyte. Syenitic magma was repeatedly emplaced within the centre at different stages of fractionation; consequently, any syenite present and country rocks periferal to the intrusion were affected and invaded by a variety of compositionally distinct metasomatic fluids. Evidence for multiple fluid events is recorded in metasomatic and magmatic-metasomatic mineral phases, that include titanite and apatite. Previous studies of zoned apatite in syenites from the centre suggested that newly emplaced syenite magmas produced a number of compositionally distinct metasomatic events (e.g., Coulson and Chambers, 1996). The studies further demonstrate that metasomatism resulted in extensive redistribution of REE and other so-called 'immobile' elements, with apatite, titanite and fluorcarbonate minerals as major repositories. This investigation builds upon the earlier work through a detailed study of titanite and zircon from North Qôroq, using scanning electron microscope based cathodoluminescence (CL) techniques. In these types of minerals, CL, although not quantitative, is a sensitive indicator of trace element presence and changes. Several mineral grains were examined using hyperspectral CL imaging techniques. Spectral data at a density of several hundred spectra per grain show the detailed distribution of the trace elements in the grains. This data provides additional insight into the development of zoning and its significance in the evolution of the intrusion.

Reference

Coulson I.M. and Chambers A.D. (1996), *Canad. Mineral.* **34**, 1163-1178.