POTENTIAL ESTIMATION OF RADIATION-INDUCED STRUCTURAL DISORDER WITH REE^{3+} LUMINESCENCE SPECTROSCOPY

Lenz, C. & Nasdala, L.

Universität Wien, Institut für Mineralogie & Kristallographie, Wien, Austria
e-mail: christoph.lenz@univie.ac.at

We present first results of a study addressing whether REE^{3+} luminescence spectroscopy can be used to estimate the degree of structural disorder in natural zircon ($ZrSiO_4$). Our results show that the degree of disorder, as observed from the broadenings and shifts of luminescence bands, generally depends on (1) chemical composition (i.e., structural disorder due to the incorporation of non-formula elements) and (2) structural state (i.e., radiation damage, crystallinity, strain/stress). Effects of radiation-induced disorder were studied on zircon samples from various locations (NASDALA et al., 2006). In that study, single-crystals were cut in two halves. One half each was then subjected to heat treatment in air to anneal the radiation damage, whereas the other half remained in its natural, radiation-damaged state. Comparison of photoluminescence (PL) spectra implies that the full-width-at-half-maximum (FWHM) of certain luminescence bands of trace Dy^{3+} is very sensitive to the accumulation of radiation damage (Figure 1). Interior regions with elevated U and Th content accumulated more radiation-damage over geologic time and hence show the strongest PL band broadening.

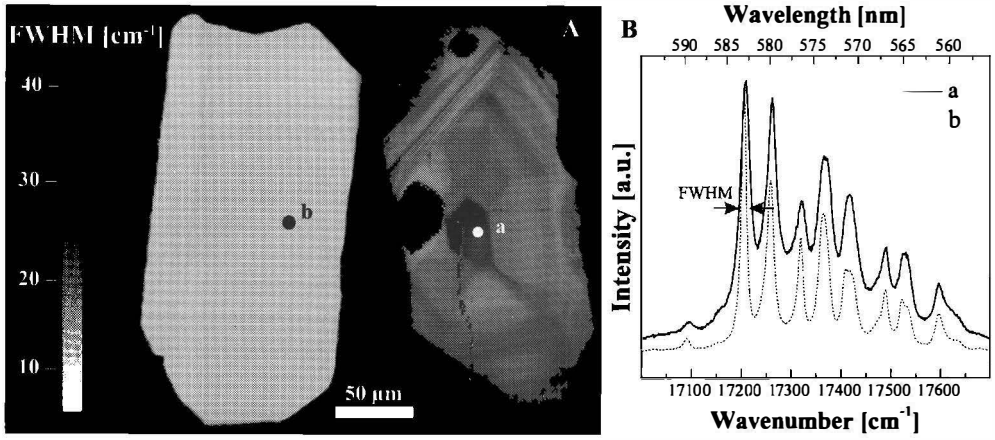

Figure 1. (**A**) Photoluminescence map (FWHM of the Dy^{3+} $^4F_{9/2} \rightarrow {}^6H_{13/2}$ transition) of a cut Archaean gabbro zircon-crystal from the Mulcahy Lake intrusion, Ontario, Canada. The left half was annealed at 1300 °C whereas the right half remained in its natural, radiation-damaged state. (**B**) Intensity-normalised PL spectra (λ_{exc} = 473 nm) showing the $^4F_{9/2} \rightarrow {}^6H_{13/2}$ transition of trace Dy^{3+} of both crystal halves (analysis points indicated in **A**).

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