# Ti-in-quartz thermometry coupled with cathodoluminescence imaging: a novel tool for interpreting the metamorphic history of migmatites*

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The usefulness of Ti as a trace element in quartz has recently become a subject of interest in the fields of metamorphic, igneous, and hydrothermal deposit petrology. The Ti content of quartz has been positively correlated with growth temperature, forming the basis of Ti-in-quartz geothermometers. An association has also been found between trace Ti and cathodoluminescence (CL) emissions in quartz, allowing textures such as growth zonation to be identified in individual crystals. Combining Ti-in-quartz thermometry with CL imaging therefore creates a powerful tool for interpreting complex geologic histories. As quartz is one of the most robust and common silicate minerals in the crust, the technique has profound potential for a wide variety of rock types. Reliable results are limited, however, to rocks for which the activity of Ti during quartz growth ($a_{TiO2}$ ) can be quantified, such as those bearing rutile. A promising yet largely unexplored application of the technique is metamorphic quartz, particularly in migmatites. Quartz may be produced during various stages of metamorphism, and is most importantly associated with the production and crystallization of partial melt. Interpreting Ti signatures in quartz using Ti-in-quartz thermometry and CL imaging could provide valuable insight into the thermal history of migmatites.

This project aims to test the coupled Ti-in-quartz thermometry and CL imaging technique using previously studied migmatite samples. Distinct textural types of quartz in a thin section can be readily identified using mineral liberation analysis (MLA) maps, then subsequently imaged using CL to create an approximate map of Ti distribution. Trace Ti in quartz can be detected by electron microprobe analyzer (EPMA) using a multi-spectrometer approach, and the high spatial resolution allows for documentation of Ti zonation. Resulting temperature estimates can then be compared to a P-T framework for the sample previously established through phase equilibria modelling. As rutile is relatively common in migmatites, $a_{TiO2}$ can be quantified in many cases; however, in rutile-absent rocks, $a_{TiO2}$ must be considered carefully. By following this procedure, the details of migmatite metamorphic history recorded in quartz will become apparent, and the effectiveness of the Ti-in-quartz technique can be evaluated.

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