Coupled Ti-in-quartz thermometry and cathodoluminescence imaging: a potential technique for investigating the thermal history of partially melted rocks

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Titanium as a trace element in quartz has 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. A relationship has also been found between trace Ti and cathodoluminescence (CL) emissions in quartz, allowing textures such as growth zonation to be recognized in individual crystals. Coupling Ti-in-quartz thermometry with CL imaging therefore creates a potentially 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 (a_{TiO2}) during quartz growth 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 by many retrograde metamorphic reactions, and is most importantly associated with the crystallization of partial melt. Interpreting Ti signatures in quartz using Ti-in-quartz thermometry and CL imaging could provide 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. Using mineral liberation analysis (MLA) maps, distinct textural varieties of quartz in a thin section can be readily identified and 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, with the advantage of ah igh spatial resolution. 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, if if rutile is absent or not stable with quartz, 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.

Atlantic Geology, 2016, Volume 52
Geological Association of Canada Newfoundland and Labrador Section ABSTRACTS – 2016 Spring Technical Meeting
doi: 10.4138/atlgeol.2016.005