Unravelling a H*P*-H*T* prograde metamorphic history from quartz and rutile inclusions in garnet

L. TUAL [1,2]*, C. MÖLLER[1], P. PITRA[3], M. WHITEHOUSE[2]

[1] Department of Geology, Lund University, Sweden
[2] Swedish Museum of Natural History, Stockholm, Sweden (*correspondence: lorraine.tual@gmail.com)
[3] Géosciences Rennes, Université de Rennes 1, France

Trace-element compositions of mineral inclusions in garnet (e.g., quartz, zircon and rutile) are commonly used to provide thermo(baro)metric estimates. However, the systematics of the thermometric equilibria in these minerals at high pressure and temperature are not fully understood. To investigate this, we analyzed *in-situ* quartz and rutile inclusions in a Fe-Ti-rich eclogite from the Sveconorwegian orogen in southern Sweden by SIMS. Abundant quartz, rutile and zircon in distinct microstructural sites (garnet core, garnet rims and matrix) make this sample particularly suitable for this study.

A *P*–*T* path, peaking at 16.5–19 kbar and 850–900 °C has been deduced for this rock by pseudosection modelling; input pressures from this model were used for trace element thermometry of each garnet microtextural domain. For *garnet cores*, Zr-in-rutile yields 700–715 °C and Ti-in-quartz 620–640 °C at 7 kbar. For *garnet rims*, temperature estimates are 760–790 °C (Zr-in-rutile) and 740–890 °C (Ti-in-quartz) at 12–18 kbar. Finally, *matrix* rutile records 775–800 °C and locally ~900 °C, and quartz records temperatures up to ~890 °C. Alongside, direct combination of Ti in quartz and Zr in rutile isopleths yields a prograde path that is nearly identical to that deduced from the pseudosection.

The pseudosection shows that rutile was produced by continuous breakdown of ilmenite during the early stages of prograde metamorphism – a reaction that was completed at ~730 °C. Thereafter, rutile grains in the garnet rim and the matrix grew larger by recrystallization. However, these rutile grains generally do not record the peak-*P* temperatures, but instead yield 775–815 °C. This is interpreted to reflect recrystallization associated with a major prograde dehydration reaction in the rock, involving continuous breakdown of hornblende and production of clinopyroxene.

This study illustrates that Zr-in-rutile and Ti-in-quartz thermobarometry can robustly constrain prograde *P*–*T* conditions and also yield important insights on recrystallization processes at high temperatures. The combination of these methods and integration of the results with pseudosection modelling provides a versatile tool for investigating the petrologic history of high-grade rocks.