Rutile U-Pb thermochronology as a tool to constrain time-resolved cooling histories in orogenic belts

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The great versatility of rutile in studies on crustal evolution and tectonics is becoming increasingly apparent. The mineral provides a reliable single-mineral thermometer, capable of retaining temperature information during high and ultra-high temperature metamorphism. Its HFSE contents can be used to investigate the geochemical environment in which rutile crystallized. Most importantly, rutile strongly fractionates U/Pb and exhibits Pb diffusion at moderate to high temperature, enabling U-Pb thermochronology. In this contribution, we take advantage of these properties and use U-Pb dating by LA-MC-ICPMS to further investigate the thermal history of rocks from the UHP zone of the Western Gneiss Complex (WGC), Norway.

Millimeter-sized single crystals of rutile from a phlogopitite vein in eclogite were mounted and polished to expose the geometric cores. Transects of 30-μm laser spots were analyzed, yielding well-defined Pb diffusion profiles reflected by ages ranging from ~415 Ma in the central domains to ~380 Ma in the outermost rims (±2%, 2σ on individual spots). The length and amplitude of the Pb diffusion profiles were used in conjunction with the well-established and verified Pb diffusion parameters [1] to 1) estimate peak temperature (~800 °C) and 2) resolve the retrograde thermal history during cooling to ~500 °C.

The conditions and timing of cooling, as constrained through rutile micro-analysis and diffusion modeling, is consistent with, and further refines the peak-to-retrograde thermal history established for the western WGC. This demonstrates that spatially resolved U-Pb analysis of rutile can be used to reliably constrain cooling histories at moderate- to high-temperatures.

[1] Cherniak (2000) *Contrib. Mineral. Petrol.* **139**. 198-207