Rutile thermochronology constrains time-resolved cooling histories in orogenic belts

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The versatility of rutile in studies on crustal evolution and tectonics is becoming increasingly apparent. The mineral's HFSE contents can be used to investigate the geochemical environment in which rutile crystallized. It provides the single-mineral Zr-in-rutile thermometer, capable of retaining temperature information during high and ultra-high temperature metamorphism. Most importantly, rutile exhibits high U/Pb and loses radiogenic Pb through volume diffusion at $T \geq 500$ °C, 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. In particular, we explore the use of Pb as a diffusive species in kinetics-based thermometry.

Millimeter-sized single crystals of rutile from a phlogopitite vein in eclogite were mounted and polished to expose their geometric cores. Transects of 30-µm laser spots were analyzed. These yield well-defined Pb diffusion profiles, with U-Pb ages ranging from *c*. 415 Ma in the central domains to ~380 Ma in the outermost rims (±2%, 2σ on individual spots). Lead diffusion zoning length was used in conjunction with well-established Pb diffusion parameters [1] to determine peak temperature conditions. The result, *c*. 810 ± 25 °C, is consistent with 800 ± 25 °C and *c*. 780 °C as estimated for the same sample using conventional and Zr-in-rutile thermometry, respectively. The cooling history is reconstructed through age zoning analysis and diffusion modeling, and agrees with constraints from $^{40}Ar/^{39}Ar$ dating.

The cooling history deduced from in-situ micro-analysis of single rutile crystals is consistent with, and further refines, that established for the WGC. The recognition that both thermometric and thermochronologic constraints can be obtained from rutile U-Pb analysis further underscores the great potential of this mineral in lithosphere research.

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