Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18375

Rutile reference material for in-situ (U-Th)/He thermochronology

ISTVÁN DUNKL AND HILMAR VON EYNATTEN

University of Göttingen

Presenting Author: istvan.dunkl@geo.uni-goettingen.de

Beyond U-Pb geochronology rutile crystals can also be dated by the (U-Th)/He thermochronometer to obtain valuable low-T age constraints. However, the quantitative extraction of the radiogenic helium from entire rutile crystals or fragments thereof by heating is a time consuming procedure, and it requires numerous re-extraction steps. The extraction of He by laser ablation is independent from the diffusion properties of the crystal and from transformation of the crystal lattice during the heating steps. This technique liberates He quantitatively, restricted to the volume of the ablation pit, allowing good spatial resolution and several analyses within a single crystal.

(U-Th)/He thermochronology of rutile is especially important at dating old, cratonic units having early Palaeozoic or even older cooling ages. The closure temperature of the dominantly used zircon and titanite helium thermochronometers show decrease by the accumulation of radioactive damages. Above the density of ca. 10E18 alpha damage/gram the closure temperature of zircon shows a dramatic drop, it approaches ambient temperatures and the crystals are practically leaking helium. Rutile typically has two orders of magnitude less actinide concentration than zircon and is not influenced by the accumulated damages even in case of Proterozoic ages. The closure temperature remains constant and the rutile thermochronometer can detect accurately tectonic and/or erosional cooling and exhumation events in deep time.

By laser ablation double dating of rutile the usage of proper reference materials is essential both for the calibration of extracted helium and also for the matrix-matched U-Pb ages. Here we suggest to use a natural rutile reference material that has homogeneous composition and the age and uranium content allow precise determination of both decay products (Pb and He). The DM-35 rutile yields 514 ± 7 (1sd) ± 3 (1se) Ma U-Pb age and 463 ± 17 (1sd) ± 4 (1se) Ma (U-Th)/He age. Using corrections based on the DM-35 in-house reference rutile we obtained geologically meaningful rutile in-situ helium ages on cratonic basements and also double-dating was performed on detrital grain populations. Routine application of in-situ rutile double dating may significantly extend the toolkit for provenance analysis of siliciclastic sediments and rocks.