Titanite "crystallinity" determination for thermochronology

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In contrast to zircon titanite plays a special role in (U-Th)/He thermochronology because it occurs also in mafic lithologies. Furthermore, titanite typically has lower concentration of actinide elements implying that radiation damage generates lower degree of metamictization. Helium diffusivity (and thus closure temperarure) is controlled by the state of the crystal lattice, which is significantly influenced by the density of alpha-damages. By increasing degree of metamictization the closure temperature shows a dramatic drop [1], [2].

Raman spectroscopy can describe the state of the crystal lattice in zircon [3]. The widening of the Raman bands correlates well with the acummulated radioactive damage density, and the modelled peak width can be used as a parameter for the "damage age" and also as a proxy for the closure temperature. In case of titanite this relation is poorly documented and the correlation is strongly biased by extreme anisotropy and the high number of Raman bands [4].

We developed a quick, in-situ, high-spatial resolution, damage-free characterization of titanite crystals that is based on the overal widening of all Raman bands detected in the spectrum. The evaluation of the spectra is performed fully automated using the IFORS software [5].

This procedure is suggested to precede titanite (U-Th)/He dating. This allows for (i) optimizing crystal selection in case of dating old terrains (typically having high damage densities in the crystals), and (ii) assigning to each measured age a diffusivity parameter. The spread in the (U-Th)/He data can then be better interpreted by considering the variability of the closure temperatures of the individual crystals.

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