Micro-Raman dating of zircon: A possible thermochronometer?

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It has since long been suggested that measurements of the self-irradiation damage densities in actinide bearing minerals and of the concentrations of the damage producing isotopes permit calculating lossless damage accumulation intervals [1, 2]. Under favourable circumstances, these calculated intervals can correspond to meaningful geological formation or cooling ages. We report Raman measurements of the self-irradiation damage in zircons from the continental deep drillhole in SE Germany (KTB; *Kontinentale Tiefbohrung*), down to >7 km depth. The wavenumbers [$\omega_1(SiO_4)$ and $\omega_3(SiO_4)$] and widths [$\Gamma_1(SiO_4)$ and $\Gamma_3(SiO_4)$] of the $\nu_1(SiO_4)$ and $\nu_3(SiO_4)$ internal-stretching bands are fairly constant down to 3 km, decrease (ω_1, ω_3) or increase (Γ_1, Γ_3) between 3 and 5 km, and plateau out at >5 km. High Γ_1 and Γ_3 associated with ω_1 and ω_3 values within the range of those of undamaged zircon at >5 km are identified as an inherited signal, predating the Late-Cretaceous to Palaeocene exhumation of the hanging wall of the Franconian thrust fault that intersects the KTB at 7 km depth. A superimposed post-exhumation signal indicates full damage retention down to ~3 km depth, partial retention between ~3 and ~5 km, and "zero" retention at greater depth. Radiation-damage ages calculated from the sample-mean Γ_3-values [3] and U and Th concentrations Between 0 and ~3 km, using a revised Γ_3-baseline to account for the background from the inherited component, are consistent with titanite and zircon (U,Th)-He ages [4, 5]. The calculation is consistent with current undestanding of the damage annealing kinetics [6], but certain assumptions involved in the age calculations require verification.

[1] Kulp *et al.* (1952) *Am. Mineral.* **37**, 709-718. [2] Hurley & Fairbairn (1953) *GSA Bull.* **64**, 659-673. [3] Nasdala *et al.* (1995) *Eur. J. Mineral.* **7**, 471-478. [4] Stockli & Farley (2004) *Chem. Geol.* **207**, 223-236. [5] Wolfe & Stockli (2010) *EPSL* **295**, 69-82. [6] Geisler (2002) *Phys. Chem. Min.* **29**, 420-429.