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Further investigation of the initial fission-track length and geometry factor in apatite fission-track thermochronology†

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ABSTRACT

The external detector method (EDM) is a widely used technique in fission track thermochronology (FTT) in which two different minerals are concomitantly employed: spontaneous tracks are observed in apatite and induced ones in the muscovite external detector. They show intrinsic differences in detection and etching properties that should be taken into account. In this work, new geometry factor values, *g*, in apatite, were obtained by directly measuring the ρ_{ed}/ρ_{is} ratios and independently determined $[GQR]_{ed/is}$ values through the measurement of projected lengths. Five mounts, two of which were large area prismatic sections and three samples composed of random-orientation pieces have been used to determine the *g*-values. A side effect of applying EDM is that the value of the initial confined induced fission track, L_0, is not measured in routine analyses. The L_0-value is an important parameter to quantify with good confidence the degree of annealing of the spontaneous fission tracks in unknown-age samples, and is essential for accurate thermal history modeling. The impact of using arbitrary L_0-values on the inference of sample thermal history is investigated and discussed. The measurement of the L_0-value for each sample to be dated using an extra irradiated apatite mount is proposed. This extra mount can be also used for determining the *g* value as an extension of the ρ_{ed}/ρ_{is} ratio method. Eight apatite samples from crystalline basement, with grains at random orientation, were used to determine the *g*-values. The results found are statistically in agreement with the values found for apatite samples (from Durango, Mexico) measured in prismatic section and also measured at random orientation. There was no observable variation in efficiency regarding crystal orientation, showing that it is relatively safe using non-prismatic grains, especially in samples with paucity of grains, as it is the case of most basin samples. Implications for the ζ-calibration and for the calibration of the direct (spectrometer-based) fission-track dating are also discussed.

Keywords: Fission-track termochronology, geometry factor, ϕ-method, ζ-calibration, initial fission-track length