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Improved modeling of fission-track annealing in apatite

Richard A. Ketcham,[1,*] Andrew Carter,[2] Raymond A. Donelick,[3] Jocelyn Barbarand,[4] and Anthony J. Hurford[2]

[1]Jackson School of Geosciences, University of Texas, Austin, Texas, U.S.A.
[2]Research School of Earth Sciences at University College of London, U.K.
[3]Apatite to Zircon, Inc., Viola, Idaho, U.S.A.
[4]Département des Sciences de la Terre, Université Paris Sud, Orsay-Cedex, France

Abstract

Two abiding issues impact the reliability of apatite fission-track analysis and thermal history inversion in particular: reproducibility of track-length measurements and variability of annealing kinetics. In the companion to this paper, we addressed the first by demonstrating that using **c**-axis projection to normalize track lengths for crystallographic angle improves reproducibility among measurements acquired by Barbarand et al. (2003a, 2003b). We continue here by looking at the effect of **c**-axis projection on extrapolation of laboratory measurements to geological time scales. We find that **c**-axis projection improves agreement between predictions of empirical annealing models fit to measurements by Barbarand et al. (2003b) analysts 1 and 3, further corroborating its effectiveness in ameliorating observer bias. Furthermore, these annealing models closely match predictions from the Carlson et al. (1999) annealing data set, which was obtained by a different analyst using a different etching protocol. Normalizing for angle thus allows us to create a single annealing model that encompasses both data sets and etching techniques. By combining the different compositional varieties of apatite in the two data sets, the resulting model provides an improved basis for estimating apatite kinetic properties in unknowns using proxies such as composition, etch-figure dimension, and unit-cell parameters. Predictions from a fanning curvilinear model form accord with conventional expectations of annealing at high and low temperatures, and its use for thermal history inversion will not introduce spurious late cooling events.

Keywords: Fission-track, apatite, annealing, anisotropy, thermochronology, fanning point