American Mineralogist, Volume 88, pages 817–829, 2003

Observations on the relationship between crystallographic orientation and biasing in apatite fission-track measurements

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ABSTRACT

Analysis of extensive apatite fission-track experimental data reveals several features concerning the influence of crystallographic orientation on measurement biasing that had not been clear previously. At low levels of annealing, anisotropy in confined track lengths is most accurately depicted by an elliptical distribution, in comparison with two suggested alternatives. Quantification of length anisotropy by *c*-axis projection is simplified and improved, resulting in a model that better achieves its goal of removing anisotropy while preserving all other useful information. The variation of observational frequency of confined tracks with respect to orientation at low annealing levels reveals a large but heretofore-unreported biasing factor related to how an investigator interprets poorly etched tracks. The concept of an "under-etching bias" is introduced to encompass this effect, which can have consequences orders-of-magnitude greater than previously studied factors such as length and etch figure geometry. As annealing progresses, radical shifts in observational frequency with respect to angle make apparent another undocumented process: total annealing of substantial fractions of tracks oriented at high angles to the *c* axis. Incorporation of this loss into a previous model describing the link between confined track length and density improves the model such that its predictions are now close to the relationship observed in progressive annealing of a single population. Because under-etching biasing effects are intimately linked with orientation and extent of annealing, any future effort to develop a rigorous length calibration scheme to support thermal history modeling should take both of them explicitly into account.