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Variability of apatite fission-track annealing kinetics: III. Extrapolation to geological time scales

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ABSTRACT

A new model for examining fission-track data from natural specimens has been developed on the basis of new laboratory data describing fission-track annealing in a wide variety of apatites and the empirical correction for fission-track length anisotropy presented in earlier papers. Using revised and simplified statistical methods, we examine how well various empirical equations are able to fit the laboratory data and reproduce expected behavior on geological time scales. Based on the latter criterion, we find that so-called "fanning Arrhenius" models of mean track length are not the best-suited for our data. Instead, we find that fitting *c*-axis projected lengths with a model that incorporates some curvature on an Arrhenius plot produces results that are in better agreement with the available geological benchmarks. In examining the relative annealing behavior of apatites with different resistance to annealing, we find that the laboratory-time-scale behavior of any two apatites can be reproduced well by a simple one- or two-parameter equation. This function is used to convert the reduced fission-track length of one apatite that has undergone a certain time-temperature history into the length that would be measured in a second, less-resistant apatite that has undergone the same history. Using this conversion, we create a single model that encompasses the annealing behavior of all of the apatites we studied. The predictions made by this model match closely those made by fits to data for individual apatites. We therefore infer that, although the conversion equation is imperfect, it presents an excellent practical solution to characterizing the range of kinetic variability for annealing of fission tracks in apatite.