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Variability of apatite fission-track annealing kinetics: I. Experimental results

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ABSTRACT

Annealing rates for fission tracks in apatite vary markedly as a complex function of composition, based on an experimental study of 15 well-characterized, compositionally diverse apatites. Extensive annealing data were obtained in 69 experiments (durations of 1, 10, 100, and 1000 h at temperatures from 75 to 400 °C) on each of four apatites, three with near end-member occupancy of the halogen site by F, Cl, and OH, plus the well-known apatite from Durango, Mexico. These results were supplemented by less-comprehensive annealing data from 12 experiments over the same range of time and temperature on each of the remaining 11 apatites. Measurements of initial fission-track length, a parameter of considerable importance to the derivation of time-temperature paths from fission-track data, reveal substantial variations from one apatite to another; initial lengths are best predicted from etch figures. Interlaboratory comparisons of data on annealing kinetics highlight discrepancies that appear to result largely from differences in the precision and accuracy of experimental temperatures. None of the factors previously proposed as the dominant compositional controls on annealing rates can account completely for annealing behavior over the full range of compositions studied. Nevertheless, relative rates of annealing among all apatites are highly systematic, which allows this data set to be used in its entirety to constrain multikinetic annealing models that predict fission-track lengths as a function of time and temperature.