Confined fission tracks in ion-irradiated and step-etched prismatic sections of Durango apatite

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Apatite fission-track analysis retraces the thermal histories of geological samples under ~120 °C but low numbers of confined tracks often lead to weak constraints on the modelling results. Ion irradiation and increasing etching time are effective means to increase the number of etched confined tracks. Our results support a linear dependence of the number of intersected tracks on the lengths and densities of both the ion and fission tracks. The effectiveness of ion irradiation also depends on the etched-track geometries, i.e. on the beam orientation and etching conditions. Knife-blade shaped ion tracks parallel to the apatite c-axis are more efficient than funnel-shaped tracks perpendicular to c but add to the angular bias in favour of high angles to c. The irradiation conditions do not affect the mean track length at a given angle to c.

The number of confined tracks increases in linear proportion to etching time above a certain threshold, which we interpret as the time required to etch a track to measurable dimensions. Past this threshold, the rate of confined track revelation is rapid. The high rate of increase is itself a direct consequence of the fact that confined tracks are not measurable if etched for less than a certain minimum length of time. Etching time does not affect the angular bias but it does increase the mean track lengths at all angles. The average rate of increase of the fossil track lengths exceeds that of the induced tracks at the 2σ level. Under some conditions, ion irradiation leads to blocking of fission tracks and the development of "semi-tracks". The elliptical model of mean horizontal confined track length vs. angle to the c-axis in prismatic apatite sections is over-constrained with respect to the known symmetries and does not provide the best possible fit to the dataset. Some observations suggest a fundamental difference between fossil and induced tracks.