

Measurements of fossil confined fission tracks in ion-irradiated apatite samples with low track densities

Min M, Enkelmann E, Jonckheere R, Trautmann C, Ratschbacher L

NUCL. INSTRUM. & METHODS IN PHYSICS RESEARCH SECT. B 259 (2007) 943-950

This investigation looks into the potential and consequences of combined ion-irradiation and sequential etching as means for increasing the number of measurable horizontal confined tracks in geological apatite samples with low fission-track densities. The gain is substantial but varies between samples depending on the size and aspect of the grains and the fraction of prismatic sections. The average maximum gain ($\rho_{\text{ion}} \approx 2 \times 10^6 \text{ cm}^{-2}$; $l_{\text{ion}} \approx 30 \text{ }\mu\text{m}$; $\theta_{\text{ion}} = 15^\circ$; 35 s etching in 4 M HNO_3 at 25 °C) is ~ 200 times. Greater gains are achieved in some cases but there are indications of saturation.

For maximum effect, the beam parameters should be tailored to the properties of the sample. The effectiveness of sequential etching is much greater than expected from the ratio of the etching times or of the track cross-sections at successive etching times. The number of confined tracks increases ~ 3.5 times between $t_e = 15$ s and 25 s and a further ~ 2 times between $t_e = 25$ s and 35 s. The total increase due to etching (~ 7 times) is still much lower than that from ion-irradiation alone, estimated at ~ 30 times. Ion-irradiation has no significant effect on the etchable lengths of individual confined tracks and no pronounced effect on their angular distribution. Sequential etching has no apparent effect on their angular distribution; its effects on the lengths of individual tracks, mean confined-track length, length distribution and anisotropy are less clear.

Overall, our results document a quasi-isotropic increase of the mean confined-track length between $t_e = 15$ s and 25 s and an according quasi-uniform shift of the tracklength distribution towards longer lengths but no significant further increase nor shift between $t_e = 25$ s and 35 s. This trend varies between samples because the relationship between the mean track length and that of individual confined tracks is affected by complex sampling issues that require detailed investigation.