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A quantitative description of fission-track etching in apatite

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Abstract

We measured the apatite etch rate v_R in 5.5 M HNO_3 at 21 °C as a function of orientation. Results for Durango apatite evidence that v_R varies by a factor >5 with angle to the ***c***-axis. Our measurements also provided track etch rates v_T and surface etch rates v_S. However, these cannot be combined for calculating track etching or counting efficiencies. By inserting the measured etch rates in a recent model, we calculate the geometries and dimensions of surface tracks in different apatite faces. The proposed model must be recalibrated for different etching protocols and adapted for other minerals. We submit that the new model justifies reviewing track counting efficiencies based on the existing (v_B-v_T) etch model. We anticipate that this will have an effect on practical aspects of fission track dating. Single-track step-etch data show that the confined track lengths increase with etch time at a decreasing average rate v_L that differs from the track etch rate v_T and the apatite etch rate v_R. Both v_T and v_L exhibit large track-to-track differences that produce irreducible length variation related to the latent-track structure resulting from formation and annealing. Step etching and track width measurements are effective for reducing or eliminating procedure-related artifacts from track length data, and so for accessing more fundamental track properties.

Keywords: Apatite, fission track, etching, apatite etch rate, track etch rate; Experimental Halogens in Honor of Jim Webster