Variability of track selection approaches and progress for a new etching protocol for apatite-fission tracks

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We report a new series of step-etch experiments to reveal the influence of microscopy technique on track selection bias. Two different aliquots of induced tracks in Durango apatite were etched for 10-15-20-25-30s and for 20-25-30s in 5.5M HNO3 at 21°C. Three different track selection criteria were applied after the initial etch step of the etching procedure: (1) all tracks with reasonable measurability under transmitted and reflected light switch with 100x objective and 2.5X optovar magnification; (2) "fully etched" tracks under transmitted light with 100x objective; and (3) "fully etched" tracks under reflected light with 100x objective. Approach 1 was applied to both aliquots and the approaches 2 and 3 to the latter aliquot. Comparing the mean track lengths, approaches 2 and 3 result in similar values over all experiments, while approach 1 provides a ~0.4 m higher in the first aliquot and ~0.3 m lower in the second aliquot than approach 2 and 3 due to higher and lower variations of effective etch times. Comparing the c-axis angles, in the 0-30° range approach 3 provides a severely reduced fraction of tracks due to their weak appearance under reflected light. Furthermore, approach 2 provides ~%14 lower track densities comparing with approaches 1 and 3.

We recommend using both transmitted and reflected light during entire track selection and measurement procedures. We are working to develop a new 2+-step etching procedure, where tracks are located after 10s of etching but measured after a second 10s etch step, resulting in better-controlled etching times while reducing the bias associated with analyst choice. Furthermore, this two-step etching procedure can be iterated for more etch-steps, by identifying newly-appeared tracks after each etch step and etching them for 10s more, to increase the number of measured tracks while maintaining consistent selection criteria.