16 May 2021

Ph.D. Peter Klint Jensen, Emeritus,

Danish Technical University, dep. Civil Engineering, Geotechnics and Geology.

Answer nr. 2 to 1. reviewer (P. Green)

The deconvolution method is a mathematical method capable of reducing the length spread of confined horizontal fission tracks in track length histograms. We show that our computer program can de-blur a track length histogram like the one put forward in the 1. Reviewer answer. Assume that a sample starts at a temperature of 63 deg. C, 150 Ma back in time. At 50 Ma it is suddenly uplifted to a temperature of 20 deg. C until the present. The corresponding track length histogram is calculated forwardly by our basin model resulting in the histogram seen in fig. 1 below. A track length annealing model by Stephanson is used. The histogram is considered to be the measured histogram. The two temperature plateaus are hardly seen in the histogram. However, after deconvolution they are seen, fig. 1b. The deconvolution process works because the filters used are not completely covering each other. The filters are derived from laboratory track annealing experiments. In this case, nine filters have been in play. Each column of the deconvolved histogram (fig. 1b) is now converted to the time it takes to generate the tracks belonging to them. The relationship is almost linear but not quite. The math in the ms gives a more precise relationship. The cumulated age histogram in fig. 1c. is obtained by adding together the time intervals from the most recent to the oldest. The line at 50 Ma shows the time of the predefined rapid uplift used in the forward modeling. Imagine that the timing of this uplift is known from other sources. The pre-depositional tracks are identified based on the error bars to be the four leftmost green columns of the cumulated ages, fig. 1c. Similarly, the red columns contain the post-uplift tracks. The rightmost green column contains both pre-and post-depositional tracks.

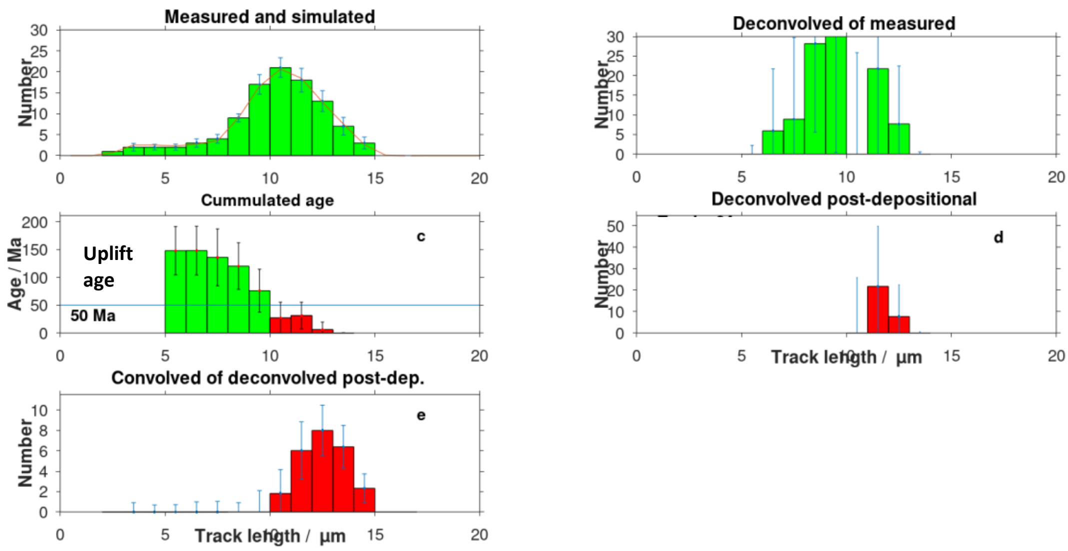
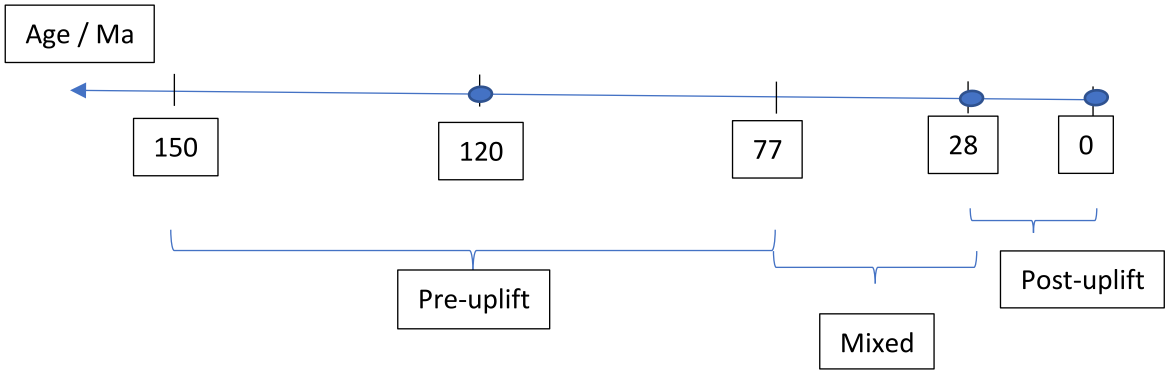


Fig. 1. a. is the forward simulated track length histogram imaging a measured histogram. b. The deconvolved histogram is a de-blurred version of the measured histogram. c. The columns of the histogram in b are converted to time intervals. They are cumulated from right to left to obtain the cumulated age

histogram in c. d. The identified post-depositional tracks. e. Convolution (spreading out) of the histogram in d identify the post-depositional part of the measured track length histogram.

Age dating is the prerequisite for temperature history calculation from fission-track data (standalone). In the example given above only three age nodes can be used for temperature calculation (blu circles).



The nodes are chosen so that they are separated from each other by at least one sigma (error bars are read on the cumulated age histogram fig. 1c.

Conclusion

1. The deconvolution method can de-blur a measured track length histogram. Marked thermal events can then be identified and their ages constrained, however, with large uncertainties. There is no need for track-length annealing models in this process.
2. Parts of a measured track length histogram can be identified (pick-pocked) with large uncertainties as being associated with a given thermal event.
3. By application of the error bars on the cumulated age diagram, fig. 1c, the number of age nodes and their ages can be picked for temperature calculation. Starting with the present temperature at age 0 Ma the temperature at the next older node 28 Ma is calculated with the application of a track annealing model assuming e.g., a piecewise linear temperature curve. Continue to the next older node, etc. The temperature history in between the nodes can not be derived from the fission-track histogram due to the overlapping of the error bars of potential age nodes. Additional information from geological interpretations and other thermal indicators are then needed.