

Geochronology Discuss., referee comment RC2
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Comment on gchron-2021-22

Karl Lang (Referee)

Referee comment on "Simulating sedimentary burial cycles – Part 2: Elemental-based multikinetic apatite fission-track interpretation and modelling techniques illustrated using examples from northern Yukon" by Dale R. Issler et al., Geochronology Discuss., <https://doi.org/10.5194/gchron-2021-22-RC2>, 2021

I generally agree with the review posted by Dr. Ketcham and have focused my comments on two areas that remain unaddressed

Summary

This manuscript presents an important discussion of a critical but often overlooked aspect of apatite fission-track dating: the effect of chemical composition on annealing kinetics. The authors present example data from two Phanerozoic sandstones in northern Canada and present very detailed fission-track and elemental analyses to compare the efficacy of chemical proxy measurements (r_{mr0}, D_{par}, etc). They also demonstrate how to exploit the natural chemical variability in a population of minerals to invert detailed T/t histories.

Recommendation

This is a well written and thorough manuscript, the topic is of significance to fission-track and (likely) other geo/thermochronology communities, and is an appropriate submission to Geochronology. It should be accepted. I only have a few minor comments.

General Comments

Use of "detrital" was a little confusing to me at first, since many applications of detrital thermochronology are now also focused on interpreting cooling histories of source rocks *prior* to deposition, and not simply the common cooling history of detrital minerals in a

sedimentary rock *after* deposition. This is a semantic difference, but perhaps adding a sentence to state this explicitly at the beginning of the manuscript might clear up any confusion amongst readers.

Why does the manuscript include a vigorous preference of LA ICPMS over EDM approach? This seems unrelated to the central motivation of the paper and, in my opinion, is largely unsupported (see comments by line). The authors should explain why they chose to use LA-ICPMS instead of EDM, but they should avoid generalized claims about the relative efficacy of one method over the other (e.g. "The LA-ICP-MS method has some distinct advantages compared with EDM" [117]).

Comments by line.

118. It has not been my experience that analytical costs are lower for LA-ICPMS than for the EDM when measured on a per grain basis. If you can measure 100 grains per mount and 50 mounts fit in a \$1000 irradiation package, that's \$5/grain. By comparison, LaserChron (probably cheapest option in US, at least) charges \$9-16 per grain for 100 grain samples, not including costs for CL imaging. Also, throughput is not necessarily higher for LA if you have to wait several months for lab time to become available. In my experience the analytical time to produce a complete fission-track dataset is comparable regardless of the analytical approach. I worry that comments like this will gradually discourage scientists from using the EDM, which is a well established and data-rich method.

137-138. Wouldn't observer bias have a greater impact on age determination when it is only accounted for in spontaneous track counting? It seems to me that observer bias may actually be reduced when it is accounted for in both the spontaneous and induced track counts, rather than just in spontaneous counts. Either way, I don't consider it fair to say that LA-ICPMS is "more objective" if it still relies on user interpretation and collection of spontaneous track data.

140. This is not an inherent limitation of the EDM, simply a choice by the operator to count fewer grains. Many detrital studies regularly count more than 100 grains per sample with the EDM.

142-143. It is convenient to make this argument here, but one could also make an alternative argument that the induced track print actually allows for more robust data collection because you can avoid the zonation issues you mention to be a problem on line 128-130. I don't understand why this is cast as an example of making the EDM less objective.

145. Again, this is not an inherent problem with EDM it is a choice by the EDM user.

