



MS: egusphere-2026-889

On some factors controlling fission-track etch rates in apatite
(On the effects of ageing and annealing on the apatite and fission-track
etch rates)

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Dear editor,

Thank you for your careful reading of our manuscript and the corresponding reviewer comments, as well as for your own comments. Our corrections in answer to the reviewers' comments are set out in the detailed responses to both reviewers, uploaded before. Our corrections in answer to your comments are detailed below. We expanded our title, rewrote our abstract and restructured our main text. We added explanations to certain sections, provided missing scale bars to figures and converted mathematical symbols to italics in the main text and supplements.

We believe that our corrected manuscript is now suitable for re-evaluation and possible publication in Geochronology. We also include a file with the changes highlighted and a new supplement file.

Sincerely,
The authors

Response to editor

Thank you to the authors for submitting an interesting set of experiments to Geochron and for engaging collegially in the discussions. Thank you to reviewers Anonymous and Professor Ketcham for thoughtfully engaging with the manuscript and the discussions. After incorporating suggestions from the reviewers, the manuscript appears to include valuable contributions to the literature within the remit of the journal.

I agree with Anonymous that the current structure of the manuscript is a significant barrier to the readability and am requesting significant revisions to the structure of the manuscript. In the current **structure**, the **title** and **introduction** do not provide any real guidance to a reader as to what to expect from the manuscript. The **abstract** is only slightly more informative. The remainder of the manuscript - except for the conclusion - is a mixture of experimental design/methods, result reporting, and discussion. The **conclusion** text contains large amounts of material that should be in a (missing) discussion section. Please revise the structure of the manuscript to clearly separate the experimental design/methods, the description of the results, and the discussion of the implications of the results.

We thank the editor for these comments. We (1) extended our **title** to make it more specific, and (2) restructured and in part reformulated our **abstract** so that it frames our work in the context of fundamental fission-track research, and explains the objectives and results of our experiments.

We are at a loss as to how to improve our **introduction**. It frames our investigations in three logical steps: (1) fission-tracks must be etched for counting and measuring; (2) the etching parameters affect the track counts and lengths, and thus the modelling of geological thermal histories; (3) etching is described with two conceptual etch rates; (4) our work determines their values and investigates how the etch rates of fossil and induced tracks are affected by annealing and ageing. At end of our introduction, we explain the broad **structure** of our manuscript.

We appreciate the suggestion of a conventional IMRD **structure**. However, because the manuscript reports three complementary but independent investigations, each with its specific method, results and interpretation, we organised our paper by experiment. This allows the reader to follow each line of evidence from methodology to interpretation before moving to the next, whereas binning all methods, results and discussions would require frequent cross-referencing between sections and make the overall argument difficult to follow. We therefore adopt the suggestion of reviewer #1, and divided sections 2-4 in Experiment, Results and Discussion.

Much of the current **conclusion** should be in the discussion section. Please change the title to more precisely reflect the contents of the manuscript, and revise the introduction to better prepare a reader for what is to come.

We agree that this section is not a conclusion, but - with respect - disagree that it is a Discussion. The immediate interpretation of each experiment is integrated within the corresponding section. The final section is a synthesis of the major findings of the three experiments. It identifies their common implications, and outlines their limitations. We propose to call it a 'Synthesis'.

I recommend also editing the abstract to more precisely summarize the contents of the manuscript: what were the experiments and what were the results, and then what does that tell us about fission track systematics.

Done (see above).

I appreciate that you objected to this structure on the basis that this would chop it up into small pieces and disrupt the narrative flow and I understand where you are coming from. However, a typical reader will not be reading this as a narrative – they will be picking and choosing from different sections to read based on what they want to get out of it. The “standard” format for scientific papers works well, and I don’t think this manuscript benefits from being an exception to it.

We appreciate the suggestion of an IMRD structure. However, because the manuscript comprises three independent investigations, the current structure allows each line of evidence to be followed from method to interpretation before introducing the next. It is an accepted organization, common in fields where several experiments address the same overarching question. The reader finishes one experiment before moving on to the next, rather than having to remember all the interim steps. A full reorganisation would fragment the presentation and obscure the logical coherence of each investigation. We therefore prefer to retain our current overall structure, while subdividing sections 2-4 in a conventional MRD manner, as suggested by reviewer #1.

The responses you made to the reviewers were very thoughtful and valuable. I think in some, perhaps many, cases you wrote the responses for the reviewers benefit without intending to use it in a revised manuscript. However, the reviewers are both subject matter experts, and if they had a comment worthy of a response – even if you consider their comment inaccurate or incorrect – other readers are likely to come to the same, perhaps erroneous, conclusions. Therefore, I suggest that you take each comment from a reviewer as an opportunity to clarify your manuscript for its readership, and consider including a relevant portion of your discussion response in the manuscript.

We included relevant parts of our responses, e.g., sections 251-254, 262-274, 361-375 and various other places.

Minor editorial comments:

P1-L3: “On their values” is not grammatically correct and I do not understand this sentence. Please rewrite.

Done.

P1-L5: In spite of what? This makes little grammatical sense. I think you mean “Despite the importance of these quantities, there are few direct measurements of VT and VR”.

Done.

P1-L6: “Numerical” data typically refers to data produced by numerical (e.g., theoretical) experiments. I think you mean “quantitative experimental results” – please rephrase. Perhaps use “This work provides experimental results relevant to factors controlling VT and VR”.

Done.

P1-L7: What is “constant core”?

Done.

P1-L8: “High” is a relative term. High relative to what?

Done.

P1-L20: Define Dpar in the abstract or use an alternative term that is not an abbreviation.

Done.

P2-L51: Please provide a short description or reference that provides context for what “Durango apatite” is. For example, see what was done on P11-L267-269.

Durango specifies that the apatite is from Durango, Mexico. It is the go-to apatite for fission-track and (U,Th)-He studies, known by all workers in these fields. It would be distracting to discuss it here again.

P2-L62: Please define Dpar

Dpar is defined on lines 59-60.

All figures: Ensure all of the axis labels, including those that indicate the values of the tick marks are *outside* of the bounds of the figure. The parts of the axis labels that indicate the units are inside of the figures, creating confusion.

Our Figure format is a 'house' format that we have used in a long series of papers in various journals, including Geochronology (e.g., Aslanian et al., 2022). It is convenient for separating tick labels (inside) from axis labels (outside). It saves space, allowing larger figure sizes in print, and except perhaps Figure 3, there is no confusion possible. As far as we know, it conforms to the rules of the journal. We therefore respectfully request to be allowed to maintain our own format.

Figure 3: Here and elsewhere. Unfortunately the typeset choice for Geochronology does not allow easy differentiation between lower case letter l (seventh letter of the alphabet) and the numeral 1 (the number one). This ambiguity is not a big problem in the main text but it makes the figure very difficult to read. Please find an unambiguous way to denote this quantity here and elsewhere. The capitol letter L might be suitable? I don't want to be prescriptive here, and I appreciate that this may be inconsistent with norms, but legibility is a serious problem.

This problem resolved itself. The journal requires that variables are in italics. This was an oversight that we have now corrected, including in the Figures. In italics, '*l*' is distinguishable from '*1*'.

P6-L151: Please clarify to a reader why this is surprising.

Done.

P12-L324-325. Please rephrase the final sentence of this paragraph eliminating the phrase “is filtered through the scientist’s selection criteria” and replace it with a less ambiguous and colloquial statement.

Done.

P15-L339: (here and elsewhere) Replace “Dpar’s” with “Dpar values”.

Done.

P15-L341: Presumably you mean 147-Sm, and not 146-Sm.

Done.

P16-L361: Please make clear that the “direct measurements and microscopic observations” referred to are those made in this manuscript. (or not, as the case may be)

Done.

P16-L362-365: This belongs in a discussion, not the conclusion section. The way this is written makes clear it is speculative and as such it should not be in this section of the manuscript. Please delete the jaunty tautological explanation of “amorphous is amorphous”. If you feel like the preceding sentence requires more exposition, rewrite the sentence so that it is clearer. Delete the sentence starting “This is however...”. The prior sentence is couched sufficiently as speculative.

We would like to hang on to 'amorphous is amorphous'. It is indeed tautological and "unscientific". But it is *memorable* because it appears self-evident, and so acts as a counterweight to the opposite "obvious" supposition that the structure and properties of fission tracks, including their etching properties, *must* vary along their lengths. It requires an effective statement to challenge a preconceived notion, and we believe that there is no substitute that can bring that home.

We explain above how solved the problem of the "Conclusion that isn't". We propose to use a part to bring together the results of the different experiments (Synthesis), and discuss their implications and limitations. We add a new Conclusion, restating the problem, our motivation and results.
