Response to editor and reviewers:

Associate editor decision: Publish subject to minor revisions (further review by editor)

by Pieter Vermeesch

Public justification (visible to the public if the article is accepted and published):

Both reviewers are pleased with the revisions made to the manuscript and have requested only a few additional changes. Once these have been addressed, I will be happy to accept the paper for publication in GChron. A third round of peer review will not be necessary.

Thanks for the positive feedback on our revised manuscript. Our responses are below in red.

Reviewer 2:

I have read the revised version of the manuscript entitled "Simplified modeling of the impact of lithospheric-scale geological processes on thermal histories and low-temperature thermochronometers: by Kellett and Whipp.

I am very satisfied with the modifications they have made to the manuscript following my comments and suggestions. They have acknowledge that their choice of an extended period of uniform (and slow) exhumation imposed at the end of the tectonic events they consider allows them to address a certain class of conditions. They have modified the text accordingly. They have also added sections in the supplementary materials describing the behavior of their 1D model in cases where this post-orogenic stage has been removed. In their reply to my comments, they indicate that their choice is, in part, a function of the audience they wish to reach with this paper ("However, we think this is an important outcome for the growing number of researchers working on orogens/geological settings that are 50 Ma and older"). I therefore think that it would be suitable to make the point in the abstract to inform the reader that the focus of this paper is on the use of the 1D model to study "old" tectonic events, I.e., those that have been followed by a non-negligible period of "passive exhumation".

We now identify the timescale of our model set in the abstract:

"Here we address this challenge by exploring the thermal and thermochronological evolution of tracked rock parcels for ***a set of 55-50 Ma*** *1D models that simulate key lithospheric geological processes, including erosional exhumation, sedimentary burial and exhumation, dip-slip faulting and delamination of the lithospheric mantle."*

We recognize the point that the reviewer is making, that most of our models include 30+ Myr of erosion following the lithospheric geological process under investigation, which makes those events arguably "old". However, we don't feel that the nuanced explanation for our modeling design fits well into the abstract – 1. that the thermochronometers must be fully "reset" during the model run to produce accurate model LTT ages, but also reach surface by the end of the model run, and – 2. that time is required to explore heat conduction from depth during lithospheric processes such as delamination (both covered in our response 15 from the previous review). These design choices are explained fully in the body of the paper. Thus, we hope that the addition of the timescale of our models in the abstract sufficiently addresses this concern, although it does not stand alone as an explanation.

Concerning the use of the Peclet number as an extra tool to describe the model results, the authors have added a very good section on its definition and use. I note, however, that the use of Pe to explain the model results is limited to only one of the cases they consider. I believe it would be beneficial for the reader if it was expanded to the other cases considered (thrusting, extensional tectonics and delamination). In this way the readers would appreciate that the effect of advection can be important (or not) not only as a function of the exhumation velocity (strongly related to the thrusting or extensional velocity/rate) but also to the thickness of the layer being exhumed. Indeed, the tectonic events and the slow post-tectonic exhumation affect layers of different thicknesses. It should not take much time of effort to do this.

We thank the reviewer for this comment and have added several references to the Pe values for other model scenarios in the main text. We note that Pe values are currently not calculated for the thrust and extensional faulting models in Tc1D, but we have tried to incorporate their values in other sections to better illustrate the impact of advective heat transport.

I hope these comments will help the authors. They only require minor modifications.

Reviewer 1:

The authors have addressed all the comments and suggestions I made on the original version of this manuscript.

One brief question (perhaps correction): Line 462 says "Furthermore, the delamination scenarios showed no relationship between thermochronometer age and timing of delamination". However, the DL results in Figure 7 panels c and d show that the cooling

ages correspond in time with the delamination event. This result seems to contradict the quoted statement.

Yes, we agree that the DL results in Figure 7 panels c and d (DL2 scenarios) show cooling ages that correspond closely in time with the delamination event. However, those plots compare two scenarios, a delamination scenario (DL models), and an erosional exhumation scenario without delamination (EE models), and it can be seen that the resulting thermal histories and LTT ages are identical, demonstrating that the thermal history is controlled by exhumation, irrespective of delamination. We feel this nuance is well explained in the paragraph from line 454 (line 457 in the "difference/tracked changes" version) and thus have not made further changes to the text.