

Response to editor and reviewers:

Associate editor decision: Publish subject to technical corrections

by Pieter Vermeesch

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

This manuscript is suitable for publication subject to the minor revisions requested by the two reviewers. Before resubmitting, please test the Conda version of your software on Windows. You may also wish to consider providing a standalone Windows executable, which would help users avoid Python's "dependency hell".

Thank you for handling our submission. We have created a new version of the software that resolves the issues with installation and have tested on Windows, macOS, and Linux. The new version will be available for installation using the Python pip installer soon and the software can currently be used with Binder without a need for installation.

RC1: 'Comment on egusphere-2026-2514', Matthew Fox, 12 Jun 2026

"Technical note: Tc1D - a 1D thermal and thermochronometer age prediction model" by Whipp et al provides details of a useful code to help people interpret thermochronometric data. The code is written in Python and it appears to be relatively easy to use. The paper is well written and clear. I suggest minor revisions.

We appreciate the prompt review and thank the reviewer for the positive and supportive comments! We address their minor comments below.

It might be useful to include the option to have spatially variable heat production. This code could then allow users to assess how heat production varies in space and time due to exhumation and how this might influence thermal histories.

This is a good point, and something that we did not explicitly describe in the manuscript text earlier. Currently, it is possible to define heat production that is constant or has an exponential decay with depth in the crust. We have clarified this in the manuscript by adding the following text: "Heat production H in the crust can be constant or decay exponentially to simulate the concentration of heat-producing elements in upper crustal rocks."

It would also be helpful to explain how this is different from Age2edot (Willett and Brandon, 2013) and age2exhum (van der Beek and Schildgen, 2023).

We agree and thank the reviewer for pointing out that we did not provide an explanation of how T_c1D compares to Age2edot and age2exhume. We have divided the paragraph about various modeling tools into two and now provide a short description of age2exhume (and age2edot) and how they differ from T_c1D to the introduction. The new text reads “Another easy-to-use software tool is age2exhume (van der Beek and Schildgen, 2023, which is also suitable for large thermochronometer datasets. age2exhume, inspired by the earlier age2edot software (Brandon et al., 1998; Willett and Brandon, 2013), uses an iterative approach to determine spatially variable best-fit exhumation rates for thermochronometer datasets, including the effects of topography and elevation on the thermal histories generated using a 1D thermal model. The key limitations for age2exhume, are that the calculated best-fit exhumation rates cannot vary with time and Dodson's approach (Dodson, 1973) is used for calculating effective closure temperatures, rather than more sophisticated age prediction algorithms that include the effects of radiation damage on calculated ages (e.g., Flowers et al., 2009; Guenthner et al., 2013).”

Sincerely,

Matthew Fox,

33: Consider citing Fox and Carter (Geosciences, 2020) here.

We have added this citation.

40: Please cite Fox et al., (Esurf, 2014) here as GLIDE has been used by the community and provides a simple approach to extract exhumation rates from thermochron data. Also consider citing Tian et al., (JGR:Solid Earth, 2025).

We have added a description and citation of GLIDE to the text. We did, however, opt not to cite Tian et al. (2025) as their model utilizes thermal history models rather than age data as its input. The new text reads “GLIDE (Fox et al., 2014) uses a linear inversion approach with 1D thermal models to estimate spatial and temporal variations in exhumation rates from low-temperature thermochronometer age datasets of ten or more ages. This powerful approach is, however, not suitable for samples that record burial or reheating.”

Figure 3: It would be nice if the erosion rate was given in km/My instead of mm/yr. That way, the integration under the curve makes much more sense and is easier to understand.

This is a good point that we had not considered earlier. We have updated the axis labels for Figures 3, 5, 7, and 8 to use km/Myr rather than mm/yr. We have also included selecting the units for the exhumation rate as a planned feature for a future version of T_c1D.

237: Please cite Nguyen et al., (2022) paper here where the 1D model used is very similar to the model presented here. Huu Nguyen, H., Carter, A., Hoang, L.V., Fox, M., Pham, S.N. and Vinh, H.B., 2022. Evolution of the continental margin of south to central Vietnam and its relationship to opening of the South China Sea (East Vietnam Sea). *Tectonics*, 41(2), p.e2021TC006971.

We have added this citation.

RC2: 'Comment on egusphere-2026-2514', Maxime Bernard, 17 Jun 2026

The authors present a new 1D thermal model, Tc1D, that enables predicting thermochronometric data following prescribed rock exhumation scenarios. The authors developed this model to allow for efficient computation relative to more complex thermal model like the 3D thermal-kinematic model Pecube, to explore the role of geological processes in explaining rock cooling histories constrained by thermochronometric data. This contribution is worth publishing in *Geochronology* journal because of its interest for the thermochronology community and is relevant to be part of the special issue: "Technical notes on modelling thermochronometric data". Overall, the manuscript is well written, very comprehensive, and therefore of high quality. I have only minor comments (see below) and support publication with technical corrections.

We again thank the reviewer for the prompt review, and for their positive and supportive comments. The minor comments are addressed below.

1. Main comment of the manuscript

1.1. In the introduction, it could be worth mentioning the difference with other software like age2exhume (van der Beek and Schildgen, 2023) and Age2edot (Willett and Brandon, 2013), as also suggested by Dr. Matthew Fow (referee 1). This would allow the community to have better sight on the range of existing 1D model for thermochronometric data prediction.

We agree with this comment and have added short descriptions of age2edot and age2exhume to the introduction, as noted above.

1.2. I would suggest using the 'z' letter instead of 'x' in equation 2 and followings, as the model uses vertical direction only.

This is a good point, thank you. To be consistent with the frequent use of z for depth-dependent variables we have replaced instances of v_x with v_z in the revised text (as well as other variables using x for a spatial coordinate).

2. Line by line comments in the manuscript

Line 137: why the default is 45 μm for the AHe grains and not 60 μm as usually assumed?

This value was used from the T_c plotter software (Whipp, Kellett et al., 2022, GChron). However, considering the more typical target grain size for He dating in apatite, we have updated the default equivalent spherical radius for apatite to 60 μm in the text and forthcoming version 0.5.0 of the software.

Figure 6: a subplot showing the thermal history or the model setup might help linking the prediction with the imposed exhumation/thermal cooling scenario.

This is a good suggestion. To avoid making the figure more complex or adding another figure to the main text, we have added a note in the text that related thermal history and geotherm history plots can be found in the supplementary material. The new text reads "...additional plots showing the evolution of geotherms and the thermal history for this model can be found at the link under the heading Code and data availability."

Line 288-289: "A summary..." instead of "An summary..."

Thanks, we have corrected this typographical error.

Figure 7: I wonder how the misfit can be this low while some predicted ages seem to be significantly off the observed age (well beyond uncertainty). Could you double check the misfit calculation, please? Maybe, it is the effect of the scale of the plot axes...

We thank the reviewer for his attention to the details of the misfit calculated in Figure 7. We have recalculated the misfit manually and can confirm that the displayed value is correct. To ensure that readers are similarly not confused, we have added text to the caption to clarify that the misfit was calculated using Equation 4 in our manuscript rather than Equation 5, for which the calculated misfit (~ 85) is considerably larger. The new text reads "Note that the misfit calculated here uses Equation 4, the default for forward models in T_c1D ."

Figure 8: Why, if grain-specific kinetics is allowed in T_c1d , here only one set of kinetic seems to have been used to model the ages?

Good question! While grain-specific kinetics are used for the He age calculations, the kinetic parameters do not vary for the fission-track age calculations currently. We have included a request for support for grain-specific kinetic parameters for fission-track age calculations in GitHub as a potential feature in a future version of T_c1D .

Line 425: "... at present to include..."? instead of "... a present to include..."

We have corrected this typographical error.

3. Other comments relative to the software

Here I provide some feedback on using and testing the associated Jupiter notebook as well as using Tc1D via a conda environment. I provide the steps as I have done them to illustrate how random users (like me) can proceed when trying to install and use the software.

3.1. The online jupyter notebook

In the online jupyter notebook using Binder and `example_tc1d.ipynb`, cell [7] returns an issue:

KeyError : 'ero_stage'. The error occurs at line 4122 from code `tc1d.py`. This error is recurrent in other examples. Therefore, I could not evaluate further the results from the jupyter notebook.

This issue arises in all examples. To me, it seems that the key « `ero_stages` » is not recognized by the program and can be linked to the version of Tc1d uploaded in Binder.

You're correct and thank you for testing things in Binder! As it turns out, there was a bug introduced in version 0.4.0 that we did not notice earlier, which we have already fixed in version 0.4.1. The bug did not affect the results presented in this work, but the fix now properly defines the "ero_stages" parameter to avoid the KeyError.

3.2. Tc1d in a conda environment on a local (windows) machine

I installed Tc1d on my own Windows machine via a conda environment. After `pip install tc1d`, I got tc1d version 0.4.0. Following the user guide online, I ran the first example as `tc1d-cli -ero-option1 10.0`. The model returned an error « `FileNotFoundError: RDAAM_He executable not found.` ». Following the instruction on the github page I downloaded the executables for the programs « `ketch_aft.exe` » and « `RDAAM_He.exe` » and put them at the same location. I have also updated the path to environment variables to include these two programs. Although tc1d then ran for longer time, it crashed because library `libgcc_s_seh-1.dll` and `libstdc++-6.dll` are not found.

Then, I tried to solve the issue by compiling the two programs, but it did not solve the problem. Also, putting the executable in the path environment did not allow to find the executables by tc1d, but putting them into the root directory (where the src is) did.

Afterall, I have been able to solve the issue by putting the required libraries `libgcc_s_seh-1.dll`, `libstdc++-6.dll`, and `libwinpthread-1.dll` in the same directory as the executables (taking the libraries from the QTQt software). Then, I was able to run the example and Tc1D.

OK, thank you for also testing the installation of T_c1D on your own computer! We had not tested T_c1D on a Windows machine, so it is very helpful to know there are possible issues related to the programs that are needed to run the age calculations. We have a beta version of T_c1D that uses the RDAAM_He and ketch_aft source code as a library rather than calling executables. We have tested this version in Window, macOS, and Linux and can confirm that it resolves the issues noted above (and simplifies installation). The new version of the code should be released very soon after fixing a few minor bugs.