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To the editor,

We thank the reviewers for their thoughtful comments. We are encouraged that they generally agree that the MDD toolkit approach is an improvement over past fitting methods and that our manuscript is good fit for *Geochronology*. To address these reviews, we intend to make the following changes:

- Additional context: As was constructively pointed out by both reviewers, we failed to appropriately describe many recent criticisms of the MDD Model. To address this comment, we will add a subsection where we review the history of the MDD model and the relevant criticisms. We will also comment on the extent to which these criticisms have been addressed. However, we note that it is out of the scope of our study to attempt to validate the MDD Model itself. Accordingly, we will adjust the tone of our language to ensure that we do not appear to be making claims to the contrary.
- Choice of Misfit statistic: Since both reviewers asked us to comment in more detail about the choice of misfit statistic, we will add additional language about this topic. Put simply, we do not believe we have a justification for the user to choose one over the other, and believe that when the two provide different answers, that the range of possibilities highlights the true uncertainty in the MDD model. We will elaborate on this view.
- Clarification of model application to Wong et al. (2023): Several specific points were made about the lack of perfect agreement between our new MDD model fits and the results from Wong et al. (2023). We will modify our language to emphasize three main points.

First, we do not intend to suggest that our work provides a *better* fit than the one presented by Wong et al. (2023). Instead, we merely intend to suggest that our fits are, within the uncertainties of all the techniques presented (e.g. K-feldspar MDD, Biotite Ar, fission track, etc.), not excluded by pre-existing thermochronological data. Second, given that we have removed a user-defined model parameter—the E_a —we intend to emphasize that this general agreement is compelling. Third, Wong et al. (2023) explicitly states in their paper supplement that they considered a range of E_a values and chose those in best agreement with independent thermochronological data. Any comparison of our model results with those of Wong et al. (2023) should be made with this in context in mind. In our revised manuscript, we will more clearly emphasize this point, as it was previously omitted.

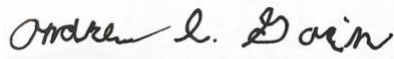
- MDD model as physical reality: Several reviewer points are based on the assertion that the MDD model should map neatly to the physical structure of a given mineral. We will modify our language to more clearly articulate our position that the MDD model need not neatly map to the physical structure of a given mineral to be useful. While we do currently assert that it remains unclear what the model domains represent physically within a mineral, we further clarify our view on the non-physicality of the model.

The MDD model proposes that the diffusive behavior of certain minerals is best described by numerous, non-interacting, infinite sheets simultaneously diffusing within the same mineral. This description is self-evidently nonphysical. However, this non-physicality does not necessitate the rejection of the MDD model as a tool for deriving the thermal histories of minerals. Instead, it should be thought of as an empirical model. While the lack of physical description for the diffusive behavior of these minerals is indeed unsatisfying, evidence suggests that the MDD model reliably predicts thermal histories supported by independent thermochronological data. In this sense, the MDD model need not map neatly to reality to produce valuable insights.

- Line-by-line comments: The reviewers pointed out several typos, and suggestions for standardizing figure axes. We appreciate their thoroughness and will address these comments as suggested in our revised manuscript.

We appreciate the reviewers' time and their constructive comments. We look forward to the opportunity to revise our manuscript.

Best Regards,

A handwritten signature in black ink that reads "Andrew L. Gorin". The signature is written in a cursive style with a clear, legible font.

Andrew L. Gorin