April 20, 2025

Dear Dr. van der Lee,

Thank you for your comments and thoughts on this manuscript and its review process. We address the remaining comments below where your comments and our response are written in black and blue, respectively.

In this revised version, we took all your comments into account and addressed them in the text. In addition, we added vertical sections from the $2.4^\circ \times 2.4^\circ$ checkerboard models in the Supplementary Material, which are taken along the same vertical sections presented in the main manuscript. Finally, we edited the entire text to fix the remaining inconsistencies.

Our models constructed with and without the additional onset-time readings from regional waveforms together with horizontal and vertical cross-sections are available from Zenodo, which we added to our "Data and code availability" statement.

We hope that this response and the related modifications to the manuscript will be sufficient for publication.

Sincerely,

Ebru Bozdağ et al.

Editor: Thank you for revising your manuscript and emphasizing the hypotheses you tested with a relatively high resolution, independently inferred P velocity model. I am generally pleased with how the reviewers' comments are taken into account, though a few of their points could benefit from

some additional attention, as specified below. Once these are addressed, I'd be pleased to accept your paper for publication Seismica and send it straight to copyediting.

In your final submission, please provide addition detail on the following points raised by the reviewers:

Again, thank you for all the comments, which significantly improved our manuscript.

Editor: 1. Response to comment on Line 209: The reviewer suggested you use CRUST1.0 while you used CRUST2.0. It seems prudent to investigate the type, size, and potential travel-time impact of the differences between these two crustal models in your study region. If you had used CRUST1.0, do you estimate that the differences in the tomographic model would have been significant? If so, in what depth range?

We updated the Discussions based on the comparisons between Crust2.0 and Crust1.0 in Fig. 1 and previous literature. Considering that the the Moho depths are not dramatically different in Crust2.0 and Crust1.0 using a higher resolution model in a first-arrival P wave inversion would not change our conclusions. Moreover, using a higher-resolution crust would not fix the problem, crustal corrections must be avoided when and if possible. Here is our revised text in the manuscript:

"In addition, our resolution in the crust is limited, which is fixed to Crust2.0 (**?**) during the inversion. We expect that a higher resolution crustal model such as Crust1.0 (**?**), the successor of Crust2.0, should not change our overall conclusions, as, despite the changes in P wave speeds, the crustal thickness variations, which is the dominant factor affecting seismic data, are not dramatically different than that of Crust2.0. However, the effect of crust on seismic waves is well known, not only on surface waves (Bozdag and Trampert, 2008; Ferreira et al. 2010) but also on body waves (Ritsema

et al. 2002), which may have an impact on our inference particularly on upper-mantle anisotropy. To this end, to minimize leakage from the crust to the upper mantle, Moho perturbations have been inverted as a parameter in some studies (Van der Lee and Nolet 1997, Vitek et al. 2023). The simultaneous inversion of the crustal and upper mantle structure is desirable, which is the subject of a future publication within a full-waveform inversion framework."

Editor: 2. Response to comment on Lines 399-401: When you refer to a "tear" please specify the object that is torn. Can you refer to a specific figure or subplot that shows this?

Here is the updated version: "As we move further East, at the western side of the Cyprus Arc, we observe a dipping fast anomaly that disappears around $200-300$ km, a possible tear **in the slab** filled with hot material followed by fast material on top of 660 km **(Fig. 9B)**. The fast anomaly observed on top of the 660 km discontinuity is the remnant of the subduction of the Tethys Ocean underneath Anatolia (Biryol et al. 2011; Abgarmi et al. 2017)."

Editor: 3. Response to comment on structural tests: If you did not carry out resolutions tests with realistic mantle structures, can you point out how the 2D checkerboard tests vary in depth? The polarity of the checkers seems to flip at certain depths, but this is not specified. Moreover, can you point out how the checkerboards help test hypotheses about structural features like slab detachment (lines 312, 423, and 498 in revised manuscript).

We use the checkerboard tests or similar tests with observed features in tomographic models to indicate the resolution power of data coverage. In this regard, we interpret good data coverage in certain regions as increasing the probability of specific hypotheses. Following your comments, we plotted vertical sections of checkerboard tests with 2.4×2.4 degree resolution along the same paths

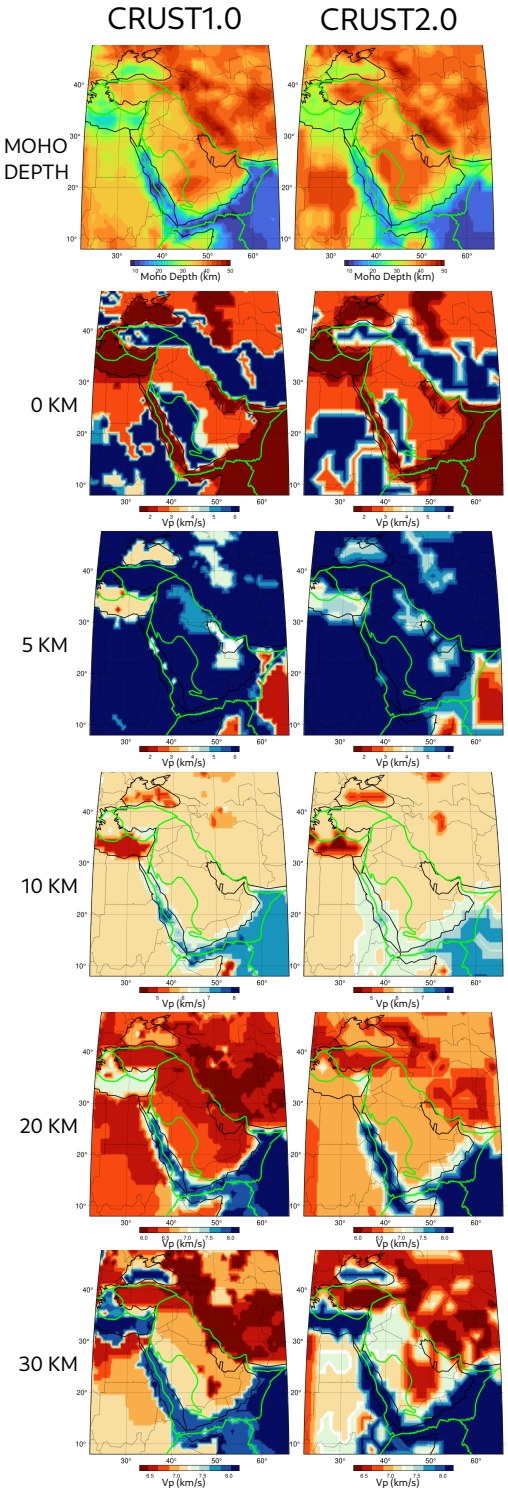

Figure 1: Cross-sections of Vp and Moho depth from Crust2.0 and Crust1.0.

presented in Figs. 9, 10 & 12 in the main text and provided their figures in the Supplementary Materials (Figs. 5, 6 & 7). The vertical resolution in checkerboards is consistent with our interpretations from the data coverage point of view and horizontal checkerboard sections, which we added in the revised manuscript. Note that we can lose the checker pattern for vertical sections taken in arbitrary directions and have some plotting issues due to the interpolation of the model to take the cross-sections, which we noted in the figure captions. In addition, the target checkerboards with oscillations in sign as a function of depth explain the reversals in the horizontal checkerboard plots.

Editor: 4. Lines 67-71 in revised manuscript: Given that you introduce passive and active rifting as end members but do not say how the two are distinguished from one another, and that the reviewer has a different interpretation of "passive" and "active", it might be best not to use these adjectives at all in describing the possible ways of rifting.

We removed these adjectives from the sentence for consistency.

Editor: 5. Line 289 still refers to Laplacian damping, which you replaced with 2nd-order differences damping in line 247.

Thanks for noticing it. We corrected it.

Final checks:

Editor: - A pdf version of the revised manuscript clearly highlighting changes/markup/edits.

See Seismica_Bozdag_etal_2025-markup_changes.pdf.

Editor: - A 'response-to-this-email' letter that shows your response to each of the 5 remaining points, together with a summary of the resulting changes made to the manuscript.

See Seismica_Bozdag_etal_2025-response_to_Editor.pdf (this file).

Editor: - The final, cleaned manuscript using the Seismica template in Microsoft Word, OpenOffice or LaTeX file format (found on the Templates page (https://seismica.library.mcgill.ca/templates/)) with figures included in the text. If using LaTeX, please also include your bibliography .bib file.

See Seismica_Bozdag_etal_2025-CLEAN.pdf. You can see the complete LaTex files in Seismica_Bozdag_etal_2025-LaTex.zip.

Editor: - Separate publication-ready figure files in .png or .pdf format at a minimum of 300 dpi resolution

Please see the directory 'Figures" in Seismica_Bozdag_etal_2025-LaTex.zip.

Editor: - Supplementary material should be uploaded as a separate pdf file that will not be formatted. Supplementary material should not be included in the main paper.

See Seismica_Bozdag_etal_2025-Supplementary_Material.pdf.

Editor: - Please make sure that the references in your paper contain DOI information.

Done.

Editor: - Please recognise reviewers in the Acknowledgements.

Done.

Editor: - Please provide all author information (ORCID, affiliation, contribution), coherent with the information entered at submission (OJS metadata).

All corrected and added except the ORCID ids of our Saudi Arabian colleagues as they do not have them. We hope it would not be an issue during the publication process.

Editor: - Please provide Data & code availability and reproducibility statements.

See our statement at the end of the manuscript.