

Constraining the depth of the lithosphere-asthenosphere boundary in tectonically complex regions using locally adjusted lithological forward models and seismic velocities

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Abstract

OK

1 Introduction

l. 36 “lower temperatures” it is better if you write “lower temperatures with respect to the ones expected by the ‘thermal’ LAB”

l. 38 Consider to replace “... these are all subsolidus processes” with “all of these processes occur under subsolidus conditions”

In addition, please define very briefly what is meant by “subsolidus processes”, as the term can be ambiguous (e.g., temperature and pressure below the solidus but possibly involving solid-state transformations or deformation).

This part is very clear, I was wondering if you might want to mention some P-to-S studies carried out within the Pannonian Basin, and then explain that your target is deeper, which is why you use S-to-P conversions instead.

l. 45-47 Consider to rephrase this sentence for a better clarity, for example:

“Receiver function analysis is a widely used method for determining the depth of seismic discontinuities, as seismic waves convert from shear to compressional (S-to-P) or vice versa (P-to-S) when crossing boundaries between materials with contrasting physical properties”.

l. 49-50 This statement: “Unlike the sharp Moho interface, the LAB lacks a distinct seismological discontinuity, making its accurate determination challenging” is clear but it would be helpful if the authors could briefly explain why its determination is more challenging (e.g. temperature effects, phase changes, resolution limits, ...)

l. 54 Please put “sensu stricto” in italic font

2. LAB depths in the Pannonian Basin

l. 79 Please replace “prepared” with “compiled”

l. 81 To avoid too many repetitions, please replace “map” with “study”

l. 87 You can delete the word “most” at the beginning of the sentence

l. 90 Replace “used” with “considered”

3. Methods

l. 104 “... and temporary stations...” delete “and”

l. 105 just write “ Pannonian-Carpathian-Alpine Seismic Experiment - PACASE (Schlömer et al., 2024), currently within the framework of the AdriaArray initiative”.

l. 116 Replace “For the 1D velocity models, the Excel workbook of Abers and Hacker (2016) was used...” with “For the 1D velocity model construction, we adopt as a reference the work of Abers and Hacker (2016), ...”

l. 120-121 “As significant compositional changes are not expected in the mantle of the region, it was used for the models of all stations”.

This is probably a strong assumption, please justify this constraint.

l. 125-127 Sorry I do not understand this sentence: “Although crustal structures are considered more complex, this uniform composition represents a sufficiently realistic approximation, and calculated velocities are in good agreement with the results of Kalmár et al. (2021)”

- You say that the crustal structures are considered more complex with respect to? Mantle?

- What do you mean with “good agreement”? Can you give an example of the velocity values computed at some stations with your method and the findings of Kalmár et al. (2021)? You can put one Table or a Figure with some stations here and probably add in the Supp. Material.

l. 136-137 Technical question: why do you use iterative time-domain deconvolution method and not frequency deconvolution?

Do you perform any quality control? Just one sentence here could be very useful.

Probably you can take a look at these works:

- Colavitti, L., & Hetényi, G., & the AlpArray Working Group. (2022). A new approach to construct 3-D crustal shear-wave velocity models: Method description and application to the Central Alps. *Acta Geodaetica et Geophysica*, 57(4), 529–562. <https://doi.org/10.1007/s40328-022-00394-4>.
- Hetényi, G., Plomerová, J., Bianchi, I., Exnerová, H. K., Bokelmann, G., Handy, M., et al. (2018). From mountain summits to roots: Crustal structure of the Eastern Alps and Bohemian Massif along longitude 13.3°E. *Tectonophysics*, 744, 239–255. <https://doi.org/10.1016/j.tecto.2018.07.001>.

l. 138 Please write one or two sentences with some characteristics about the 1D migration method described in Kalmár et al. (2023). This can be very useful for the readers.

4. Parameter tests

4.1 Heat flow

l. 147 Please rephrase the sentence in this way: “While pressure can be reliably calculated for a given depth, estimating the rate of temperature increase (the geotherm) is more challenging, as it can vary regionally depending on several factors, most notably lithospheric architecture and thermal history”

l. 151-153 Probably this sentence “The high heat... of karst systems” needs at least one reference to support this statement.

l. 156 What about the uncertainties of the P- and S-wave velocity profile?

I would not expect to see an error bar on the velocity profile, but it might be worth including a sentence in the main text addressing the uncertainty associated with the velocity profiles obtained for the different heat flows.

4.2 Mantle mineral composition

OK

4.3 Pargasite

OK

4.4 Partial melt

OK

5. Results

5.1 Model set on 4 stations

l. 211 Please replace “building” with “construction”

l. 242 “... beyond the negative phase on the receiver function” probably here you can refer to one image of the RFs in the supplement.

5.2 Models of rest of the stations

l. 246 For which reason, do you separate the model related to the permanent stations and to the temporary ones? Please justify your choice.

Probably you can also think to revise the current title from “Models of rest of the stations” to “Models for the other stations”.

l. 256 Replace “On this figure” with “In **Fig. 7**”

6. Discussion

6.1 Comparison of LAB depth obtained with local vs. global velocity models

l. 324-326 “Our results... respectively”

consider to rephrase the sentence: “Our results are consistent with this observation. However, significant discrepancies are found only for the SOP station, where the LAB was previously estimated at 110 km depth, while migration using the global IASP91 model and the forward velocity model developed in this study yielded depths of 70 and 66 km, respectively (Fig. 9a)”.

6.2 Effect of melt beneath the LAB

l. 343 “... presence of volatiles” please specify which volatiles you mean.

6.3 Effect of metasomatism and volatile-bearing phases on seismic velocities

l. 371 Please quantify “very small volumes”: this scale is even smaller with respect to the outcrop?

l. 388 “... is still a matter of debate” please mention some works related to crustal thickness and the content of hydrous minerals.

6.4 Implication of surface heat flow

l. 391 Please rephrase the opening sentence with something like:

“The reliability of surface heat flow as an indicator of subsurface temperatures may be questioned”.

l. 398 Replace “because” with “since”

l. 408 Rephrase like this: “Stations KOVH, MORH and A266A” represent outliers,...”

7. Conclusions

l. 431-432 At this point: “While global models such as IASP91 provide a useful reference, they lack the resolution to capture local-scale variations in lithospheric and asthenospheric properties” you could consider adding a short remark about the potential use of 3D reference models for a potential future work, which could help capture lateral heterogeneities in the lithosphere and asthenosphere.

I hope my suggestions will be helpful in improving the manuscript,

Best Regards,

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Figures

Figure 1

Map is fine from my point of view. I suggest just 2 minor comments:

- In the Legend on the top left, you can put the title “Stations” centered with respect to the white rectangle, as you did for the name of the symbol of the stations
- In the inset on the top right, you can color differently the lands (in light yellow) and the seas (light blue)

Figure 2

In Fig. c), it is probably better to flip the y-axis, considering the convention you used for Fig. a) and Fig. b) as well.

Figure 3

OK

Figure 4

OK

Figure 5

OK

Figure 6

For a better visibility, you can think to put the limit of the y-axis from the panel **(a)**, **(c)**, **(e)** and **(g)** from -0.5 to 4.5 (still using the label from 0 to 4).

Figure 7

Unless any particular reason, I think you can limit the vertical axis in **(b)** and **(c)** to the upper limit of 100 km.

Figure 8

OK

Figure 9

The figure is appropriate as it stands, but I would recommend displaying depth scale values at 10 km intervals instead of 5 km to ensure better readability.