

RC1: 'Comment on egusphere-2024-2692', Anonymous Referee #1, 18 Dec 2024

The topic of the manuscript is very interesting for the local geology as well as a reproducible approach for other basin setting for which heterogeneous boreholes information are available. The manuscript is generally well written, clear and concise. Only the Abstract needs significantly improvement. In fact, the abstract struggles to summarize the study effectively and comprehensively. It is not clear that there is and what is the difference between the datasets used to calibrate (A) and to derive the profiles (B). Nor is the methodology clear (sonic velocity or seismic interval velocity). There is not enough information on the stratigraphy of the area. These should be few, synthetic but are essential to understand the logic of the work. The importance of the Top of Jurassic boundary and its relationships with the rest of the stratigraphy should be presented and highlighted. On the contrary, the formulas do not really need to be included in the abstract. possibly only the value of R^2 . For the rest, it's a pleasure to read a well-crafted manuscript with well-defined objectives from the beginning. I have only one major concern about Figure 1, which needs to be completely redrawn. This and other minor suggestions are indicated in the annotated pdf. Finally, I recommend publication once the (few) comments above have been addressed.

Author reply:

Dear reviewer#1,

Thank you for the positive feedback and constructive comments.

We agree that the abstract needs significant revisions. We therefore completely rewrote the abstract and tried to implement all your suggestions.

Figure 1: we also agree that figure 1 should be redrafted. We tried to accommodate your comments and changed the caption of figure 1b, to highlight that the shown cross-section is a schematic cross-section and not based on real data (e.g. seismic reflection data).

Other major changes (also based on the other reviewers' suggestions):

- Several iterations to improve readability and to eliminate grammar and spelling errors.*
- We changed the naming of dataset A and B into datasets I and II.*
- We restructured chapter 2 by dividing it into subsections ("Geological setting", "Previous studies addressing velocity-density relationships and vertical stress", and a newly added section which emphasizes the "Geothermal energy extraction in the NAFB")*
- Figure 2: we changed the color palette to black and white for better visuals. The lithostratigraphic descriptions have been changed such that they do not conflict with the main lithological units used in the density and vertical stress determination.*
- Figure 3: we replaced the blue dots with minimum and maximum bordering lines of possible A-B combinations. We also spotted a mistake in plotting Gardner's mixed A-B combination, which we adjusted, and which now fits much better our A-B trend shown in figure 4a). We updated the respective parts in the discussion accordingly.*
- Figure 5a: we added R^2 values for each density-depth trend in the figure caption*
- Figure 5b & c: we annotated obvious outliers*
- Figure 6: the background maps now follow the same style as the new figure 1*

- *Figure 7: We adjusted the grid line width and the title of the x-axes.*
- *Section 4.4: We discuss the shape of the power law vertical stress gradient model, which reflects the effect of sediment compaction and thus increasing density with depth (or vertical effective stress).*
- *We added a subsection in the Results and discussion section, where we discuss the geological controls on density, velocity and vertical stress including the impact of mechanical and chemical compaction, cementation, tectonic stress and diagenesis on density and velocity*
- *Upper Jurassic: we added a small sub-section in the Results and discussion section where we discuss the implications of our results regarding geothermal exploration and production in the study area. We added a subsection to chapter 2 introducing geothermal energy production in the NAFB (see above).*

Point-by-point reply:

Please find our point-by-point answers to your additional comments directly in the annotated pdf of the manuscript "Reply_Manuscript_Comments_Reviewer#1.pdf"

Many thanks and kind regards,

Michael Drews, Peter Obermeier and Florian Duschl