

Response to Referee #2

Beyond hydraulic diffusion: reaction front propagation and timescales in metamorphic
(de)volatilization processes

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We thank Dr. Nicolas Riel for the careful reading of our manuscript, the constructive suggestion, and the positive assessment of our work. We agree that the origin of the thermodynamic input values should be stated more clearly. We have added brief clarifications in Sections 2.3 and 4.4, as detailed below.

Main comment: Thermodynamic input values

Referee comment: *For the numerical application, the reaction is represented throughout the manuscript using a look-up table relating total density, ρ_{total} , to fluid pressure, P (Fig. 2a/2e, Fig. 3a/3e).*

The manuscript reads that such a relation “can be determined for specific reactions from equilibrium phase calculations using open-access software such as PerpleX . . . or Thermolab”.

However, I don’t see the description of how the look-up-table for the numerical results was obtained.

- 1. Were these $\rho_{\text{total}}-P$ (or $\Delta\rho_{\text{total}}$, ΔP) values taken from independent Perple_X/Thermolab calculations run for this study, or from the literature (e.g., Schmalholtz et al., 2024)?*
- 2. If from phase-equilibrium calculations, what $P-T$ conditions (or $P-T$ path) and bulk composition were assumed for each reaction?*
- 3. What equation of state was used for the fluid/vapor densities, particularly for the water-to-vapor transition in section 4.4?*

I think that adding these details is important (even briefly, e.g. as a table in an appendix or the data availability statement) and would help the readers reproduce the reported permeability and timescale estimates which would strengthen the already strong quantitative applications in Section 4.

Response: We thank the referee for this comment. The thermodynamic values used to parameterise the numerical density–pressure relations were calculated using Thermolab (Vrijmoed and Podladchikov, 2022). The values for dehydration and water-to-vapor transitions are consistent with tabulated thermodynamic properties. Analogous relations can also be obtained using Perple_X. We have added this clarification in Section 2.3.

For the applications, we use representative material properties and density changes, as discussed in Section 4 and the cited studies. In particular, the gypsum example follows the experimental setting of Fusseis et al. (2012). The water and vapor densities are based on Thermolab calculations, while the analytical estimates use the rounded values and approximations stated in Section 4.4. We have added a short clarification there to identify the origin of these properties.

These additions clarify the source and use of the thermodynamic input values while retaining the existing analytical formulation.

Minor comment: Software name

Referee comment: $L144 \rightarrow \textit{Perple_X}$.

Response: We thank the referee. We have corrected “PerpleX” to “Perple_X”.

We again thank the referee for the constructive suggestion and the positive assessment of our work.