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Interactive comment on "Pore-scale permeability prediction for Newtonian and non-Newtonian fluids" *by* Philipp Eichheimer et al.

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The manuscript proposes a new application of the LaMEM open-source code - originally designed for geodynamic applications - to the modelling of sample-scale newtonian and non-newtonian fluids in porous systems. The main application proposed by the author is the estimation of rock permeability as a substitute/complement to laboratory measurement.
This study is meaningful tool to tackle the long running problem of estimating permeability of rocks. In particular, when laboratory measurements are difficult or impossible. It brings significant improvement compared to other numerical models by introducing stencil rescaling along rock-fluid boundaries which seem to greatly improve the accuracy of the permeability estimation while limiting the computational cost. The

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robustness of the code is backed by sufficient benchmarking as well as comparison with experimentally measured permeabilities. Furthermore, the manuscript is clear and well written. Overall I would recommend this manuscript for publication in its current form with only a few minor – mostly cosmetic - modifications. Here is a list of minor suggestions to improve the manuscript:

1. I could not find any link to this manuscript version of the LaMEM code in the text. If I am correct it is an open source code and therefore it would be necessary to provide the code as an online supplementary or at least a link to the repository in the manuscript.
2. The only issue I have with this manuscript is that I find the information provided on the stencil rescaling a little limited. Given the importance it takes in the manuscript, I would expect a more extended explanation of the method and its implementation in the code. In particular, I believe better discussion on the stability an accuracy of the FD stencil rescaling with references would improve the quality of the manuscript.
3. In page 12 line 2 is written: “using power law exponents ranging from 0.5 to 2.” Yet, in figure 6 you only show two values that are tested rather than a range. I would suggest changing the phrasing to “when using 0.5 and 2 as values for the power law exponents”.
4. In Fig. 3, 4 and 5 black lines with a numerical value are shown but not explained in the caption. It took me quite some time to understand it was the curve local slop. Therefore, I suggest adding a sentence in the caption to explicitly tell what these black lines are, or remove them as the figures are already self-explanatory without giving a numerical value for the local slop. item In figure 4 you most likely flipped P3 and P4 in the top left corner schematic as according to line 22-23 page 8 P4 is the largest tube and not P3.

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5. In figure 5 the box displaying streamlines around the sphere show significant variations of flow velocity perpendicular to the direction of flow (3 orders of magnitude!!). This is very puzzling as I would expect the flow to be relatively homogenous laterally. Is this a rendering mistake or a consequence of boundary conditions? It should either be corrected or explained in the text.

6. In figure A1: rtol should be added below the x-axis of subfigure a) and b).

7. In the authors contribution there is a spelling mistake in the authors initials. OK is written instead of MOK for M. O. Kottwitz.

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