

Solid Earth Discuss., referee comment RC1
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Comment on se-2021-140

Anonymous Referee #1

Referee comment on "Matrix gas flow through "impermeable" rocks – shales and tight sandstone" by Ernest Rutter et al., Solid Earth Discuss.,
<https://doi.org/10.5194/se-2021-140-RC1>, 2022

General Comments

The paper presents interesting study of permeability of tight rocks with comparable porosities over a wide range of pressure conditions. The authors explain the pressure dependence of permeability using a model that capillary tubes with eccentric cross sections. However, the model fails to explain the permeability evolution in Bowland shale which is interpreted to be a result of the heterogeneity of the pore size and tortuosity. Overall, I found the study well supported by the amount of data and nicely discussed.

Specific Comments

- In line 88-89, it is not clear what the author means by 'bedding horizontal'. Please clarify.
- The author mentioned conducting permeability measurements using both pulse-decay and oscillation method. But it is hard in the later plots to distinguish measurements from different method. Could the author elaborate on how much difference would it make using different method for permeability measurements in this study.
- In line 221-225, as described by the author, the samples were exposed to higher effective pressure before the application of pore pressure. Would this contribute partly to the later observed difference in the 'm' and 'n' variation in the effective pressure law.
- In line 344-349, would the bioturbation in the Haynesville shale be partly the reason for the higher permeability and lower pressure sensitivity in the normal to bedding flow?
- The authors attributed the different pressure sensitivity of permeability in the Bowland

shale to the pore structure complexities (heterogeneity of the pore size and tortuosity). Is there any direct microstructural evidence comparing the Bowland shale to the other two rock types?

- The use of pore pressure parameter 'n' and the pore pressure coefficient 'm' in the discussion of the effective pressure can be confusing. It might help the reader if this is introduced and discussed earlier in the paper (line 258-260 might be a good place for a clarification).

Technical Corrections

- In section 2, it might be more reader friendly and easier to compare if the author could put the composition proportions, density and porosity data in a table.