This manuscript explores fluid flow and mass transport through a discontinuous porosity distribution, a common feature in layered geological formations. The authors present numerical results obtained using a novel space-time method capable of handling these discontinuities, unlike traditional methods that often smooth them out. Examining the results, this method appears promising. However, improvements are needed to adequately justify the advantage of applying this new method to study fluid flow through a discontinuous porosity. A major concern is that the present work is an application of a new method that was initially presented in a non-peer-reviewed work (an arXiv manuscript). This could significantly impact the reliability of this work. Therefore, I suggest a major revision to include as much content as possible in the theory section to convince readers that this new method is reliable without needing to consult an unpublished work. Please also see the specific comments below.

- The abstract needs to be clearer about the key contribution of this manuscript. Is it the 'novel space-time method' itself? Or was this method developed elsewhere, and this work applies it to study porous flow through a discontinuous boundary? If it is the former, it would be better to briefly explain the novelty in the abstract. If it is the latter, it needs to briefly report more details of the results. For example, what is the "influence" of layering? How does this method help to distinguish such influence, which could be missed by other methods?
- P2. "In addition, we utilize a newly developed space-time method that has been shown to be more accurate in solving this particular problem in the presence of jump discontinuities [1]." This new method is an essential element of this work; however, it refers to a non-peer-reviewed citation. While this could significantly impact the credibility of the results, the authors might consider including results demonstrating that this method is indeed 'more accurate' for this specific problem. I could not find such content in the results section.
- P2. "An additional advantage of the space-time method is that it can be coupled to simple models of chemical-tracer transport in a straightforward manner." I do not understand why this space-time method makes the coupling more straightforward than in other methods using a smoothing scheme.
- Eq 1a and 1b need a reference or a more detailed explanation of how they are derived from the standard mass and momentum equations.
- P2, "... $\frac{\eta_b \sigma}{(1-\phi)\phi^m}$ can be regarded as effective viscosity..." is confusing as there is no such coefficient in Eq 1.
- P3, regarding the equations for v^e and v^f: Firstly, please number these equations (and other equations onwards that have not been numbered). Secondly, are both equations only valid when the solid velocity is zero? Is this a assumption applied in the entire work? Why assuming this then? What is the general formulation without such a limitation?
- P3, why can the concentration ratio KD be assumed to be a constant?

- P4, Eq 3 and Eq 1 are inconsistent. In Eq 3, within the brackets on the RHS, the first term of 3a is the same as the last term of 3b. However, the corresponding terms in Eq 1a and 1b are different.
- P4, the meaning of $\bar{p}$, φ, div$_x$, $p(0, \cdot)$, and p_0 is unclear. Please explain them.
- P4, It is not immediately clear how Eq 4 becomes Eq 5. Please explain this more clearly, possibly with some intermediate steps.
- P4, "The resulting adaptive scheme..." It would be greatly helpful to explain what you mean by 'adaptive' here and how this scheme is adaptive in the calculation. Figure 1 is shown as an example to illustrate the space-time grids. However, some essential details are missing to understand the figure, for example, the meaning of the colors in panel (b).
- P4, It is not clear why the discontinuity of porosity does not cause a problem here. The mathematical formulation still contains the gradient of porosity, which yields a singular value where the discontinuity is prescribed. How has this issue been resolved in this new scheme?
- P5, sec 2.3. The non-dimensionalised values seem to have mistakes. Based on the definitions, the non-dimensionalized values are actually Q=1/600 and T=23.65. Please check these, and also the following calculations if these values are incorrect.
- P6 onwards. The results show that the location of the discontinuity does not vary over time. It seems to remain as a straight line throughout. Why does this discontinuous boundary not advect with the solid phase?

- The results in Section 3 need a discussion to justify the advantage of this new method: what novel feature can only this new method resolve that a conventional method using a sharp but smooth transition can not resolve? How important is this new feature in understanding the actual physical world?

References:

[1] M. Bachmayr and S. Boisseree. An adaptive space-time method for nonlinear poroviscoelastic flows with discontinuous porosities, 2024.