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Hydrology and Earth System Sciences Discussions



# *Interactive comment on* "Evidence of non-Darcy flow and non-Fickian transport in fractured media at laboratory scale" *by* C. Cherubini et al.

**Anonymous Referee #1**

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This manuscript presents an interesting and potentially valuable experiment that directly measures solute transport through a lab sample of fractured rock under controlled conditions. The artificially fractured rock, whose flow characteristics have been explored in a previous study, is known to demonstrate hydraulic complexities such as non-Darcy flow. It also has structural complexities (rough fractures, fracture intersections, variable fracture aperture, significant matrix porosity, known stagnation zones within the fracture network, etc.) that are realistic and likely to impact solute transport, and yet are known well enough that the effect of individual features could potentially be studied. The measured results of a solute transport experiment at various flow rates through a single flowpath configuration are analyzed with respect to standard transport concepts, models, relevant dimensionless numbers, etc. What is demonstrated is that the solute transport is non-Fickian and has features typical of flow through fractured



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rock. These include BTCs better fit by MIM than ADE, advective-dominated transport, nonequilibrium of different domains, and a dominance of geometrical dispersion in the fractures. The paper unfortunately has serious weaknesses. The most substantial of these is a lack of interpretation in terms of hydrologic processes, issues, or significant questions that need to be answered. Another major shortcoming is that editorial mistakes such as misnumbering of equations, undefined or ill-defined variables, deficient labeling, and inadequate descriptions make this manuscript difficult and in some places essentially impossible to follow. Thus it needs major revision. If the authors submit a revision, it should be re-reviewed to evaluate how shortcomings have been addressed and to make sure of the soundness of some points that currently are not described well enough to be evaluated.

Sections 4 and 5 have the most significant problems. Many quantitative results are stated without comment or interpretation as to what their significance is. Examples include the A and B coefficients (section 4.2) and the flux threshold for inertial vs. viscous dominance (p. 238, line 3). Some results have an obvious basic meaning, for example the values of $\beta$ and Da, but the manuscript does not extend the interpretation to what significance these have for the sample, the flow conditions, or possible implications for other media or flow situations. Various of these results confirm the conclusion that domains are not in equilibrium and therefore require treatment other than the standard ADE, but the diverse lines of evidence pointing toward the same thing does little to enhance the reader's understanding. Section 5 repeats some of these same things but without adding further interpretation or understanding. Some parts of section 5, for example the last two paragraphs, are so general and obvious that they should just be deleted. Others, like the dominance of geometrical dispersion (p. 240, line 3) should be discussed further and with more substance. For example, does the result say anything about contributions to immobility of the fracture stagnation zones or the internal pores of the limestone, or does it have significance for pollution or remediation issues, or does it provide guidance on how such studies should be conducted in the future? The paper needs to convince readers that what has been learned here is new and



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important.

The paper has many typo and grammatical errors that need correction or rewriting to clarify meaning. One that occurs repeatedly is the phrase “in correspondence of” (for example twice in the last paragraph on p. 235) which needs replacement with expressions like “in”, “at”, “to”, “in relation to”, or “compared to”. Some references are missing from the list, for example Bodin et al. and Detwiler et al. Some variables are not defined or incompletely defined (like hc), and with the equation numbers given incorrectly, can’t be figured out. Geometrical parameters like hc should be shown in figure 3. That figure also needs other details, like the valve labels a and b. Another problem is knowing what is meant by dh, dH, and “difference head”. In Figure 9 there are two y axes but it is not clear which axis is for which parts of what is plotted.

The paper needs major revision, but I do not recommend rejection at this stage because of the high potential value of the experiment and results.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 221, 2013.