Hydrol. Earth Syst. Sci. Discuss., 11, C3959–C3962, 2014
www.hydrol-earth-syst-sci-discuss.net/11/C3959/2014/


Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Controls of macropore network characteristics on preferential solute transport" *by* M. Larsbo et al.

**Anonymous Referee #3**

Received and published: 21 September 2014

## General comments

This paper presents a study on preferential transport in undisturbed topsoil samples. The pore network structure has beed observed with Xray tomography. Measures that quantify macropores and thus possible preferential pathways in the pore structure have been derived from the images. Breakthrough curves have been measured in the samples under steady state, unsaturated flow conditions with two different flow rates close to full water saturation. Measures for early breakthrough as well as for the spread of breakthrough times have been calculated from the breakthrough curves and measures for pore structure were related to measures for transport behavior. The experiments are interesting and the paper is well written. I have only few comments that are minor.



1. The interpretation of the data is based on the hydraulic parameters of the soils. The assumption on the shape of the parameter functions seems quite strong to me. In particular, the relation between pressure head and unsaturated hydraulic conductivity is important, as it is used to calculate hydraulic conductivities and saturation states that are again related to transport properties. This assumption is also discussed in Section 3.2.2 (Page 9571, lines 12-14). A power law is assumed as functional form and the power coefficient is fitted from the data. The coefficient was estimated from two data points for a sample (at pressure head -1 cm and at -5 cm). The reasoning for the shape is that it has been found in previous work. However, there are other functional forms that are also used in practice and the estimates of hydraulic conductivity could be very different for different shapes. It would have been more convincing to use this shape if three data points would have been used (meaning that a third experiment for each probe would have had to be carried out). However, I guess that it is not possible to test this at this late stage and the comment is not so important that it would stand in the way of publication of the paper.

2. Also, it would have been interesting to see the water content distribution during the transport experiments. One of the findings of the paper is that preferential transport is small if the macropore network is a well connected network of smaller channels. It would be interesting to know if this is also related to the variability of the water content distribution.

3. Line 17 on page 9554: It would here be useful to specify these measures or indicators. Some sentences would also be useful about the difference between the fitted parameters and the usual parameters for the CDE. Parameters for the CDE are also obtained from moments of the breakthrough curve (as outlined later, moments of the breakthrough curve are also used in this paper together with the 5

4. Equation (2): Are you sure that this is used as second central moment? I think a standard definition would be $\mu_2 = \frac{\int_0^\infty (t-\mu_1)^2 c_0(t)dt}{\int_0^\infty c_0(t)dt}$

5. Last sentence on page 9560: What does this imply? Is the expected error large or can it be neglected?

6. Page 9563 around lines 14-16: I think it is not sufficient to give the commands of the names that are used in the specific software packages. The name of the method or algorithm that is behind this command should be given.

7. Section 2.6.: It could be discussed a bit more that what is here measured is the effective hydraulic conductivity of the full system. I find it somewhat surprising that for a heterogeneous structure a power law is assumed for the effective hydraulic conductivity function. One would expect maybe something that is more bimodal.

8. Page 9565, line 22: How is 'mean aggregate width' defined?

9. On page 9569 in lines 4-9 it is argued that in previous studies it has been shown that better connected flow pathways in flow direction result in preferential flow, while this is here not necessarily the case. I think that this comparison is misleading. To compare preferential flow in a heterogeneous medium, one would have to compare media with the same mean parameter values. In the studies on preferential flow in heterogeneous hydraulic conductivity fields, one would relate a heterogeneous medium to a homogeneous medium with the same effective hydraulic conductivity. In this case connected flow channels in general promote preferential flow. But also in these studies one would find stronger preferential flow if few highly conductive channels were connected than if a large volume of highly conductive channels would span the medium.

10. Page 0570 line 15: I would disagree that in Figure 10 a strong relationship is supported. One could say that a trend can be supported. But the spread in the



data is quite large. The same is true for the last sentence in Section 3.2.2: I agree that a trend could be postulated. But I do not really agree that there is a remarkably strong relation, in particular in the plots in Figure 8.

11. Conclusions: From lines 25 on page 9571 to line 3 on page 9572 it is hypothesized that the dense macropore network prevents preferential transport as it increases diffusion into the matrix. This is one reason. But another reason is certainly that the heterogeneous structure is much more homogenized, so that a larger cross section of the medium participates in the fast transport.

12. Conclusions: From line 3 to line 7 on page 9471 it is hypothesized that the near-saturated hydraulic conductivity is a good measure for preferential transport. I do not understand why this should be so. The near-saturated hydraulic conductivity is one lumped parameter that includes many different effects. Different structures made of different materials could result in the same parameter. Also a homogeneous medium could have the same parameter value. I agree that it would be one useful parameter for preferential transport. However, I think that additional information on small scale structure would be required to estimate preferential transport.