

## ***Interactive comment on “Saturated and unsaturated salt transport in peat from a constructed fen” by Reuven B. Simhayov et al.***

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Reply to Reviewer #2

We thank the reviewer for his/hers comments. We found the comments and suggestions of reviewer 2 insightful and helpful. S/he picked up on several issues also identified by reviewer 1 (in such cases we refer back to those comments). We have done our best to adopt suggestions, and otherwise have provided further explanation or a rebuttal. Our answers to the review are as follows: Answers to comments by reviewer #2 (Structure: quote of reviewer and an answer starting with — in the following line).

1. “Lines 9-10. This opening sentence is overly complex and confusing as written. I would advise revising the sentence by playing more careful attention to syntax and

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shortening the sentence. For example it can be changed to: The underlying processes governing solute transport were analyzed in peat from an experimentally constructed fen peatland by performing saturated and unsaturated solute breakthrough experiments using Na<sup>+</sup> and Cl<sup>-</sup> as reactive and non-reactive solutes, respectively. A good rule of thumb with regard to syntax is to keep like elements of a sentence together”.

—We agree and appreciate this helpful comment. In our revised manuscript, we will be careful in enhancing readability, e.g. by adopting proposed sentence.

2. “Line 16: Please don’t begin a sentence with a stand-alone pronoun (e.g. “This”), which in this context is ambiguous. Add the appropriate words or words after “This” to clarify the subject of this sentence.”

—we will try to address this throughout the document.

3. “Line 17: change “(!infinity)” to “(which approaches)””

— we will change this as proposed.

4. “Line 17: See my note about stand-alone pronouns above. It is always preferable to avoid introducing unintended ambiguity by avoiding this usage altogether.”

—We agree and will change it to be decisive.

5. “Lines 27-28: Does this study have broader implications beyond the specific experimental setting and its selective process of constructing the peat columns in the lab? The concluding sentence of the abstract should address this question and point out the broader significance of these findings. Are these results specific to this experimental apparatus, study site, other reconstructed fens. Can the results provide new insights on the limitations of the dual porosity model of pristine peatlands as well?”

— We agree with both comments/questions. The study does have a broader implication, and we think we can exploit this aspect more than we have done. We will state the significance of our study/conclusions in the abstract of a revised manuscript. i.e.

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the mobile-immobile solute transport model cannot be selected per se.

6. "Lines 32-33. The subject of this sentence is too long. Please shorten the subject and move the verb to the beginning of the sentence. "

—As stated previously, we will be more specific in the use of our language and address this in a revised manuscript.

7. "Line 35: Change "which" to "that""

—see for previous comment.

8. "Line 40: Change "Generally, Sphagnum" to "Generally, in Sphagnum""

—as previous comment.

9. "Lines 32-49: First two paragraphs: Some of the ideas expressed in these opening paragraphs should be reduced and incorporated into the Abstract to provide a better rationale for this study and its broader significance."

—We understand this is related to the comments on lines 27-28, and will, in a revised manuscript, carefully reassess how to make the abstract stronger. This is a good suggestion, it is logical and helps strengthen the essence of the article in the abstract, and will be addressed in the revised manuscript.

10. "Line 64: Please avoid using (especially at the beginning of a sentence) a stand-alone pronoun. In this case the subject of this sentence is not clear. "

—we agree and will check our manuscript for these instances.

11. "Line 71: A dangerous assertion since any person's knowledge of the literature is always limited. For example, the authors could also cite Comas, X. and L. Slater (2004) Low frequency electrical properties of peat Water Resources Research, Vol. 40, W12414, doi:10.1029/2004WR003534, 2004."

—We agree, and in the following, we will be more reserved in the revised manuscript

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by writing: "As to the current knowledge of the authors.". Additionally, we will consider the mentioned publication, and possible implications from it. We will also add the suggested citation.

12. "Line 77: Please add the appropriate word or words after the stand-alone pronoun "this" to clarify its meaning. Otherwise the subject of this sentence is ambiguous. "

—We will replace 'this' by stating "[. . .], the method of estimating  $n_e$  from photo-imagery may easily lead to a systematic miscalculation of effective pore water velocity."

13. "Line 85: The authors may want to consider the possibility that interactions between NaCl and dissolved organic matter (e.g. organic acids) may induce changes in the pore size and geometry as originally proposed by Ours et al. 1997 and supported by Comas & Slater 2005 or Levy et al. 2016? "

—We fully agree with this statement, and had, for this reason, explicitly included a pretreatment to equilibrate and flush the samples. This is clearly stated in lines 152-155 and see no necessity to for changes.

14. "Line 88: Change "We approach this" to "We approach this objective""

—we will correct this as suggested.

15. "Lines 88-89: Were these experiments conducted in the field or lab? It would be a good idea to specify the later here."

—we are surprised that this was not clear, but will add the following sentence in the revised manuscript: "lab based experiments including" in line 88.

16. "Lines 109-112. I am confused. The previous text describes the peat used in this experiment was dominated by sedge remains. However, but figure caption suggests that the peat was composed of Sphagnum moss. Please provide an explanation in this figure caption if possible. "

—We realize we did not elaborate on this point sufficiently, and failed to make it clear to

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the reader, since also the other reviewer commented on this. Therefore, we will be more specific on the description of the peat characteristics (e.g. by repeating the findings of other researchers in a revised manuscript). We do note, that we give references to other research on the same constructed peatland, and we do present a scanning electron microscopy images of the Sphagnum remnants in the peat samples (lines 348-350).

17. "Lines 112-125: How were these samples collected? A very brief description would be crucial since any method to secure peat samples for laboratory experiments will produce deformations to the original peat fabric, which will alter the hydraulic properties of the peat and therefore affect the results of the experiments. I realize that artifacts are unavoidable regardless of the sampling methods used but it would still be a good idea to address this issue here. It appears that the material used in this experiment were collected from a pile of peat that was excavated from an intact fen and then dumped in a pile. It would probably be a good idea to add a sentence or two to describe how peat was collected from this excavated pile. Please remember that peat is a generic term covering a wide and heterogeneous range of porous media. "

—This concern was also raised by the other reviewer, and we seem to have failed to be precise in describing the a) characteristics of the peat, b) the sampling method, and c) the site description. As we have mentioned before, we will be careful to present the information more coherently in a revised manuscript. We do point out, that at several points in the manuscript we give descriptions, e.g. lines 102-105 where we state: "the peat has been disturbed for a few years prior to sampling. It was taken from a pile that was created using heavy machinery. It is therefore likely that these disturbances had a much greater effect on the peat properties than the lab preparation. Further the preparation was designed to reduce the variability caused by the disturbances.". Moreover, the peat was not sieved, as suggested by reviewer 1, but coarse material was carefully removed ( $\leq 2\%$  in volume) and the peat was gently mixed to increase homogeneity. It is unlikely this caused a change to the cellular structure of the cells.

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18. "Line 118: The authors should provide a rationale for adapting this unusual plan for packing peat into their permeameter columns. The approach will alter the fabric of the original in situ peat by preferentially removing coarser material and rearranging the packing and intra particle porosity of the finer-grained material. "

—See answer to previous comment.

19. "Line 384: How can the bulk density and porosity be similar if they have different units of measure (gm/cm<sup>3</sup> vs %)?"

— We think the reviewer refers to line 284 (not 384): This similarity is not apparent, in Table 1 the bulk density is clearly given by 0.12 g/cm<sup>3</sup> and porosity by 0.93 [-]. The numbers with % sign are the coefficient of variation as mentioned in the caption, which is the standard deviation of the three replicates divided by their mean. Therefore, we do not believe we need to change anything here.

"Do you mean instead that they are statistically related? "

—No, it is a measure for the similarity of the replicates.

20. "Lines 307-310: Is this conclusion specific to soils that have high levels of Cl and other salts?"

—It is specific to the use of EC electrodes to monitor the transition of reactive ions in any solution that flows through a reactive medium. We will incorporate this explanation.

21. "Line 342: Place the non-restrictive clause ("which is the ratio of advective vs diffusive transfer") directly after the subject it modifies (=Peclet number). I suggest changing this sentence to: The Peclet number, "which is the ratio of advective vs diffusive transfer, was 33.9. for the fitted Cl<sup>-</sup> breakthrough data." "

—Agreed. This is a sensible suggestion and will make the changes accordingly in the revised manuscript. In the next comments, we will limit our response to "agreed", indicating we will revise the manuscript accordingly.

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22. "Line 356: change "this" to "this finding" to clarify the meaning of the stand-alone pronoun "this""

— agreed.

23. "Lines 352-357: "Additionally, evidence found in the SEM scans of the peat used in this study (Fig. 1), shows that the cell walls have decayed, with only the skeleton of the cell remaining," I suggest clarifying this sentence since it is not clear whether the authors are specifically referring to the slender chlorophyllose cells (which I think is their intention) or the much larger hyaline cells that have rigid reinforcing structures and microfibril reinforcing structures that are resistant to decay (and will therefore retain their shape when dead). This paragraph also seems to contradict the opening description of the fine-grained peat that was packed into the lab permeameters. "

— We thank you for this helpful and knowledgeable sentence. In discussing the decomposition of the Sphagnum moss parts, we were not specific enough. Generally, the sentences (lines 352-357) relate to the decomposition of the membranes of the hyaline cells. In the presence of intact hyaline cells, the cells act as dead-end pores, where the membranes restrict the solute transport to very small openings. Once the hyaline cell membranes have decayed, solutes can be transported by advection through-out the inner-plant matrix. Thus, the dead end pores no longer exist, a fact which can serve as an explanation for why the parameterization of solute transport models does not indicate a mobile and an immobile domain. While the reviewers comment does not contradict our findings, we will elaborate carefully on the different structures in the peat in a revised manuscript. Finally, the comment does not contradict our study description and methods, since it is unlikely that the careful packing impacted cell membranes (as discussed in the answer to comment on lines 112-115).

24. "Lines 354-355: Please add the appropriate citations to support the statement that "solute transport in peat has to be simulated using the MIM.""

—We will gladly address this by giving more references to the literature, by rephrasing

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and providing references: 'These results contradict the hitherto common finding in laboratory studies that breakthrough experiments on peat need to be described by the MIM (Hoag and Price, 1997; Liu et al., 2016; Rezanezhad et al., 2012; Rezanezhad et al., 2017; Thiemeyer et al., 2017)'

25. "Lines 358-359: Either delete the adverb "As" at the beginning of this sentence or add an appropriate verb to complete this sentence."

—Agreed.

26. "Lines 362: Delete "these" to avoid a run on sentence. "and the robust estimates of v and D for the CDE, these were""

—Agreed.

27. "Line 401: Change" With this" to "With this approach""

—Agreed.

28. "Line 409: Did the authors consider chemical interactions between the ionic composition of the pore waters and organic acids as suggested by Ours et al. 1997? "

—See answer to comment on line 85.

29. "Line 401: I suggest changing "With this we tested if the common assumption" to "With this approach we investigated whether the common assumption"" —Agreed.

30. "Line 410: Please add the appropriate word or words after "this" to clarify the subject of this sentence. I think they are referring to "this result" but I am not certain."

—Agreed.

31. "Line 411: Was the peat primarily composed of Sphagnum? Elsewhere in the text the peat was described as sedge peat extracted from a fen."

—See lines 348-350.

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32. "Line 419-420: How can this statement ("has decayed enough to lose the cell walls but not enough to break the cell skeleton ") be true if the cell walls provide the structural basis of all plant cells. Please revise this statement both here and elsewhere in the text.

— We inadvertently used the word "cell walls" while we meant "cell membranes". We will correct this in a revised manuscript.

33. "Line 421: Another possible reason could be the sampling plan, which selectively packed the finer-grained peat particles into the permeameters. This procedure altered the fabric of the original peat fabric, which was probably first altered by the extraction of an intact fen and the deposition of the peat into a spoil heap. "

— There is no dispute that any manipulation of a sample alters it. However, the prior disturbance, as mentioned in the comment, is likely to have had a greater impact. The peat was not manipulated in a destructive manner such as sieving or milling. The reduced variability as a result of the careful homogenization process provides the improved ability to understand the hydraulic properties of the peat. While we doubt the sample preparation had a notable effect on the value of the parameters, we are certain it did not invalidate our interpretation of the processes, and thus our conclusions. As indicated elsewhere in this reply and in the reply to the reviewer #1, we will make it clearer in a revised manuscript, that both the sampling methods and sampling treatments, in the light of the type of sampling site, are acceptable.

34. "Lines 437-438: "From the industry perspective, choosing and peat with dead end pores would allow a potential for significant attenuation." Remove "and" from this sentence."

— Agreed.

35. "Are the authors concluding that partially decomposed peat (preferentially dominated by Sphagnum) provides the best material for optimizing solute attenuation in

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reconstructed peatlands?"

—The sentence tries to convey that the hydraulic and transport properties of the peat should be checked and match the desired function. Therefore, to answer the reviewers question, if solute attenuation is the goal then peat with a larger amount of sphagnum and a dual porosity structure would be a better choice. We will add additional text in the revised manuscript.

References used in Reply to Reviewer #2:

Hoag, R.S., and Price, J.S. (1997). The effects of matrix diffusion on solute transport and retardation in undisturbed peat in laboratory columns. *Journal of Contaminant Hydrology* 28:193–205.

Liu, H., Janssen, M., and Lennartz, B. (2016). Changes in flow and transport patterns in fen peat following soil degradation. *European Journal of Soil Science* 67:763–772.

Rezanezhad, F., Price, J.S., & Craig, J.R. (2012). The effect of dual-porosity on transport and retardation in peat: A laboratory experiment. *Can. J. Soil Sci.*, 92: 1-10.

Rezanezhad, F., Kleimeier, C., Milojevic, T., Liu, H., Weber, T.K.D., Van Cappellen, P., and Lennartz, B. (2017). The Role of Pore Structure on Nitrate Reduction in Peat Soil: A Physical Characterization of Pore Distribution and Solute Transport, *Wetlands*, doi 10.1007/s13157-017-0930-4.

Tiemeyer, B., Pfaffner, N., Frank, S., Kaiser, K., Fiedler, S., (2017). Pore water velocity and ionic strength effects on DOC release from peat-sand mixtures: results from laboratory and field experiments. *Geoderma* 296:86-97.

Interactive comment on SOIL Discuss., <https://doi.org/10.5194/soil-2017-20>, 2017.

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