Response to anonymous referee #2

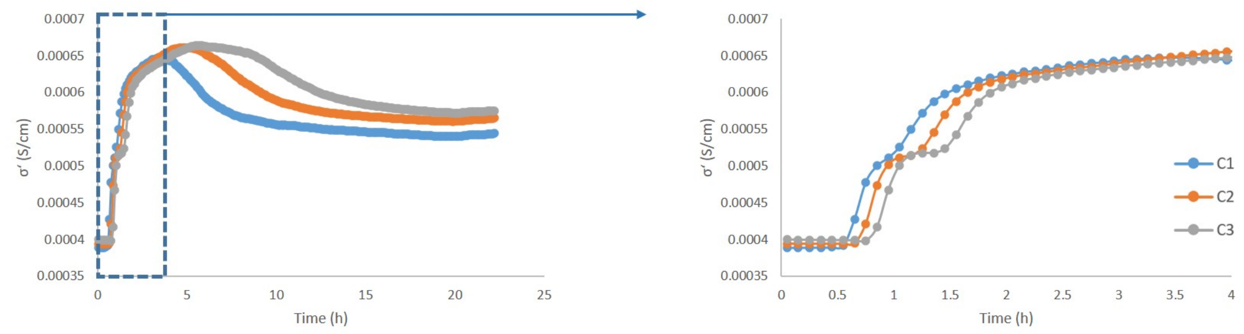
We would like to thank anonymous referee #2 for the comments.
The main concerns of the reviewer are related to two aspects:

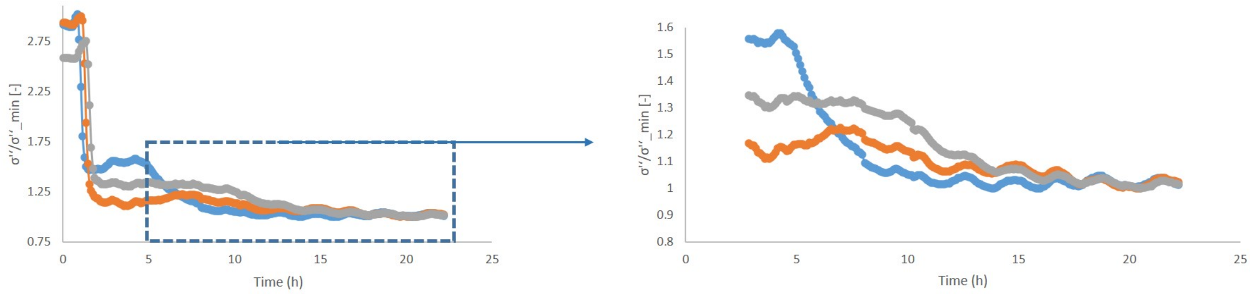
1. The novelty of the presented work in light of previous research in the field.
2. The applicability to real world problems.

We jointly address these concerns in the following reply.

1. The innovation in our work (as it was presented in the original text) stems primarily from the heterogeneous experiment. To the best of our knowledge, this aspect was not examined before. In the text, we discuss our results in light of previous studies that looked into the SIP response of different-textured soil in no-flow conditions. We also suggest a connection between the imaginary SIP response (in the sand compared to the loam) and the CEC of the different soils. In the revised version of the paper we will support our findings with CEC measurements of the sand and loam.
We agree that expanding the paper (by additional experiments with other contaminants) would enhance the novelty of our work, in addition to addressing the second concern. We thus intend to do so (as elaborated in section 2).

2. The transport of additional solutes will be examined and presented. In a series of experiments, we examined a few alternatives.
We hereby present some of the result of our additional experiments. The following results show the real and imaginary components of the complex conductivity (at 1 Hz) over time in a sand column during a continuous Zinc injection.





The results clearly show the BT of the non-reactive ions around t=1h (the Cl^- anion and Na^+ cation that behaves as a non-reactive solute since the experiment started after a long $NaCl$ pre-wash). A second geo-electrical BT is observed around t=1.7h. This BT corresponds to the increased concentrations of Ca^{2+} that was washed out during the Zn injection and was detected by ICP. The subsequent drop in σ' is probably the result of Zn precipitation. PhreeqC simulations confirmed a positive precipitation potential of $Zn(OH)_2$, which is expected to be the dominant species in the system.
The imaginary conductivity presented a slight increase initially and then decreased significantly (similarly to our $Ca^{2+} - Na^+$ exchange experiment). A second pattern of increase and decrease is observed between t=2-14h. This pattern corresponds (timing-wise) to the observed drop in σ' and hence is likely to be related to the Zn precipitation process. Further laboratory work and analysis are still needed to complete this experiment. We are also currently testing similar setups for monitoring of organic pollutants and other metals.

3. The introduction will be expanded to include additional papers that addressed the link between BTCs / ion-exchange processes and SIP monitoring in soil. For example, Izumoto et al., 2020, Slater et al., 2009 and Mellage et al., 2018 will be included as examples of previous studies that combined geo-electrical monitoring with transport processes or ADE modeling.

References:

1. Izumoto, S., Huisman, J. A., Wu, Y., and Vereecken, H. (2020). Effect of solute concentration on the spectral induced polarization response of calcite precipitation. Geophysical Journal International, 220(2), 1187-1196.-
2. Slater, L. D., Day-Lewis, F. D., Ntarlagiannis, D., O'Brien, M., and Yee, N. (2009). Geo-electrical measurement and modeling of biogeochemical breakthrough behavior during microbial activity. Geophysical research letters, 36(14).-
3. Mellage, A., Holmes, A. B., Linley, S., Vallee, L., Rezanezhad, F., Thomson, N.,and Van Cappellen, P. (2018). Sensing coated iron-oxide nanoparticles with spectral induced polarization (SIP): experiments in natural sand packed flow-through columns. Environmental science and technology, 52(24), 14256-14265.-