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Discussions

# *Interactive comment on* "Tracer test modeling for local scale residence time distribution characterization in an artificial recharge site" *by* C. Valhondo et al.

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We thank the reviewer for his/her constructive comments and the help to improve the manuscript. As we did with the other reviewers comments and in the spirit of the HESS discussion, we debate below the points that might need further explanations. Detailed responses to all comments from the three reviewers will be composed and sent with the revised manuscript.

Some of the most important issues highlighted by reviewer 3 , such as the modeling tool strategy, calibration strategy, the way the local and the large scale models were coupled, and the reason to divide the aquifer into seven 2m-thick layers, were also raised by the reviewer Prof. Marc Walther. Answers to those issues are discussed by



Valhondo et al (2016) and will not be discussed here. Other issues highlighted are addressed below.

1- Amino G acid input time function and infiltration basin zones:

The amino G acid input was modeled as a time dependent source term that distributes the total used mass (8 kg) over a 15 minutes period. In reality, the tracer was poured at the entrance of the infiltration. Presumably, it travel on the basin so that it was not homogeneously distributed in the whole basin water volume. This together with the potential degradation of amino-G acid resulted in a higher concentration of amino-G acid close to the infiltration basin entrance than in the rest of the basin. Actually, the amino-G acid concentration measured in P8.3, placed close to the infiltration basin entrance, was 2.75 times higher than the expected concentration for an homogeneous dilution. To emulate this process we divided the infiltration basin in nine zones and applied a weighting factor to the amino-G acid time function for each zone. The factor is greater than one in the zones close to the entrance of the infiltration basin and lower than one in the rest of the zones. The mass balance was taken into account to ensure that the total amino-G acid mass introduced was precise (6683 mg in Het-1, 6853 mg in Het-2, and 7885 mg in Hom) . In the revised manuscript we will add to table 1 the information about the amino-G acid mass for each outcome (Het-1, Het-2, and Hom).

2- Preferential flow paths:

The assumption that flow through the reactive barrier occurs through preferential flow paths is suggested by the redox indicators species measured in the infiltration basin, the suction cups, and the monitoring point P8.3. It is discusses by Valhondo et al., (2014 and 2015). Indications of preferential flow paths include: (1) very fast arrival of the tracer (it would have taken several days if flow was uniform), and (2) presence in P8.3 of oxidizing species (e.g. NO3-) and disappearance of reducing species that had been sampled in the unsaturated zone (e.g. Fe+2). We considered the heterogeneity of the reactive barrier and the high permeability of the aquifer (clean sand and gravel)

as the main causes favoring the flow of the recharge water along fingers and traveling at a velocity similar to the hydraulic conductivity (Hill and Parlange, 1972; Selker et al., 1996; Cueto-Felgueroso and Juanes., 2008). To emulate the fast infiltration of recharge water through these preferential flow paths we distributed the recharge water volume entering into the infiltration basin between layer-9 (representing the surface of the reactive barrier) and the surface area of the infiltration basin projected on layer-7 (representing the aquifer). As it turned out, best fit was obtained by distributing inflow 60% and 40% between layer-9 and Layer-7.

3- TCA reactivity:

TCA is very persistent in the environment with reported half-life times of 136-720 days in groundwater (Zhao et al., 2015). TCA can be degraded by biotransformation or abiotically. TCA biotransformation occurs mainly through the process of reductive dechlorination for which anaerobic conditions are desired and DOC is used as substrate . The natural groundwater of the aquifer is mainly aerobic, with average O2 concentration of 3mg/l and average DOC concentration of 2.5mg/l. Therefore, we expected little biodegradation and half life time higher than the model residence time. The abiotic TCA transformation into DCE and acetate by common hydrolysis in water happens as a first-order kinetic law with a half-life time of 2.9 years at 15 °C (Lookman et al., 2004), which is much longer than the residencen time in the local domain. Therefore, TCA can be considered as a conservative tracer in the time scale of the model.

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