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Hydrology and Earth System Sciences Discussions

Interactive comment on "A parameter identifiability study of two chalk tracer tests" *by* S. A. Mathias et al.

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The study addresses the tracer transport in a highly heterogeneous system (chalk). This topic is apparently within the scope of HESS. The paper is well organized and easy to follow. However, the paper did not provide sufficient information on the chalk characterizations in the test areas and this would have made it not possible for readers to figure out what processes were actually important in generating the observed break-through curves. This is essential to judge the overall quality of the paper because matching the observed data does not mean the model itself is right (we could achieve this by using a physically wrong model). Specific comments are as follows.

1. The paper presents a novel concept for the model calibration but the central findings are less convincing. The mass recovery fractions for two tracer tests are significantly different: 95% for the Horsehealth and 55% for the South Farm. This difference indicates that dominant processes are different. For the Horsehealth test, the higher mass recovery may mean that dispersions (both mechanical dispersion and matrix diffusion) are less important. For the South Farm test, the lower mass recovery rate may mean that dispersions are quite important. However, same conclusions were reached for both tests: 'It was found that the single fracture model (SFM) (which ignores mechanical dispersion) obtained the best mass recovery, excellent model performance and best parameter identifiability in both the tests studied. However, there was no objective evidence 20 suggesting that mechanical dispersion was negligible. Moreover, the SFM (with just two parameters) was found to be good at approximating the Single Fracture Dispersion Model SFDM (with three parameters) when different, and potentially erroneous parameters, were used'. Conceptually, because of the high mass recovery fraction and negligible dispersion for the Horsehealth test, SFM could be the best model to use; because of the low mass recovery fraction and high dispersion for the South Farm test, PFDM could be the best model to use. *The authors may have to address the discrepancy between the conceptual models and their findings.*

2. Substantial conclusions were reached but not supported well by the results. More justifications are required for the conclusion: "Overall, this study emphasises the importance of adequate temporal sampling of breakthrough curve data prior to peak concentrations, to ensure adequate characterisation of mechanical dispersion processes, and continued monitoring afterwards, to ensure adequate characterisation of fracture spacing (where possible), when parameterising dual-porosity solute transport models".

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