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Single-Well Injection-Withdrawal Experiments for Ground Flow Estimation

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We present a closer look on the Single-Well Injection-Withdrawal Experiment (SWIW) also known as Push-Pull Experiments and its ability to determine the groundwater velocity, as one of the major parameters concerning reservoir management. SWIW are tripartite. One starts with the tracer injection, followed by a quiescence period, where the tracer transport is dominated by the ambient flow field in the reservoir. The last phase is the withdrawal where the tracer break trough curve (BTC) is recorded. From the shape of the BTC, we are able to determine the groundwater velocity. The problem is numerically modeled using COMSOL Multiphysics. We compare with an advanced inversion scheme, based on analytical solutions and implemented in MATLAB. The results show that the BTC of a SWIW experiment is highly dependent on interaction between the parameters for groundwater velocity, pumping rates and the duration of the quiescence phase as well as the reservoir geometry. For the specific tracer applied in the model a minor influence is given by diffusion, dispersion and sorption processes.

In dependence of the quiescence time and the groundwater velocity one can distinguish between three characteristic BTC types for the single tracer SWIW. These are given for tracers around the well, tracer between well and stagnation point and tracer beyond the stagnation point. The transition between these different cases is also discussed.

The COMSOL Multiphysics model is used to investigate observations from a SWIW experiment performed recently in Japan. The latter is performed in cooperation with Technical University Berlin.

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