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Numerical simulation of bench-scale tank experiments to quantify transverse dispersion

E. BALLARINI[1], S. BAUER[1], C. EBERHARDT[2] & C. BEYER[1]

1 Institute for Geosciences, University of Kiel, Ludewig-Meyn-Str. 10, D-24118 Kiel, Germany
ballarin@gpi.uni-kiel.de

2 Center for Applied Geosciences, University of Tübingen, Sigwartstraße 10, D-72076 Tübingen, Germany

Abstract Transverse mixing has been studied within the context of contaminant transport in aquifers, as it represents an important mixing process and is an essential prerequisite for geochemical and biodegradation reactions. In this work, the effects of different hydraulic parameters on plume development in homogeneous and heterogeneous porous media were investigated. A series of detailed and well controlled 2D bench-scale tank experiments, where one or more conservative tracers are injected, was performed in a homogeneous porous medium consisting of a fine matrix (0.25–0.3 mm) and in a heterogeneous medium that has the same matrix grain size but includes a more permeable lens (grain size 1.0–1.5 mm). The experiments were evaluated by numerical simulation. Results of a sensitivity analysis show that contrary to the homogeneous experiments, the tracer distribution is not very sensitive to variations in transverse dispersivity. In fact, only the order of magnitude of this parameter can be estimated by fitting the numerical results to the laboratory measurements. The plume shape and position in the heterogeneous set-up is mainly controlled by the contrast in the hydraulic conductivities between the matrix and the more permeable inclusion. A unique parameter set could be calibrated to closely fit the measured concentration data. For porous media with a grain size of 0.2–0.3 mm and 1.0–1.5 mm (i.e. permeable inclusion in the heterogeneous set-up) and a porosity of 0.42 and 0.43, the fitted longitudinal dispersivities are 3.49×10^{-4} m and 7.6×10^{-4} m, while the transverse dispersivities are 1.48×10^{-5} m and 7.1×10^{-5} m, respectively.

Key words transverse mixing; heterogeneity; bench-scale experiments; conservative tracers