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Recovering tracer test input functions from fluid electrical conductivity logging in fractured porous rocks

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A radially convergent tracer test was carried out in the Chalk outcrop of Berkshire, UK. Fluorescent tracers were injected into two boreholes lying 32 m (PL10A) and 54 m (PL10B) from the abstraction hole (BBA). The tracers were also mixed with an NaCl solution so that that vertical distributions of tracer within the injection wells could be monitored using fluid electrical conductivity (FEC) logging. The breakthrough curve (BTC) from PL10A was uni-modal, had a first arrival time of 14 min. The BTC from PL10B exhibited two distinct peaks and a first arrival time of just 4 min. Chalk is a dual-porosity medium where fast flow occurs in fractures while matrix flow is close to negligible. Solute transport is strongly retarded due to diffusion of solutes between the fractures and the matrix. A log-log late-time-slope (LTS) of -1.5 in tracer BTCs is indicative of Fickian matrix diffusion. Both BTCs show LTSs $<$-1.5. Previously, it has been suggested that LTSs less than -1.5 are indicative of multiple mass-transfer rates and/or multiple flow-pathways. In this paper, the tracer test input functions were derived by numerically modelling the observed temporal and vertical distribution of FEC in the injection wells. These were then convoluted with a conventional, Fickian matrix diffusion dual-porosity model, which showed that the non -1.5 LTSs in the BTCs from PL10A and PL10B are due to the way in which the tracers left the injection wells into the aquifer.