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Mallinnusseminaari 12.12.2016
Design Factory, Espoo, Finland

Role of connectivity on the formation of anomalous transport nearby pumping wells in heterogeneous aquifers

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This presentation provides an overview of recent results obtained from analytical, numerical and experimental studies on anomalous transport nearby pumping wells and in presence of connected hydrogeological structures. Connectivity affects the behavior of solute transport in heterogeneous aquifers, and in particular generates anomalous transport, which characterizes the typically nonsymmetric breakthrough curves (BTCs) observed during tracer tests. These BTCs display pronounced “tailing”, which means longer-than-expected breakthrough of contaminants at a control section and persistence of contaminants in the subsurface. The first part of this presentation is devoted on the achievements obtained under fully saturated conditions. Here, it can be shown that anomalous transport is directly controlled by the impact of connectivity and stratification of flow and transport, which affect how solute particles arrive at the controlling over longer time scales than those predicted by classical theories (e.g. Fickian dispesion based models). In the second part of this presentation, light is shed on a recent experimental investigation conducted to evaluate the impact of connectivity on anomalous transport and scaling of BTCs under variably saturated aquifer conditions. Several experimental tracer tests were performed in a metric-scale heterogeneous sandbox from 26 different injection locations. Two sets of tests have been performed on the same sandbox with the same hydrogeological configuration. One set was performed under unsaturated settings (phreatic aquifer) and one set under fully saturated conditions (confined aquifer). We show that despite the presence of the same connected features in the two systems, the conservative tracer injected in the unsaturated sandbox resulted in highly skewed BTCs, while in the corresponding confined system most of the BTCs injected from the same locations were quite symmetric, showing no evidence of anomalous transport.