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Comparison of different investigation methods to characterise alluvial gravel aquifers

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For reliable groundwater transport modelling of unconsolidated porous aquifers, high resolution characterisation of spatially heterogeneous hydraulic and transport properties is of great importance. Predictions of first-arrival times and long term behaviour depend strongly on the quality of estimated hydraulic and transport parameters. By neglecting small-scale structures such as sand lenses and sediment intra-channel deposits, predictions are hardly accurate. This paper deals with the comparison of methods to characterize hydraulic parameters governing solute transport in unconsolidated porous aquifer materials. A large number of single-well slug tests, cross-well slug tests, a pumping test and a multi-level tracer test were conducted in a shallow alluvial gravel aquifer. This facilitated describing the spatial variation of hydraulic and transport parameters with high resolution.
Multi-level slug tests results show distinct positive correlation with porosity-logs and drill cores and are thus an effective means to identify and characterize subsurface structures at high resolution. Values for hydraulic conductivity gained from pumping tests and cross-well slug tests revealed good accordance but were around one order of magnitude higher than the values derived from multi-level slug tests. This might be due to the fact that the three methods are involving different test-volumes. Hence, the determination of hydraulic conductivity underlies a scale dependency: larger test volumes tend to be characterized by larger K-values. Furthermore, our pumping test results show the importance of a high sampling rate, in our case 50 Hz, in order to determine reliably the hydraulic properties storage and anisotropy of hydraulic conductivity. Although pumping tests typically estimate hydraulic parameters on large-scale, small-scale heterogeneity could also be identified and characterized. This was again possible through the high resolution records of the early time drawdown. Finally, results of multi-level tracer testing supported observations from slug tests and porosity logs.