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Geostatistical identification of spatially distributed parameter fields by hydraulic tomography

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In recent years, hydraulic tomography has gained increasing interest from the hydrogeological community as a tool to estimate spatial distributions of hydraulic parameters. Most studies so far, however, have considered either numerical test cases or well-defined laboratory experiments. In the current contribution, we present results obtained from 24 pumping tests using 52 observation wells leading to 179 drawdown curves at the Krauthausen test site of the research center Jülich.

We characterize the drawdown curves by their temporal moments and invert temporal-moment generating equations to infer transmissivity and storativity fields. Our inverse scheme is based on the quasi-linear geostatistical approach, which is a Bayesian method in which the hydraulic parameters are assumed to be random space functions. Provided the amount of collected data is sufficient, the approach allows to estimate the geostatistical meta-parameters from the measurements as well.

Our analysis clearly shows that the standard type-curve methods are not capable of retrieving the spatial distribution of the parameter fields, whereas the geostatistical approach does. The estimation of the variances and correlation lengths depends strongly on the measurement error of heads. Storativities are more complicated to estimate than transmissivities, presumably because unresolved heterogeneity in the conductivity field is aliased into variability of storativity.