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Characterization of the spatial variability of hydraulic parameters by inverse modeling

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We present a methodology for the inversion of hydraulic test data based on the concept of hydraulic tomography. Inversion of transient head data is performed in a field test conducted at the Altona Flat Rock experimental site, located near Plattsburgh, New York State, USA and in synthetic datasets based on this field site. The purpose of this study was to assess how much variability in transmissivity (T) and storativity (S) is warranted by hydraulic tomography tests. It is well known that cross-hole hydraulic tests can mistake variation in transmissivity as variation in storativity. We hypothesize that we can decouple S and T in hydraulic tomography inversion by (1) inverting T and S simultaneously and (2) inverting both steady and pulse hydraulic stress configurations. The experimental site is in a single saturated sub-horizontal bedding plane fracture that extends over the scale of kilometers. Seven open boreholes have been drilled to a depth of 12.2 m in the formation at reciprocal distances ranging from 7 to 15.8 m. Packer injection tests show the presence of a saturated horizontal fracture at 7.6 m. of depth, which intersects all the wells. The single fracture is characterized by a highly variable aperture which leads to a wide range of T and S as estimated from slug tests. The inversion was performed within a Bayesian framework by using the pilot point concept and by assuming unknown the stochastic parameters of the spatial variability models of T and S, i.e. mean, variance and integral scales. From this analysis we conclude that, even under the assumption of highly heterogeneous transmissivity field, the field data cannot be inverted without varying both T and S in space. We also find that non-steady pump test designs (e.g. pulse, multi-pulse) may improve

decoupling of T and S inversion of cross-hole hydraulic test data.