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Cost-Effective Hydraulic Tomography Surveys for Predicting Flow and Transport in Heterogeneous Aquifers

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This study presents cost-effective hydraulic tomography surveys (HTS) to characterize flow and transport in heterogeneous aquifers. The HTS accounts for responses of hydraulic stresses caused by pumping or injection events at different locations of an aquifer. A sequential data assimilation procedure based on cokriging algorithm is then used to map the aquifer hydraulic conductivity (K). This study uses a synthetic two-dimensional aquifer to assess the accuracy of predicted concentration breakthrough curves (BTCs) based on the K fields estimated by geometric mean, kriging, and HTS. Such K fields represent different degrees of flow resolutions as compared with the synthetically generated one. Without intensive experiments to calibrate accurate dispersivities at sites, the flow field based on HTS K field can yield accurate predictions of BTC peaks and phases. On the basis of calculating mean absolute and square errors for estimated K fields, numerical assessments on the HTS operation strategy shows that more pumping events will generally lead to more accurate estimations of K fields and the pump locations need to be installed parallel to aquifer layers to maximize the delivery of head information from pumps to measurement points. Additionally, the number of direct K measurements used in HTS is not sensitive to final estimations of K field. The appropriate distances of installed wells are suggested to be less than one third of the ln K correlation length in x-direction.