Imaging hydraulic conductivity by cross-borehole induced polarization - a novel inversion procedure

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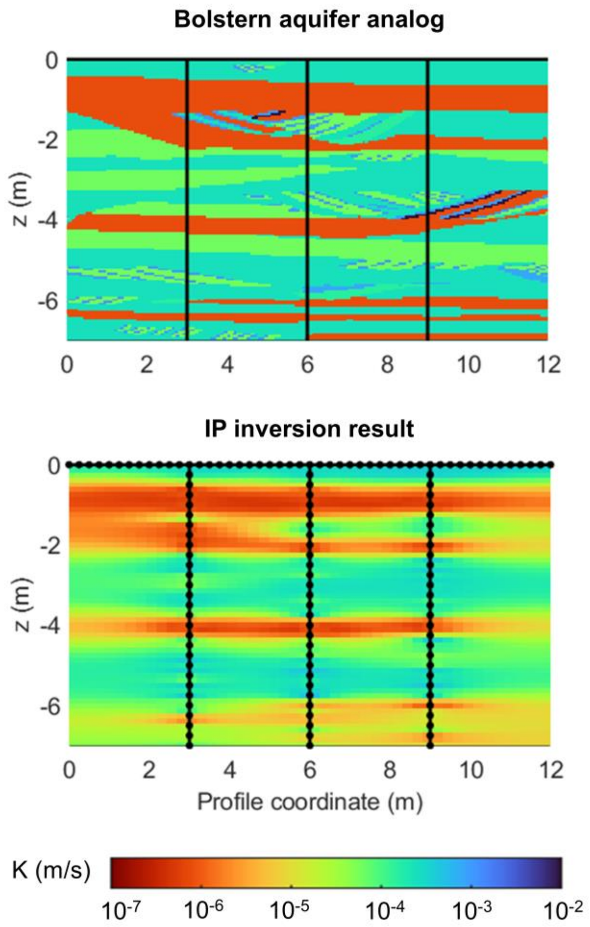
For the reliable modeling of groundwater flow and transport processes, the quantitative accuracy and spatial resolution of the underlying hydraulic conductivity (K) information is crucial. In the field, the distribution of K is often obtained by performing pumping tests (which can be time-consuming and costly) or by simply inferring them from sparse borehole data (often missing important small-scale heterogeneities). However, geophysical measurements may reveal the spatial distribution of K with high accuracy and resolution in a time- and cost-efficient way. In this work, we present a novel inversion procedure for induced polarization (IP) data allowing the direct computation of the K-distribution in an aquifer. We implement our strategy for the Bolstern aquifer analog data set [1] as a realistic test case for strongly heterogeneous sedimentary unconsolidated aquifers.

Synthetic IP experiments are carried out on the Bolstern data set with a combined surface profile and cross-borehole setup. The inversion procedure consists in a re-parameterization of the Cole-Cole model [2] through petrophysical equations linking electrical and hydraulic parameters [3,4]. Thereby, the direct computation of K from the IP data is possible. Furthermore, we suggest two novel calibration strategies incorporating pumping test data into the IP inversion.

The results show that the spatial distribution of K can be reconstructed by the IP inversion to a high degree of resolution and accuracy. Using an electrode spacing of 0.25 m reveals all relevant small-scale structures and incorporating pumping test data ensures the reliability of the K-estimates. We also evaluate the performance of the inversion and different calibration strategies by a transport simulation. Thereby, we show that the IP method is indeed a helpful tool for providing the K-information required for groundwater modeling.



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