SUBSURFACE CHARACTERIZATION FOR HYDROGEOLOGIC STUDIES: HYDRAULIC, HYDROLOGIC, AND GEOLOGIC INFORMATION COLLECTION STEPS

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The characterization of hydraulic parameters is essential part of groundwater studies for flow and transport modeling. However it is difficult to estimate hydraulic conductivity field from hydraulic pumping tests (Batu, 1998) and core samples because of heterogeneity of parameter field and disturbance in samples. Geophysical techniques, especially electrical resistivity methods, have been applied to groundwater studies and resistivity distribution imaging has been performed for subsurface characterization (Mazac et al., 1987). We can obtain resistivity distribution from inversion analysis with field survey data.

The geologic and resistivity field information can be gathered from geophysical technique and hydraulic information can be obtained from hydraulic pumping test and core samples. Our goal is to estimate heterogeneous hydraulic conductivity field by combining the two sets of information from the two techniques. There is one problem for each technique. From geophysical method, we can have heterogeneous resistivity distribution however we cannot relate the resistivity distribution to hydraulic conductivity distribution directly. From hydraulic method, we can have averaged or lumped hydraulic conductivity from pumping tests and point hydraulic conductivity from disturbed core samples however we cannot have heterogeneous parameter distribution. In this study, an efficient method to characterize three-dimensional (3-D) heterogeneous hydraulic conductivity distribution is developed by combining hydraulic and geophysical techniques. The following steps are suggested for the estimation.

(1) Surface dipole-dipole resistivity survey and inversion for subsurface resistivity image

Obtain 3-D resistivity distribution by performing inversion with field survey data.

Make the first decision of geologic information, like the number of layers, thickness of them, bedrock location, geometry of aquifer, etc.

(2) Well location decision

Determine the well locations for hydraulic pumping tests and core sampling based on the geophysical information. (Cost-effective well location design)

(3) Hydraulic pumping tests and core sampling

Estimate averaged (or lumped) hydraulic conductivity from the analysis of drawdown data and point hydraulic conductivity from (disturbed) core samples.

Make the second decision of geologic information and correct the first decision, if necessary, according to the information of vertical distribution of aquifer material from core samples.

(4) Resistivity – Aquifer material

Determine the material distribution from the resistivity distribution, core sample data, and the relationship between resistivity and aquifer materials.

(5) Aquifer material – Hydraulic conductivity

Determine hydraulic conductivity distribution from the material distribution, the results from hydraulic pumping test analysis, core sample analysis, and the relationship between aquifer material and hydraulic conductivity.

This method can be applied to from laboratory scale to field scale groundwater studies and must be helpful for cost-effective well location design in field scale analysis and we can expect more accurate groundwater flow and transport modeling.

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