Technische Universität München

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Efficient Software for Computing Correlated K-Ss Tomographs

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Computational Modeling of Saturated Flow

Governing differential equation:

$$\nabla \cdot \left(K \nabla h \right) + S_s \dot{h} = q$$

$K = K(x, y, z)$ = hydraulic conductivity

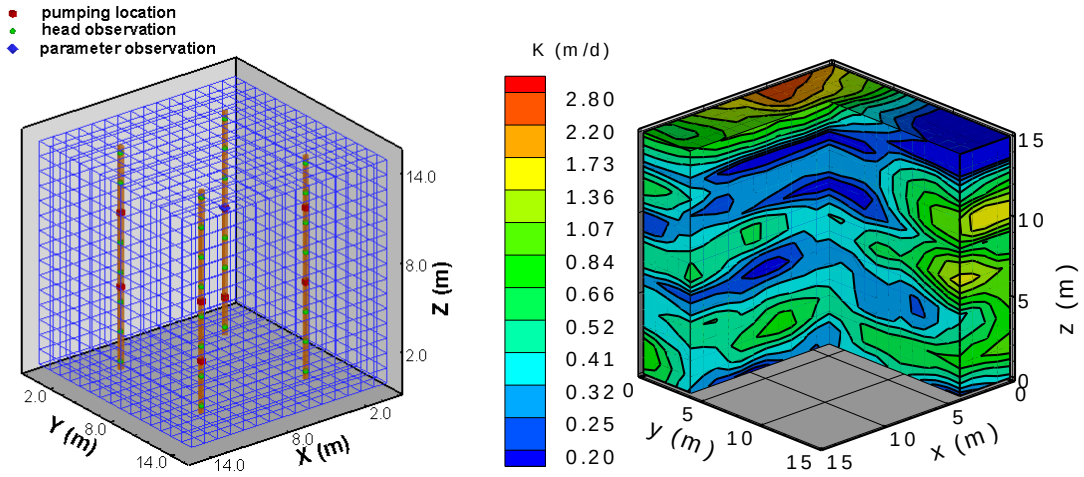
$S_s = S_s(x, y, z)$ = specific storage

$h = h(x, y, z, t)$ = potentiometric head

$q = q(x, y, z, t)$ = source/sink rate

Finite element solution:

$$[K]\{h\} + [S_s]\{\dot{h}\} = \{q\}$$



(From Professor Jim Yeh at University of Arizona)

Hydraulic Tomography –
'CAT scan' of the subsurface

Yeh and Liu (2000) to estimate the spatial distributions of K and Ss (tomographs/images) by applying hydraulic stresses at various locations sequentially and observing the hydraulic responses at other measurement locations

Software Lab Project Tasks

In this software lab project, the students will:

(1) develop a program to compute the hydraulic responses (h) to hydraulic stresses (q) by using linear 3D finite elements to solve the governing differential equation;

(2) implement the adjoint sensitivity method to efficiently compute the first-derivatives of h with respect to K and Ss at each pixel;

(3) test the significance of incorporating K-Ss correlation on the tomographs using data at University of Waterloo experimental site.

(Optional) – If time allows, implement efficient representations of correlated K-Ss fields to obtain compressed high-resolution tomographs for large scale problems.