Geophysical Research Abstracts,
Vol. 10, EGU2008-A-02514, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-02514
EGU General Assembly 2008

Determination of the full permeability tensor

W. Kull (1), O. A. Cirpka (2)

(1) Universität Stuttgart, Institut für Wasserbau, Pfaffenwaldring 61,70569 Stuttgart, Germany (iwswkull@iws.uni-stuttgart.de),

(2) Swiss Federal Institute of Aquatic Science & Technology, (EAWAG), Überlandstr. 133, C-8600 Dübendorf, Switzerland

This work presents a new method of getting the full permeability tensor. Therefore a special construction of a three dimensional working permeameter with a corresponding numerical program is developed. And others, non hydraulic proceedings, like a magnetic and an optical method are used for comparison so that the understanding of the three-dimensional character of permeability in the range of small and middle scale is upgraded.

Usual conducted permeameter experiments according to DIN 18130 are one – dimensional. The water flows only in one direction through the sample, so you get the right value of permeability for isotropic media. But every anisotropic sample, like the most natural sediments constitutes in this permeameter an apparent permeability, which is added up to dislocation from measurement direction, and the direction of the main hydraulic permeability. And we get no information about the second and the third main direction of the hydraulic permeability tensor.

The new designed three- dimensional permeameter has on every side of the 0,1 m^3 sized sample a filter area which can be used for inflow, outflow, closed or some special shortcuts with other sides. So a large number of different measurements combinations is possible. The selected 22 experiments with measured flux and the corresponding piezometer height on every side create an overdetermined problem.

To determine the anisotropy hydraulic conductivity tensor of samples an inverse model is developed by integrating a forward model into a numerical parameter estimation

scheme.

The forward model, which is working with the FEM, simulates the water flow by estimated value and built up a computional grid orientated to the main directions. For parameter estimation we work with a second-order non –linear least-square minimization scheme, the Gauss-Newton method. To obtain a more stabilized numerical procedure the Levenberg-Marquardt algorithm is applied. Finally, the sensitivities of hydraulic measurement with respect to the spatial hydraulic conductivity distribution are calculated by the adjoint state method.

The model presumes homogenous characteristics of the samples. In order to investigate the reaction to heterogenous dataset, artificial randomised three dimensional fields with known qualities are feed in the inverse modelling program. The output is compared with the known qualities of the heterogenous input.

The additional magnetic technique is the Anisotropy Measurement of Susceptibility, AMS. After hydraulic investigations the samples are made smaller and the pore space is filled with ferrofluid. The magnetic particles of the fluid constitute with the measurements in 15 directions a magnetic tensor of the pore structure.

The resulted tensor, the hydraulic and the magnetic one, of different natural or artificial sediment samples, as soon as some two-dimensional image analyses of the microscopic pore structure are compared.