Modelling the interaction of stress-field and hydrodynamic properties in porous media

Gesa Ziefle, Jobst Maßmann, Martin Kohlmeier, Werner Zielke
Institute of Fluid Mechanics - Leibniz University of Hannover
e-mail: ziefle@hydromech.uni-hannover.de

The simulation of coupled hydro-mechanical problems is a topic of actual research. Particularly in the field of geotechnics numerous applications like disposal of radioactive waste, geothermic problems or other migration problems in mechanically loaded host rocks with low permeabilities can be found. Investigating the applicability of such barrier systems, swelling and shrinkage as well as advective and diffusive transport processes have to be analyzed. On the mechanical side the visco-elasto-plastic behavior of the solid matrix and potential material damage or changes of material properties have to be mentioned.

The coupling of the participating processes takes place in the incorporation of stress-induced strains in the mass balance of the fluid as well as in the application of Terzaghi´s effective stresses. Additionally, nonlinear relations of capillary pressures and saturations as well as relative permeability and saturations are used. The application of the prescribed model indicates that many of the long-term processes can not yet be analyzed. Supplementary effects of the hydro-mechanical modelling to the material properties used in the constitutive models have to be incorporated.

Mechanical deformations as well as swelling and shrinkage result in changes of the porosity of the host rock. The relationship between porosity and permeability indicates a direct influence on the hydraulic process. This dependency has to be considered in a stress-dependent permeability, which is already described in (Ziefle et al., 2004). Besides that, approaches to simulate pressure- and porosity-dependent compressibilities have to be developed and implemented in the numerical model of the finite element code RockFlow. Incorporating the initial conditions of the material, the nonlinear elastic behavior can be analyzed. First results of the incorporation of this effect will be presented in this contribution.

References:
Ziefle, G., Kohlmeier, M., Zielke, W., Einbeziehung gekoppelter HM-Modellierung in die Materialbeschreibung teilgesättigter Medien, In: Proceedings of 5. Workshop "Porous Media", Blaubeuren, 2004.