KTH Royal Institute of Technology
Numerical Analysis Group

Project proposal

Bachelor thesis project proposal:
Physics Preserving Numerical Methods for Subsurface Flow and Transport

Project description. Subsurface flow and transport are physical processes that describe how groundwater flows beneath the earth surface. These processes are also important in order to understand how geothermal energy can be extracted via water running through (and heated by) the hot subsurface rock. The rock and sand through which the water flows are generally formed in a structured way, in sedimentary layers and in channels. The different layers may be more or less difficult for the water to flow through, the easier the flow the more *permeable* rock. This property, the *permeability* of the rock, can vary by orders of magnitudes, and this makes construction of numerical methods for such problems challenging. In addition, standard numerical methods do not preserve the physics properly.
In this project we consider how to construct numerical methods for subsurface flow and transport in such a way that the physics is preserved and also so that the numerical solvers work well.

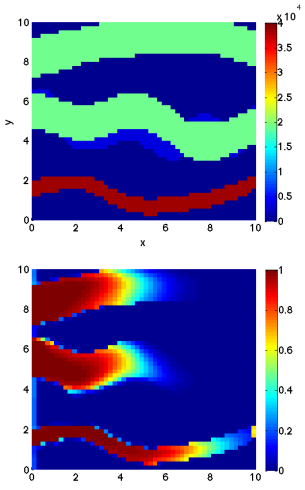

Figure 1: Permeability of channels in the earth (top) and water flowing through the channels (bottom). The water flows faster through the thin, highly permeable channel.

The project consists of tasks:

- Understanding the mathematical model for incompressible single phase flow, consisting by the continuity equation and Darcy's law.
- Discretize the mathematical model with finite difference (FD) methods (standard scheme) and finite volume (FV) metods (TPFA scheme).
- Implement and compare standard methods (FD) to specifically tailored methods for permeability with high contrast (TPFA, MPFA). Identify and understand the problems with standard methods.
- Improve different aspects of the specifically tailored methods, this can be related both to numerical properties as well as preserving the physical properties of the underlying mathematical model.

References and further reading:

- http://folk.ntnu.no/andreas/papers/ResSimMatlab.pdf

Supervision: Anna Nissen
contact: anissen@kth.se