Underground Computational Mathematics:
Models and Analyses of an Evolving Subsurface of Planet Earth

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Abstract

In the talk we discuss mathematical models of complex phenomena in the subsurface of the Earth such as flow, transport, and heat conduction, as well as mechanical deformation. The models are coupled systems of nonlinear partial differential equations which typically have solutions of low regularity; they also require a lot of data, frequently given at disparate multiple scales. To use the models for prediction, we run simulations based on our computational algorithms constructed based on rigorous analyses. However, the simulations are only useful if the data for the models are also reasonably accurate. We show how one can construct such data from first principles starting from xray micro-CT tomography at the millimeter scale up to the Darcy scale of meters and further to the kilometer scale of the Arctic landscape. We illustrate with simulation examples and present current work including the challenges going forward.

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