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Published in:
ATV - Jord og Grundvand 2016

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

MODELING CONTAMINANT TRANSPORT IN LIMESTONE AQUIFERS

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Limestone aquifers are a major drinking water resource in Denmark. Many of them are threatened by contaminants like chlorinated solvents. Understanding the fate and transport of these contaminants is crucial to evaluate the risk to drinking water supply and to plan remedial actions. Limestone aquifers are often heavily fractured and contain chert layers and nodules. This leads to a preferential flow and transport of contaminants in highly conductive zones of the aquifer and to an exchange with the low-conductive limestone matrix, making the understanding and prediction of the contaminant propagation a challenge. Several approaches have been developed to model contaminant transport in fractured media, such as discrete fracture, equivalent porous media, and dual continuum models. However, these modeling concepts are not well tested for plume migration in real limestone geologies. Our goal was therefore to develop, evaluate and compare approaches for modeling transport of contaminants in fractured limestone aquifers and to obtain the required model parameters from field tests.

The model comparison was conducted for a contaminated site at Akacievej, Hedehusene, where a plume of dissolved PCE has migrated through a fractured limestone aquifer. Field data at the site includes information on spill history, distribution of the contaminant (multilevel sampling), geology and hydrogeology. To describe the geology and fracture system, data from borehole logs and cores was combined with flow logs and pump test data. A conceptual model was constructed for the site and used as the basis for numerical models. The models were used to evaluate a pump and treat remediation system, which has been running at the site for 8 years, and to evaluate the speed at which the contaminant plume is migrating downstream of the site.

Simulation results show considerable differences between modeling approaches depending on the aquifer properties, and that it is important to carefully select the modeling approach to suit the model purpose. A combined pump and tracer test is scheduled for spring 2016, which will allow for a calibration of the models and improve the conceptual understanding of the interplay of fractures and limestone matrix. It will provide further guidance for the discrimination between the different models for the application to contaminant transport in fractured limestone aquifers.

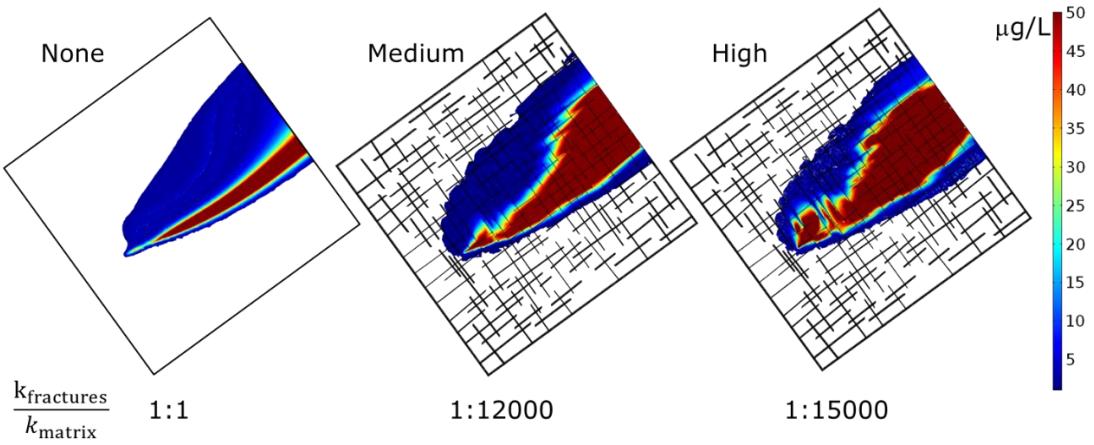

Figure 1: Plume migration simulated with no fractures, medium contrast between fracture conductivity and matrix conductivity, and a high contrast.

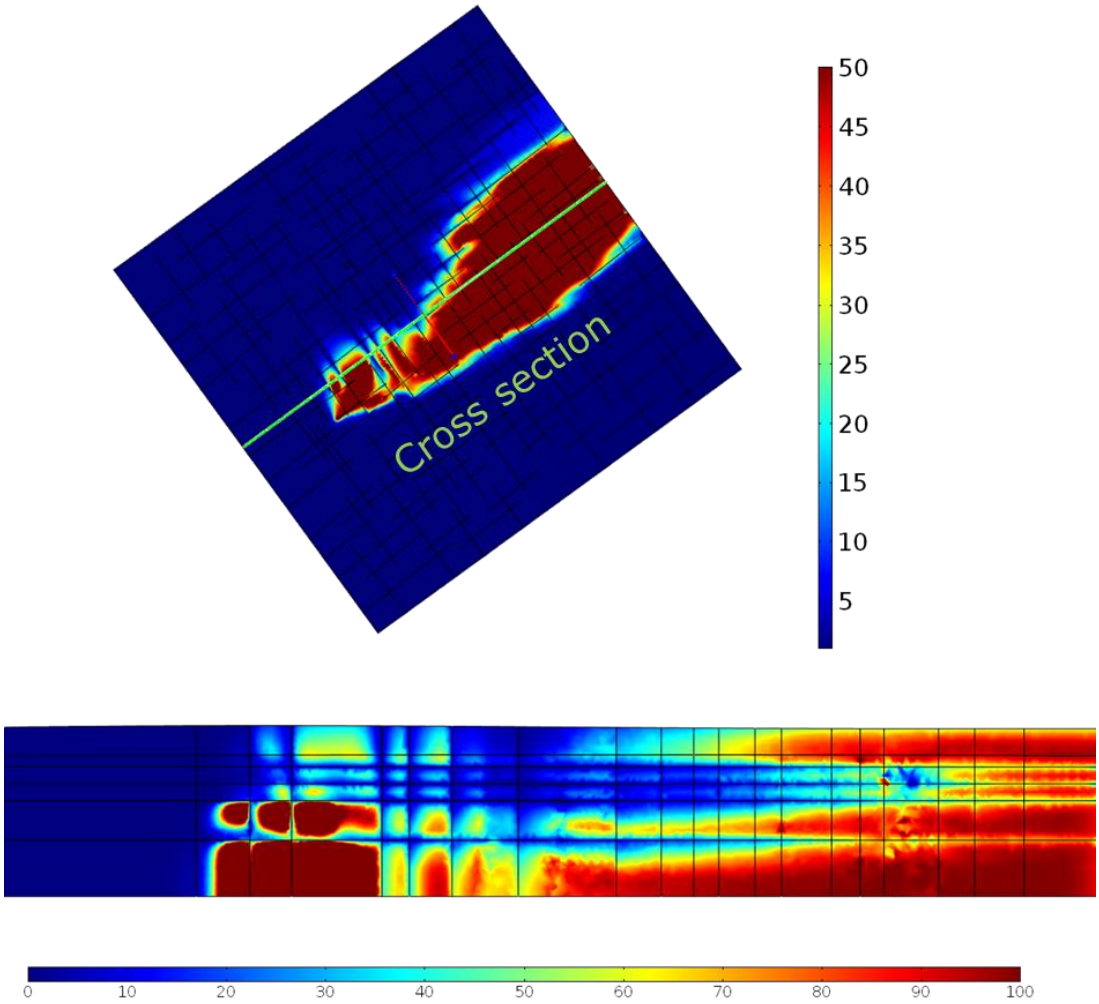

Figure 2: Simulated 3D effects in a horizontally and vertically fractured aquifer.