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Examining Flow Paths In Bunter Sediments In Thuringian Basin

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EXAMINING FLOW PATHS IN BUNTER SEDIMENTS IN THURINGIAN BASIN

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We present a study on the Thuringian Basin, a large area in central Germany. Within this basin exist areas with very different interesting geo- and hydrological properties. We set up models and simulations for four subdomains within the basin, which describe different depositional environments - eolian, fluvial, sandflat and lacustrine. Researchers want to investigate which paths the water is taking in the subsurface and how fast it is moving. To investigate this, four model areas with regard to their architectural design are employed. First simulation results suggest dependencies of flow paths and flow velocities due to different architectural elements (from the sequence of the subsurface layers) and characteristics such as the varying permeabilities.

INTRODUCTION

This study examines the movement of water below ground within the Thuringian Basin using numerical simulations. The Thuringian Basin covers most of the area of the German Free State Thuringia. It is bordered by the Harz mountains in the north, by the Thuringian Forest in the south and by the Thuringian slate belt in the east. The most important litostratigraphic layers are Keuper, Muschelkalk, Bunter and Zechstein which are of Triassic age deposits. Each of these layers can be further subdivided according to the deposit history. The present day geometry of the basin developed 80 million years ago. At this time, the Thuringian Basin began to subside and the surrounding regions were squeezed together. The subsidence and compressions results in some fault zones, see Figure 1.

It is assumed that the Bunter in the Thuringian Basin is a major aquifer. The sediments of Lower and Middle Bunter formations are composed of fluvial, sandflat, eolian and lacustrine facies. The first step to gain knowledge about flow paths within the Bunter was to investigate small scale 3d sub-domains within the basin, which describe the different depositional environments - eolian, fluvial, sandflat and lacustrine.

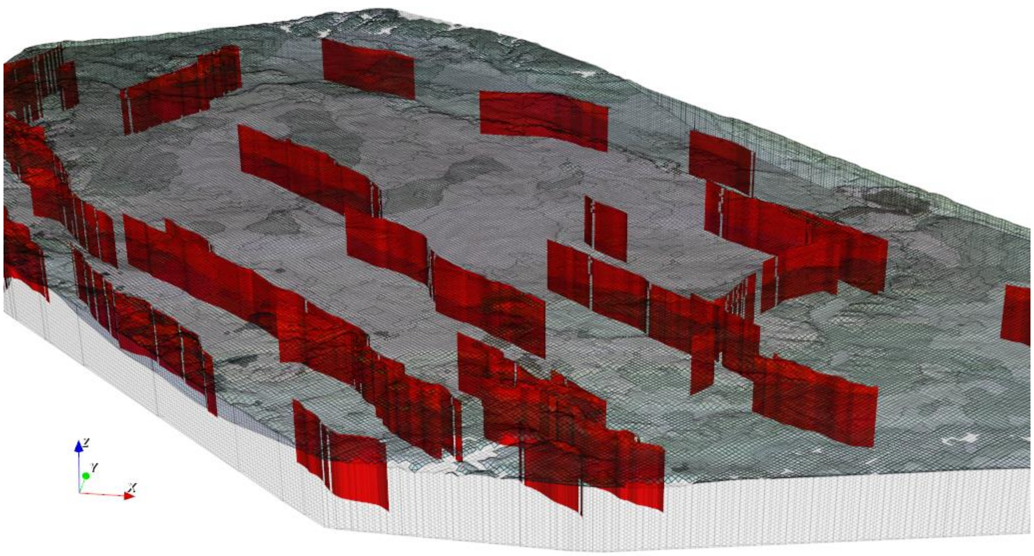

Figure 1: 3d overview model including faults

GENERAL MODEL SETUPS

The investigated models are created deploying the software GOCAD. The layering is deducted from typical formation strutures of the study areas. All model domains are small scale, axis parallel blocks of size [-3, 3] m × [-1, 1] m × [0, *h*] m, where the height *h* is model specific. The meshes used for the simulations consists of 500.000 nodes and 480.249 quad elements. We investigated flow in *x* and *y* directions in two scenarios setups using the scientific open source software package OpenGeoSys (Kolditz et. al 2012, [1]). Boundary condition were first type on either sides of the model with a hydraulic gradient of 10e-3 for both setups.

Kunkel et al., 2013 [2] investigated the litofacial structuring. The data for parametrization is derived from plug measurements from cores and outcrops. The measurements showed the four different groups of fluvial, sandflat, eolian and lacustrine origin with permeability ranges of [4,93], (0,300], [45,300], (0, 75] mD respectively.

SIMULATION RESULTS

Exemplary we show fluvial setup. In Figure 2 the permeability distribution is depicted. Spheres show time of residence by size along the flow paths.

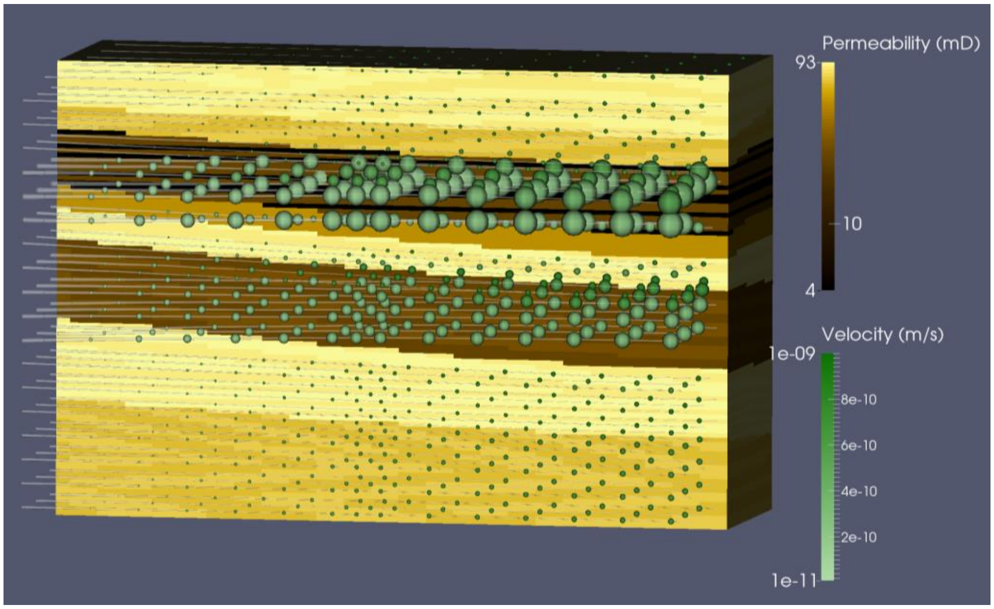

Figure 2: The fluvial setup.

CONCLUSIONS

The prelimary results of this study show, that flow paths are highly dependending on the spatial permeability distribution. A possible consequence of the results is that the litostratigraphic layer Bunter should be modeled according to the depositional environments.

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REFERENCES

[1] Kolditz, O., Bauer, S., Bilke, L., Böttcher, N., Delfs, J.O., Fischer, T., Görke, U.J., Kalbacher, T., Kosakowski, G., McDermott, C.I., Park, C.H., Radu, F., Rink, K., Shao, H.B., Sun, F., Sun, Y.Y., Singh, a. K., Taron, J., Walther, M., Wang, W., Watanabe, N., Wu, Y., Xie, M., Xu, W., Zehner, B., 2012. OpenGeoSys: an open-source initiative for numerical simulation of thermo-hydro-mechanical/chemical (THM/C) processes in porous media. Environ. Earth Sci. 67, 589–599.

[2] C. Kunkel, D. Beyer, U. Hilse, M. Aehnelt, T. Voigt, R. Gaupp: 3D-small-scale modeling of facies development and variations of the Lower and Middle Buntsandstein formations in the Thuringian Syncline. Sedimentary Basins Jena 2013, Jena, 23. - 25.09.2013