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Modeling density dependent flow in the sedimentary basin of Thuringia

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Salty groundwater reaching the surface or coming close to it is a phenomena that can be observed in many places of the Thuringian Basin. However, it is not obvious, why denser brine overlays lighter fresh water in this region. The hydrogeological processes which cause the rising of saltwater plumes from deeper geological layers to the surface are not yet fully understood. The goal of this modeling project is to investigate the mechanism of brine transport within the aquifers of sedimentary basins in general and of Thuringian Basin in particular.

In this study we focus at investigating the fluid dynamics of the basin and how the fluid convection of the deep horizons interacts with groundwater flow near the surface. By gradually increasing the complexity of our model we analyze the major mechanism influencing the flow pattern: geology and hydraulic properties, fluid density differences caused by temperature and salt concentration gradients, fractures and faults as well as boundary conditions of the model, like inflow, outflow and groundwater recharge.

For our numerical investigations we use a cross section of the Thuringian basin of approximately 80km length and maximal 800m height. The hydrogeological model is based on the major stratigraphical units from upper Perm (Zechstein) to upper Triassic (Keuper) with the lower Triassic (Bundsandstein) formations representing the main aquifer. The structural model as well as aquifer parameters are provided by geological partner groups of the University of Jena, Germany. To investigate hydrogeological scenarios we use the groundwater simulation program OpenGeoSys, which allows us to calculate thermally, hydrologically and chemically coupled processes. The challenge for us is to include density driven flow as a numerically very sensitive process on a grid that represents a large scale geologically realistic setting.

With this work we contribute to the understanding of fluid convection processes influenced by density differences and local geological characteristics, especially for the local conditions in the sedimentary basin of Thuringia.