

**Mechanisms and fluid-dynamics driving saline waters within the**

**North East German Basin:**

**Results from thermohaline numerical simulations.**

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## Abstract

In several areas of the North East German Basin (NEGB) saline water comes close to or even reaches the surface. Although this phenomenon has been observed during the past two centuries, the origin and mechanisms of brines within the NEGB aquifer are not fully understood. In geothermal systems, the driving forces can be intrinsic to the basin, like thermal variations, and/or external due to hydraulic head. In order to clarify the possible mechanisms of brine transport, thermohaline simulations have been carried for 2D and 3D model scenarios.

For this purpose, a hydrogeological model of the NEGB has been developed which contains the major stratigraphic and hydrogeologic units from the Quaternary to the Upper Permian. In contrast to normal groundwater models for freshwater, large-scale simulation of coupled flow, mass and heat transfer requires a proper fluid density model. Field measurements of pore fluid pressure and temperatures, as well as laboratory investigations of solute content provided density input data. The brine stratification is unstable in the deeper underground suggesting that convective flows are favoured.

The governing equations of density driven flow have been solved by the use of the finite element software FEFLOW 5<sup>®</sup>. The numerical approach of thermohaline simulations has been performed by testing different grid resolutions. The 2D model allows to quantify the interaction between diffusive solute transport, thermally and head-driven flow (forced versus free convection). The main fluid-dynamics of salt migration throughout the NEGB have been inferred from temporal analysis of the transport processes. Additionally, viscosity effects have been taken into account and have been evaluated. Based on these 2D numerical results, a regional picture of the transport processes affecting the NEGB has been tracked down. The 3D regional model (230x330 km) indicates that salt water occurring close to the surface may mainly be driven by hydrostatical forces from the surrounding highlands, describing part of the phenomena. In addition, a smaller 3D scale model (10x10 km) has been constructed with a grid resolution accounting for temperature effects. The results point towards that thermally induced flow, which may play a dominant role in areas with minor topography.

In summary, the complex pattern of near surface occurrences probably results from the interaction of hydrostatic and thermal forces.

Scenarios that allow for mixed convection are needed to understand the mechanism behind numerous previously unexplained field observations of deep-groundwater occurrences near the basin surface. The potential presence of large-scale convection cells has implications both for the fundamental understanding of basin processes as well as for socio-economic issues.