Geophysical Research Abstracts, Vol. 8, 00928, 2006
SRef-ID: 1607-7962/gra/EGU06-A-00928

Hydrochemical and numerical modelling of geogenic groundwater salinzation in the North German Basin

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Groundwater salinization becomes a worldwide problem at a progressive rate. Even, in the North German Basin (NGB) part of the groundwater resources cannot be used for drinking water supply because of anthropogenic and geogenic salinization. Apart from coastal areas, where infiltration of marine saltwater may take place, geogenic groundwater salinization of shallow aquifer systems is mainly attributed to the subrosion of salt diapirs and the up-coning of deep-seated brine or formation water. Although the up-coning of saline water has been observed for centuries, knowledge and understanding of the processes driving saline waters to ascend, their hydrochemistry and their genesis are still rather poor. The present work delineates possbile mechanism of fluid transport and discusses different hydrochemical data sets with respect to genesis, alteration and mixing processes of geogenic groundwater salinization.

Hydrochemical investigation in the Berlin-Brandenburg area lead to a better understanding of deep seated brines chemistry, their genesis and evolution. Typical hydrochemical distribution patterns exist for the investigated aquifer complexes. Hydrochemistry is mainly dominated by Na-Cl composition (Lower Cretaceous to Upper Keuper) and Na-Ca-Cl-composition (Zechstein-Rotliegend). Most of the brines show cation exchange and dolomitization processes. Salinization is predominantly caused by ablation of Permian halite bodies. Formation waters are still present and mix with percolating waters. Residual brines and leachates could be identified. Mixing processes as well as local hydrochemical and isotopic anomalies suggest, that fluid migration takes place between the aquifer complexes on a large regional scale. Shallow groundwater salinization occurs mainly in discharge areas or in the neighbourhood of waterworks, where the man-made drawdown lead to a displacement of the saltwater-freshwater interface. However, the up-coning of saline water, might not only be driven by pressure gradients, but also by thermo-haline convection.

In order to analyse the possible transport mechanisms 3D thermohaline simulations have been carried out for two different scenarios. A large scale regional model (230x330 km) indicates that salt water occurring close to the surface within the lowlands along the larger rivers may mainly be driven by hydrostatical forces from the surrounding highlands, accounting for part of the phenomena. In addition a smaller scale model (10x10 km) has been constructed with a grid resolution accounting for possible convective flow. The results indicate that convective flow 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.

This project is supported by the German Science Foundation (DFG) as part of the SPP 1135 “Dynamics of Sedimentary Systems under varying Stress Conditions by Example of the Central European Basin System”.