Geophysical Research Abstracts
Vol. 15, EGU2013-10032-1, 2013
EGU General Assembly 2013

Hydrochemical field investigations at a potential CO_2 storage site - analysis of natural salinisation processes as an indicator for deep reaching flow processes in Eastern Brandenburg (Germany)

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The storage of CO_2 in deep saline aquifers may cause an upward brine migration as a result of the pressure increase and brine displacement in the reservoir. With regard to a possible endangerment for regional freshwater resources the understanding of natural and induced migration processes of brines is therefore of great importance for the evaluation of potential storage sites.

Within the framework of the BMBF project 'brine – CO_2 storage in Eastern Brandenburg' (Germany), hydrochemical investigations were carried out to get an idea of the sources of salinisation, the migration pathways and the current processes and interactions between salt- and freshwater aquifers above a potential CO_2 storage reservoir. This reservoir is located at a salt anticline structure in a Lower Triassic sandstone formation at a depth of about 1000 m.

Since the 19th century freshwater salinisation and salinised soils in part with populations of halophytes were observed in Brandenburg. Both, fault zones in the Mesozoic/Tertiary and Pleistocene erosion processes led locally to a leakage of the Oligocene Rupelian clay formation, the most important confining layer between Mesozoic saltwater and Cenozoic freshwater aquifers, and thus potential migration pathways for brines. Possible sources for the salinisation are the leaching of deep Permian salt structures as well as in situ brackish or marine waters from Tertiary and Mesozoic sediments. Still unclear is especially the timescale of the salinisation processes in the shallow aquifers.

To answer these questions, extensive groundwater samples from Pleistocene, Tertiary and Mesozoic aquifers down to depths of 450 m were taken in an investigation area of 50 x 50 km^2 surrounding the potential storage site. In addition, deep thermal waters in Brandenburg in depths down to 1700 m were sampled to have comparable data for the storage reservoir and the deep caprock formations. Field parameters and a wide range of hydrochemical indicators (anions, cations, trace elements) were analysed to obtain information about characteristic reactions and hydraulic pathways between the aquifers. This was complemented by the measuring of the stable and unstable isotopes. $^{34}S/^{18}O(SO_4)$ illustrate the origin and genesis of dissolved sulfate as well as reduction and oxidation processes. $^{87}Sr/^{86}Sr$ are valuable indicators of water-rock interactions and a tracer for the origin of salinity. The stable water isotopes ($^{18}O/^{2}H$) give a picture about the climatic conditions of the groundwater recharge and the influence of brackish or marine waters. With the aid of radio-isotopes ($^{3}T/^{3}He$, ^{4}He, ^{14}C) the mean residence time respectivly a relative age of groundwaters were determined.

The results show that upward brine migration from the Mesozoic aquifers and Permian salt structures is responsible for the salinisation of the freshwater aquifers indicating deep reaching flow processes, which connect the shallow freshwater with deep saline aquifers. The natural salinisation processes have only a slow temporal dynamic. A clear correlation of groundwater age and salinisation respectivly depth were found in the investigation area indicating ages of the salinised waters in the freshwater aquifers up to several 1000 years. These data can be used for calibrating hydrogeological models for the site characterisation.