Title: Isotopic and Hydrochemical Analysis of Groundwater Salinization in Berlin: Implications for the management of salinity prone well fields

Authors: Christoph Sprenger[1], Gunnar Lorenzen[2], Dwight Baldwin[1], Alexander Sperlich[2], Nasrin Haacke[1]

1- Kompetenzzentrum Wasser Berlin gemeinnützige GmbH, Grunewaldstr. 61-62, 10825 Berlin
2- Berliner Wasserbetriebe, Neue Jüdenstraße 1, 10179 Berlin

Abstract

In the North German Basin, highly mineralised saline groundwaters are common below the Lower Oligocene Rupelian clay. The Rupelian Clay separates the Quaternary and Tertiary freshwater aquifer complex from the underlying saline aquifer complex and is of great importance for groundwater management. However, brackish groundwater influenced by deep saline water is found in the freshwater aquifer complex where the Rupelian Clay has been eroded. This is often the case above salt structures and along Pleistocene channels deeply cut into the underlying strata. As a result of this groundwater salinisation, various water utilities in the Berlin-Brandenburg region, including the Berlin water utility (Berliner Wasserbetriebe), were forced to reduce groundwater extraction volumes at certain locations or to abandon drinking water wells.

This study analyses the spatial and temporal variations of environmental isotopes ($\delta^{18}O$, $\delta^{2}H$, ^{14}C and $\delta^{13}C$) and hydrochemistry (Cl^-, Br^-, HCO_3^- and DOC) in combination with a 3D geological model of stratigraphic units in the freshwater aquifer complex focusing on a waterworks with elevated saltwater intrusion risk in Berlin (Germany). Issues on the genesis and temporal dynamics of geogenic groundwater salinisation were addressed in the study.

A graphical method was employed to identify dominant geochemical processes and to produce a qualitative estimate of radiocarbon age using measured ^{14}C and $\delta\,^{13}C$ and dissolved inorganic carbon (as hydrogen carbonate). The analyses indicate additional carbon input from ancient organic matter, which is more depleted in ^{13}C than recent soil CO_2. Radiocarbon dating revealed time scales of thousands to tens of thousands of years, depending on depth and geological conditions. The local meteoric water line (LMWL) and isotopic signatures ($\delta^{18}O$, $\delta^{2}H$) of hydrological half-years (winter/summer) were calculated using volume-weighted least squares from the local Global Network of Isotopes in Precipitation (GNIP) data station. The calculation of the hydrological half-year signatures proved to be particularly useful for the interpretation of regional flow and mixing processes. The half-year signatures allowed differentiation between samples influenced by bank filtrate and natural groundwater recharge. Stable isotopes in deep groundwater (>50 m below surface) samples showed light isotopic signatures indicating cold recharge conditions, e.g. during the Weichselian glacial period. Analysis of Cl/Br and DOC content revealed the geological units in which saltwater migration is dominant and where DOC dissolution occurs along the flow path. Together with isotopic measurements, literature research, numerical modelling and hydrochemical monitoring, an improved understanding of deep groundwater circulation and its implications for groundwater management in the freshwater aquifer complex has been developed. Although the spatial variability of elevated Cl concentrations due to saline upwelling in a well field is high, recommendations for the sustainable operation of saltwater-influenced well galleries were developed.