Evolution of saltwater intrusions in coastal aquifers during the past and the future

R. Meyer[1]*, T.O. Sonnenborg[2], P. Engesgaard[1], A.-S. Høyer[2], F. Jørgensen[2], K. Hinsby[2], B. Hansen[2], J.B. Jensen[2] and J.A. Piotrowski[3]

[1]*Department of Geosciences and Natural Resource Management, University of Copenhagen, DK-1350 Copenhagen, DENMARK*
*(*correspondence: reme@ign.ku.dk)*
[2]*GEUS Geological Survey of Denmark and Greenland, Copenhagen and Aarhus, DENMARK*
[3]*Department of Geoscience, Aarhus University, DK-8000 Aarhus C, DENMARK*

Today, groundwater is the main source of water supply in Denmark. Aquifers in low lying areas near the Wadden Sea in Southern Denmark are vulnerable to saltwater intrusion, which is likely to intensify due to relative sea level rise. To understand the dynamics and development of this complex flow system, the initial hydrodynamic conditions imposed by the last Scandinavian Ice Sheet (SIS) must be taken into account (Piotrowski 2007).

We investigate the influence of SIS during the Weichselian glaciation on the current groundwater flow pattern and the development of salt water intrusions in the coastal aquifers due to postglacial sea level rise. It is likely that the groundwater-flow dynamics, driven by the postglacial hydraulic head drop and the relative sea level rise are not yet equilibrated and, enhanced by the potential future sea level rise due to climate change, contamination of fresh-water aquifers will continue.

Based on a geological voxel model spanning Miocene through Quaternary deposits (Jørgensen et al. 2015) a large-scale 3D finite-difference numerical groundwater flow and transport model, including density-driven flow is used to simulate the distribution of the current saltwater intrusion and to investigate the evolution of saltwater intrusion during the last 15000 and future 200 years.

In a field campaign in February 2015, groundwater samples from Miocene and Quaternary aquifers were collected for isotope age dating that is used to calibrate and validate the numerical transport model. Chemical and isotopic composition of groundwater will be used to determine its the origin. Where the collected data and simulations indicate groundwater recharged during the last glaciation analyses of heavy noble gases will be carried out in order to estimate recharge temperatures and evaluate the recharge mechanism.

References:

Jørgensen, F., Høyer, A.-S., Sandersen, P.B.E., He, X. and Foged, N., 2015. Combining 3D geological modelling techniques to address variations in geology, data type and density – An example from Southern Denmark. Computers & Geosciences 81, 53–63.

Piotrowski, J.A., 2007. Groundwater Under Ice Sheets and Glaciers. In: Knight, P.G. (ed.) Glacier Science and Environmental Change. Blackwell Publishing, Oxford, UK, pp. 50–60.