Environmental assessment
Pollution plume related to groundwater
Ribe, Denmark

Introduction

From 1956 until 1973, untreated wastewater from a chemical plant was dumped into 6 pits in a plantation in the south-western part of Jutland, Denmark 0.5-1.0 km from the coastline. Today, it is one of the worst pollution scenarios in Denmark with high concentrations of, for example, chlorinated organic solvents. The pollution is known to move seawards and a 3 km stretch of the beach is now closed to the public.

As an alternative to a costly offshore drilling campaign, a small SkyTEM TDEM survey starting 1.0 km inland and ending 1.0 km offshore was flown in 2006. The purpose of the survey was to demonstrate the SkyTEM TDEM system's ability to map the geological structures in the coastal zone and to measure the depth of the sea water in areas with shallow sea water.

SkyTEM airborne system setup

- Dual TDEM moment
- 314 m^2 transmitter area
- Peak moment of 120 000 Am^2 (high moment) and 12 000 Am^2 (low moment)
- Two receivers recording the responses from both the z- and the x-component
- TDEM system at 25 m above terrain

Benefits

- The high peak moment enables great penetration depth and the low peak moment ensures good resolution of near-surface anomalies.
- The two-component receiver system produces a high degree of information on the shape and orientation of the recognized conductors.
- The fast approximate inversion method using a 1D multi-layer model (30 layers) has a typical computation time of 0.2 seconds per sounding, ~50 times faster than traditional layered 1D inversions but a similar model section is produced.

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Key results

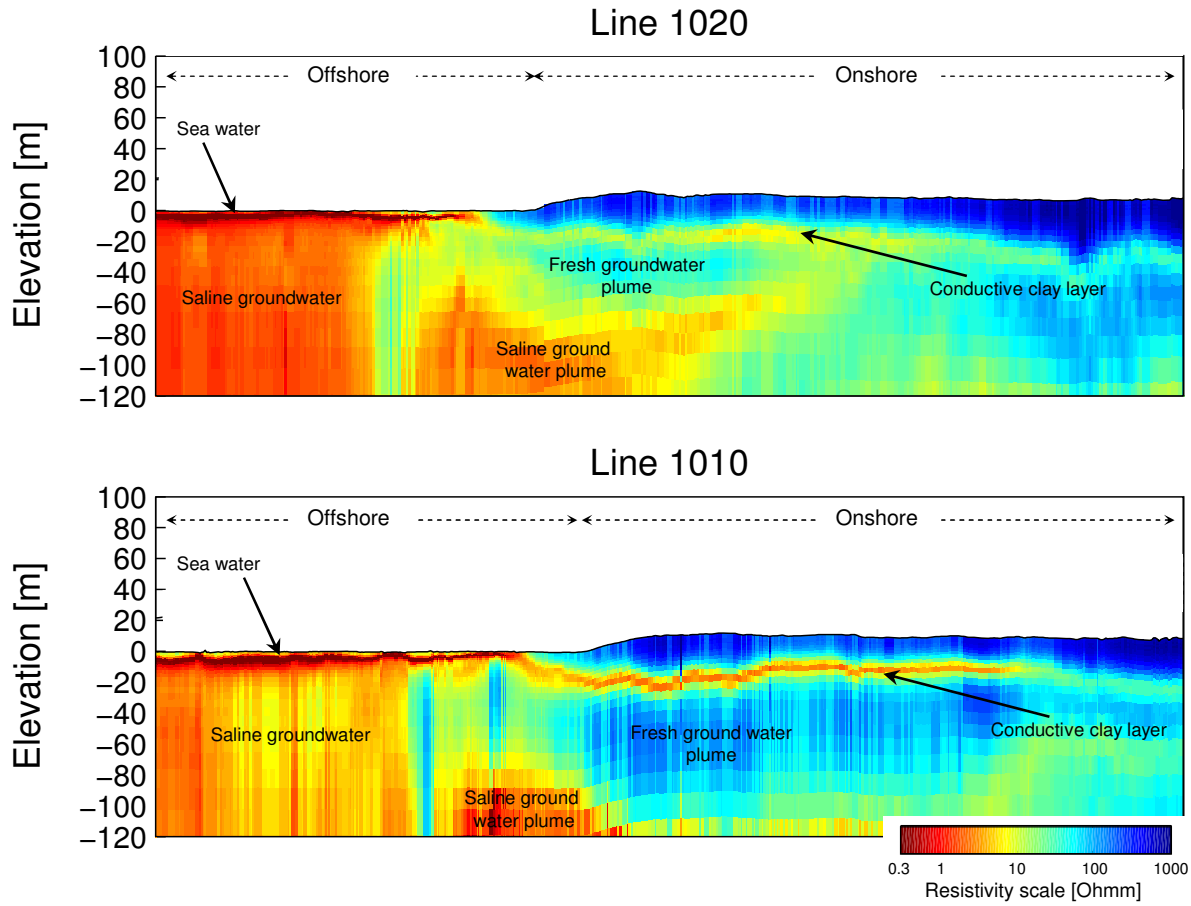
• Onshore, high resistivities are found in accordance with the known geology of postglacial deposits, primarily coarse-grained sand.

• A rather thin very conductive clay layer at a depth of 20-25 m can be tracked to the easternmost part of the profile, however here with weaker conductivity. This layer has trapped part of the pollution while the overlying sand formation has been leached, thus retaining its higher resistivities.

• Higher resistivities are found below the conductive clay layer indicating fresh-water saturated sand. Also this formation is known to carry pollution towards the sea. The fresh water can be seen infiltrating seawards under the sea water at least 200 m, but probably up to 500 m, with increasing conductivity due to mixing with seawater.

• The sea water is seen as the very conductive surface layer west of the seashore and the water depth is clearly indicated in the model section.

• Below the fresh-water plume under the sea, salt water is found and this salt water clearly infiltrates fresh water under the land side of the survey line. Thus, a fresh-water plume is moving out under the sea and below that a salt-water plume is moving under the fresh water towards land.



Multi-layer fast approximate inversion of the two lines perpendicular to the coast line. Red colours indicate low resistivity (saline groundwater) and blue colours indicate high resistivity (fresh groundwater).

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