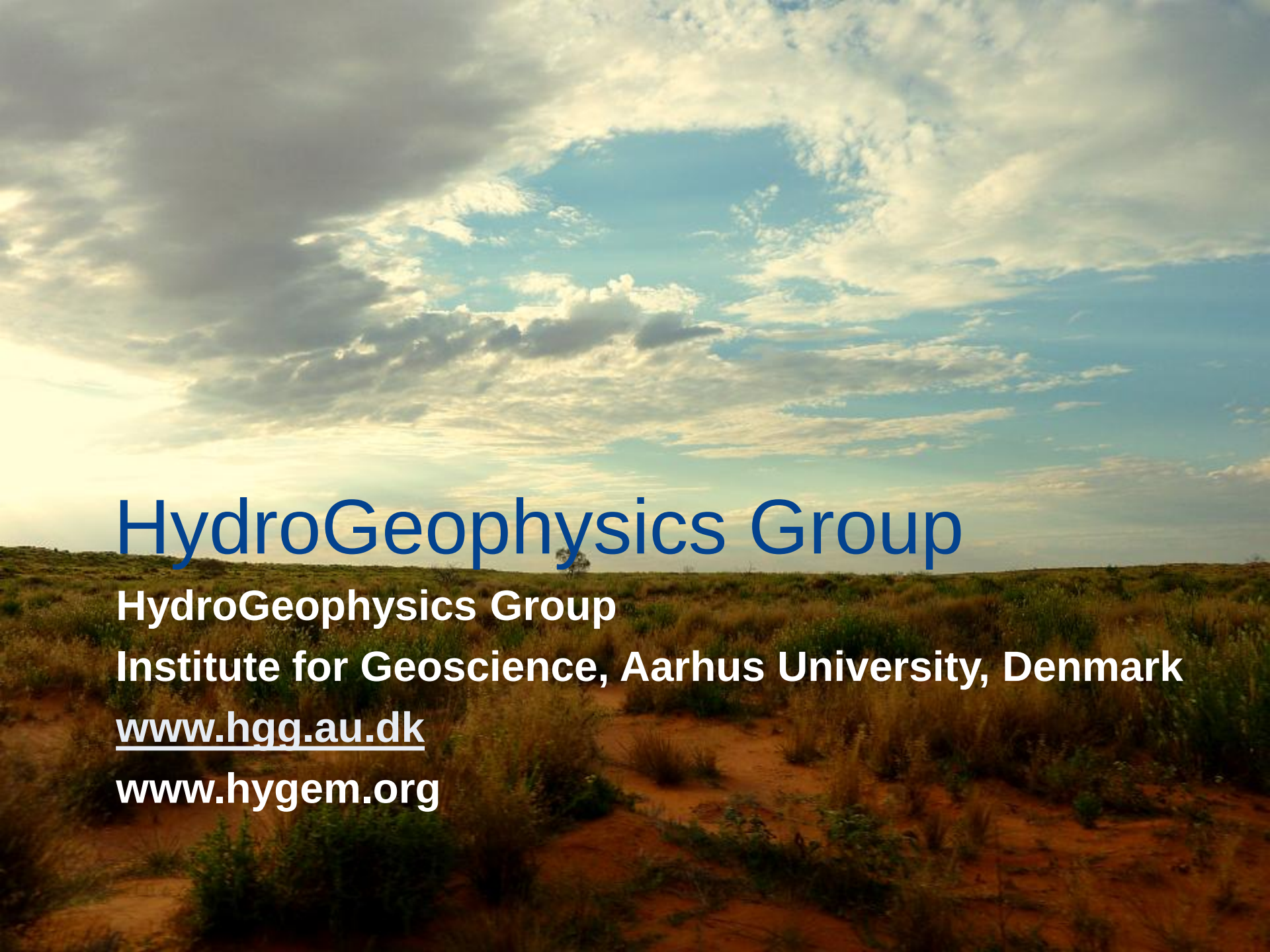


HydroGeophysics Group

HydroGeophysics Group

Institute for Geoscience, Aarhus University, Denmark

www.hgg.au.dk

www.hygem.org

People in HyGEM

- **Esben Auken, PI**
- **Jesper Pedersen, HGG, administrative services**
- **Karen Engelsgaard, HGG, project secretary**
- **Tove Lolk, Economy Center Science, finances**
- **Simon Ejlertsen, technician**

- **Ahmad Behroozmand , Post Doc, WP1**
- **Gianluca Fiandaca, Senior researcher (Post Doc), WP2**
- **Nikolaj Foged, PhD student, WP4**
- **NN PhD student, WP4**

The HydroGeophysics Research Group

- **Dedicated research and development in E&EM methods**
  - instrumentation
  - field methodology
  - data processing and inversion algorithms
  - presentation software
  - integration of geophysics into geological and hydrological models

The HydroGeophysics Research Group

- **Instruments and systems**
  - SkyTEM, PACES, El-log
- **Software**
  - Aarhus Workbench, SiTEM/Semdi, em1dinv
- **GERDA - national geophysical database**

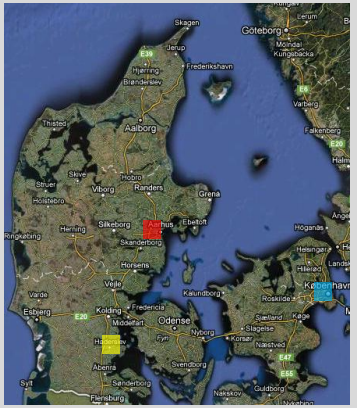
The HydroGeophysics Research Group

- **15 staff members (geophysicists, post doc’s, software developers, electronic engineers, technicians)**
- **5 PhD's and a number of master students**
- **A comprehensive master program in E&EM methods**
- **International group with English as the main communication language**

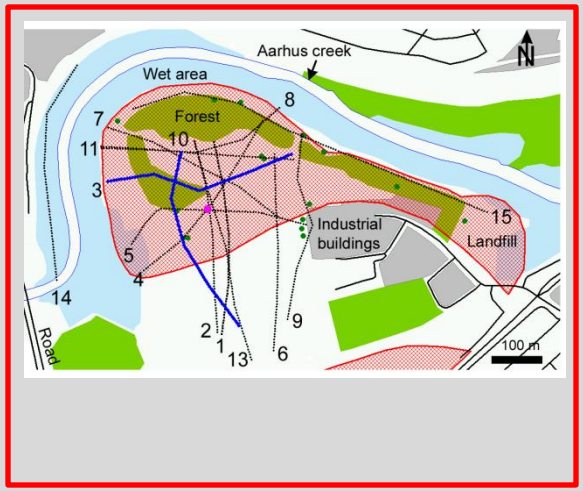
- **Exiting projects worldwide**

Induced polarization and DC

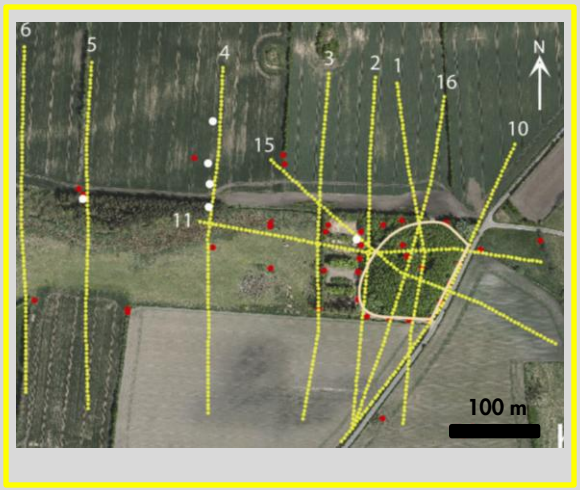
Landfill case studies in Denmark



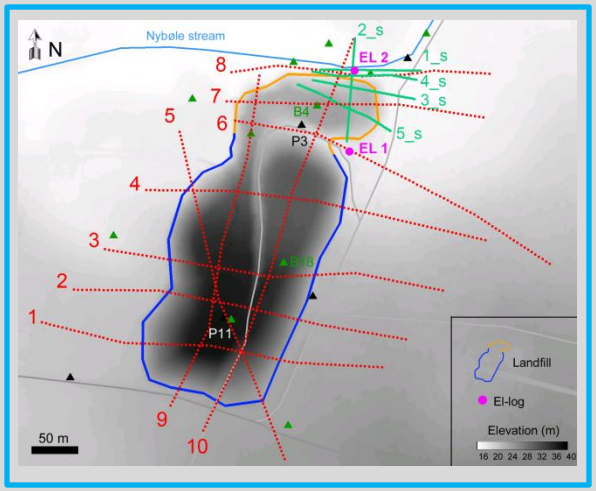
Eskelund



Hørløkke

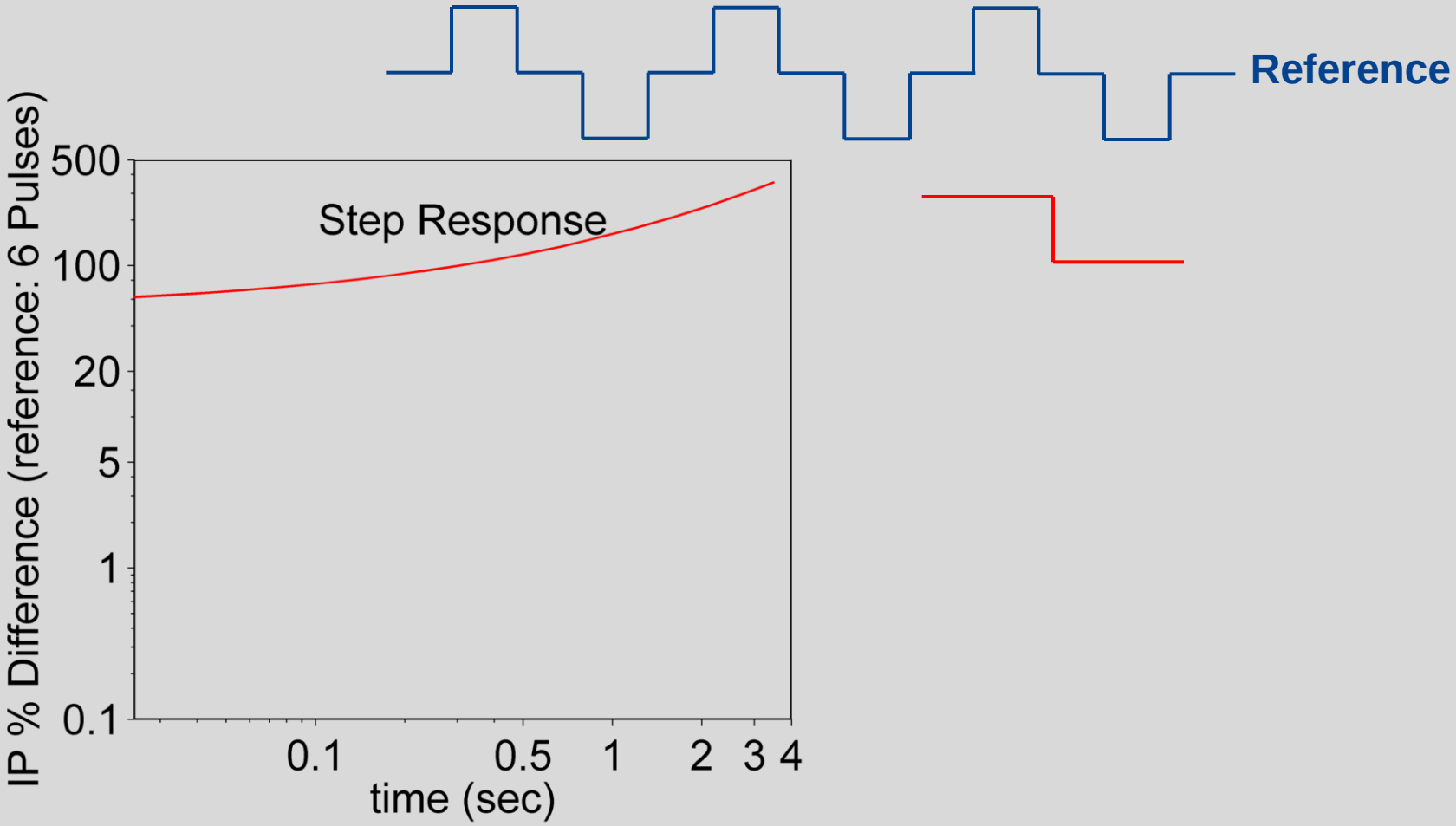


Risby

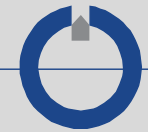


- **Investigated by numerous IP/DC sections**
  - 5 m takeout
  - Syscal-Pro

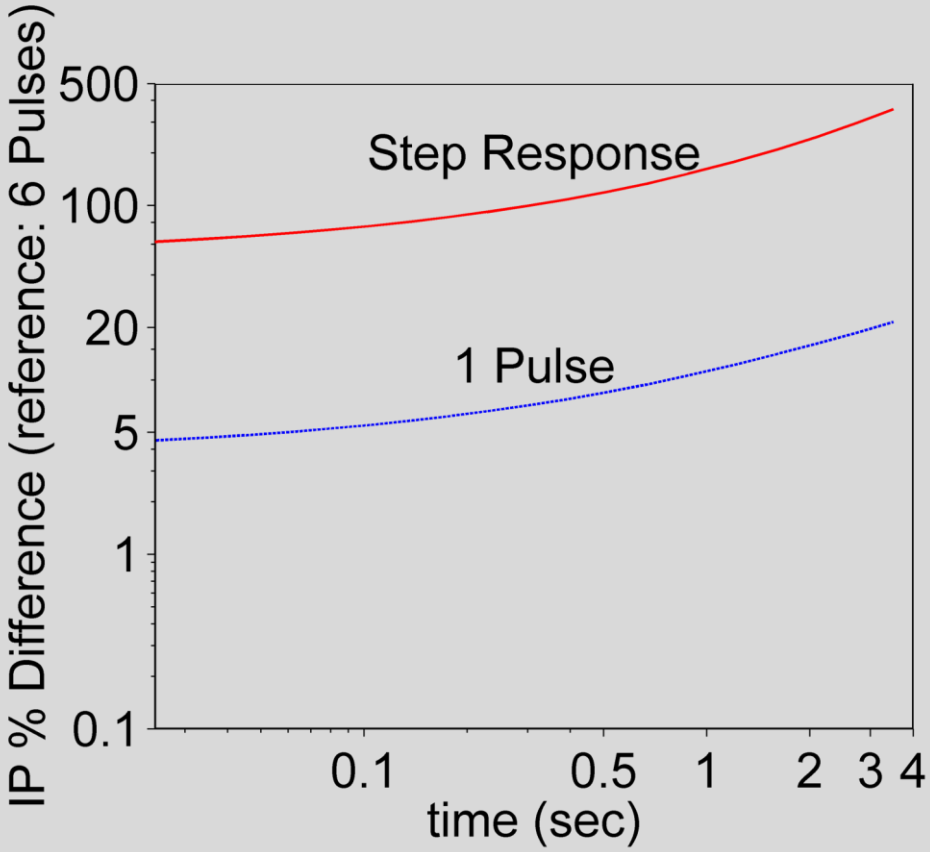
Waveform: % Difference



parameters {m_0=100 mV/V, τ=2 sec, C=0.5}; $T_{on} = T_{off}$ = 4 sec

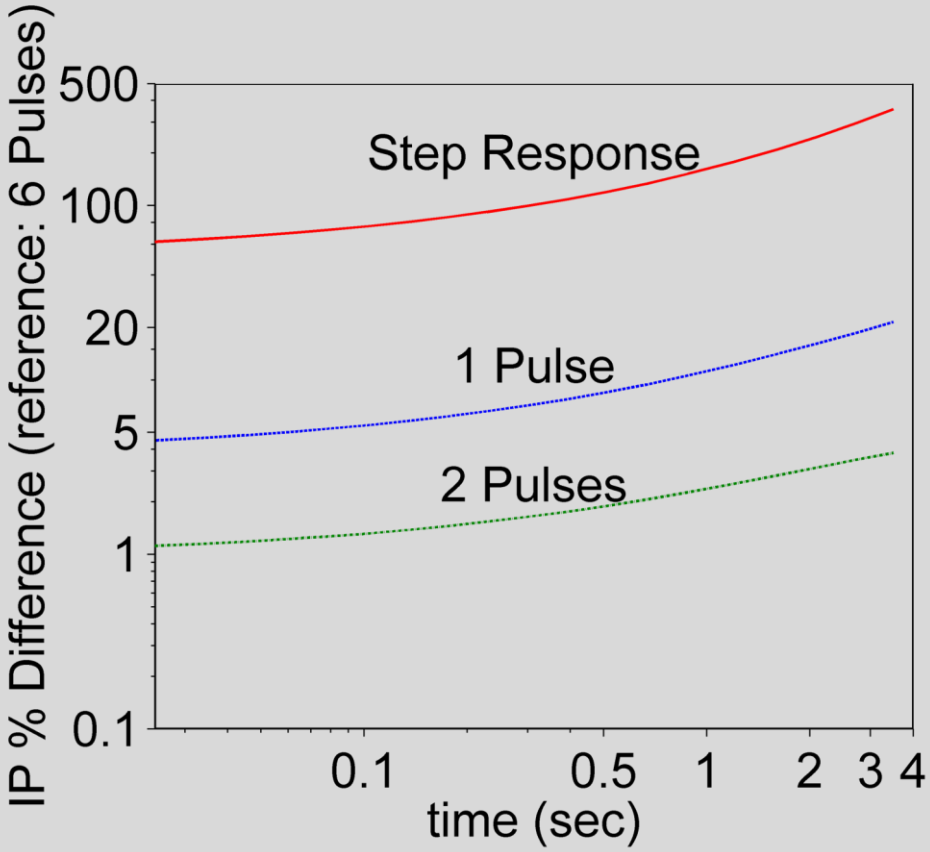


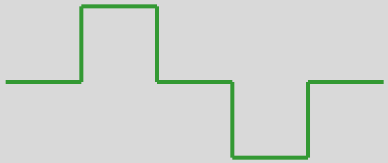
Waveform: % Difference



parameters {m_0=100 mV/V, τ=2 sec, C=0.5}; $T_{on} = T_{off}$ = 4 sec

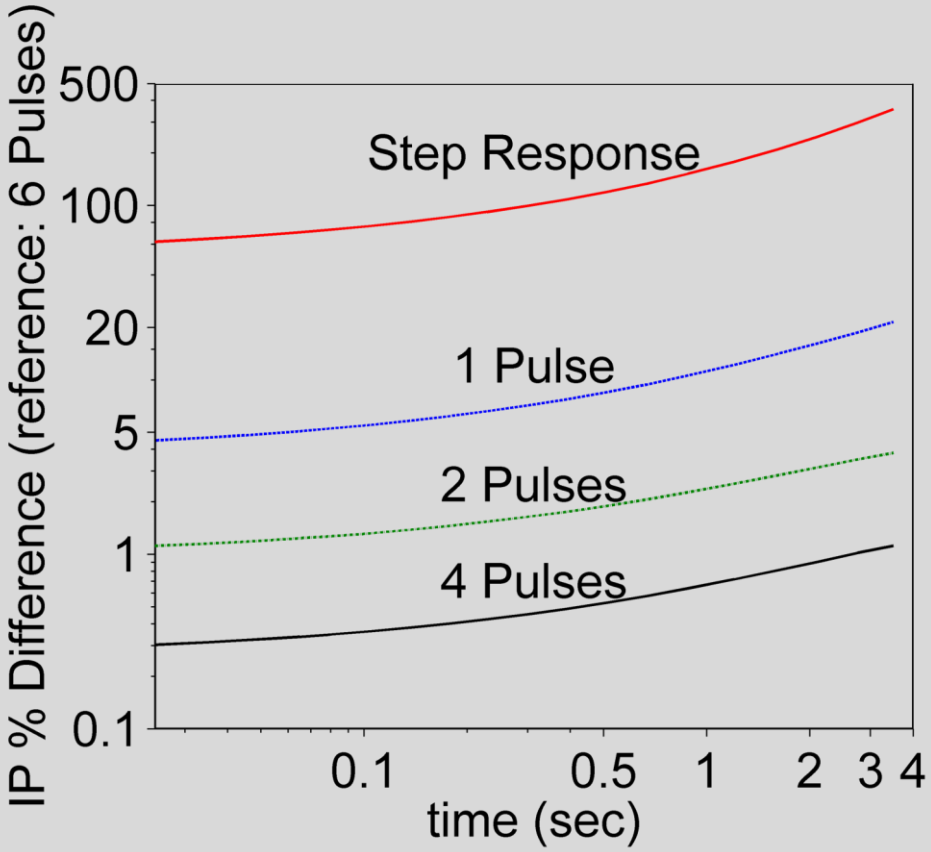
Waveform: % Difference



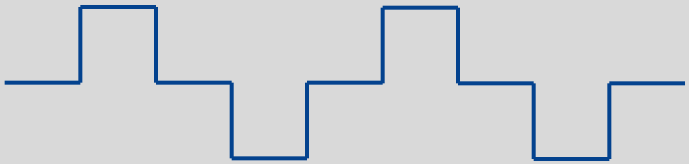


parameters {m_0=100 mV/V, τ=2 sec, C=0.5}; $T_{on} = T_{off}$ = 4 sec

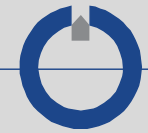
Waveform: % Difference



The actual Stack size has to be modeled

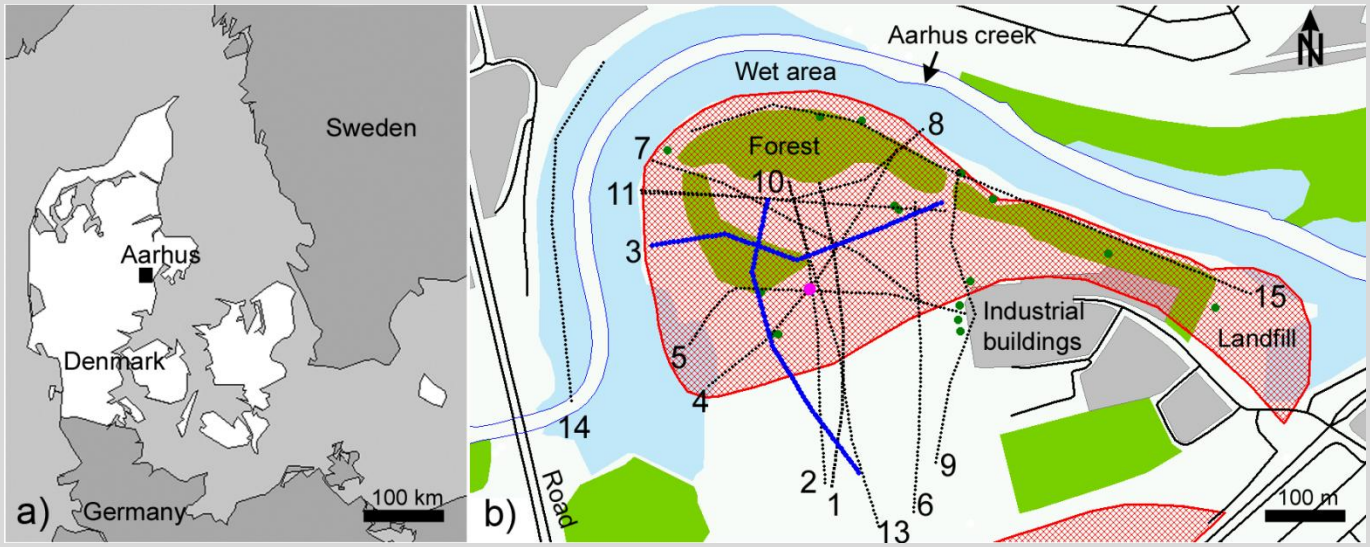


parameters {m_0=100 mV/V, τ=2 sec, C=0.5}; $T_{on} = T_{off}$ = 4 sec



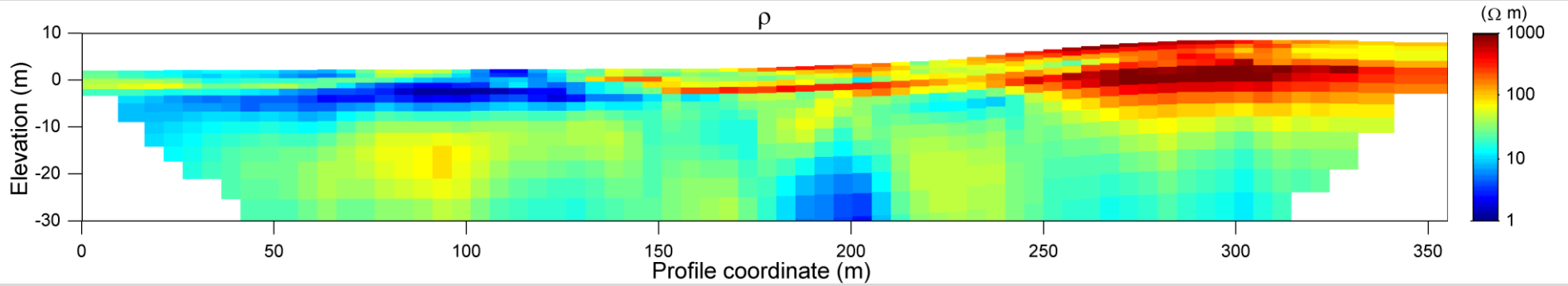
Field Example

- **Eskelund Landfill, Aarhus, Denmark**

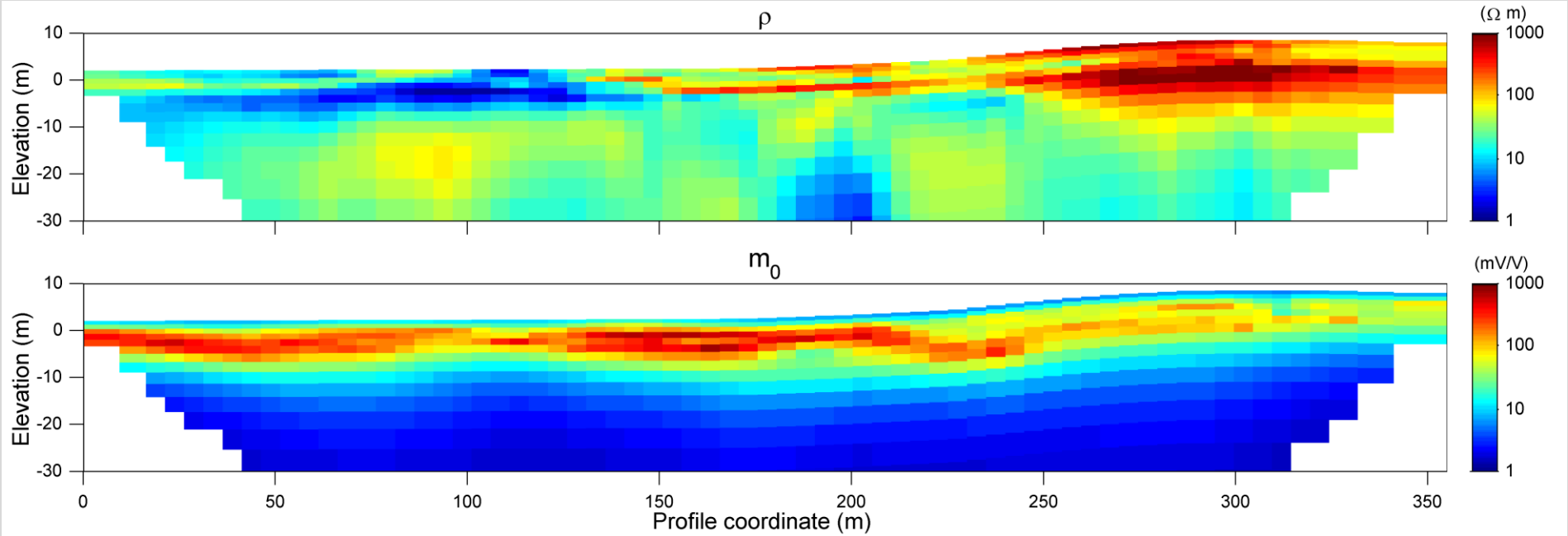


- **13 profiles, minimum 355 m long**
- **Equipment: Syscal Pro, Iris Instruments**
- **72 electrodes, 5m between takeouts, > 1400 quadrapoles per profile**
- **15 boreholes to asses inversion quality**

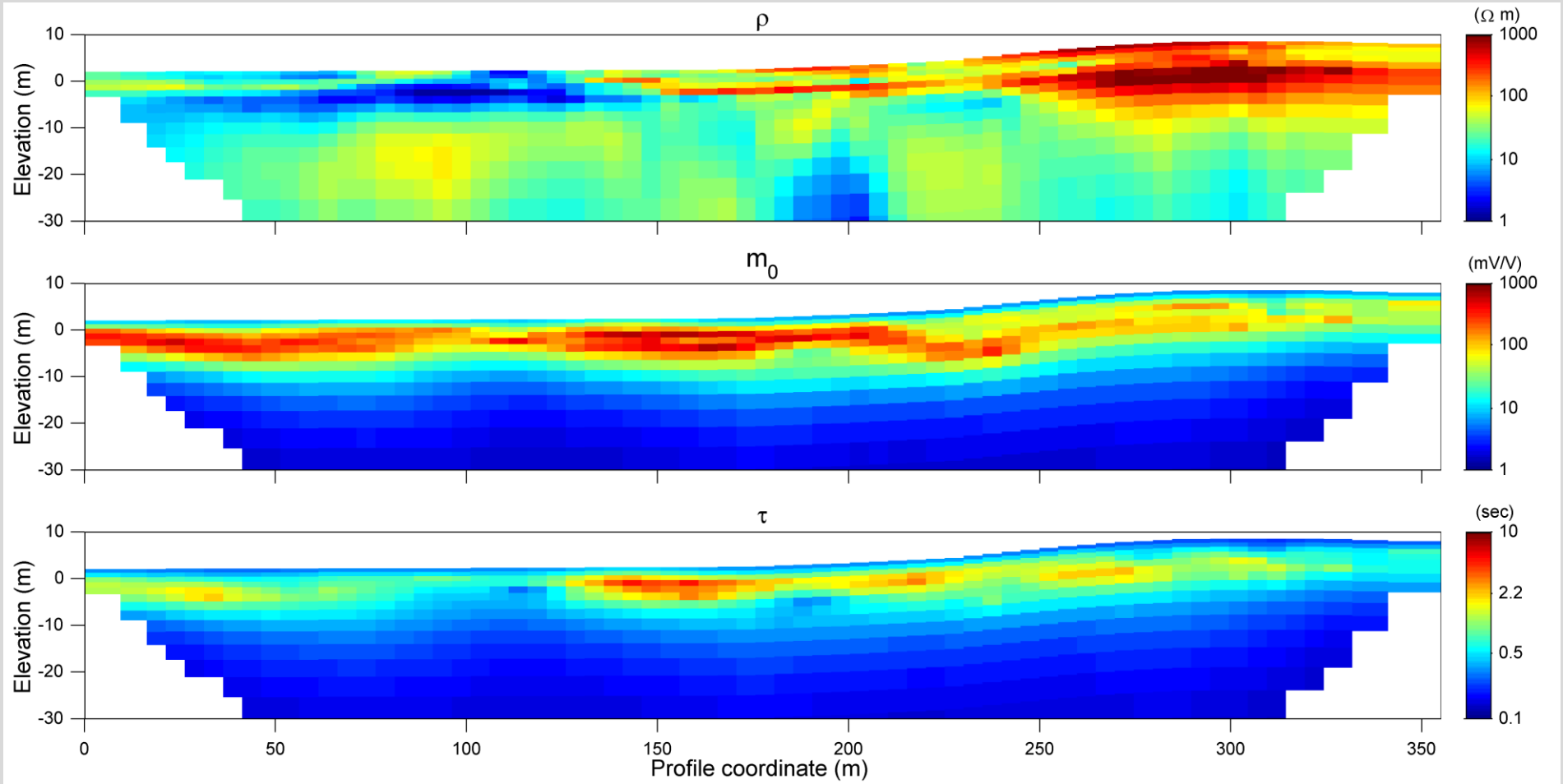
Field Example: Inversion model



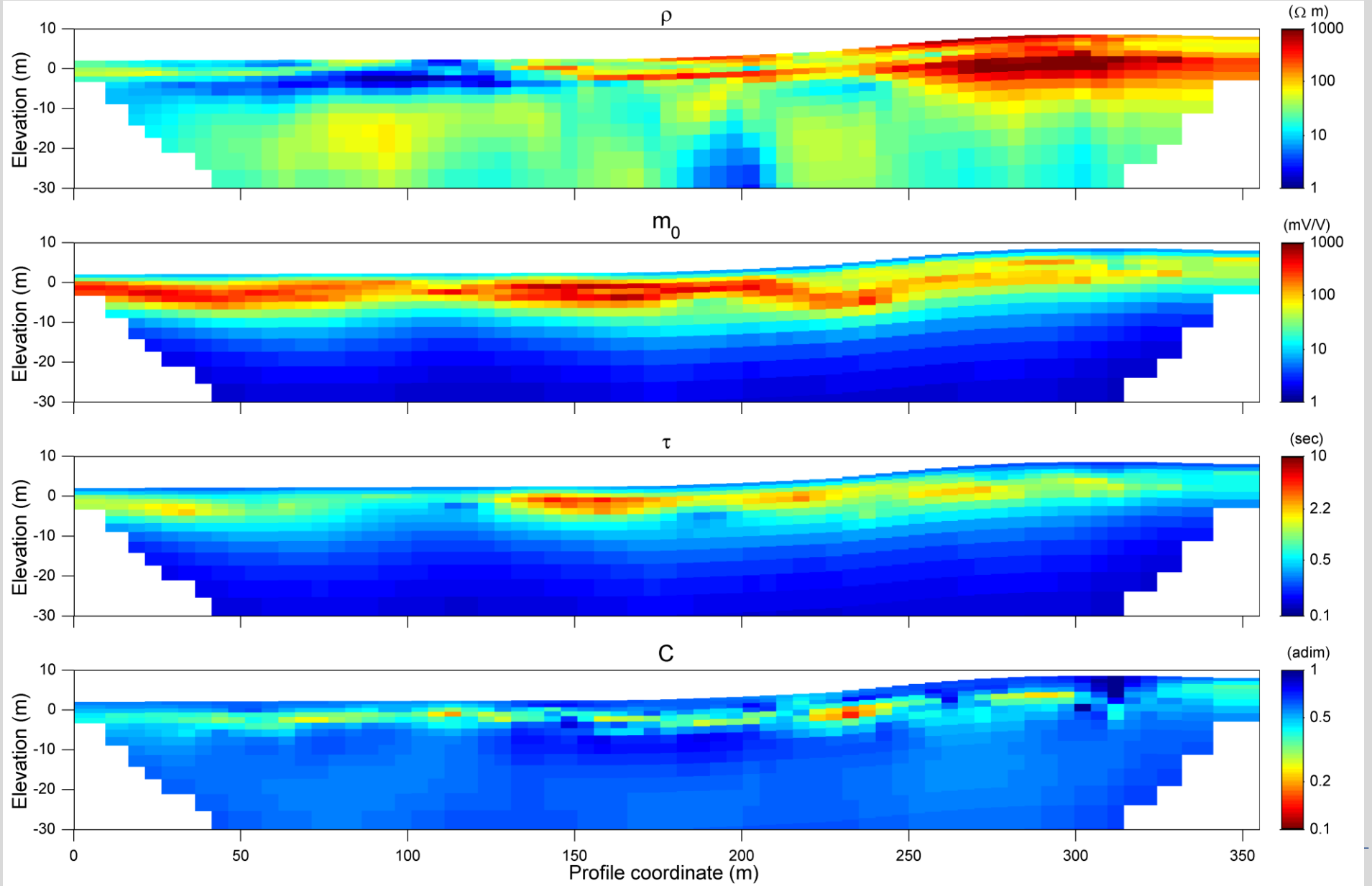
Field Example: Inversion model



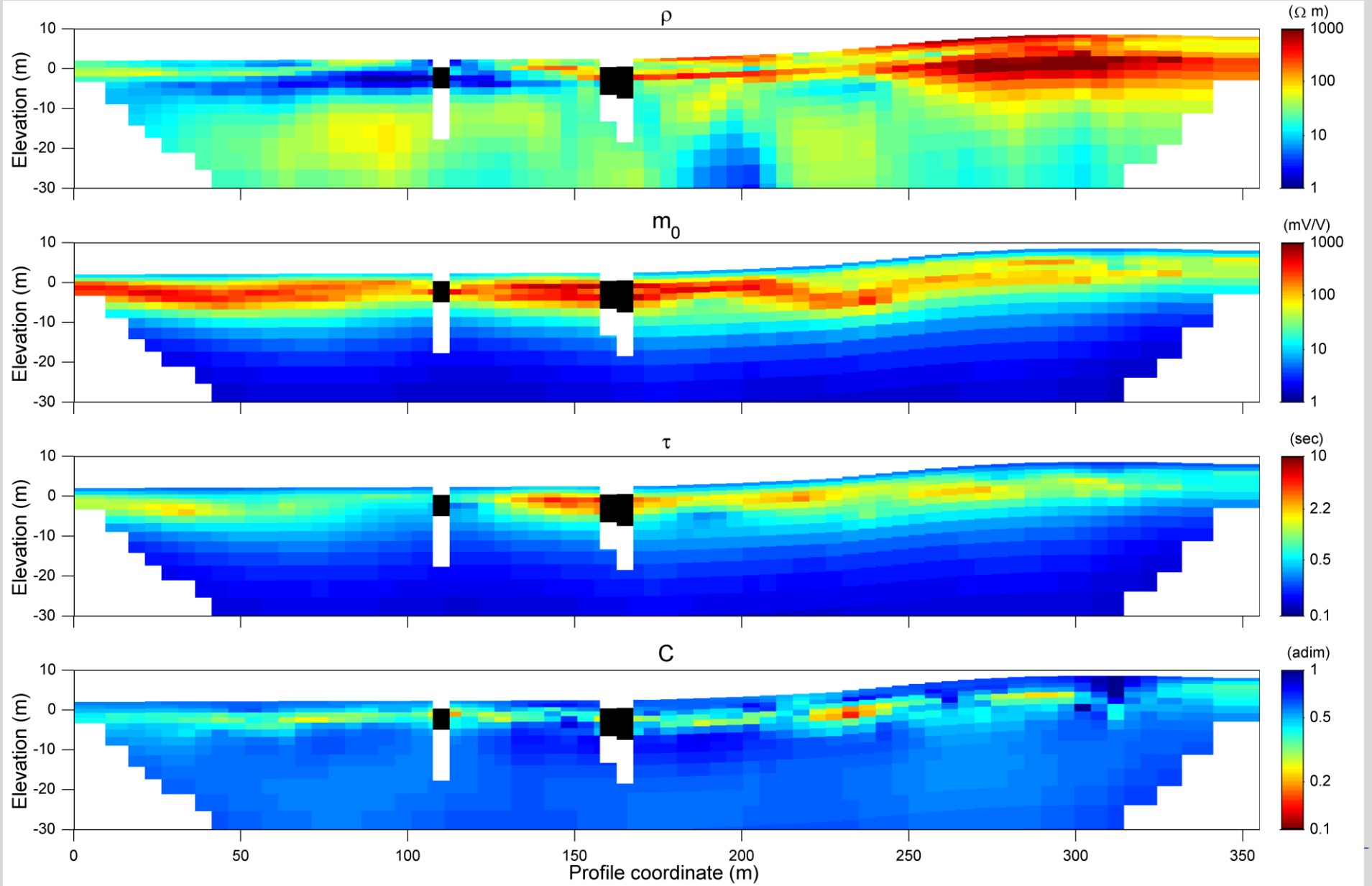
Field Example: Inversion model



Field Examples: Inversion model

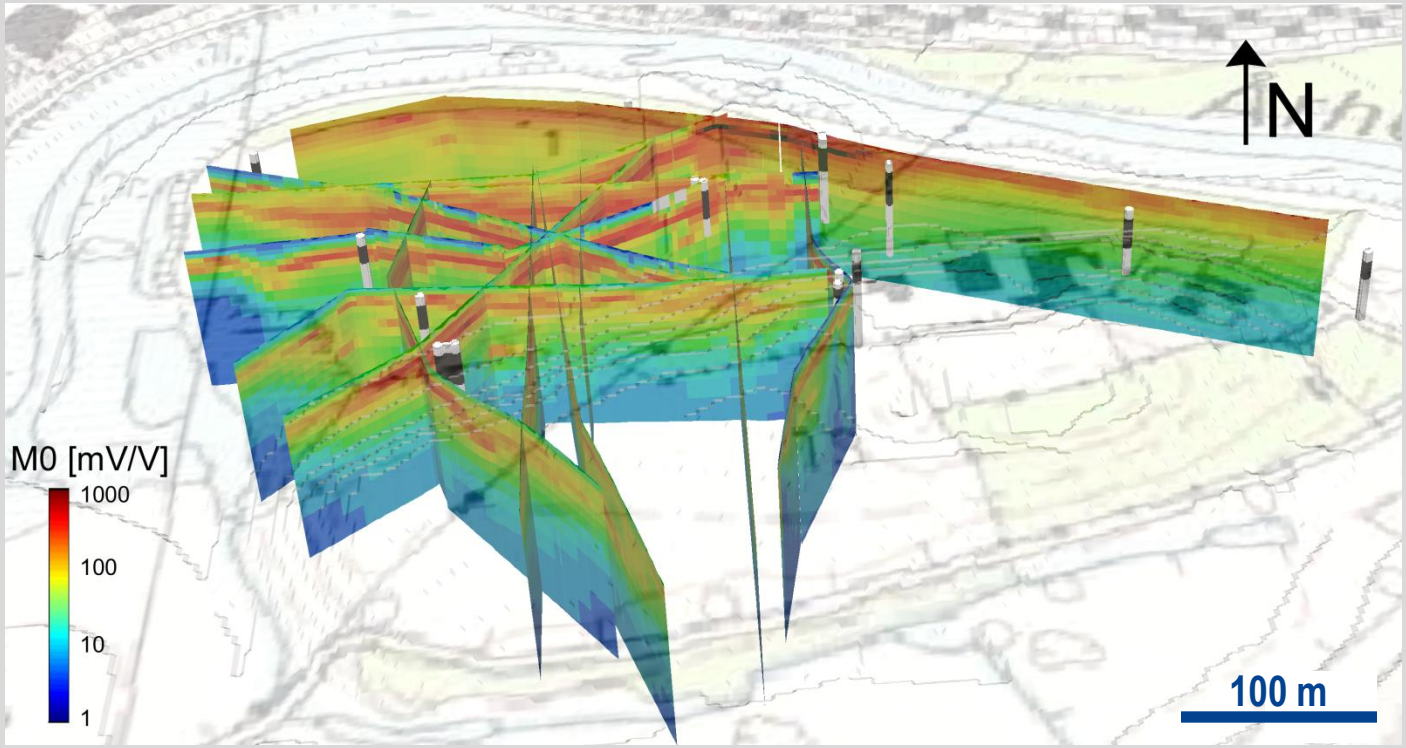


Field Example: Inversion model



Results – landfill characterization

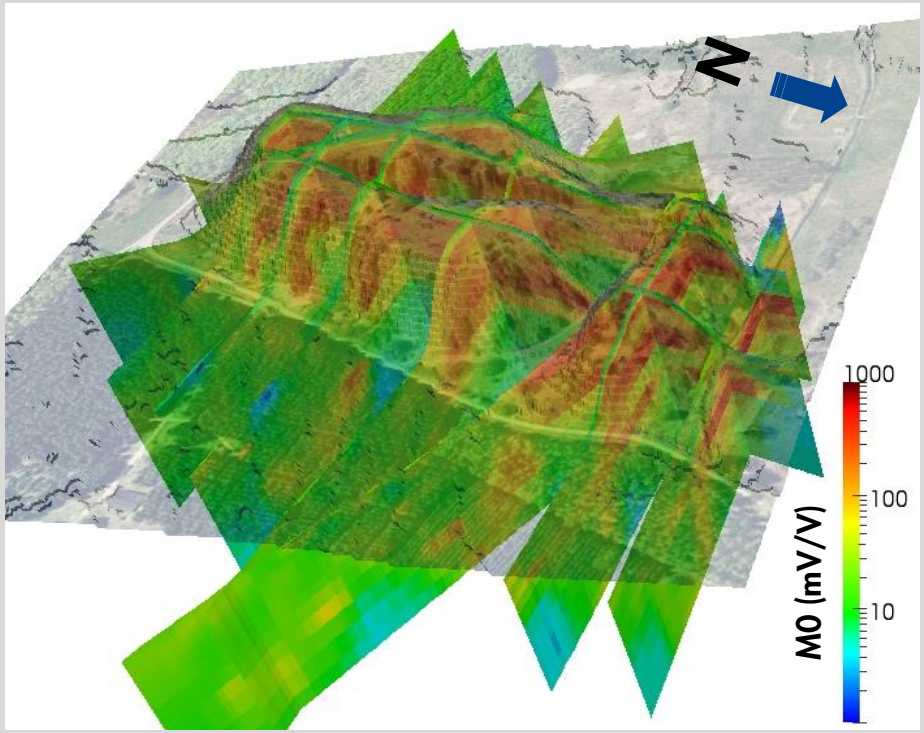
- **Eskelund**

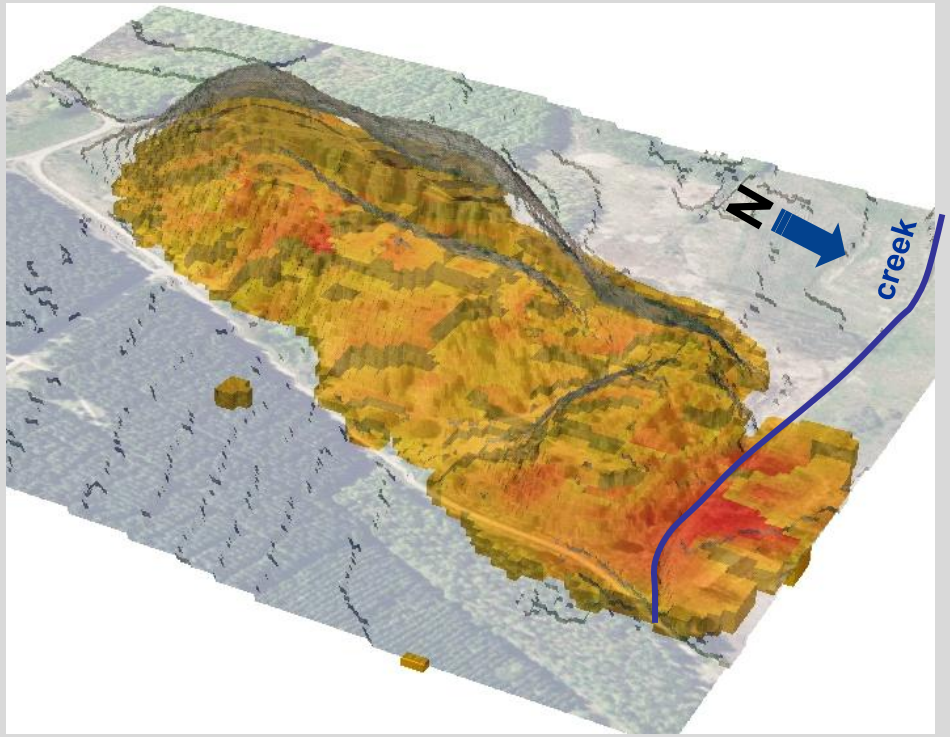


waste **peat** **cover layer/ clay/sand**

Results – landfill characterization

- **Risby**

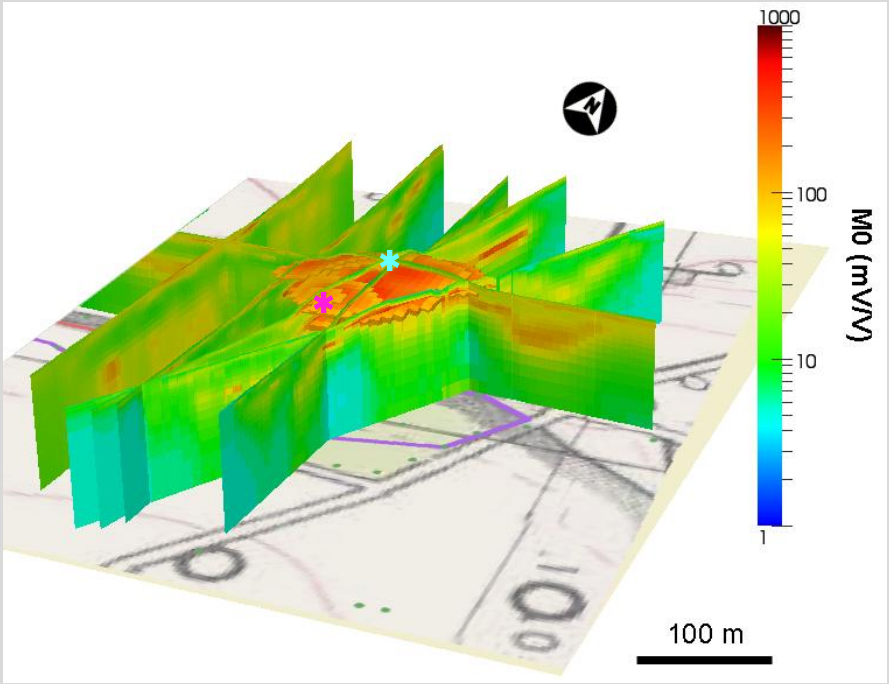


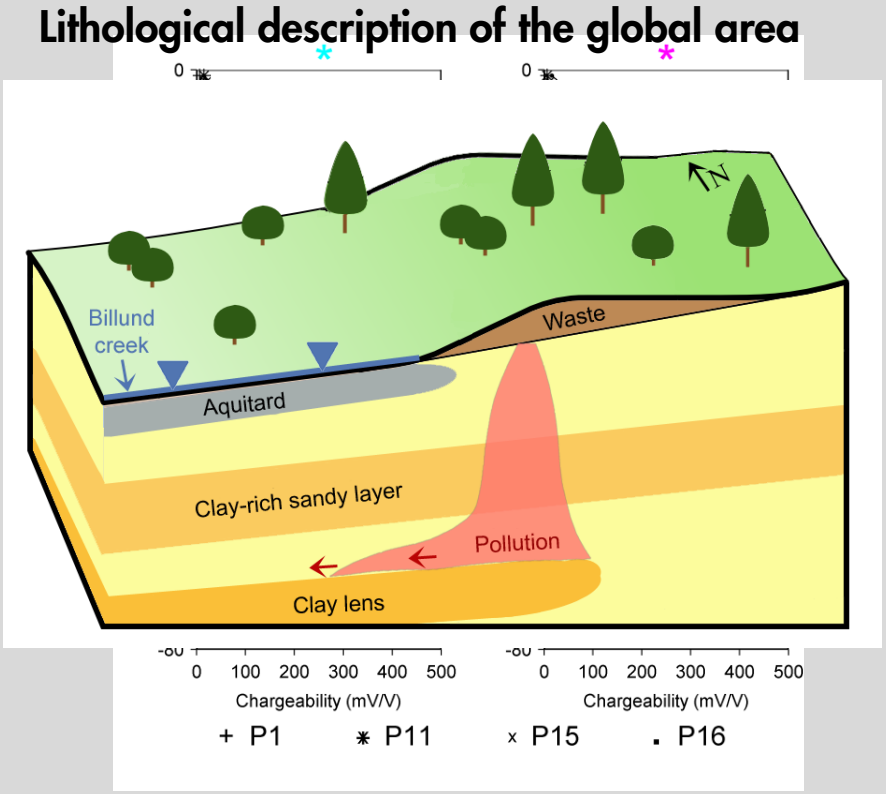


Isovolume of chargeability 100-560 mV/V

Results – landfill characterization

- **Hørløkke**





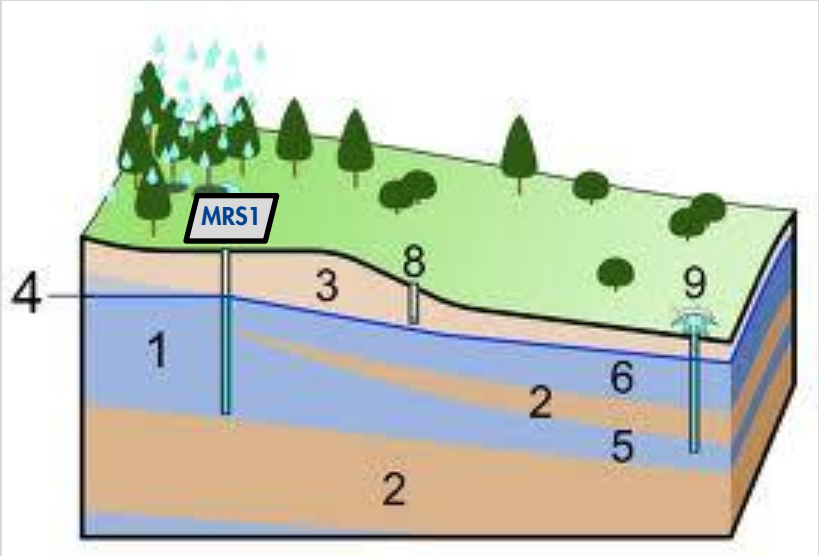
MRS

- **Efficient data processing**
- **Data inversion – joint with tem**

Hydrogeological interpretations

- **Quantitative estimate of hydraulic conductivity**

W_{MRS} : water content
T_{MRS} : relaxation time

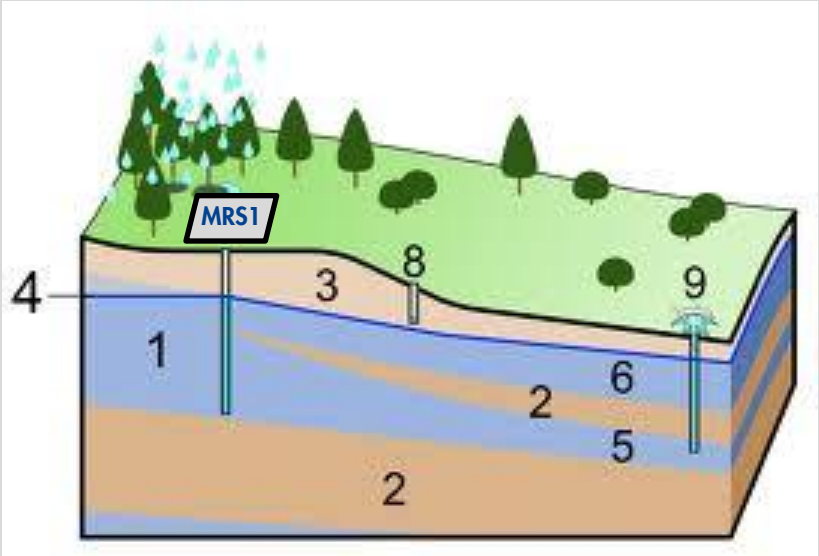


Hydrogeological interpretations

- **Quantitative estimate of hydraulic conductivity**

W_{MRS} : water content
T_{MRS} : relaxation time

a=1 ; b=2 (Legchenko et al., 2004)



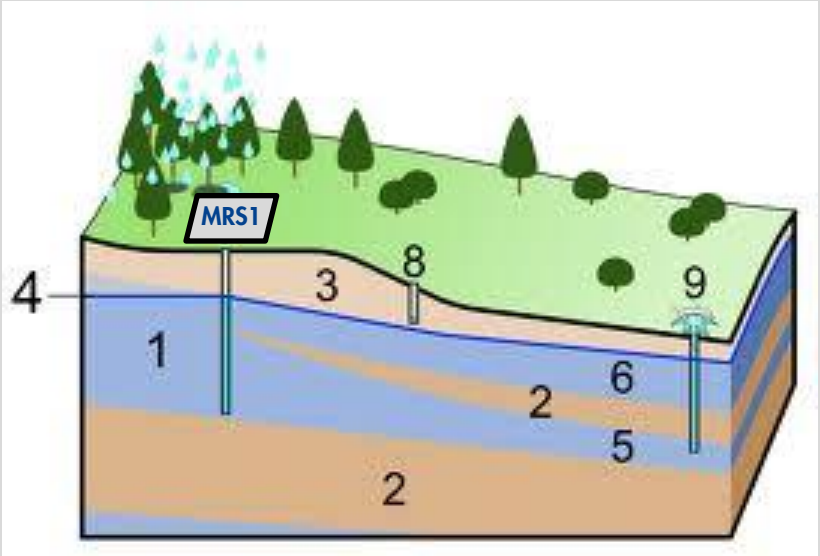
Hydrogeological interpretations

- **Quantitative estimate of hydraulic conductivity**

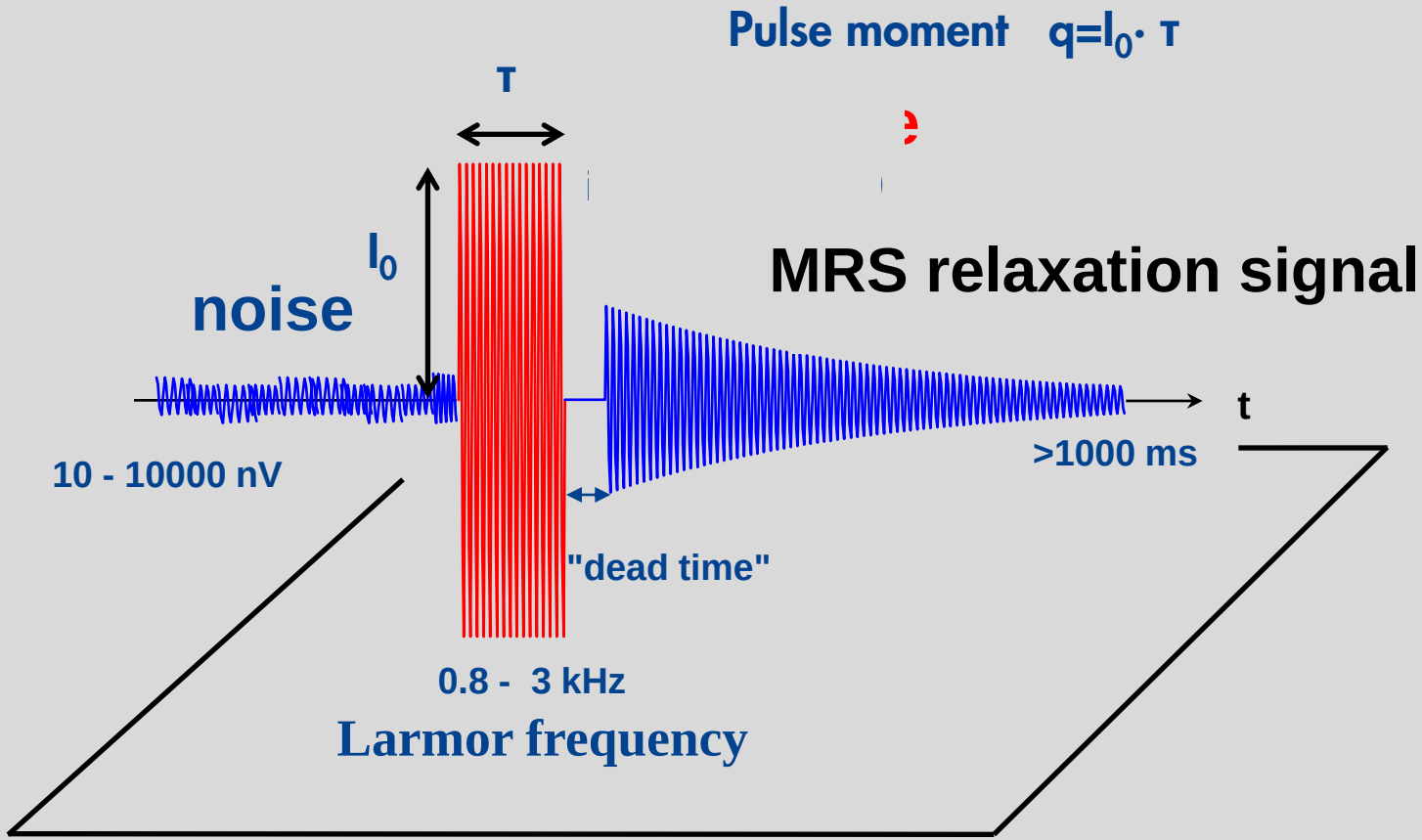
Calibration factor (site-specific)

W_{MRS} : water content
T_{MRS} : relaxation time

a=1 ; b=2 (Legchenko et al., 2004)

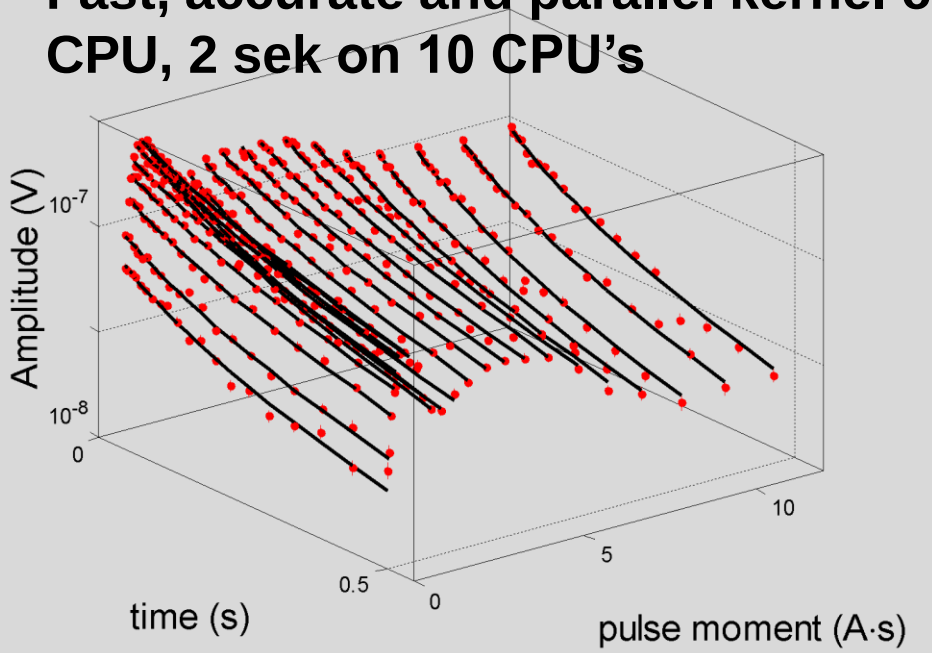


Principle of measurement



Magnetic Resonance Sounding (MRS)

- **Full data set – Q and T**
- **Joint inversion with TEM or DC**
- **Fast, accurate and parallel kernel calculation – 20 sek on one CPU, 2 sek on 10 CPU's**

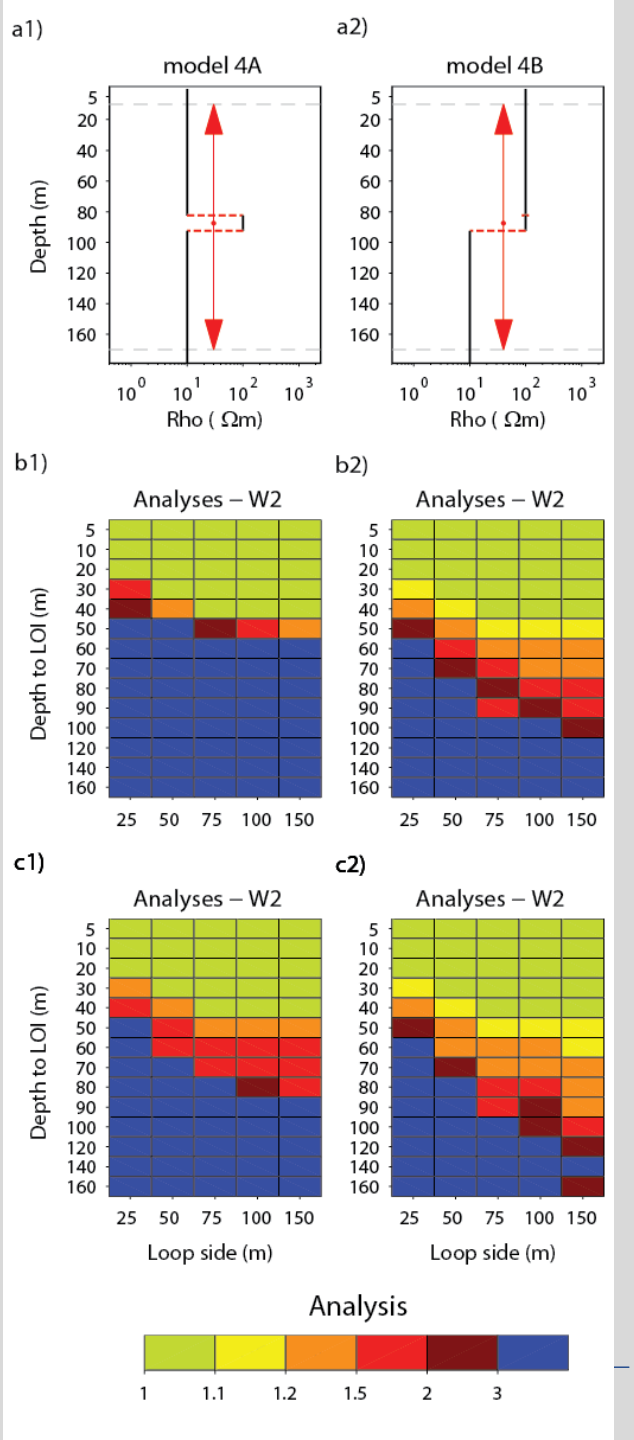


q ⟺ **Depth information**

Effect of loop side

- **Model 4A: Top conductive layer**

- **Model 4B: Top resistive layer**

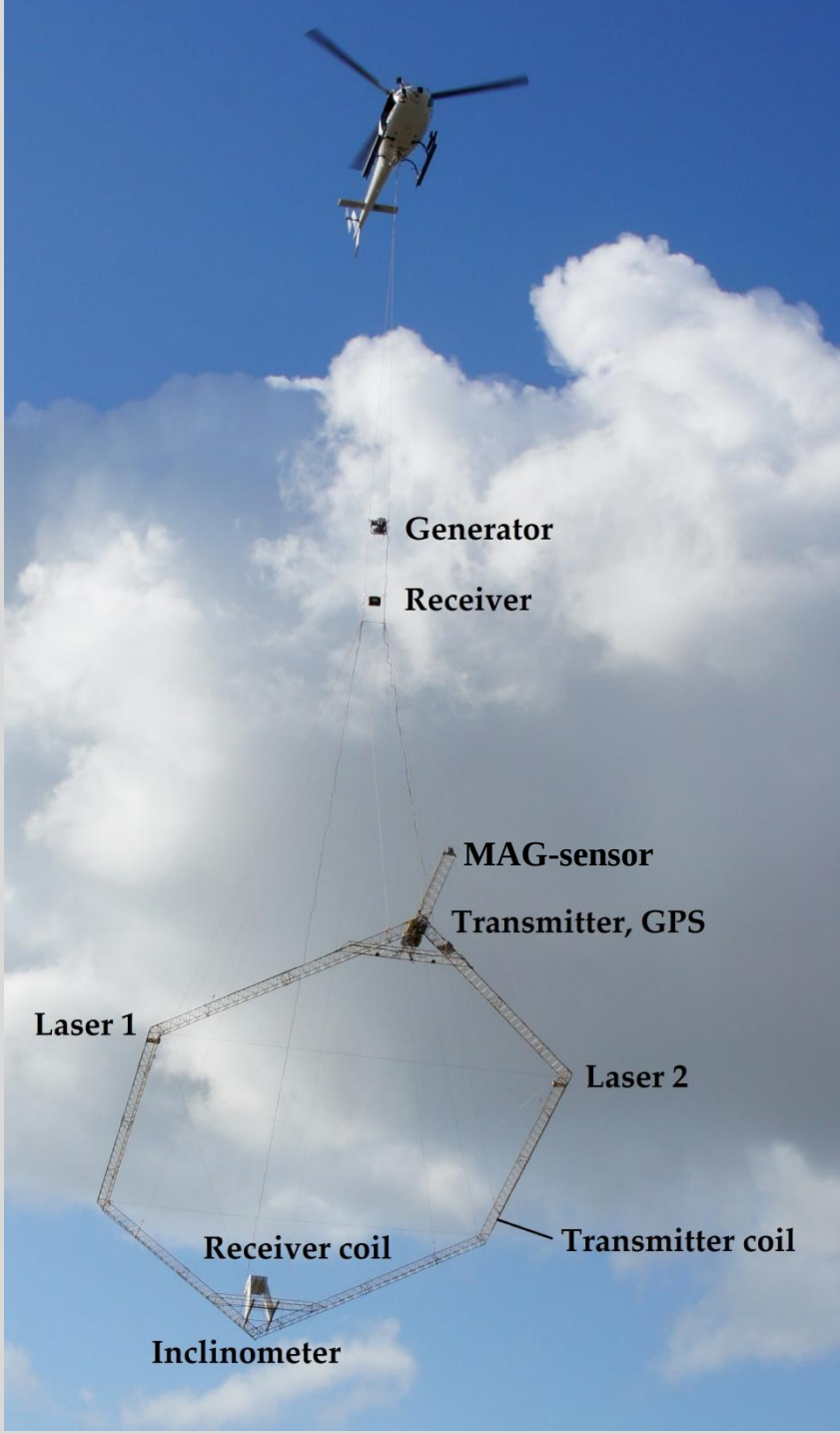


Transient electromagnetic

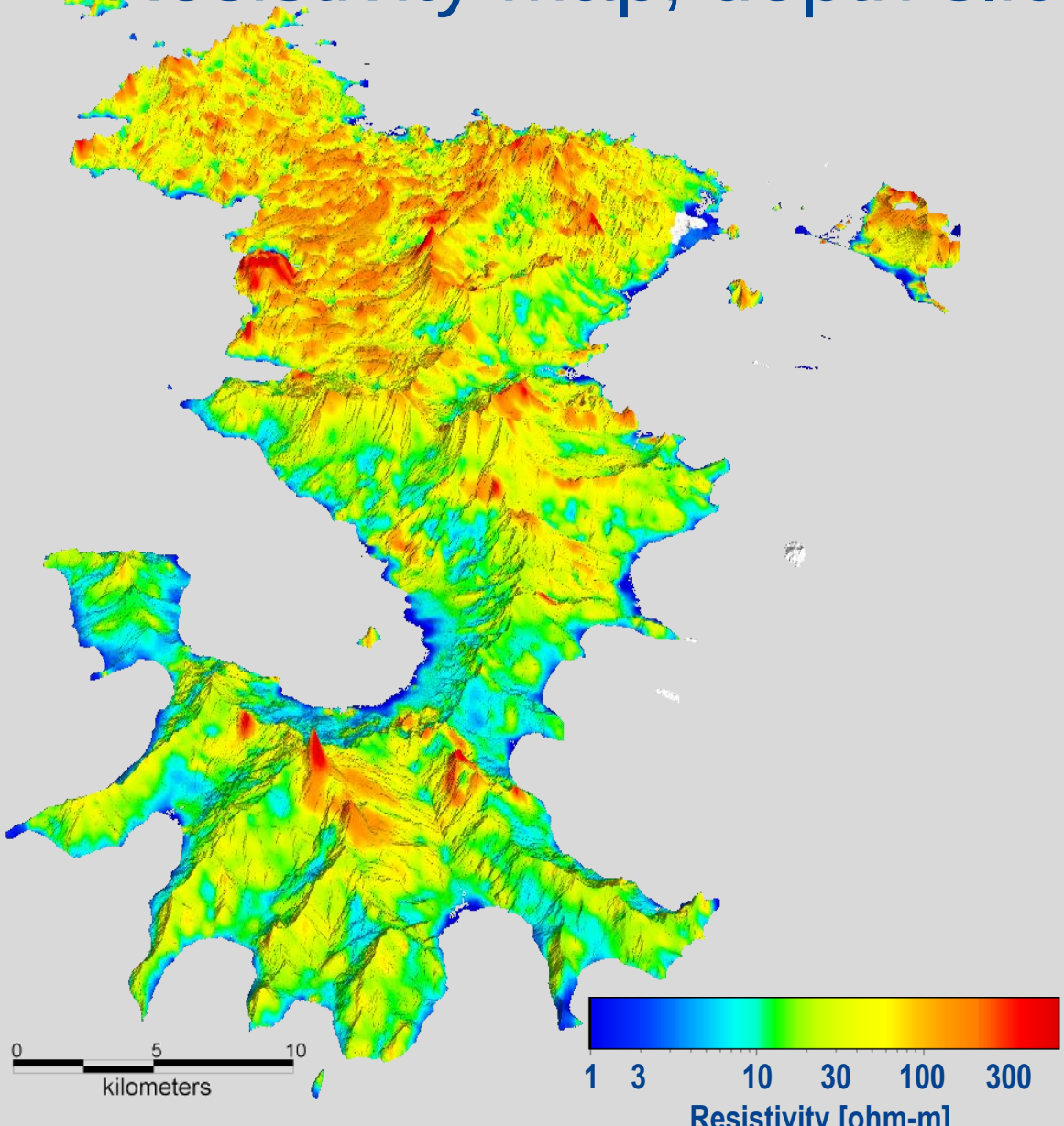
- **On the ground**
- **In the air**

The SkyTEM system

- **Airborne TDEM system**
- **Dual moment system:**
  - Super low moment:
    - 3,100 Am^2
    - 7 μs to 1ms (begin off ramp time)
  - High moment (HM):
    - 123,000 Am^2
    - 0.8 ms to 10 ms
- **Magnetometer**

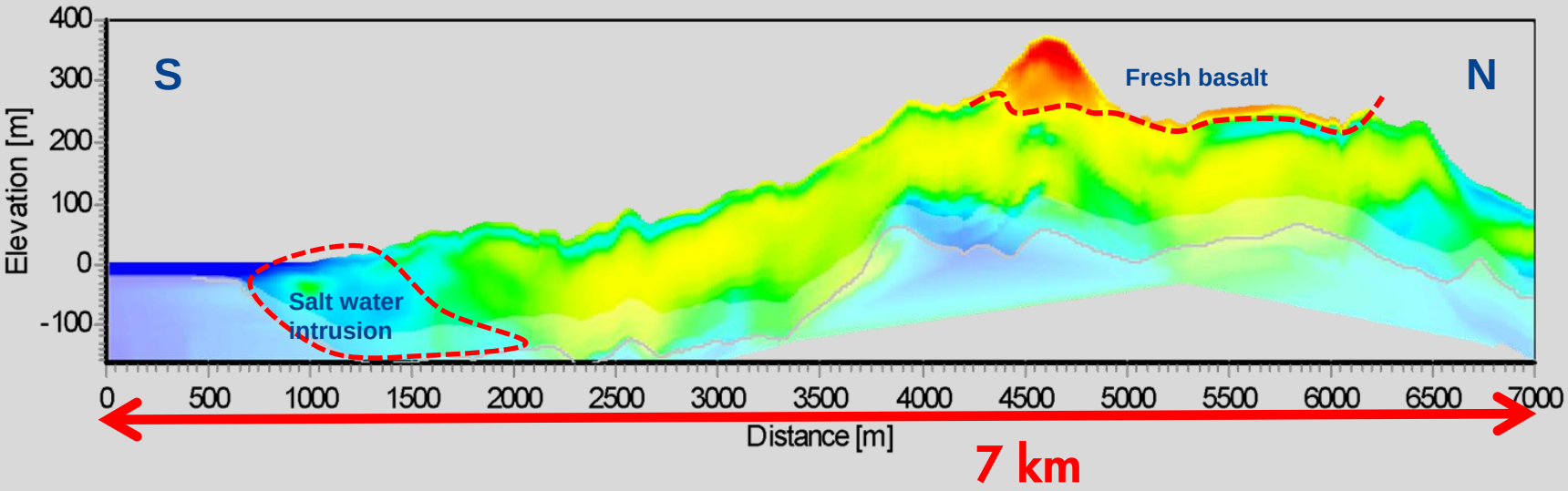


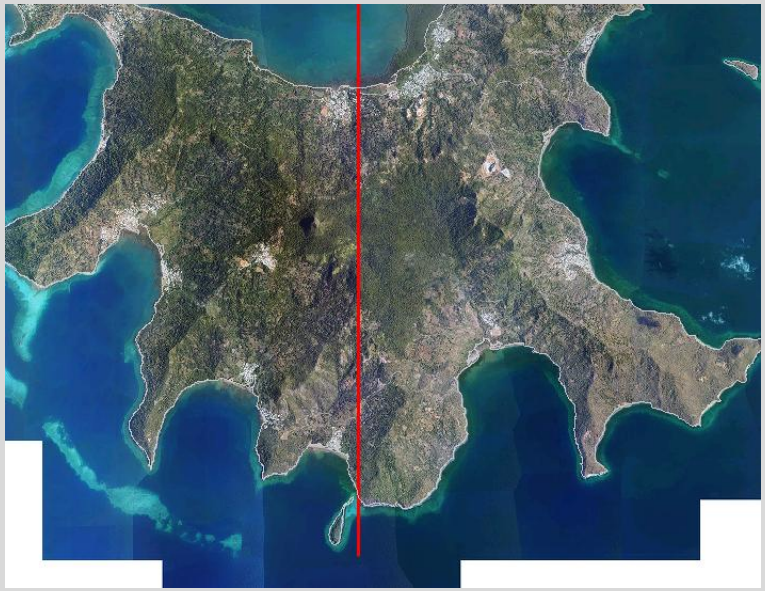
Resistivity map, depth slice 5 m

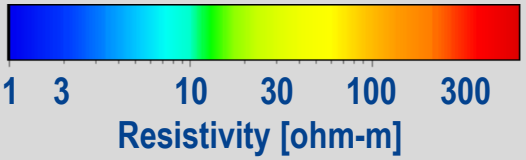


HydroGeophysics Group
AARHUS UNIVERSITY

Cross sections (SN 13)







HydroGeophysics Group
AARHUS UNIVERSITY

HyGEM wishes from AU-G

- **Overall wish: Do our best to build efficient tools for management of groundwater resources**
- **Develop one or more tools which can be used to intelligently and partly automatic integrate large results of AEM datasets into hydrological models**
- **Develop a code for inversion of large AEM and groundbased datasets – site independent, multiple data types, integration with geological information**
- **Develop a better noise reduction system for NMR data – and work on the integration of these data more directly into the groundwater models**