E-TEST in EMR: Hydrogeophysical characterization

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About us

Joost Hase, PhD Student – University of Bonn

- Geoelectric surveys, SIP laboratory measurements

Yannick Forth, PhD Student – University of Liège

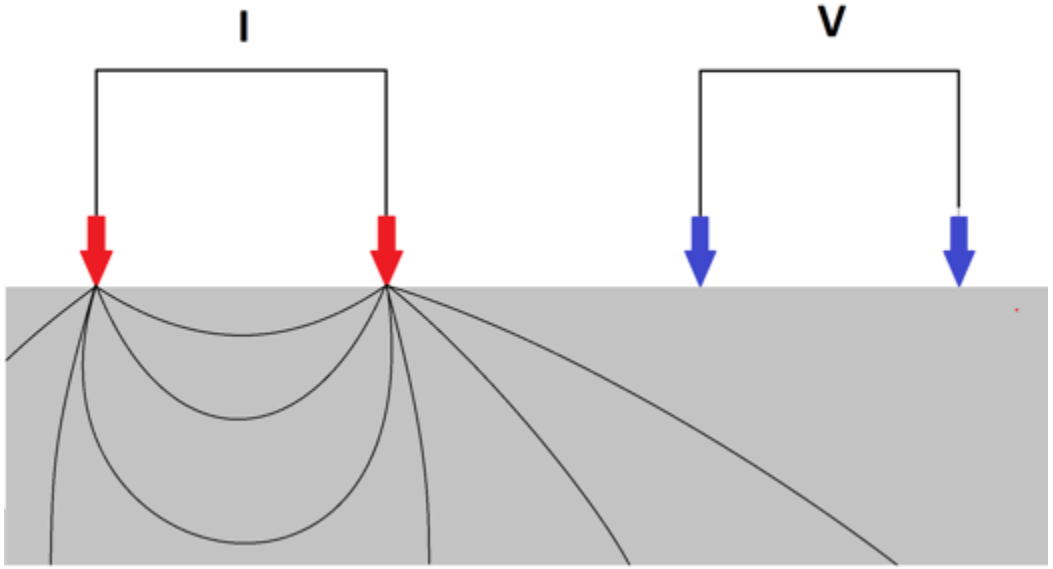
- Geoelectric surveys

Objective:

- Geologic structures and lithology
- Hydrogeophysical characteristics

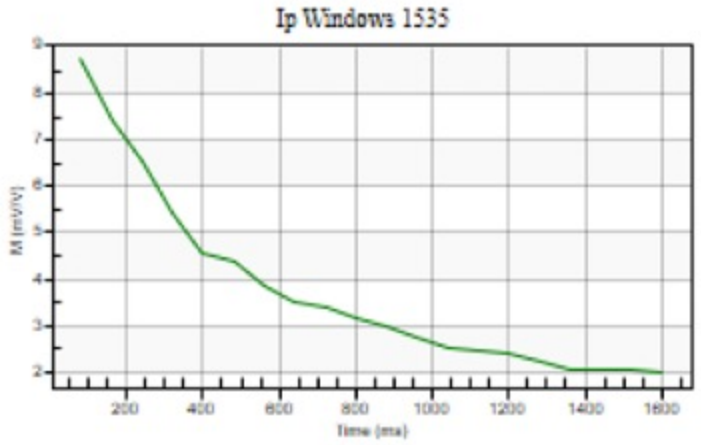
Electrical Resistivity Tomography (ERT)

- Current injected using two electrodes
- Electric voltage measured two different electrodes
- Measured voltage depends on subsurface resistivity ruled by lithology, porosity and water content
- Reconstruction through tomography

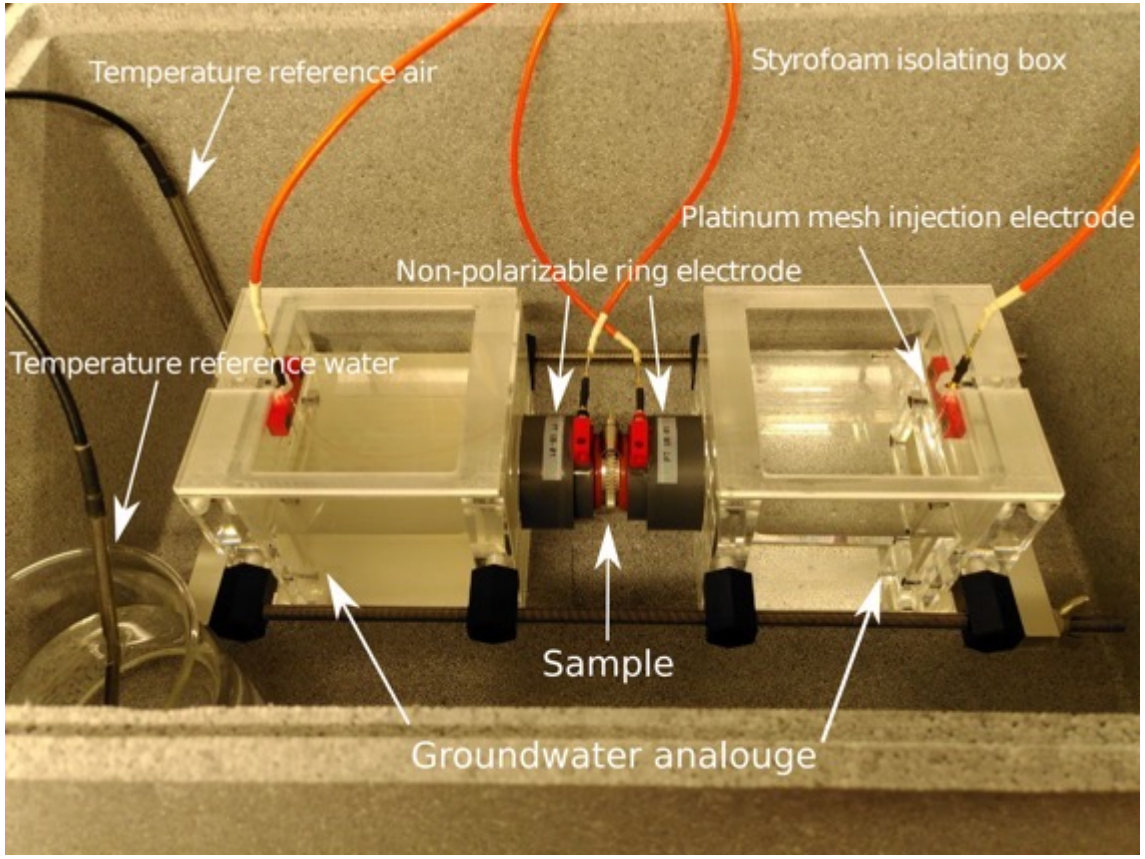


Induced polarization (IP)

- Chargeability of subsurface from decay curves
- IP in frequency domain able to determine porosity
  - ➢ Solves issue of ERT ambiguity of porosity vs water content



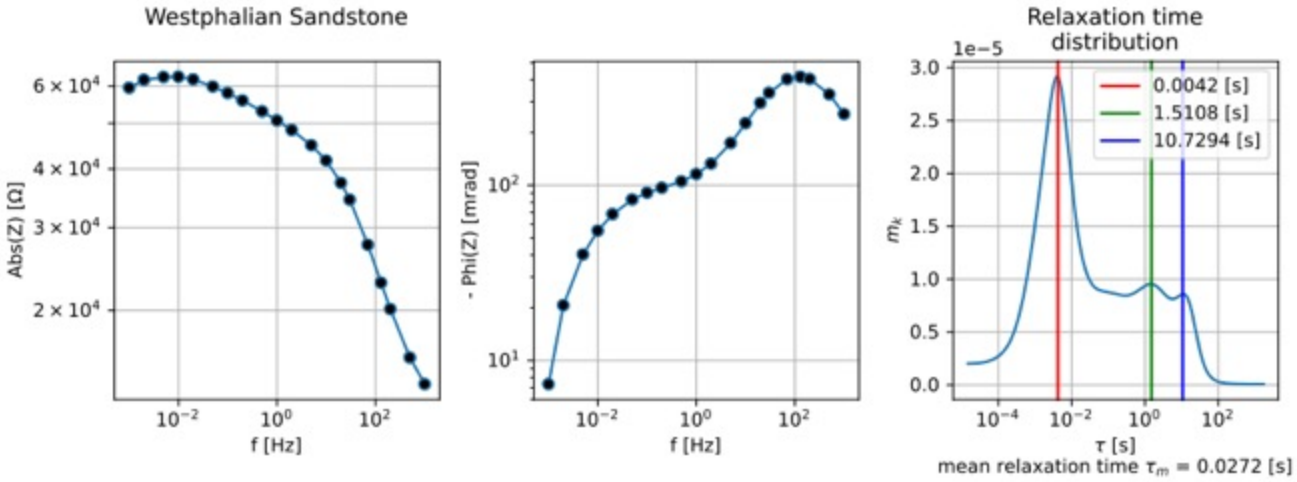
SIP and petrophysical measurements



SIP and petrophysical measurements on 30+ samples from:

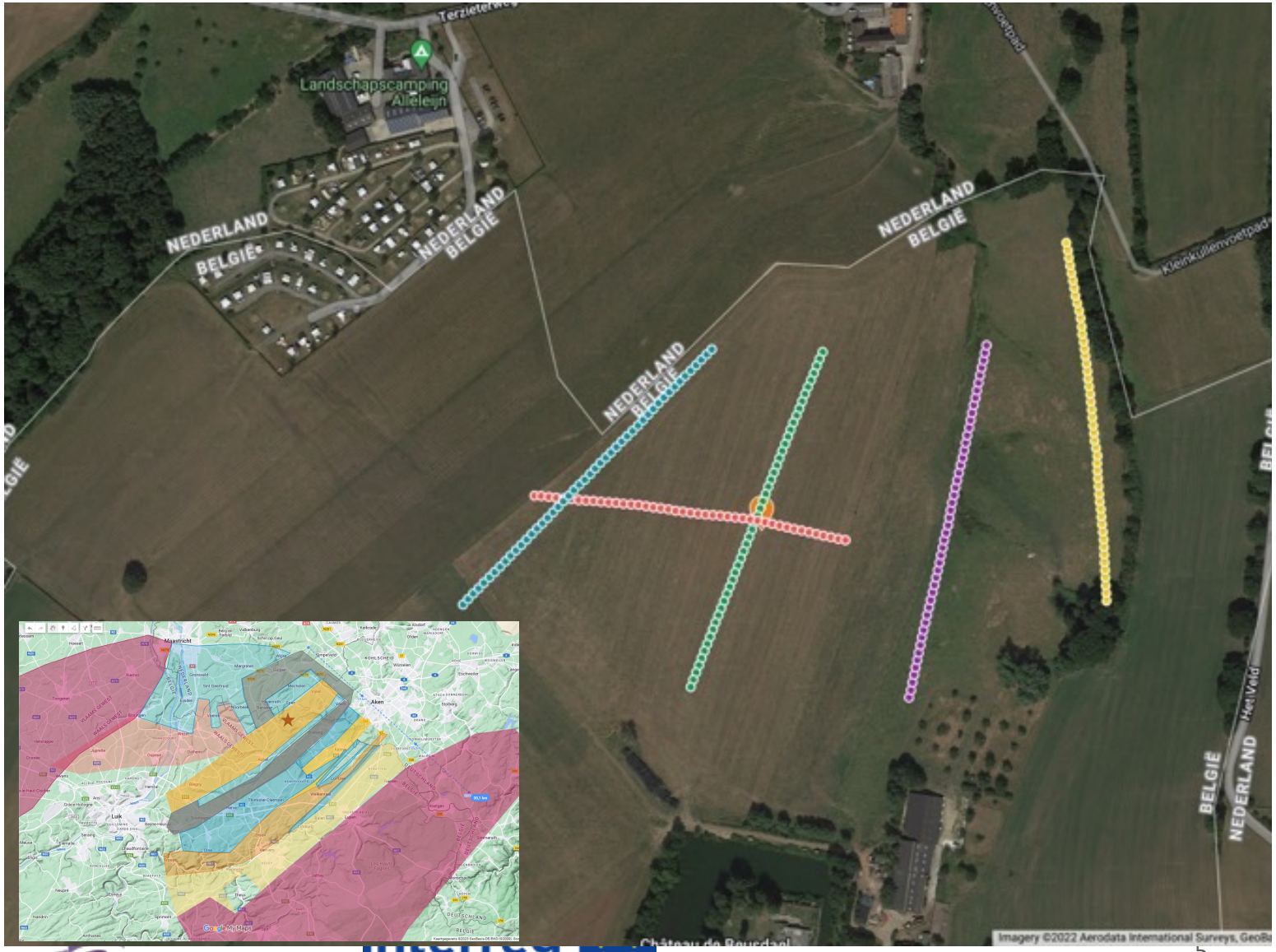
- Cottessen Borehole
- Surface outcrops

to improve hydrogeophysical and litholigical characterization.

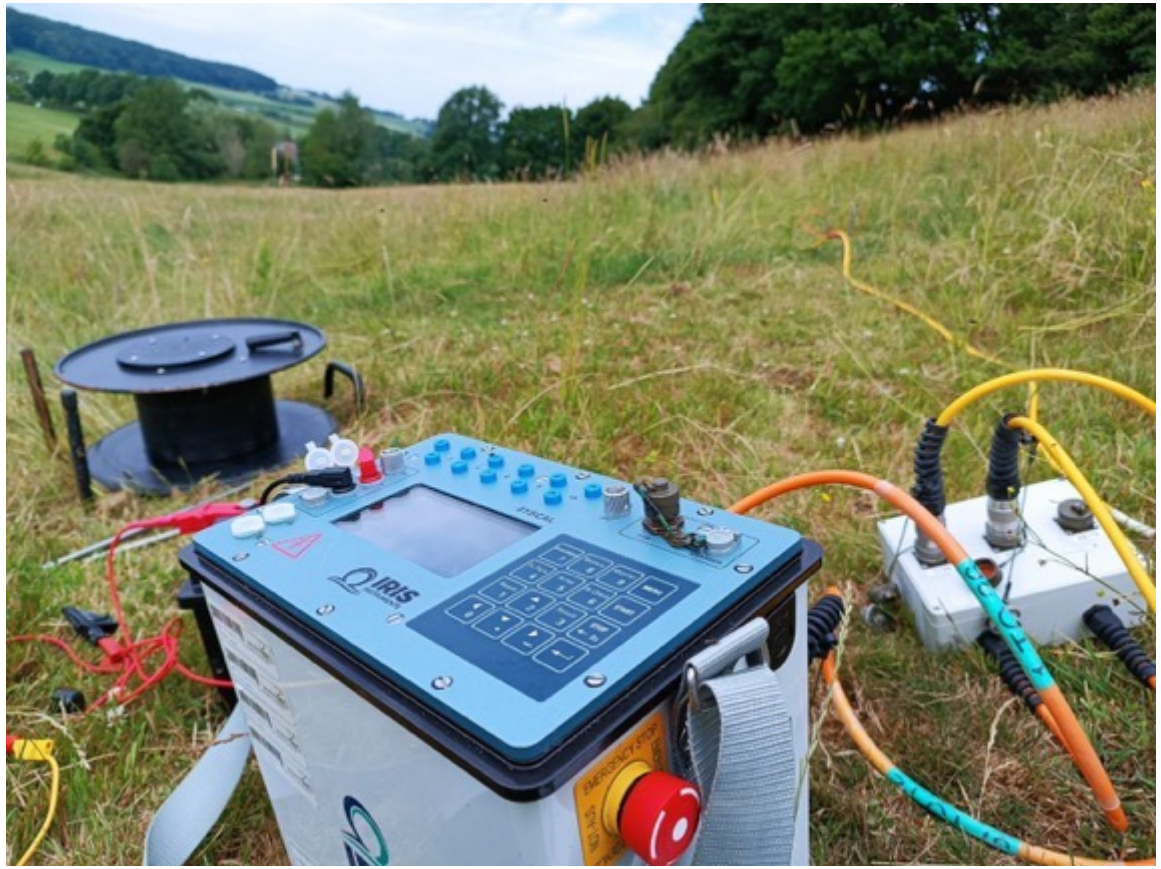


Survey site Beusdael

	Type	Campaign
Purple	N-S ERT/IP profile	March 22
Light-blue	NE-SW ERT/IP profile	March 22
Green	N-S ERT/IP profile	June 22
Red	W-E ERT/IP profile	June 22
Yellow	N-S ERT/IP profie	June 22
Orange	Azimuth-Survey (Midpoint)	June 22

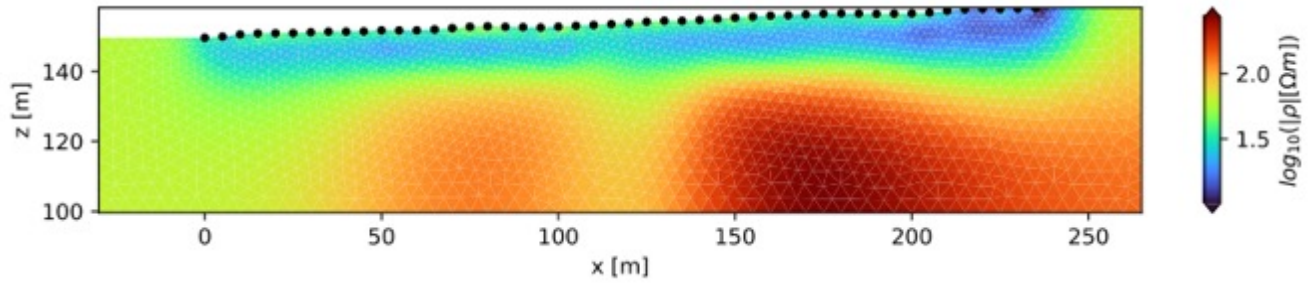


Field work

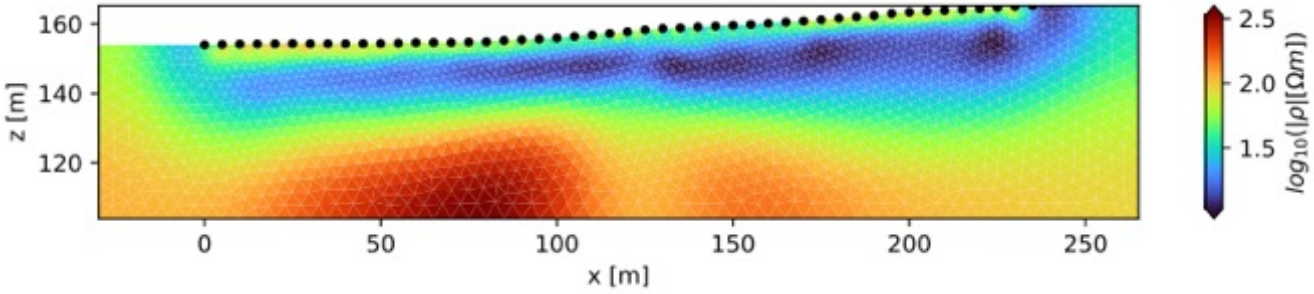


Reproduction of previous geoelectric measurements

Purple N-S ERT/IP profile, March 22

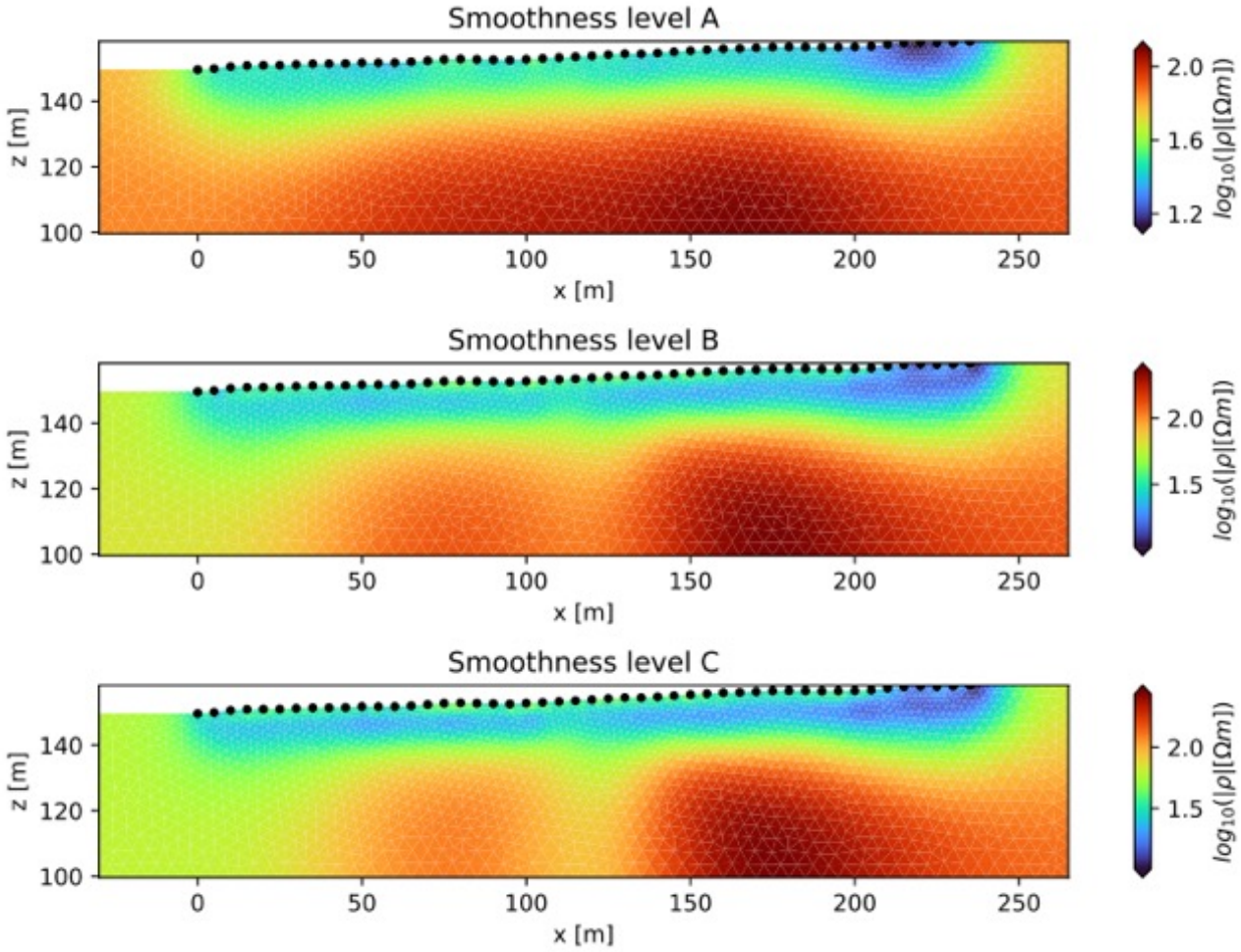


Light-blue N-S ERT/IP profile, March 22



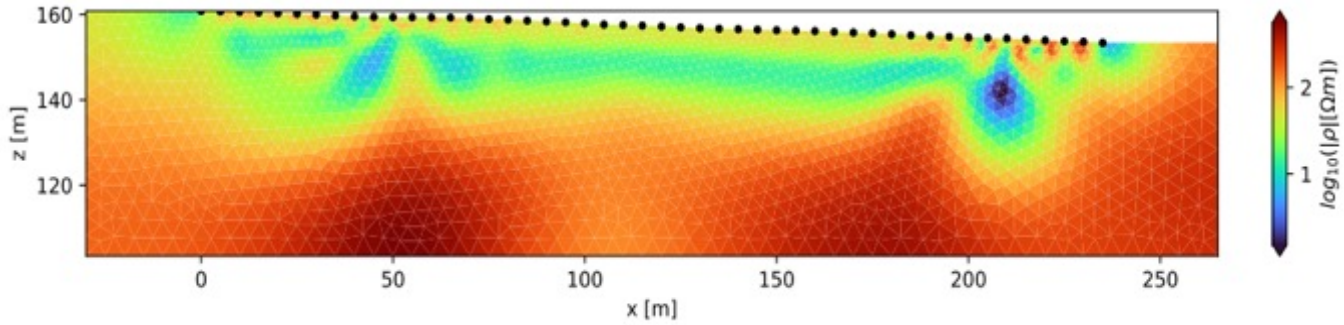
Processing and inversion

- **Processing**: Filtering of low-quality data points, error quantification
- **Inversion**: Fitting of a subsurface model to the field measurements
- To constrain the inversion one has to introduce prior information → **smoothing**
- The smoothing level is a hyperparameter and has to be chosen carefully

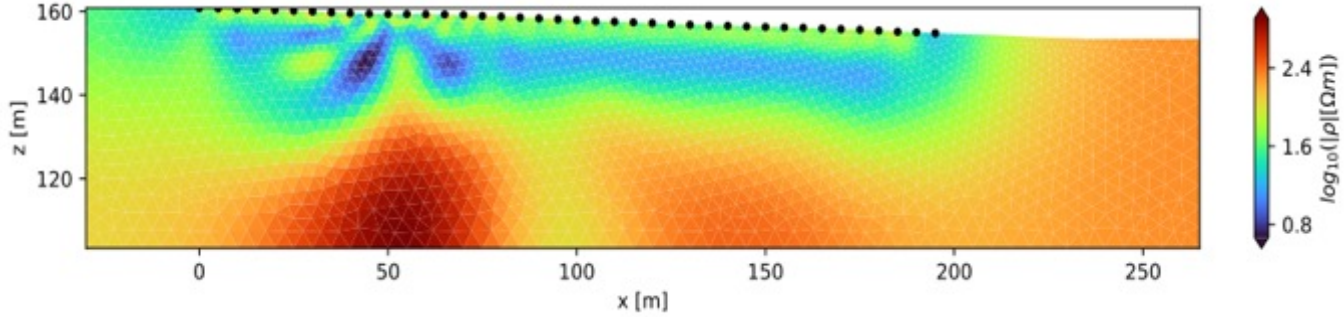


Validation of suspected fault location

Green N-S ERT/IP profile, June 22 (complete)

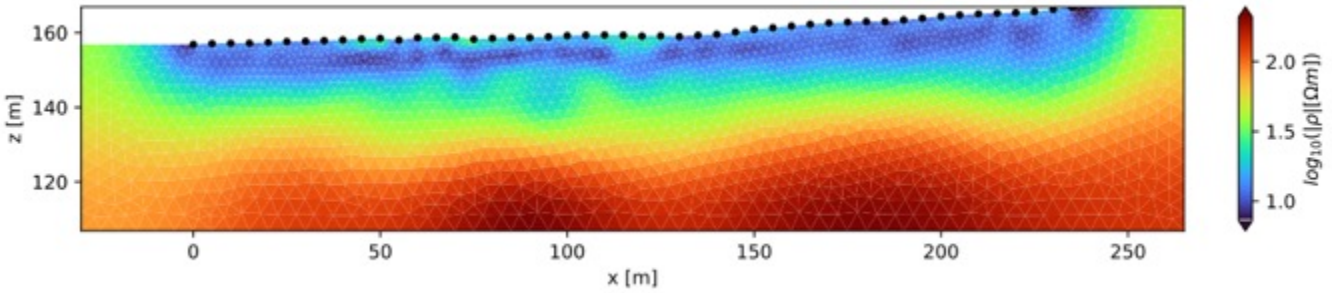


Green N-S ERT/IP profile, June 22 (cut)

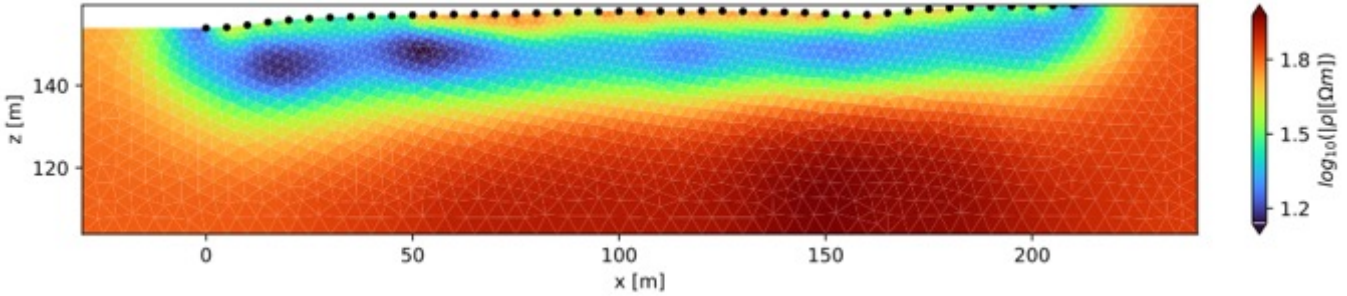


Validation of suspected fault location

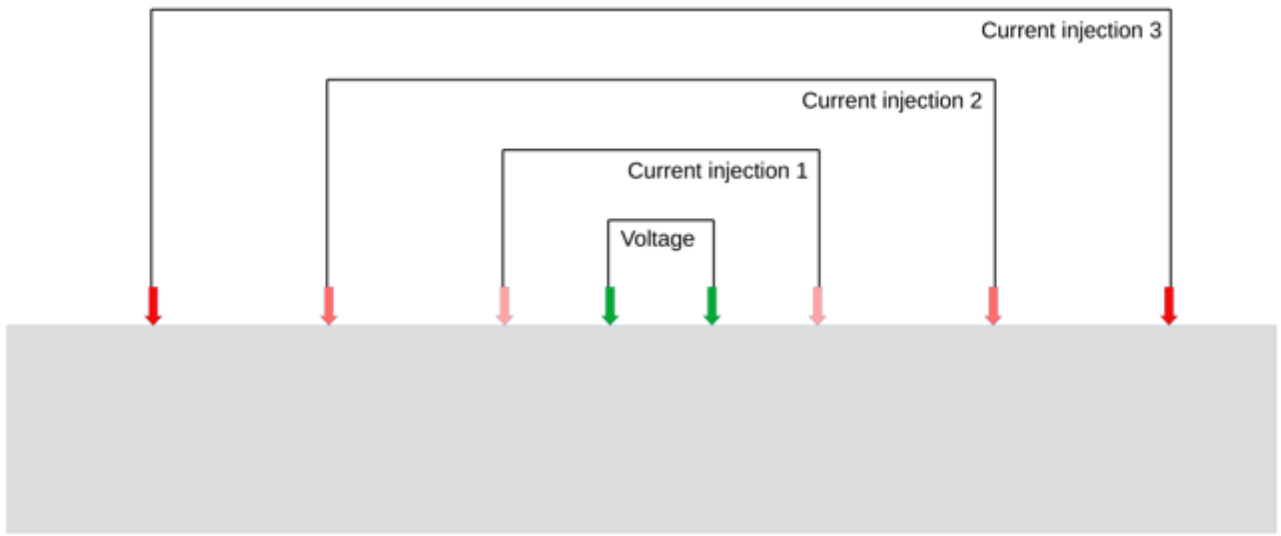
Yellow N-S ERT/IP profile, June 22

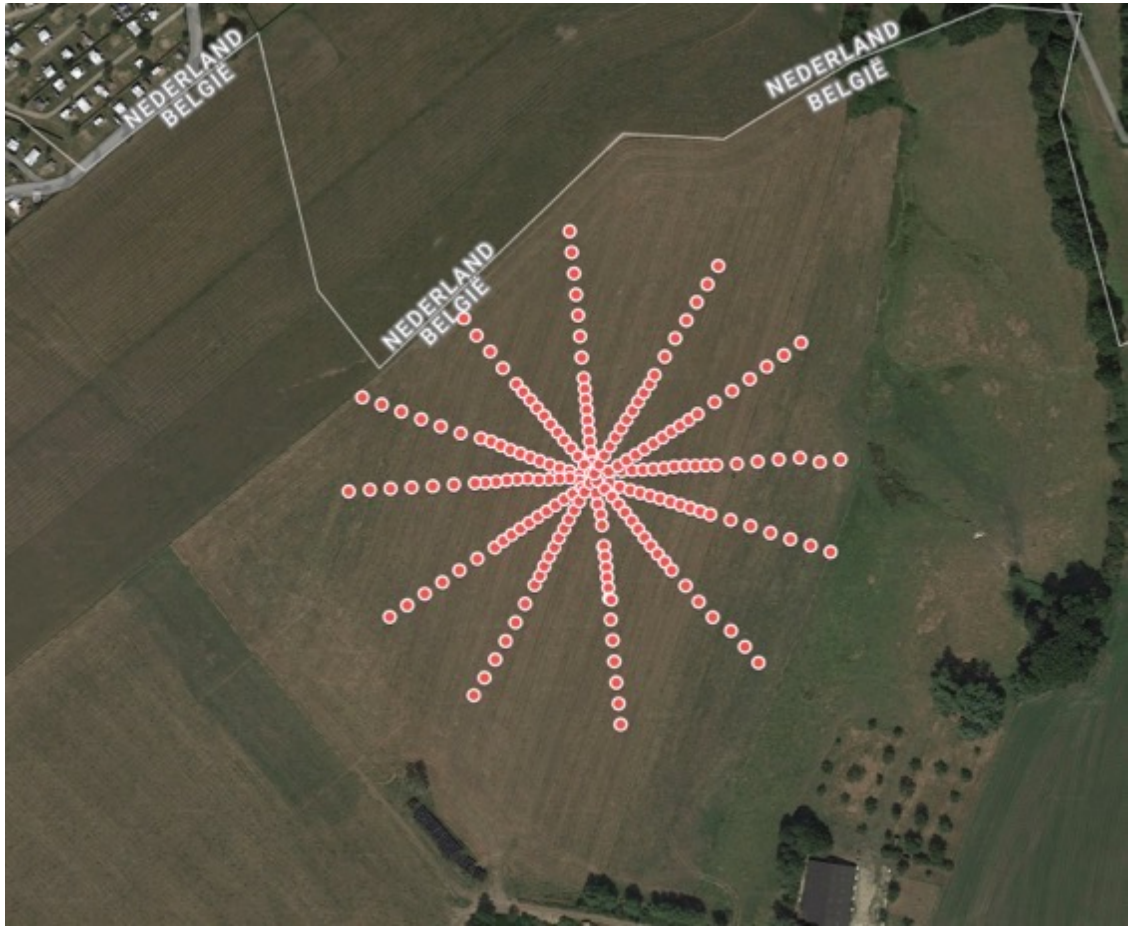


Red W-E ERT/IP profile, June 22



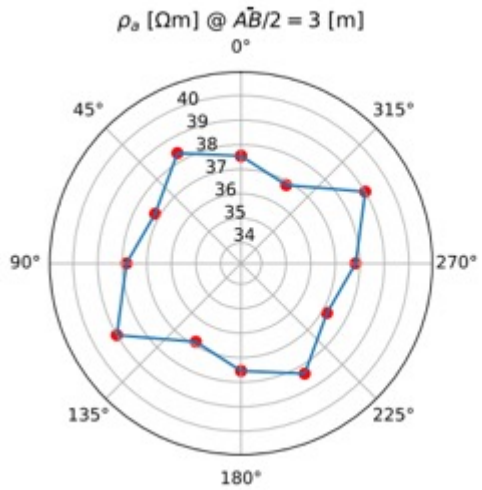
Azimuth survey design

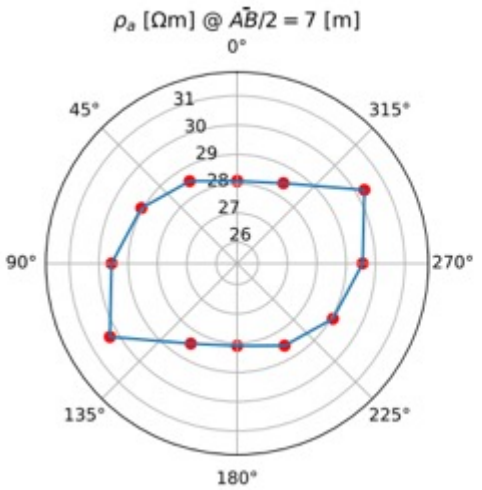


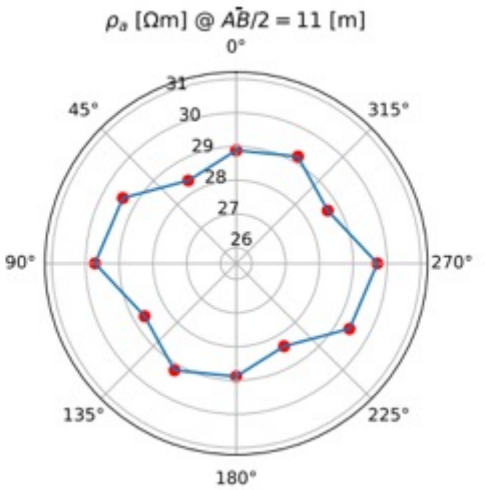


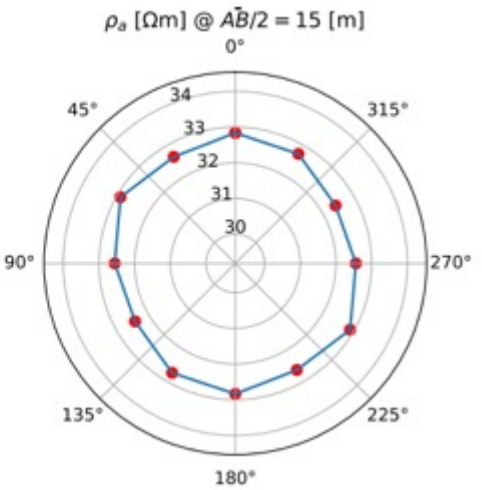
- Increasing distance between current electrodes causes deeper penetration depth of electric field
- Rotation around common midpoint yields information on large scale anisotropy

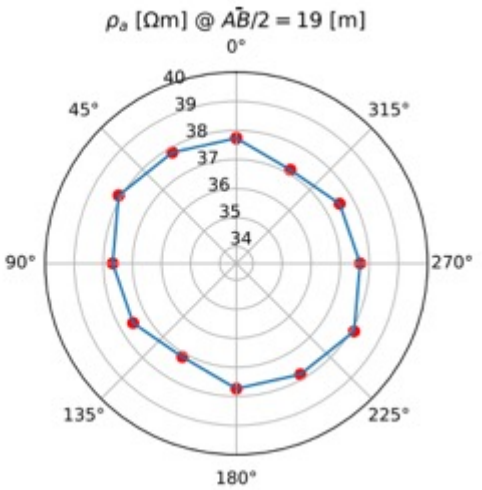
Azimuth survey

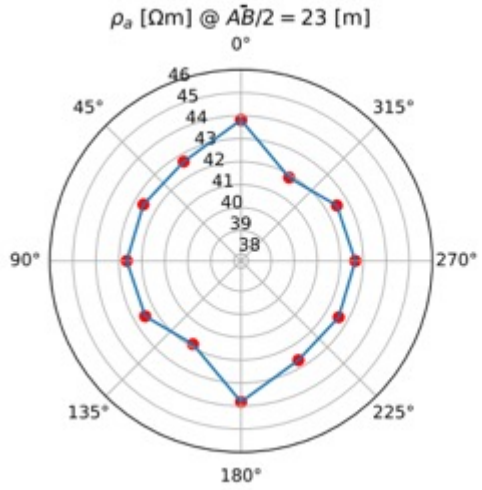


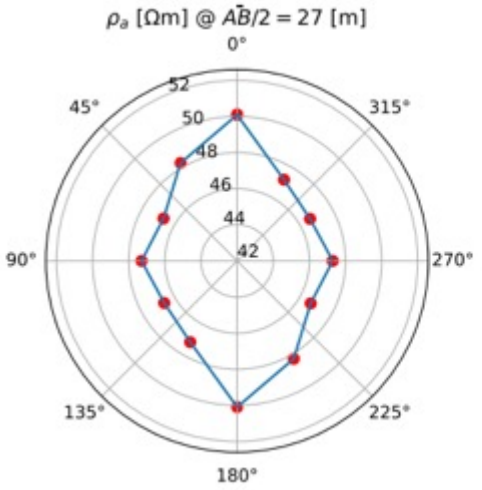


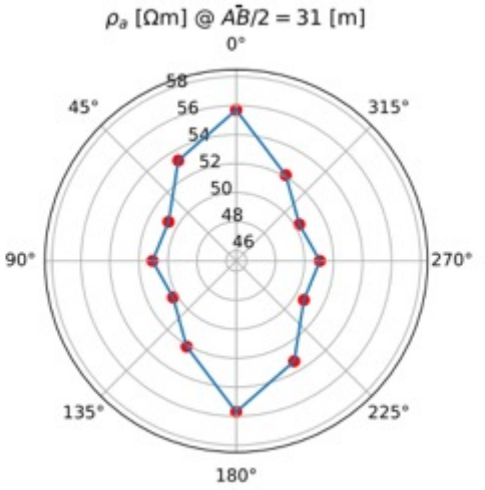


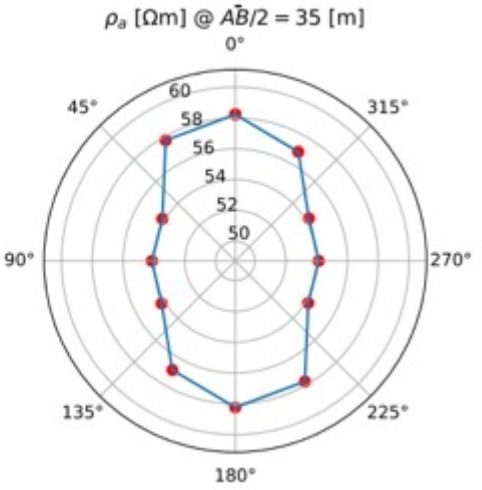


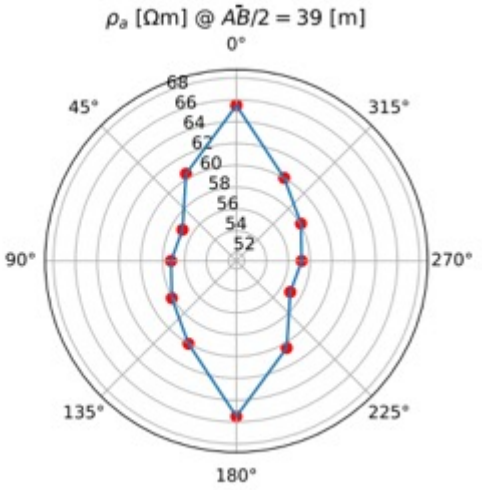












3D Deep ERT

What are we missing?

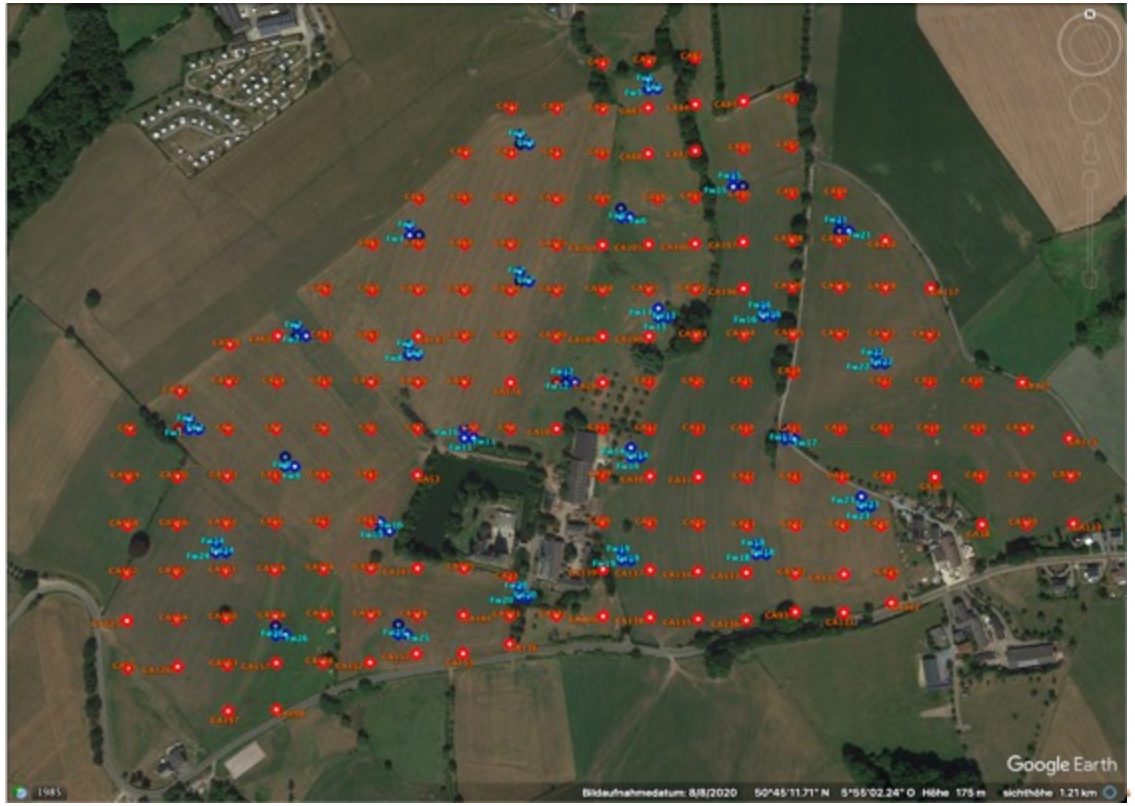
- Information at ET depth ~300 m

IRIS Fullwaver System

- Independent receiver spread across 800 m^2
- DC injection up to 3 A

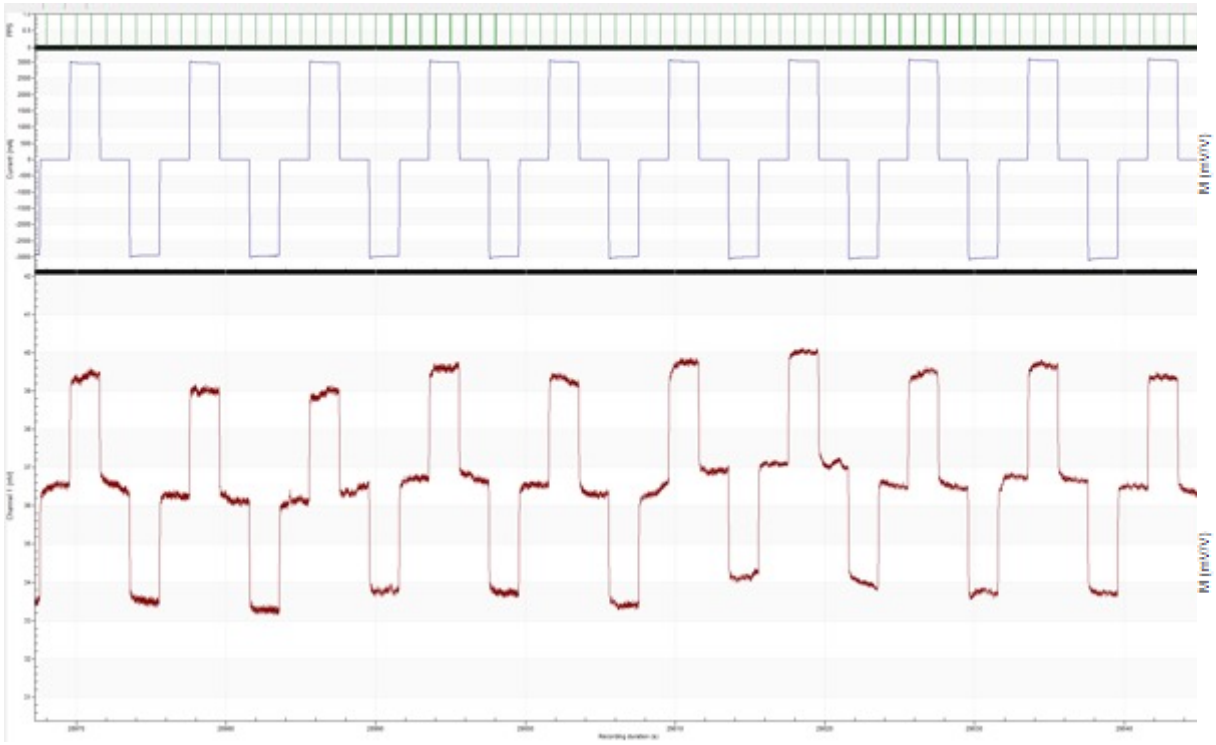
→ Large dipoles injecting to large depth

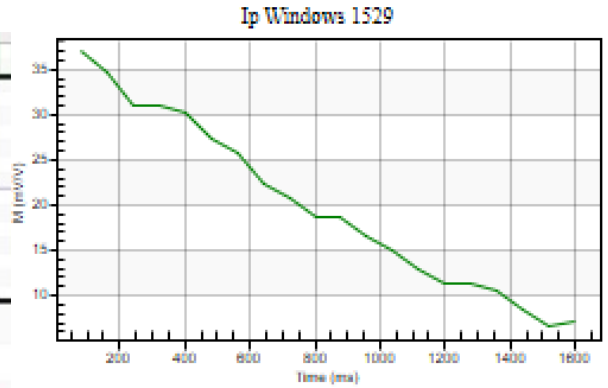
Deep ERT – Set up

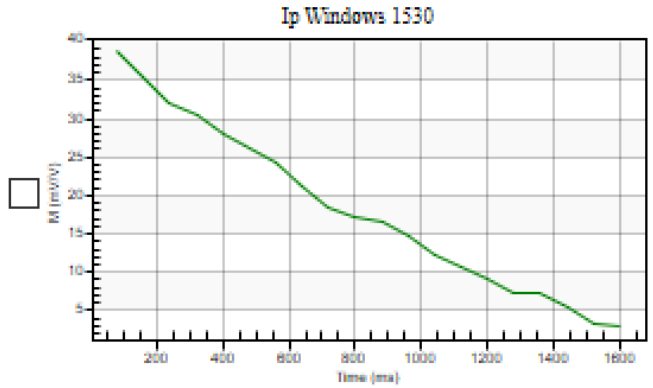


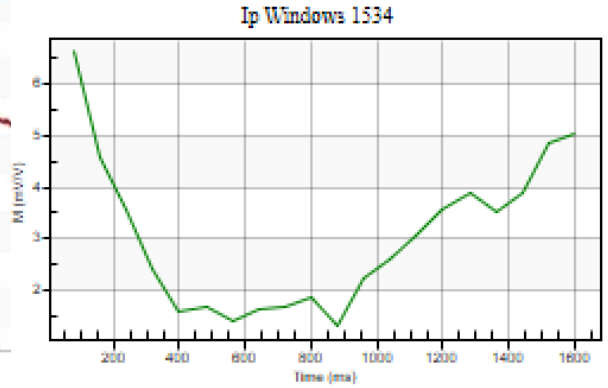
Source: IRIS Instruments

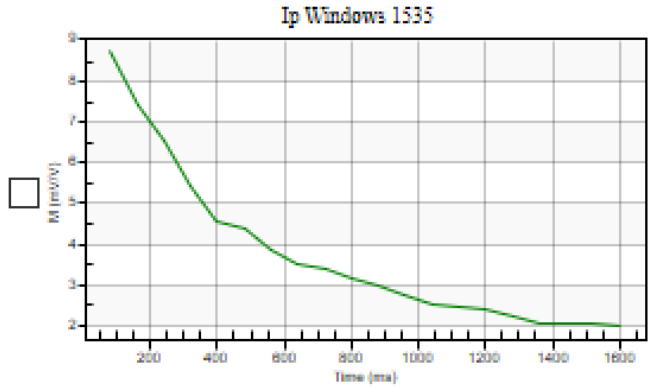
Deep ERT – Example data







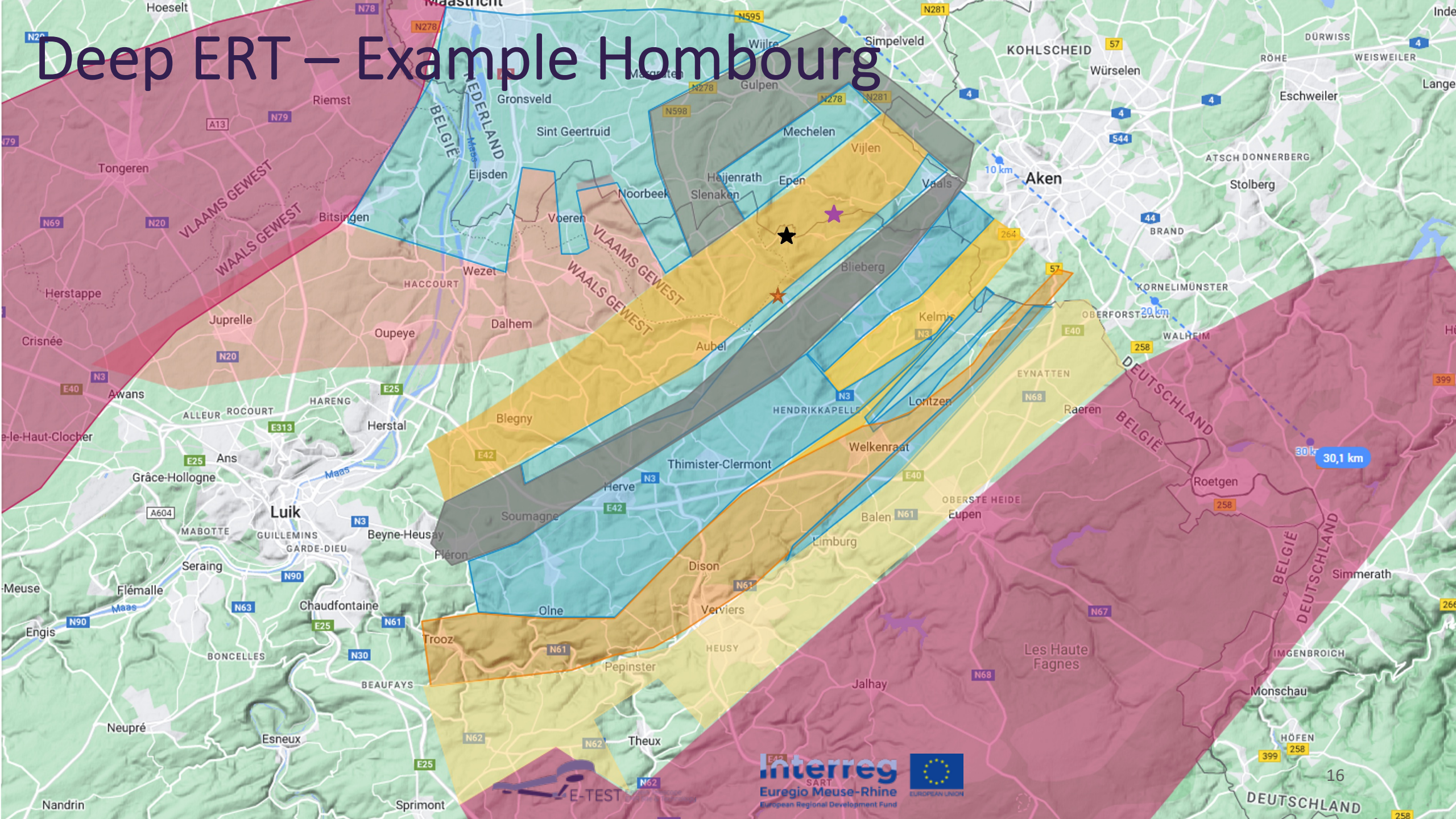




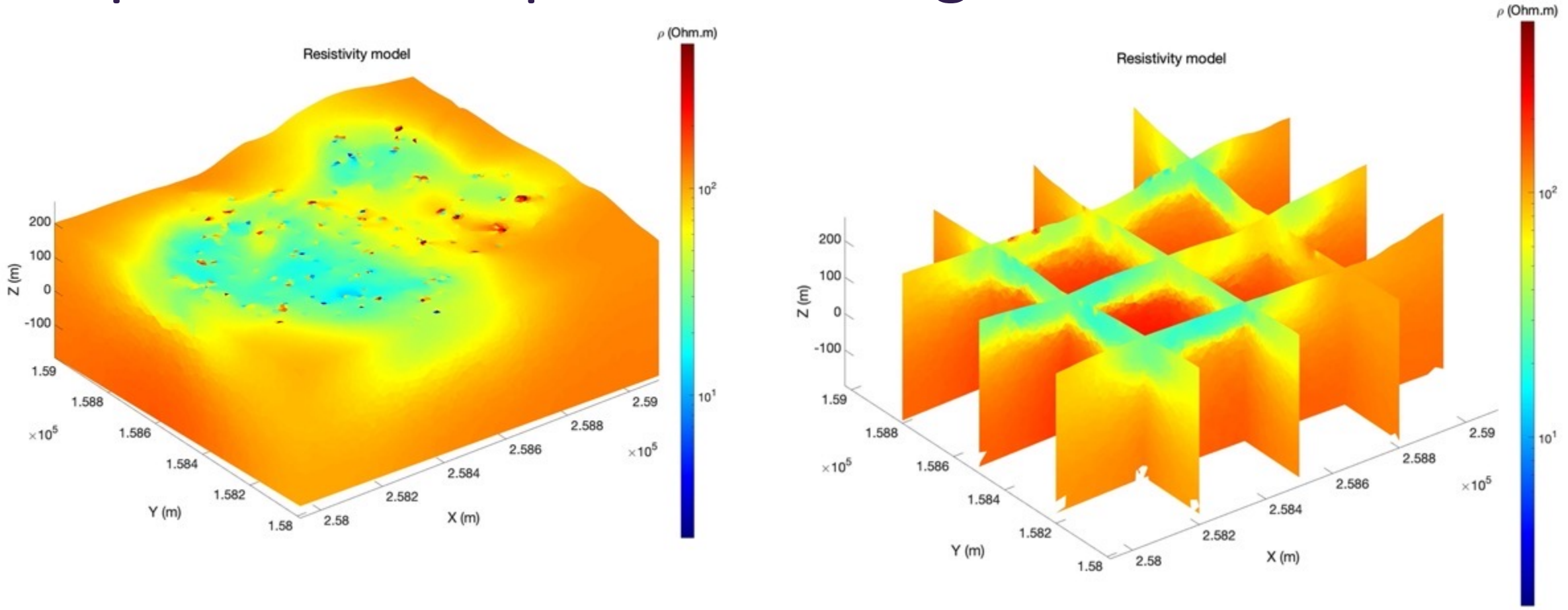
- Injected current signal
- Recorded Voltage signal

- IP decay curves

Deep ERT – Example Hombourg

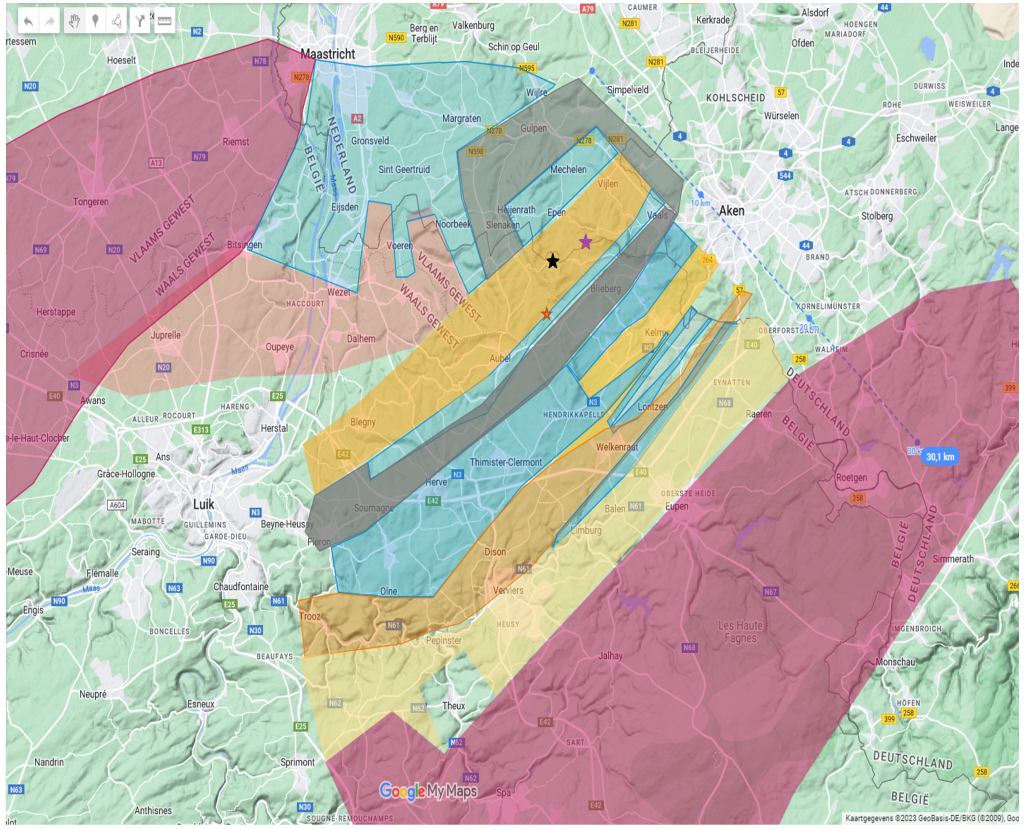


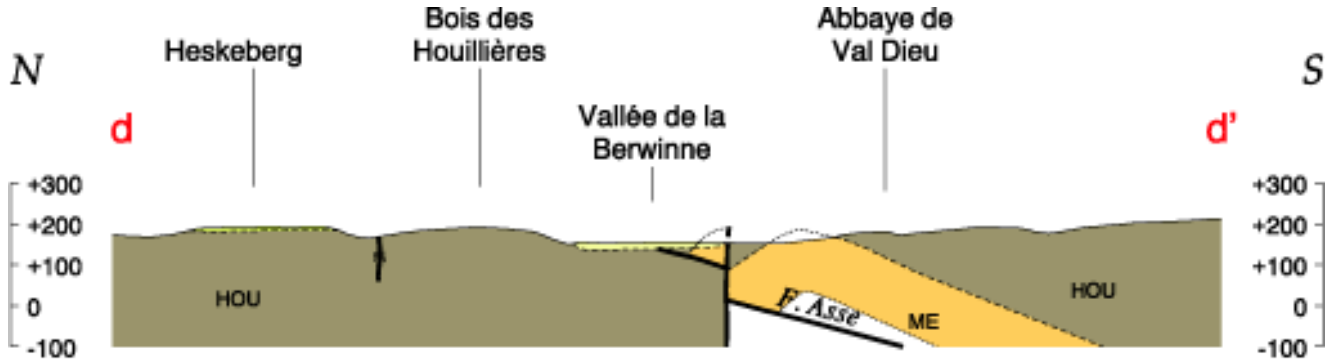
Deep ERT – Example Hombourg

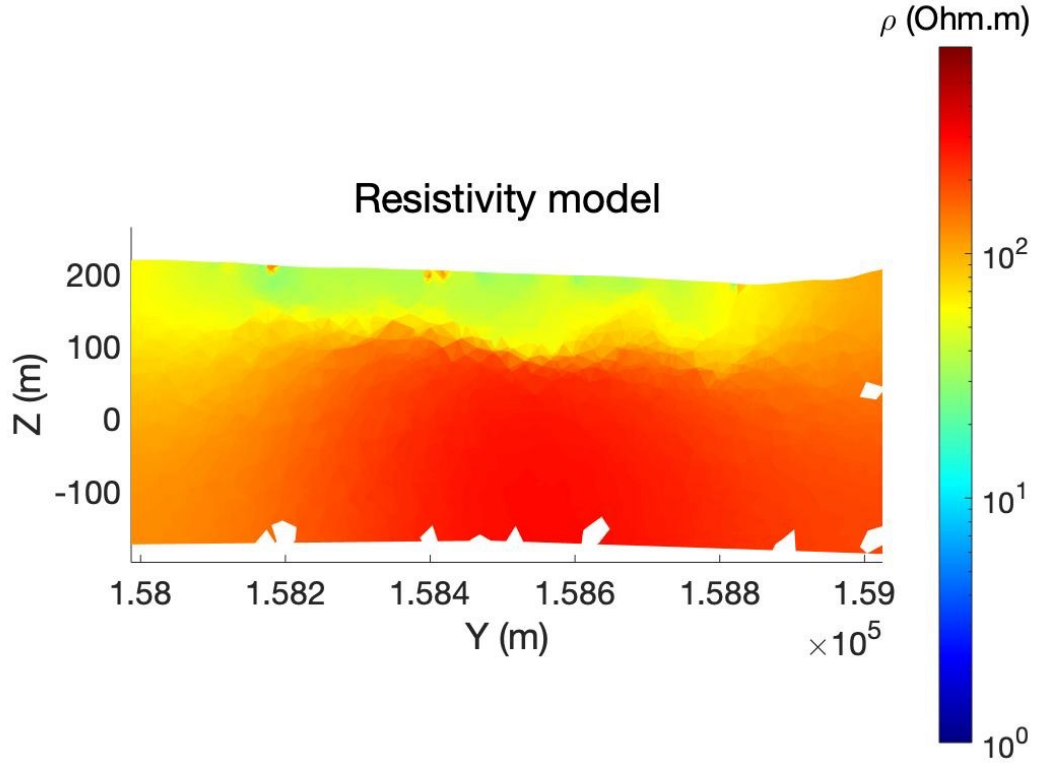


- Bedrock and dipping of layers observed
- No faults detected

Deep ERT – Example Hombourg







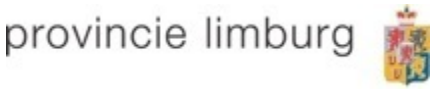
Challenges with deep ERT surveys

- Resolution / sensitivity is dependent on remote electrode position, receivers geometry and geology > requires adequate methodology to quantify it
- Long and time-consuming permitting process compared to “standard” survey
- High coordinative effort during conduction
- Ensuring survey safety is demanding

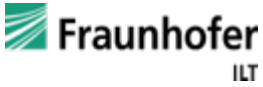
Conclusion

- Resistivity is an efficient proxy to map the Famenian, and other lithologies in the area
- Fault suspected at Beusdael within the BVD and characterized near surface
- Deep ERT survey for large scale deep electric characterization
- Cross-borehole ERT would provide higher resolution close to fault

E-TEST is co-funded by the Regions:



E-TEST is also co-funded by the own-fundings of all Partners:



E-TEST partners

NMWP.
The Innovation Engineers.

E-TEST Einstein Telescope EMR Site & Technology

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