# E-TEST in EMR: Hydrogeophysical characterization

E-TEST TEAM

E-TEST Einstein Telescope EMR Site & Technology

Interreg Euregio Meuse-Rhine European Regional Development Fund

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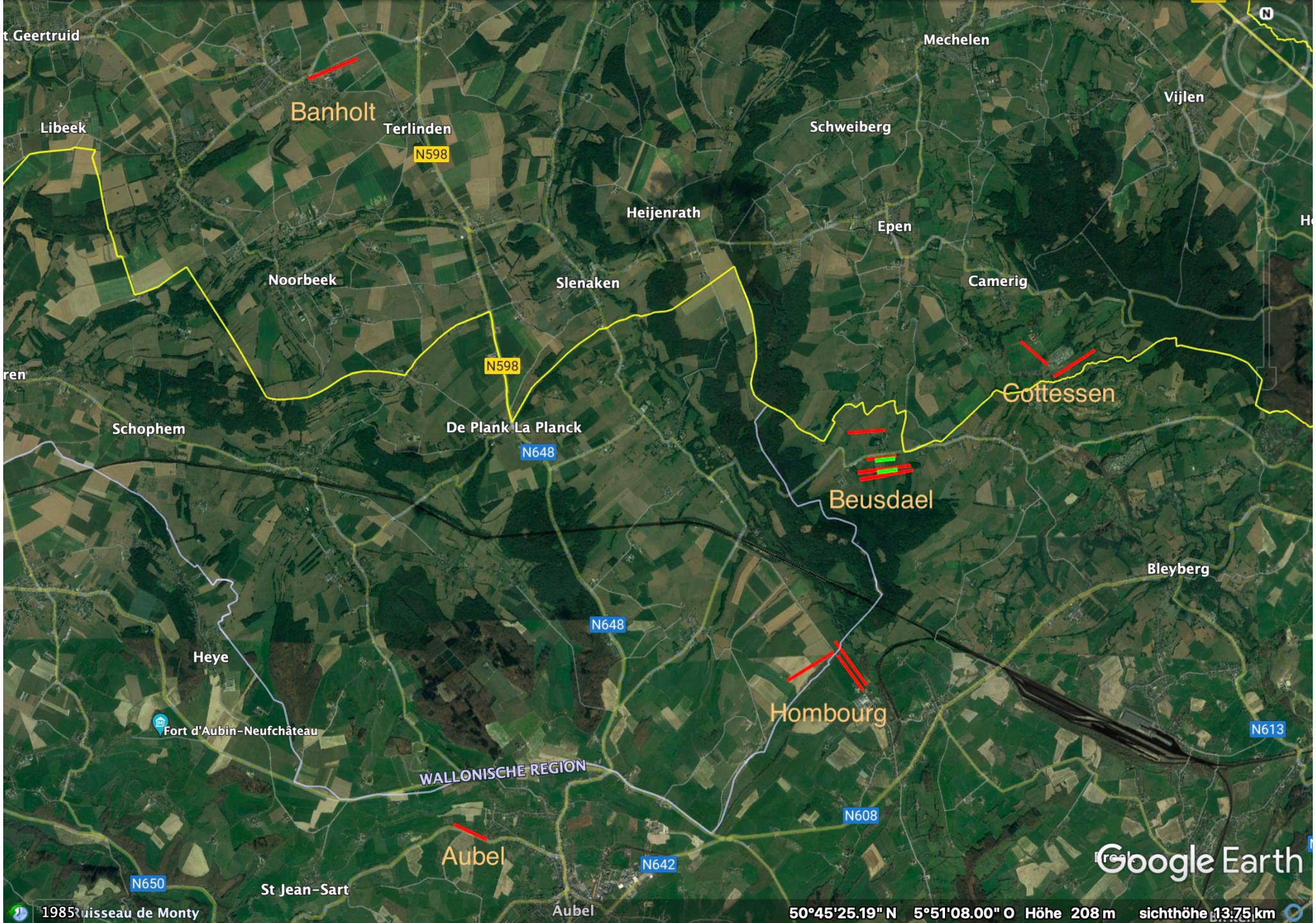
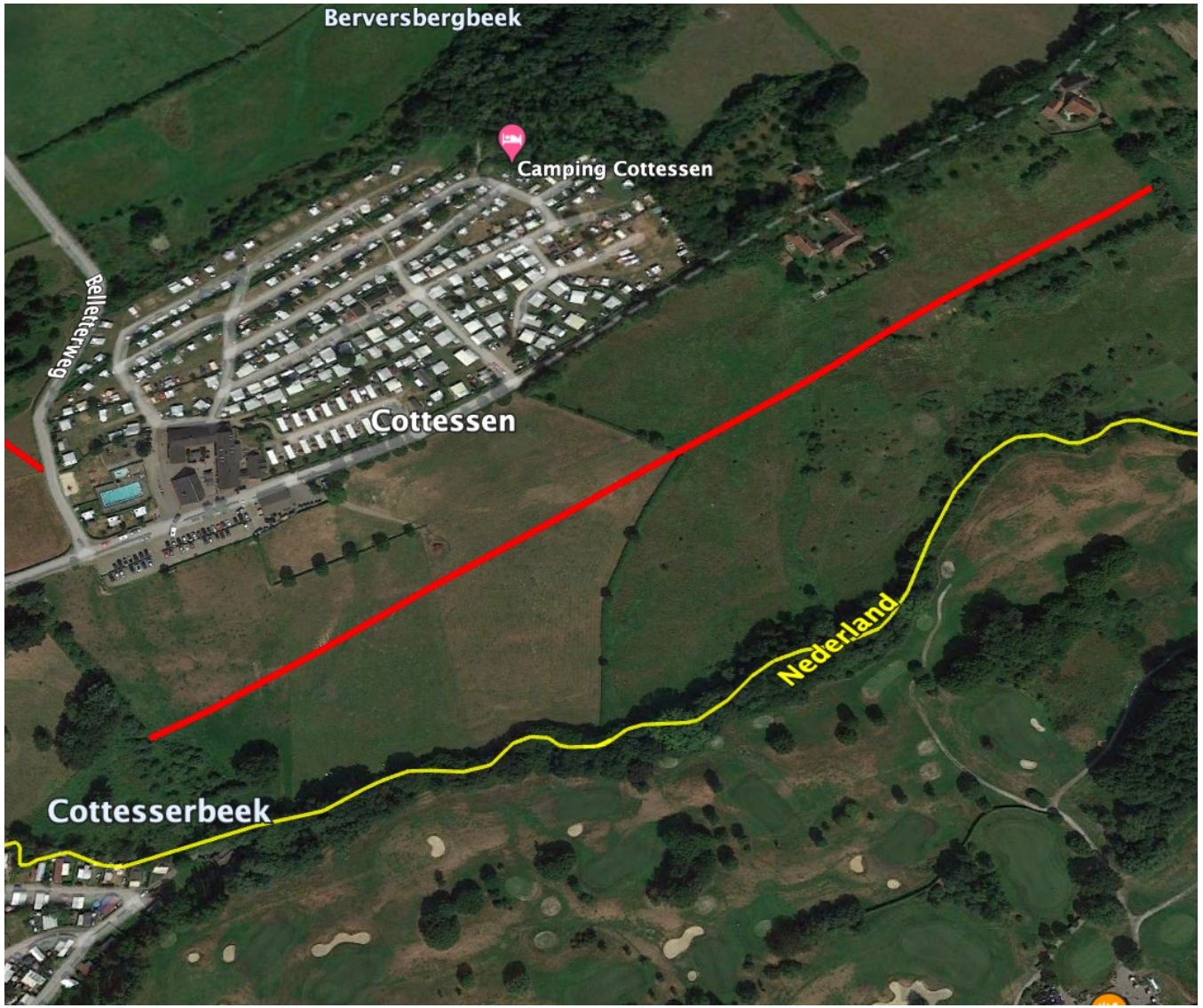
# Introduction

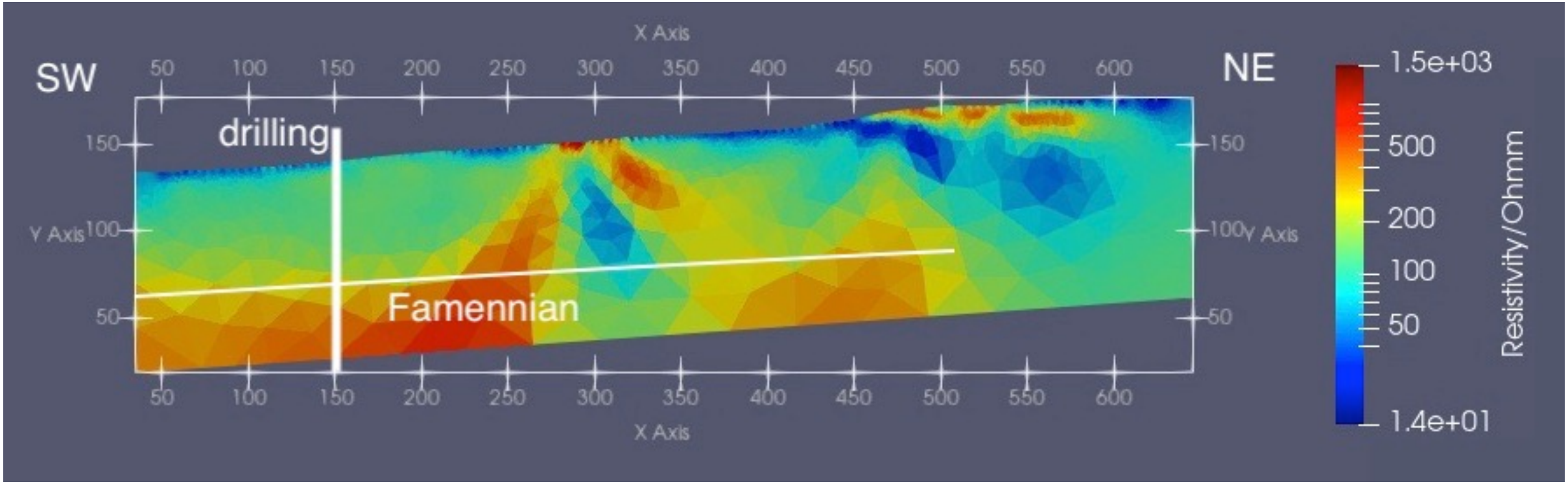
- Geological structure and hydrogeological behavior important for ET design
- Geoelectric surveys are performed with different target depths
- Combination of
  - 2D ERT profiles
  - 3D Deep ERT surveys
  - Cross-borehole measurements
- Laboratory measurements for calibration of inversion
- Inversion approach is developed to couple petrophysical models to the measured electrical parameters
- Need to account for realistic geological structure and lithology


Banholt
Terlinden
N598
Libeek
Mechelen
Vijlen
Schweiberg
Heijenrath
Epen
Noorbeek
Slenaken
Camerig
N598
Gottessen
Schophem
De Plank La Planck
N648
Beusdael
Bleyberg
N648
Heye
Hombourg
Fort d'Aubin-Neufchâteau
N613
WALLONISCHE REGION
N608
Aubel
N642
N650
St Jean-Sart
Aubel
Google Earth
1985 Ruisseau de Monty
50°45'25.19" N 5°51'08.00" O Höhe 208 m sichthöhe 13.75 km

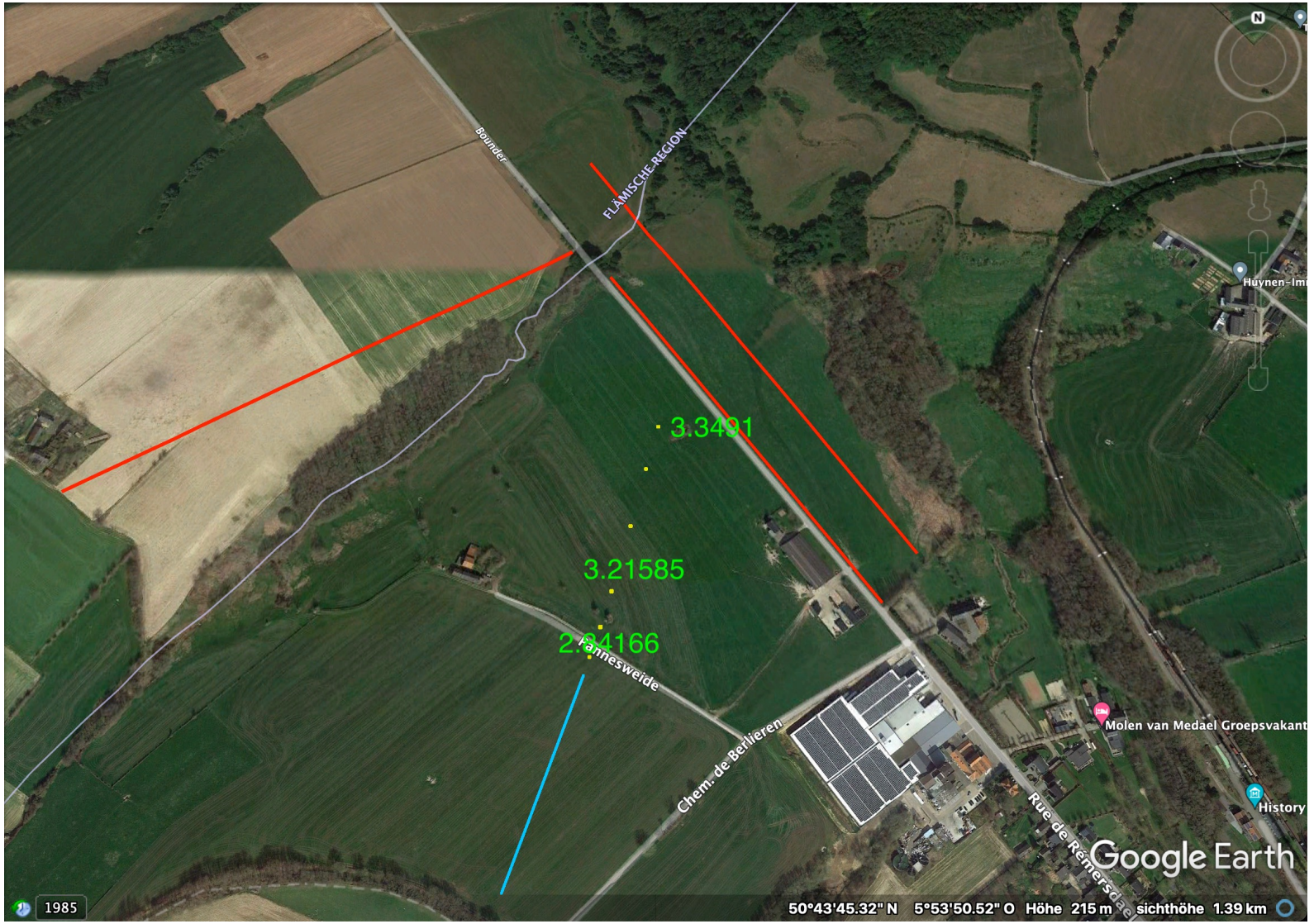
# Cottessen


Berversbergbeek
Camping Cottessen
Bellefterweg
Cottessen
Nederland
Cottesserbeek

# Survey Cottessen

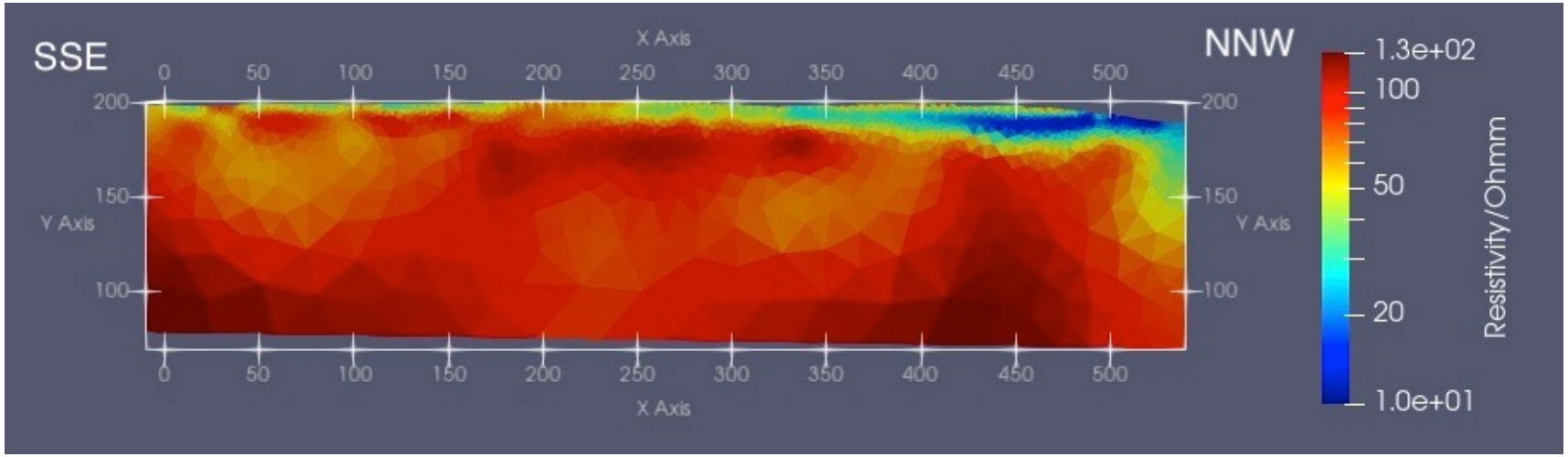


# Hombourg

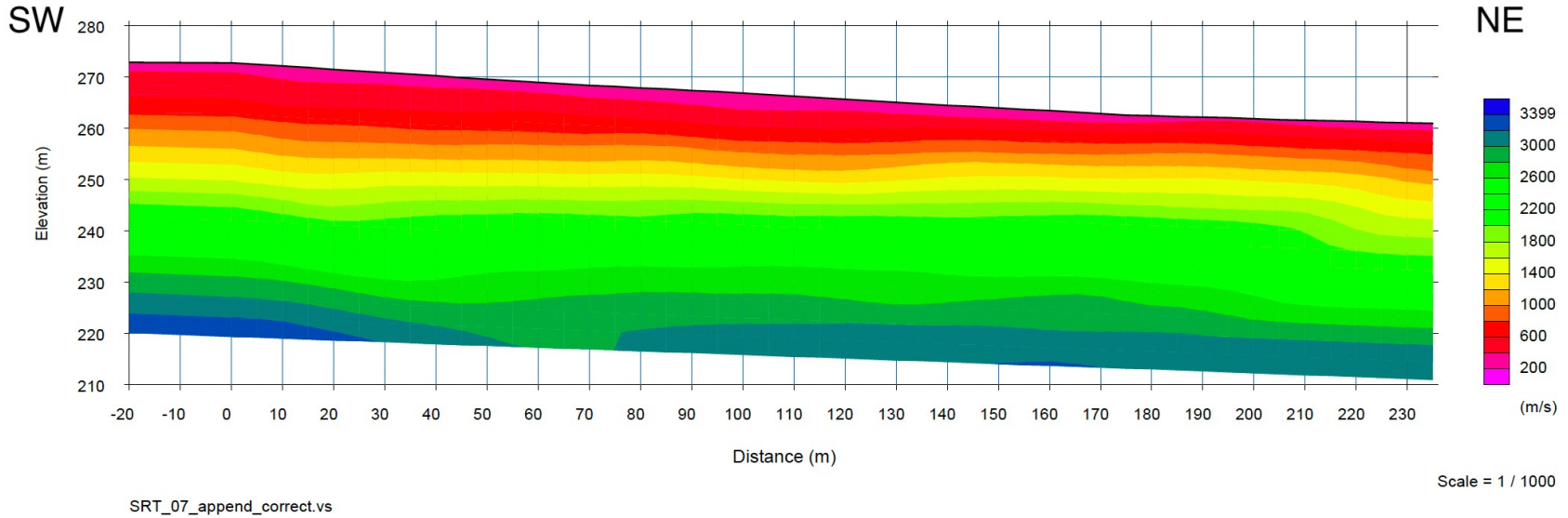

Rounder
FLÄMISCHE REGION
3.3491
3.21585
2.94166
Annesweide
Chem. de Berlieren
Molen van Medael Groepsvakant
History
Rue de Rémersdael
Google Earth
1985
50°43'45.32" N 5°53'50.52" O Höhe 215 m sichthöhe 1.39 km

# Survey Hombourg

**ERT**



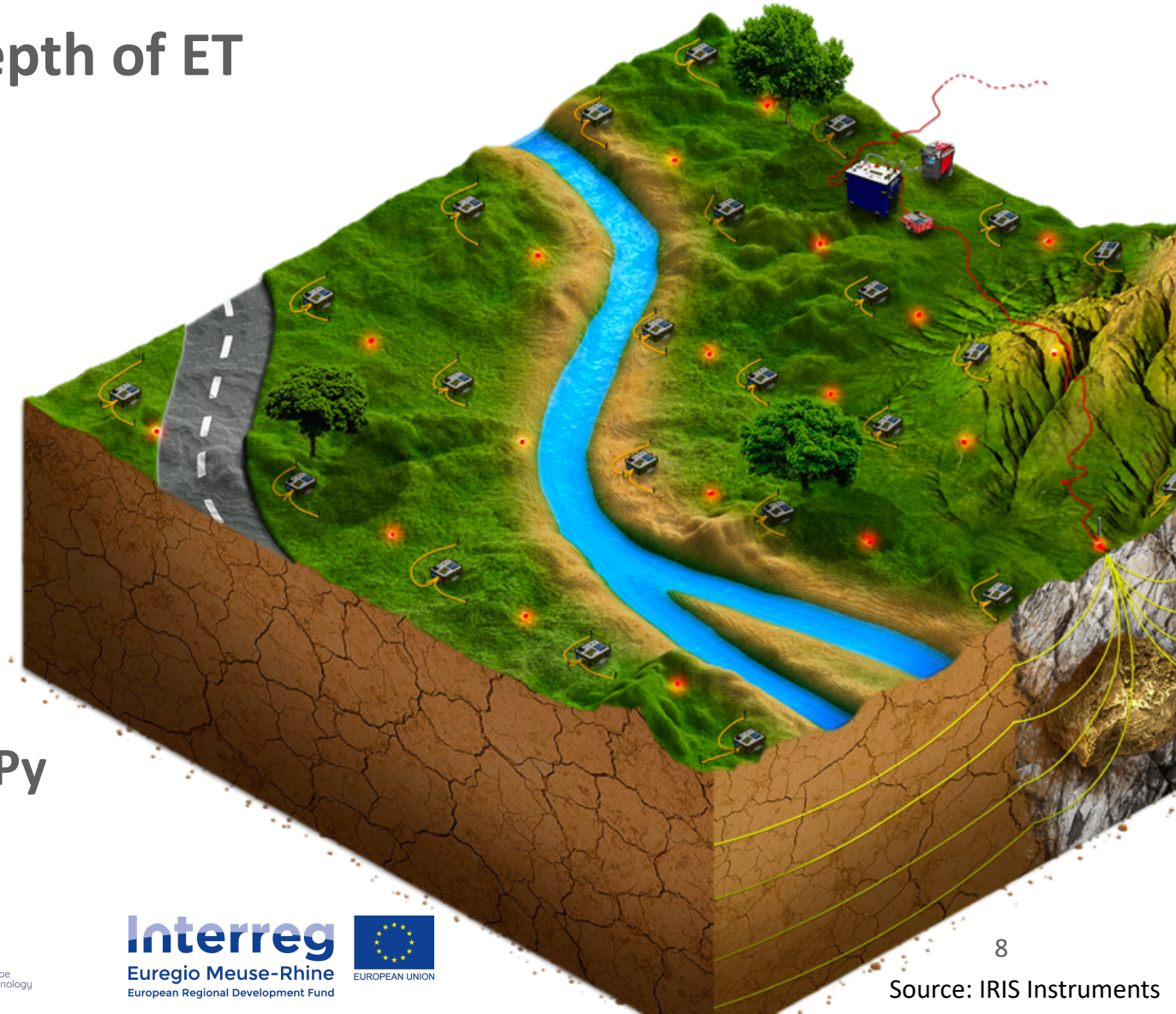

**SRT**



# Deep ERT

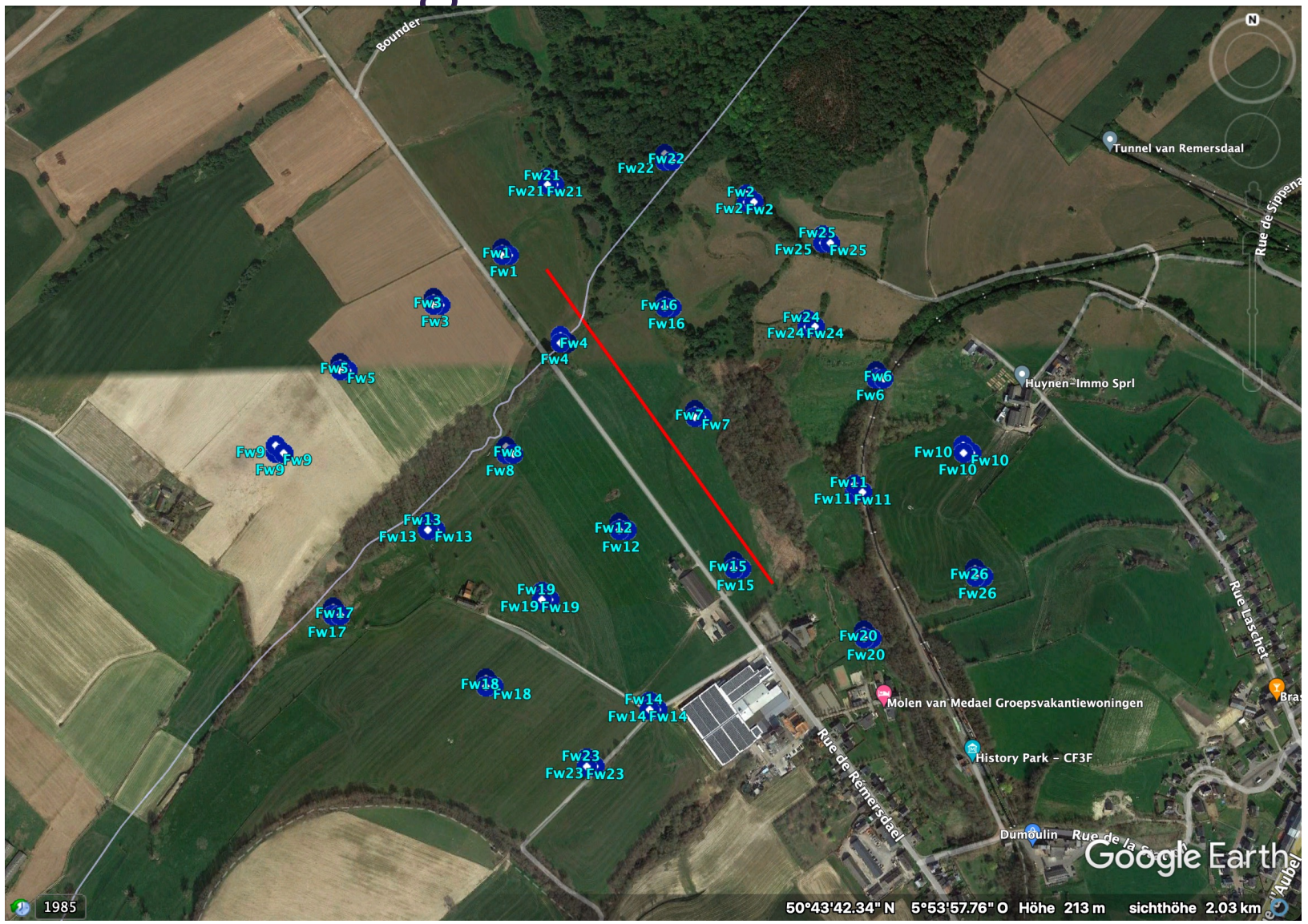
- **Gaining information from target depth of ET**
  - Corner points
  - Along seismic lines

- **Survey design is model dependent**
  - Constraints on remote electrode
  - Account geological uncertainty
  - ➢ **Integrate forward modelling to GemPy**

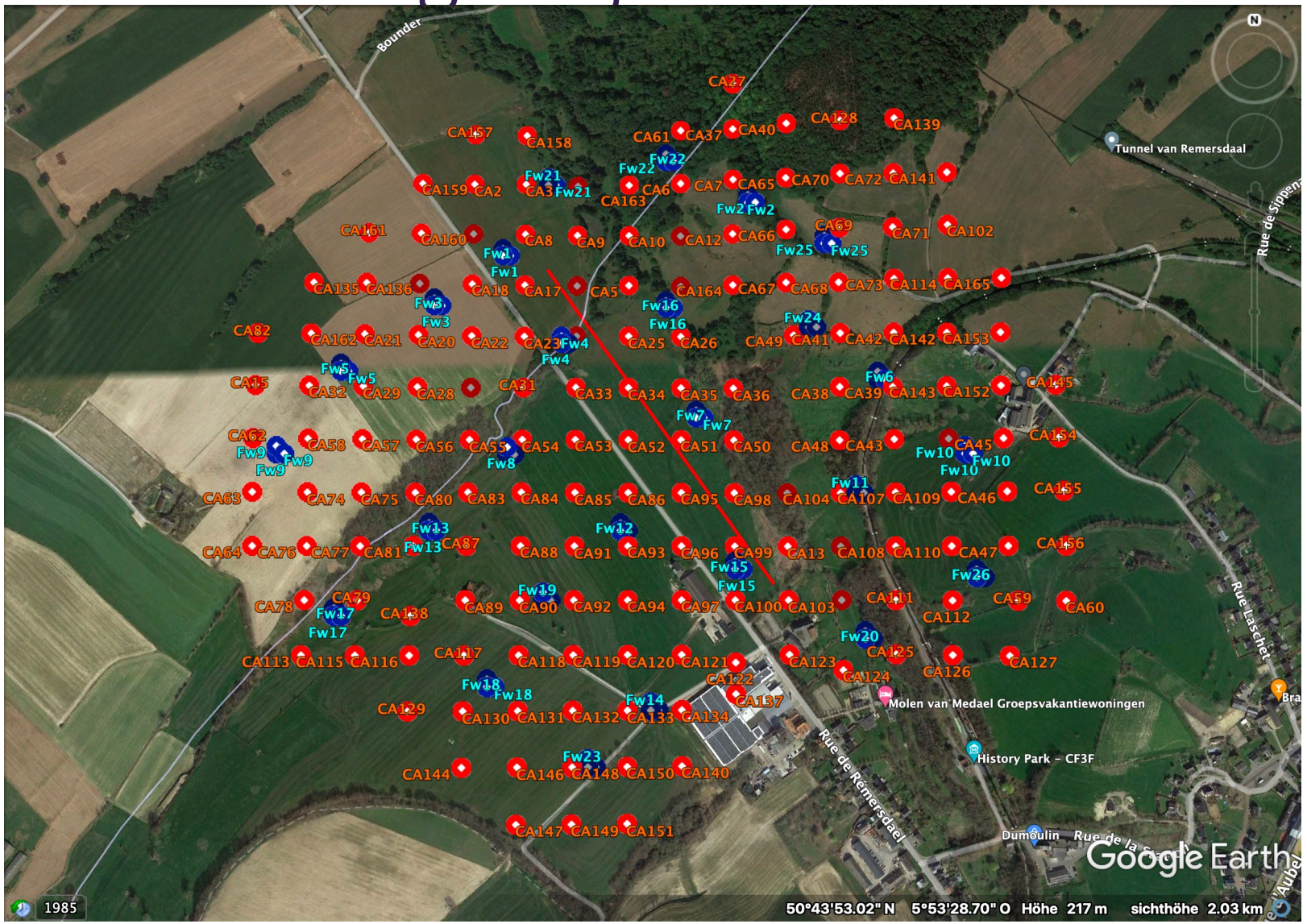


Source: IRIS Instruments

# Deep ERT Hombourg - Receiver



# Deep ERT Homborug - Injections



# Cross-borehole measurement setup

- Sensors in boreholes for improved spatial resolution at depth

- Synthetic studies for optimization of measurement scheme

- Imaging of conduction and polarization properties for improved hydrogeophysical characterization

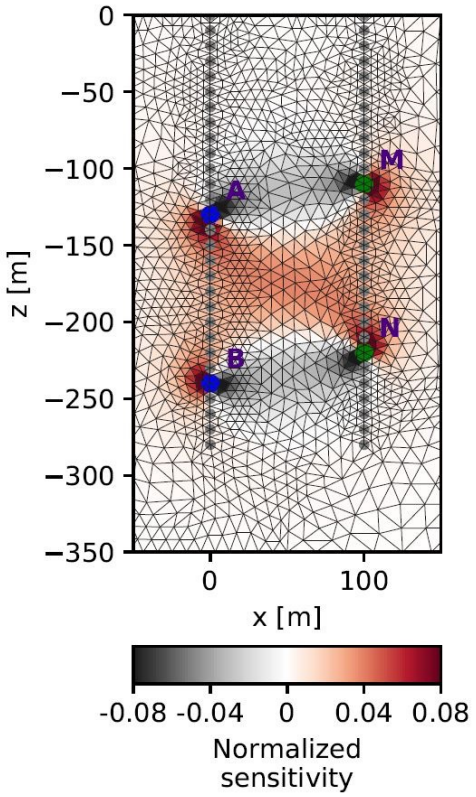



Fig. Above: Synthetic sensitivity study

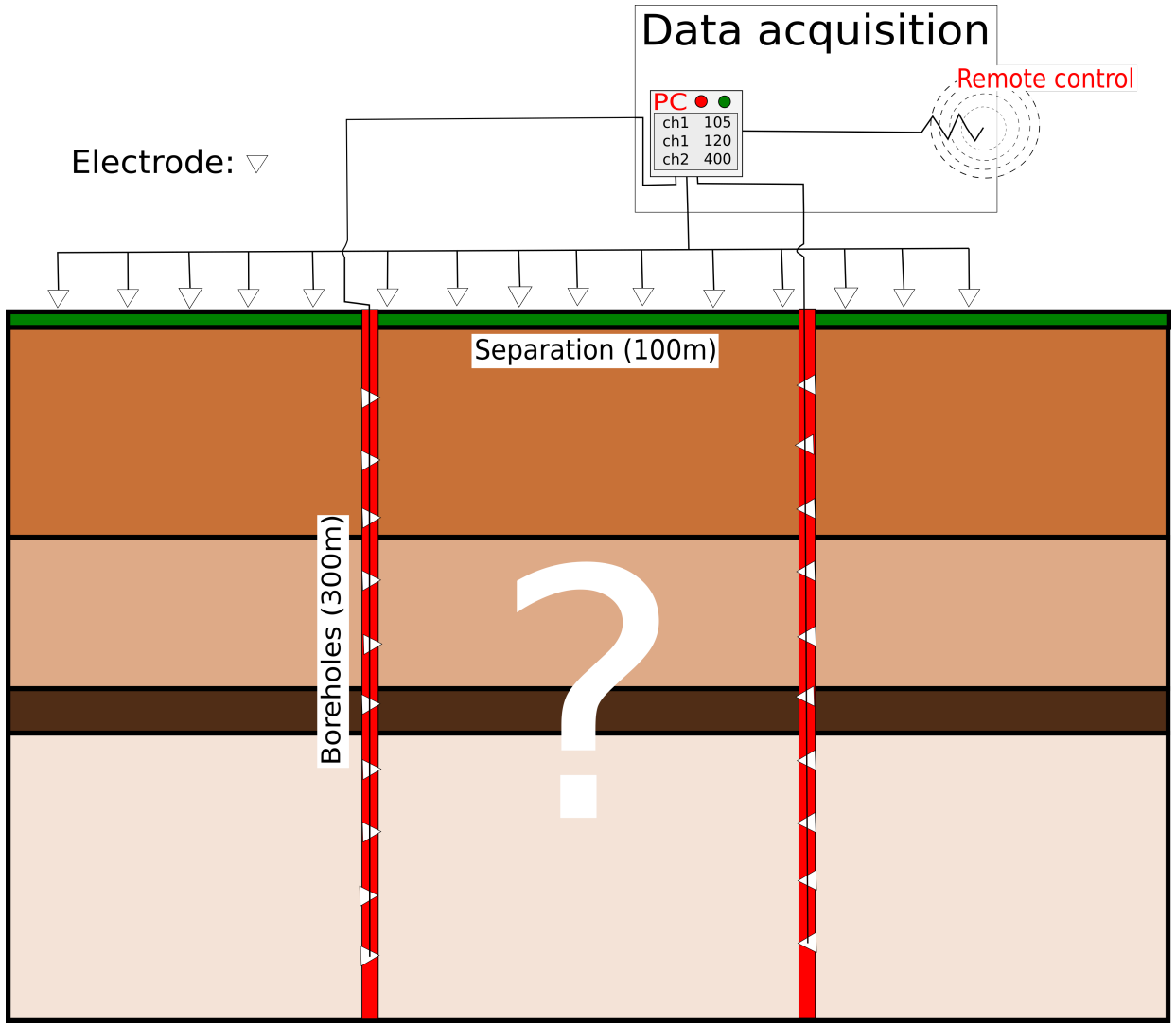



Fig. Right: Sketch of the planed measurement setup

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# Geoelectric Frequency -domain IP measurements

- The frequency dependent complex resistivity of relevant rock formations was measured in the laboratory.

- Measurements of porosity and permeability are supplemented with measurements of the inner surface area (BET) and a geochemical characterisation (XRF).

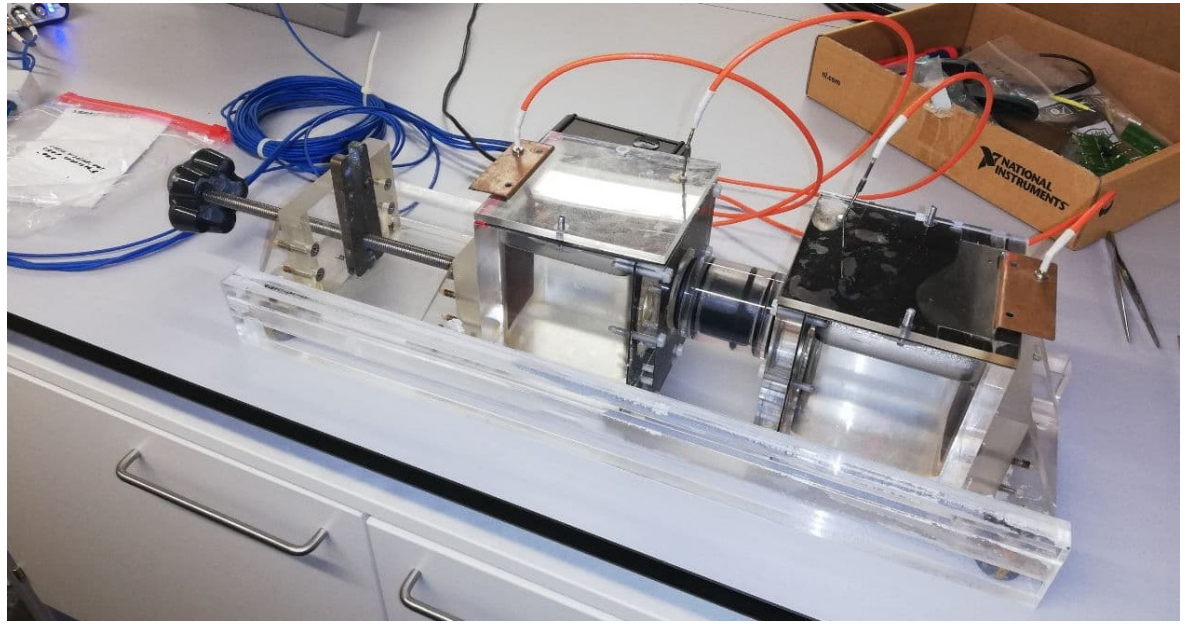

Fig. Above: 3x3 cm probes of Westphalian Sandstone

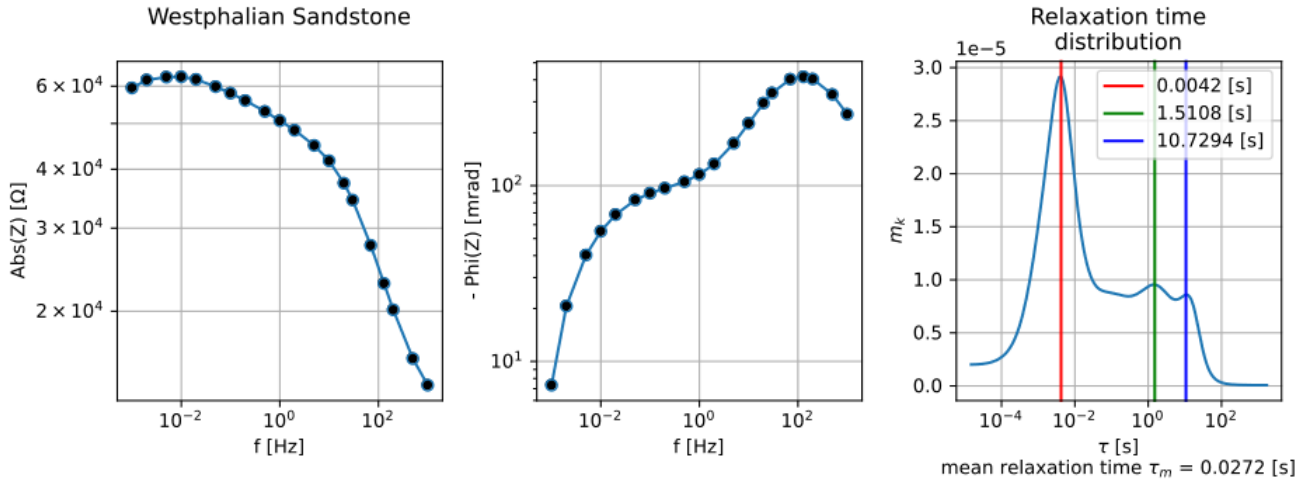


Fig. Above: Spectral Indoced Polarization measurement device

Fig. Left: Measured spectrum and characterization of the relaxation behaviour

# Preparation for cross-borehole ERT/IP

Development of an inversion approach to extract spectral IP-properties from Time-domain IP field measurements and make a quantification of the textural and hydraulic rock properties possible.

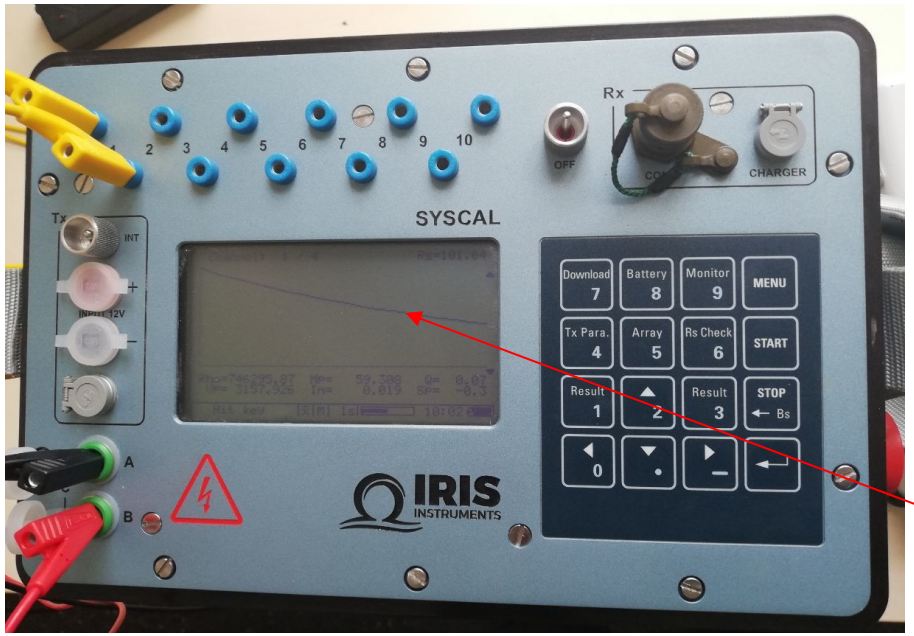


Fig: TDIP measurement with the Syscal

IP-data processing

Measured TDIP transient

permeability, porosity, inner surface

Tomographic inversion

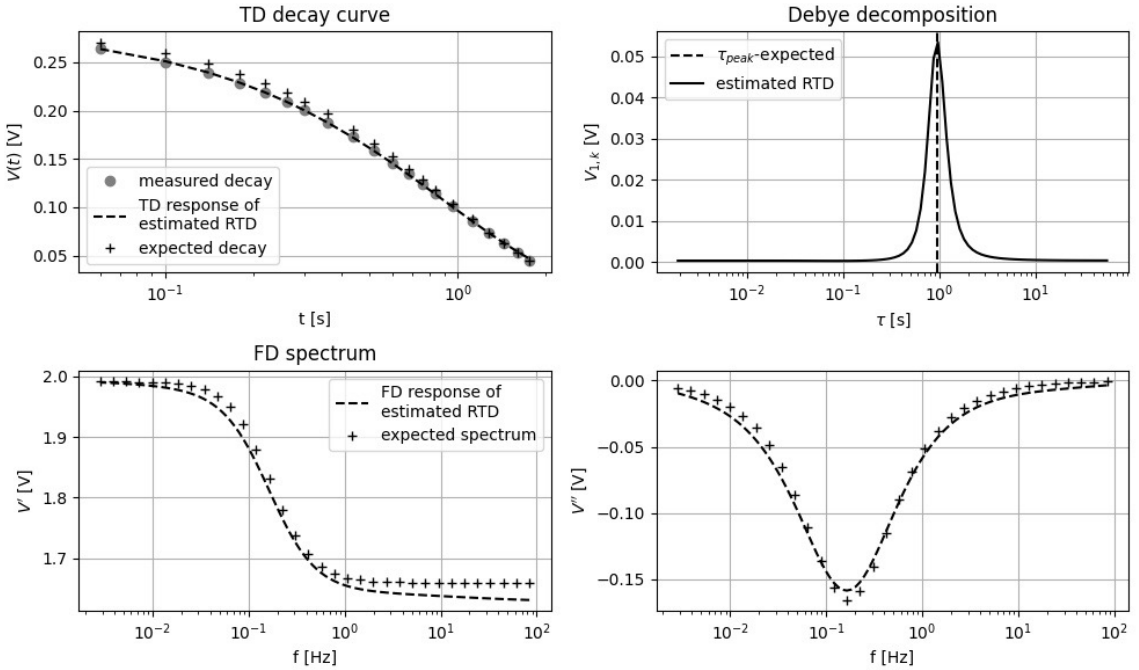


Fig: TD-FD conversion using Debye decomposition (example for known test circuit)

# E-TEST in EMR: Active and passive seismic surveys

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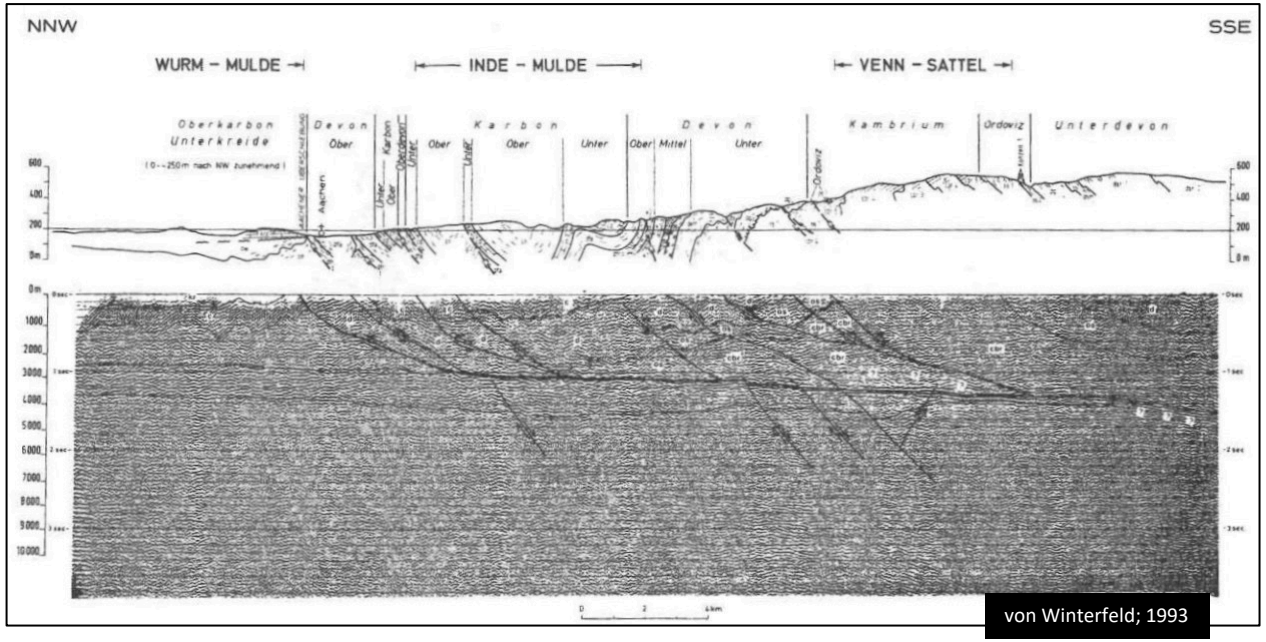
# Why use seismic investigations & how it is done

- **2D or 3D information on subsurface**
  - Rock layering
  - Structures in the subsurface
- **Active seismic campaign**
  - 2D lines
  - Using vibro-seis trucks
- **Passive seismic campaign**
  - Battery-driven geophones



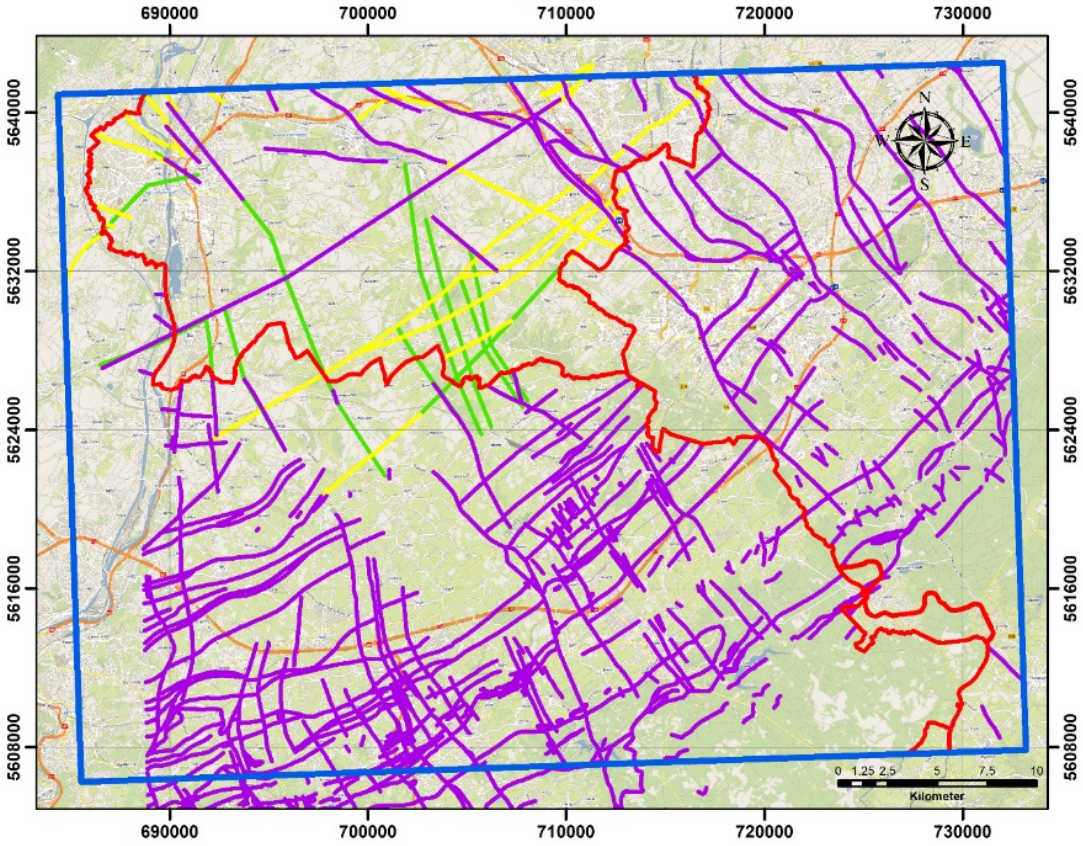
von Winterfeld; 1993

© Bjorn Vink


dmt-group.com

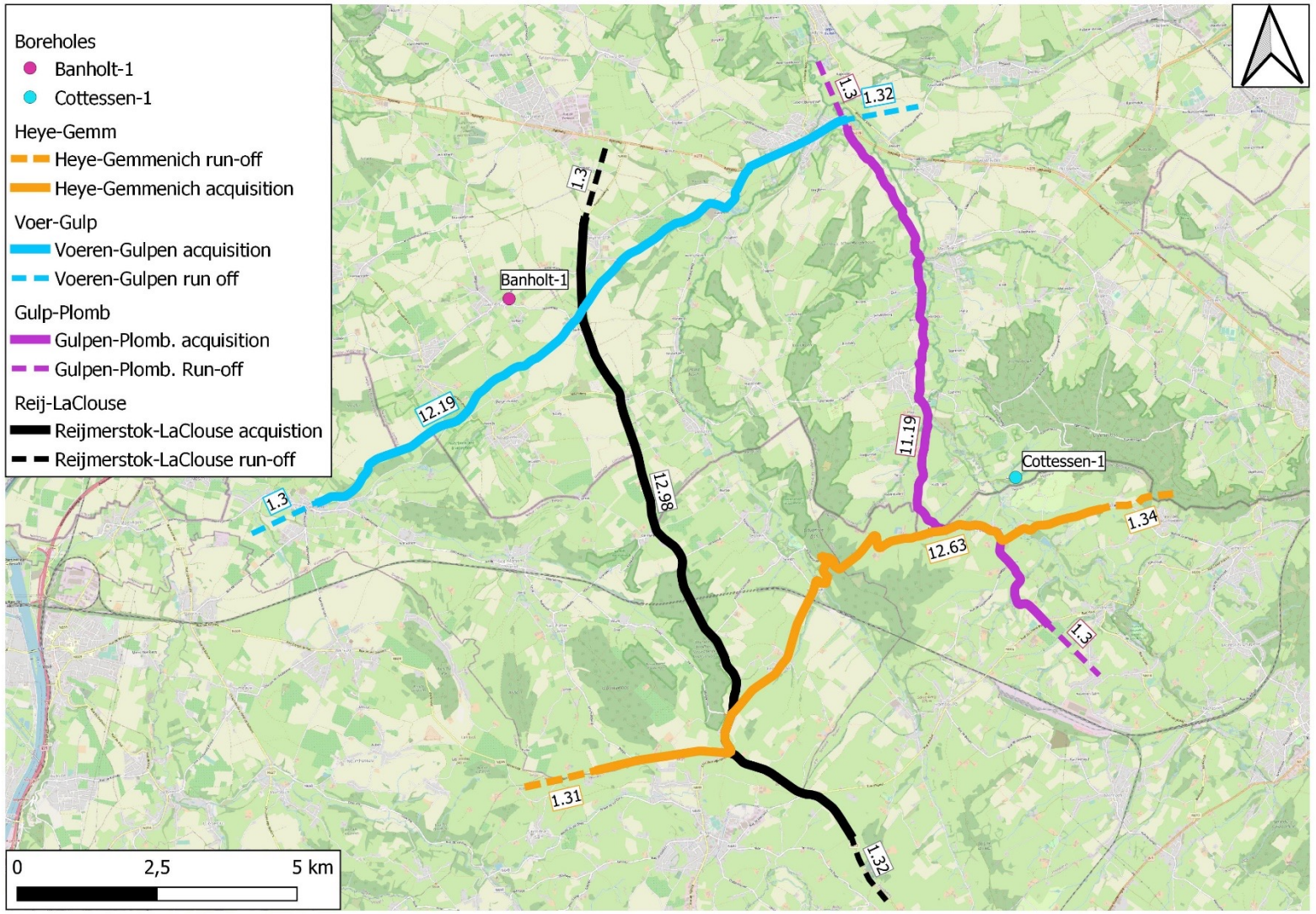
# Active and passive seismic investigations

- **2D Active seismic survey**
  - Lines in high angle to existing geological structures
  - Follow existing infrastructure
- **Passive seismic campaigns**
  - Clusters of geophones in an area
  - Geophones record for ca. 2 months
  - Use of any passive input signal
    - Earthquakes in the Eifel mountains
    - Traffic, windmills, etc.



# 2D Seismic Survey – Planned acquisition geometry

- Each line at least 10 km
- Run-off at ends of each line to achieve a half-fold at the end
- 2D seismic lines



# Status & challenges of active seismic survey

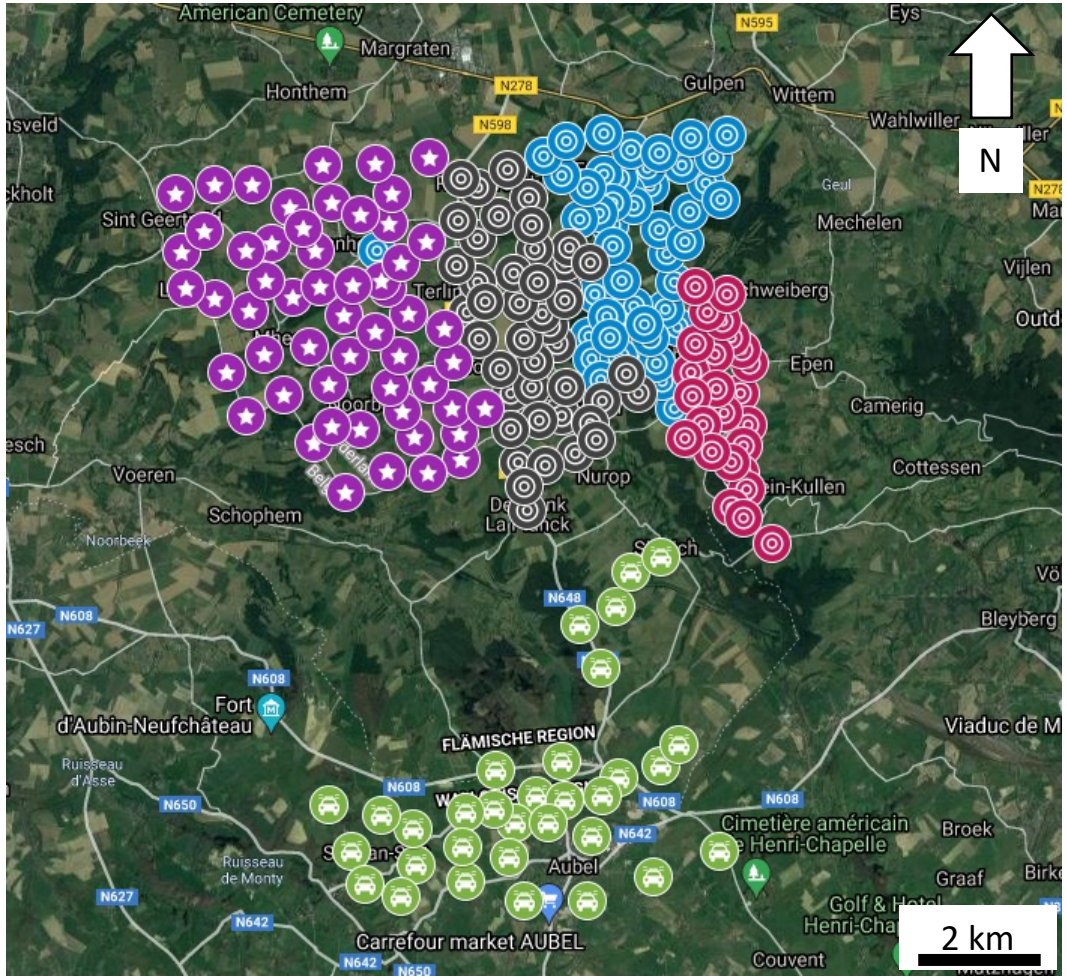
- **Status**
  - Tender is published and currently open
  - Permitting phase started
    - Contact with local authorities
    - Check for environmental requirements and UXOs
- **Challenges**
  - Meeting requirements in 3 regions
  - Potential loss of signal due to strong impedance contrast between Cretaceous soft-rock and Paleozoic hard-rock
  - Finding time slot that is in accordance to natural protection of animals

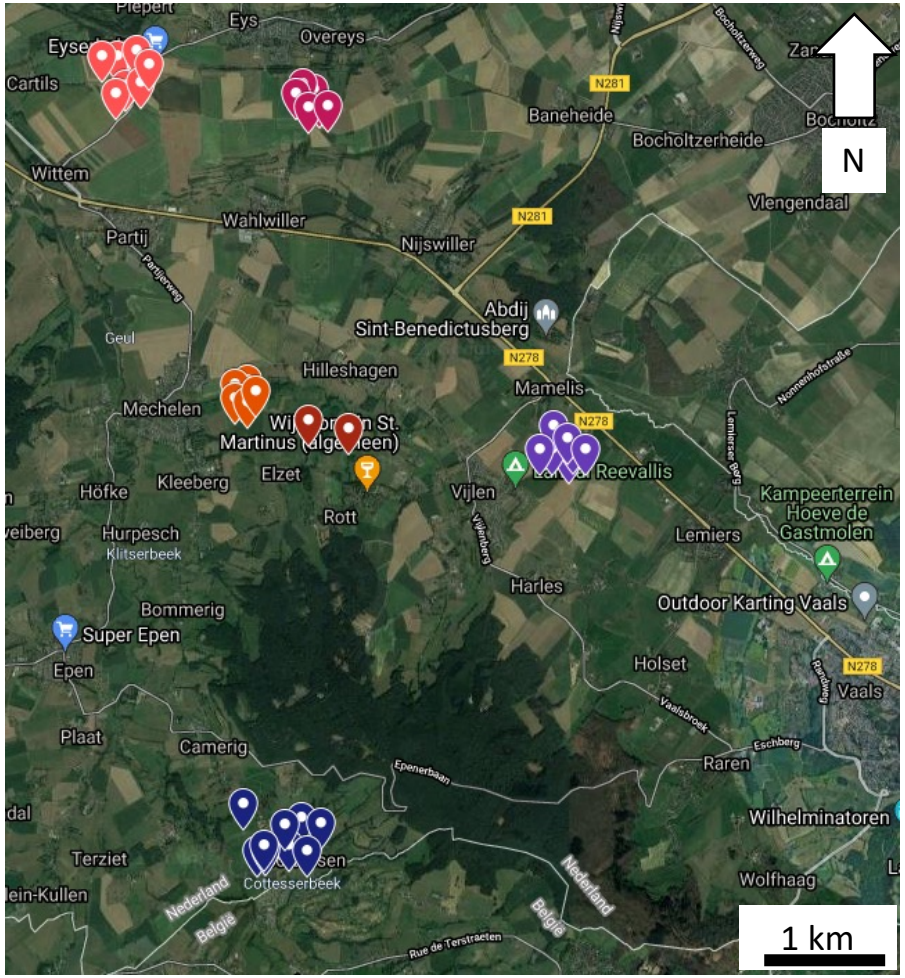
# Forecast of active seismic survey

- **S2 2021**
  - Closing Tender and awarding of tender to successful bidder
- **S1 2022**
  - Acquiring seismic data by contractor
  - Processing of seismic data by contractor (depends on data acquisition)
- **S2 2022**
  - Processing of seismic data by contractor (if still required)
  - Data analysis and interpretation of seismic data
  - Integration with further data sets (e.g. boreholes, near-surface geophysics) for data analysis
- **S1 2023**
  - Reporting

# Passive Seismic Campaigns

- Passive sensors placed as clusters in the field to cover different areas



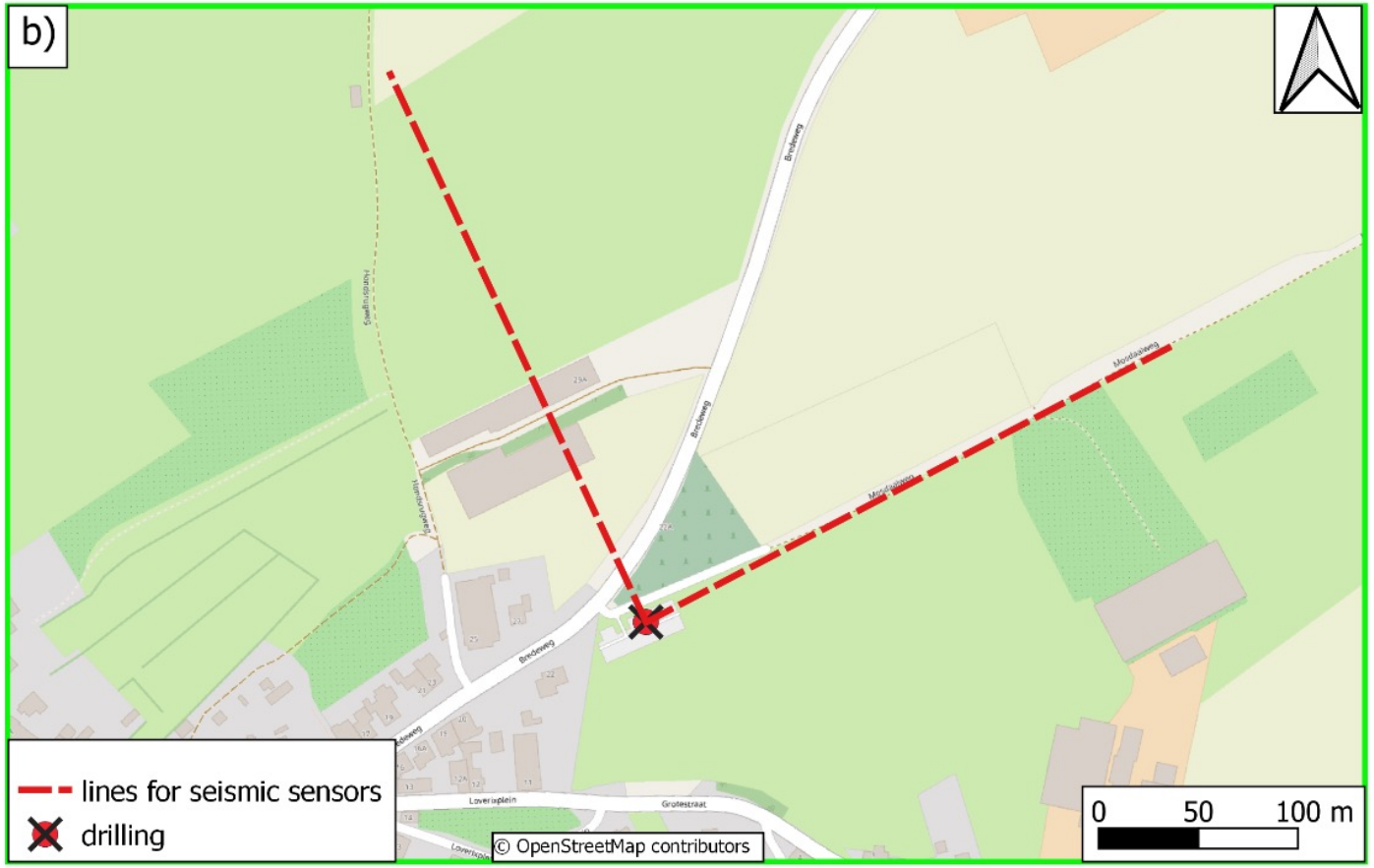



# Passive Seismic Campaign during Active Seismic

- Passive sensors placed around active lines
- Gain subsurface information around and in between active seismic lines

# Passive Seismic Campaign during drilling

- Passive sensors placed around drill sites (Banholt and Cottessen)
- L-shaped geometry of passive seismic sensors
- Several sensors along a line
- One sensor attached to drill rig to measure signal of drill rig



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Vlaanderen is ondernemen

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