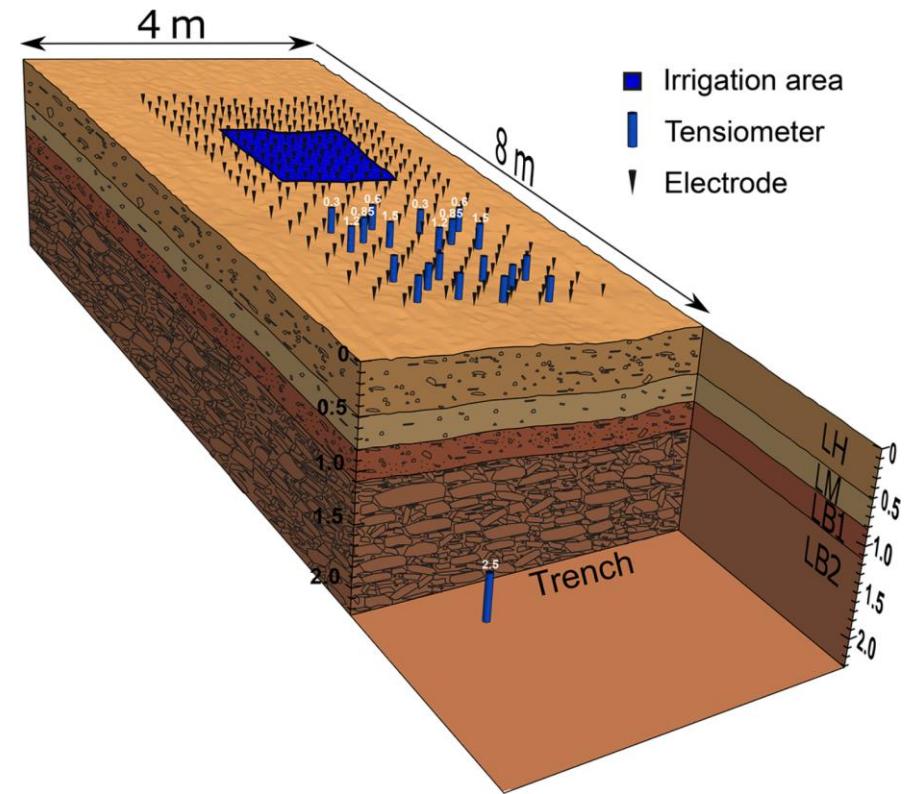


Near Surface Geophysical methods for site characterization

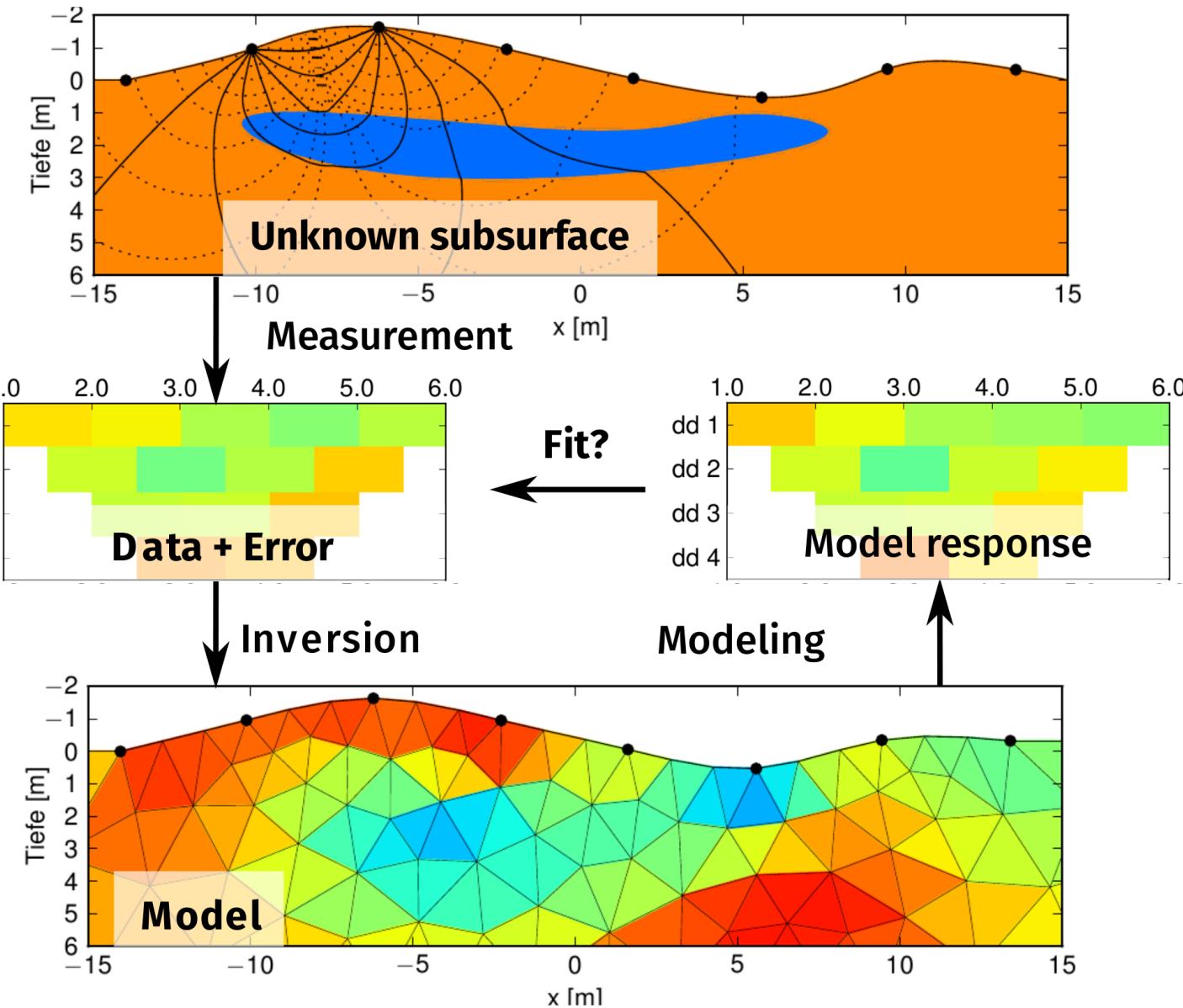
5. ERT: cases, 3D, monitoring, IP

- Summary of geophysical inversion
- 3D magnetics inversion example
- A recent ERT case study from Borkum
- 3D ERT layouts
- Geophysical monitoring (example ERT)
- Induced polarization



Geophysical Inversion: a complication task!

- 1 Data acquisition
- 2 Preprocessing (quality check and filtering)
- 3 Parameterization (i.e., mesh generation)
- 4 Inversion
- 5 Evaluate fit between measured & simulated data
- 6 Postprocessing & visualization of final model(s)
- 7 Interpretation



What did we learn of inversion?

- Least-square minimization of objective function
- Different models (geometry, mesh) & dimensions (0-3)
- Inherent ambiguity in imaging process
Different subsurface models can fit the data
- General rule: Occams razor (*„Don't overcomplicate“*)
Fitting the data to degree of errors
- Have a look at your data misfit: uncorrelated Gaussian distribution
- Often (2D, 3D) only smoothness-constrained inversion possible
„Find smoothest model that can fit our data“ (info on resolution)
- External information (borehole, other methods) reduces ambiguity

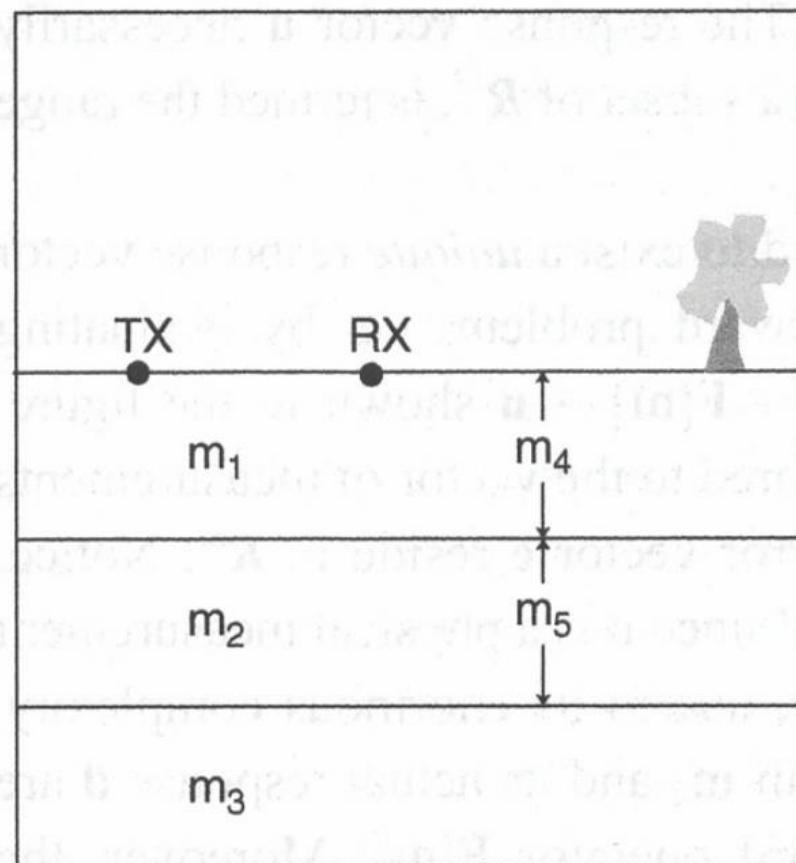
Inversion: Model types and dimensions

1D: soundings, refraction

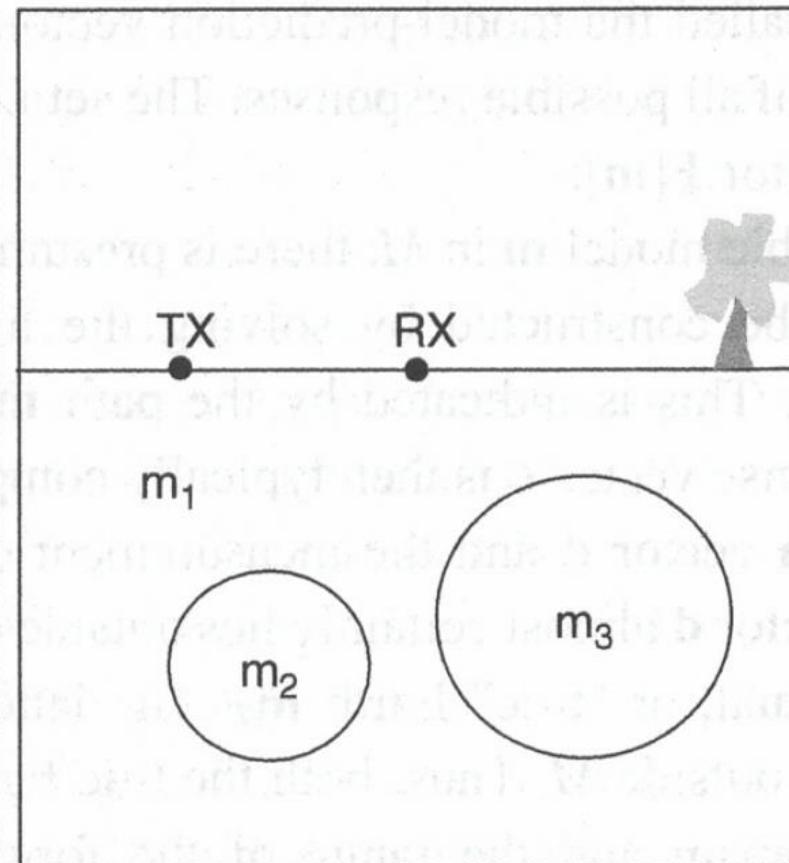
0D: gravity, magnetics

2D,3D: ERT, seismics, EM, grav/mag

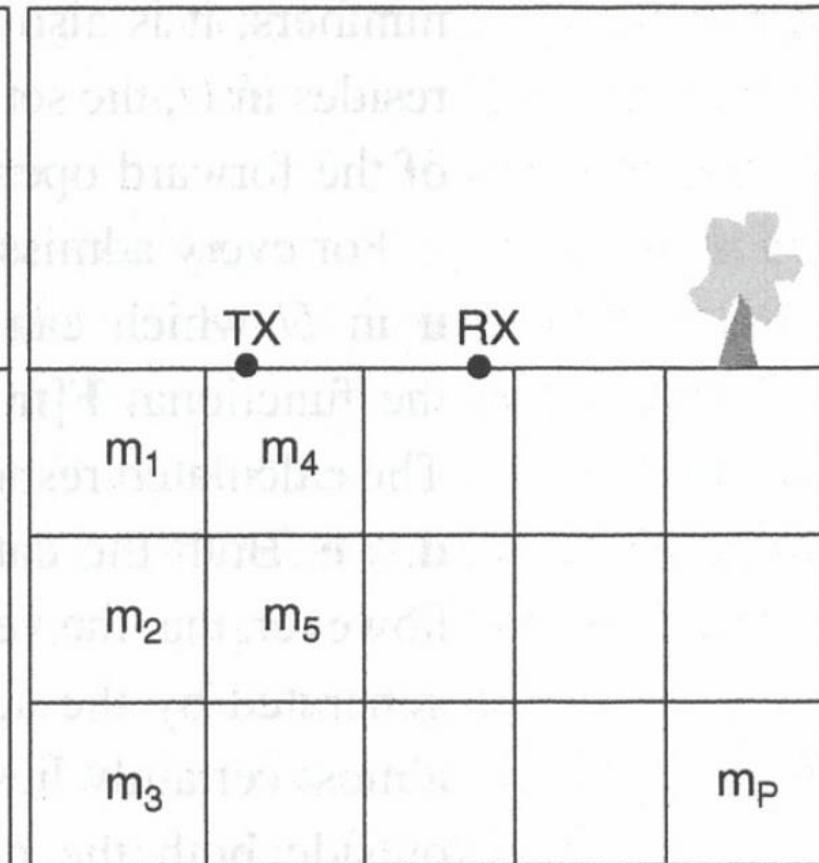
(a) layered model



(b) parametric model

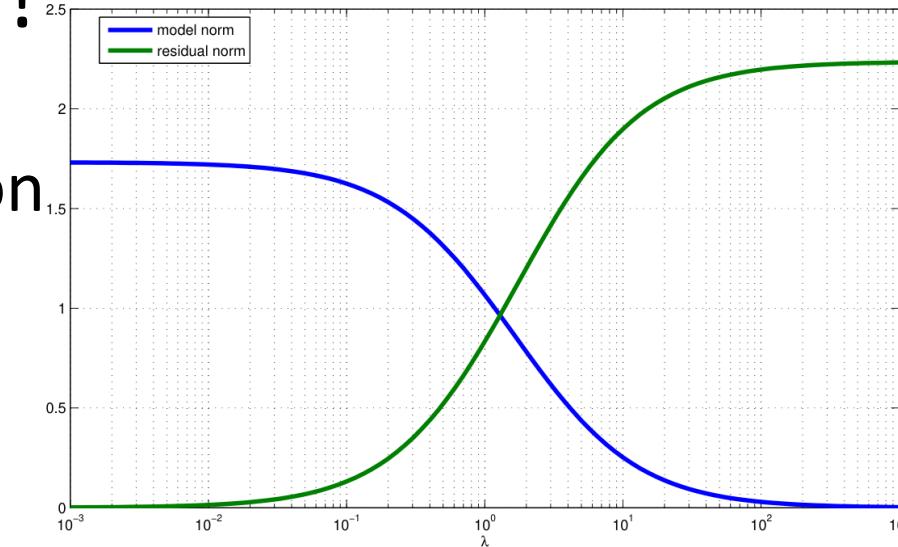


(c) gridded model



What did we learn of inversion?

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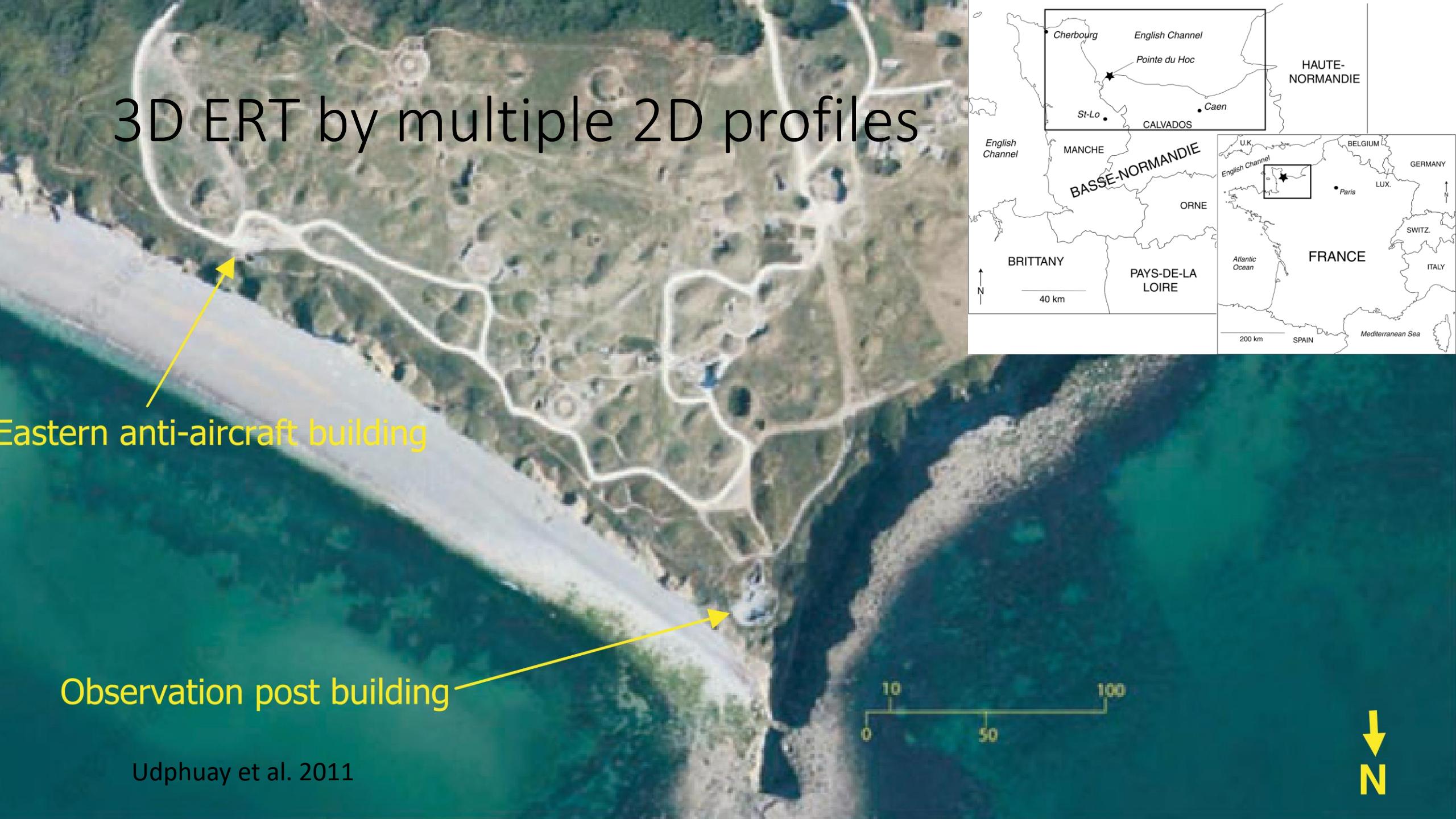


3D ERT layouts

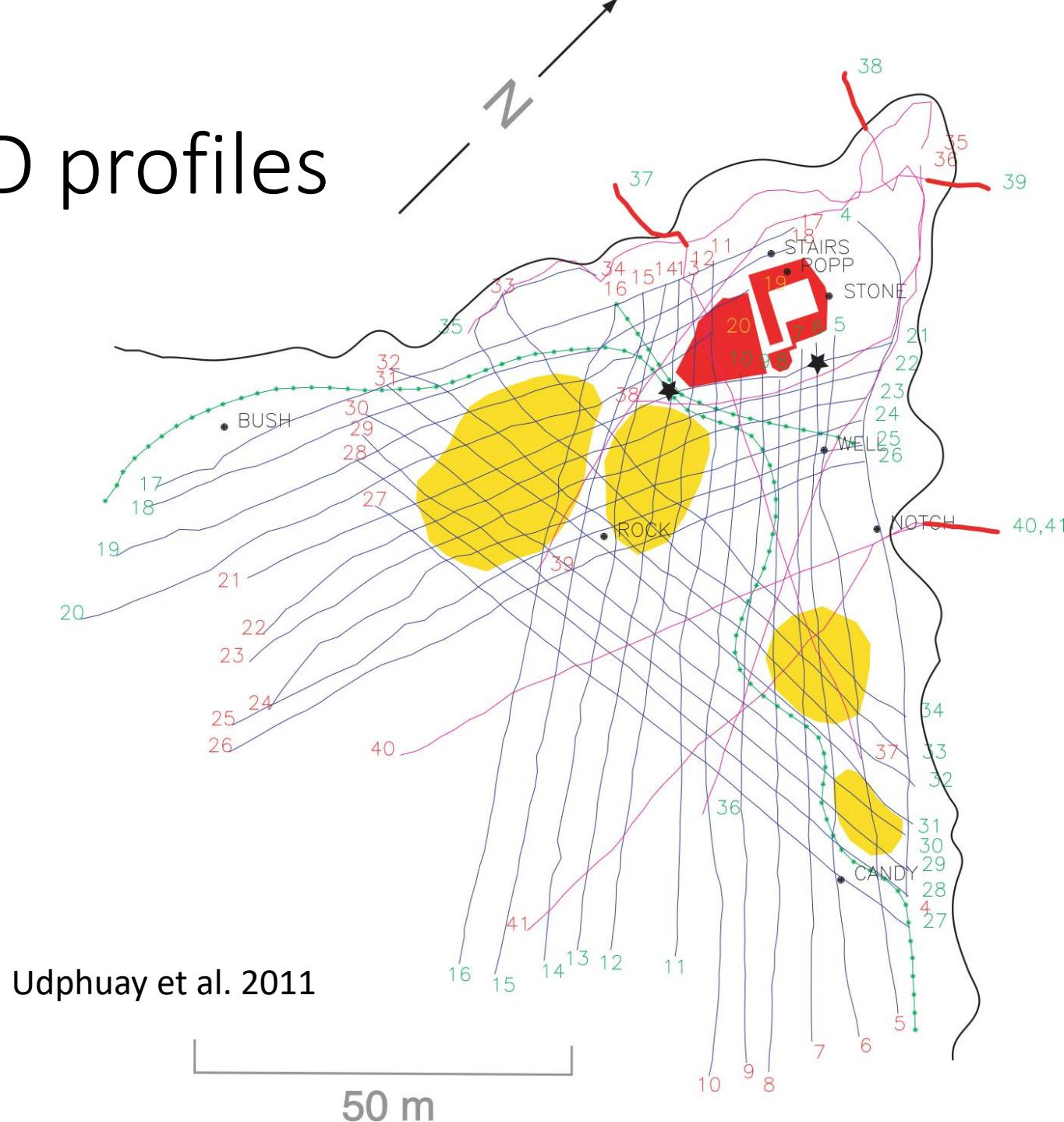
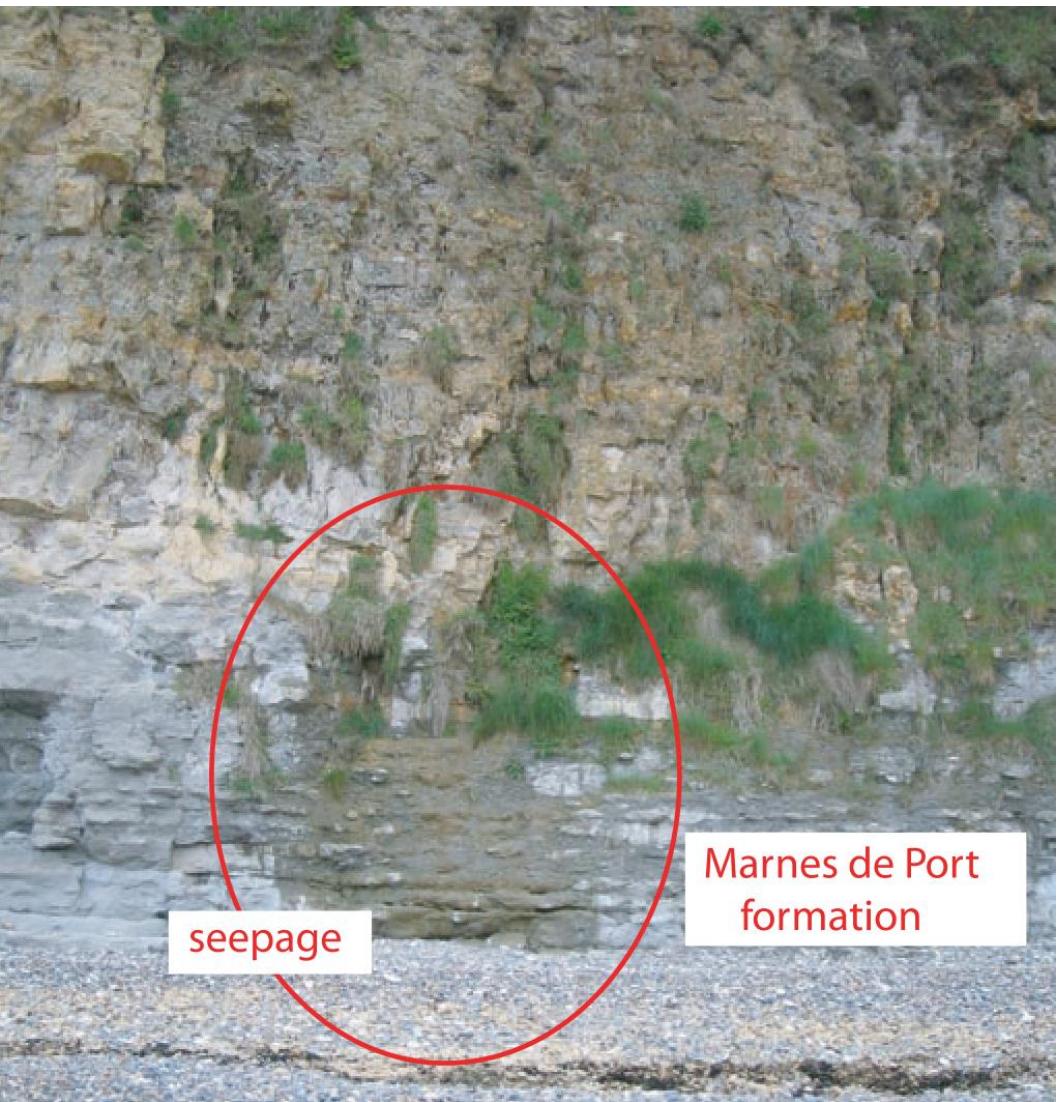
3d electrode
grids



3D ERT by multiple 2D profiles

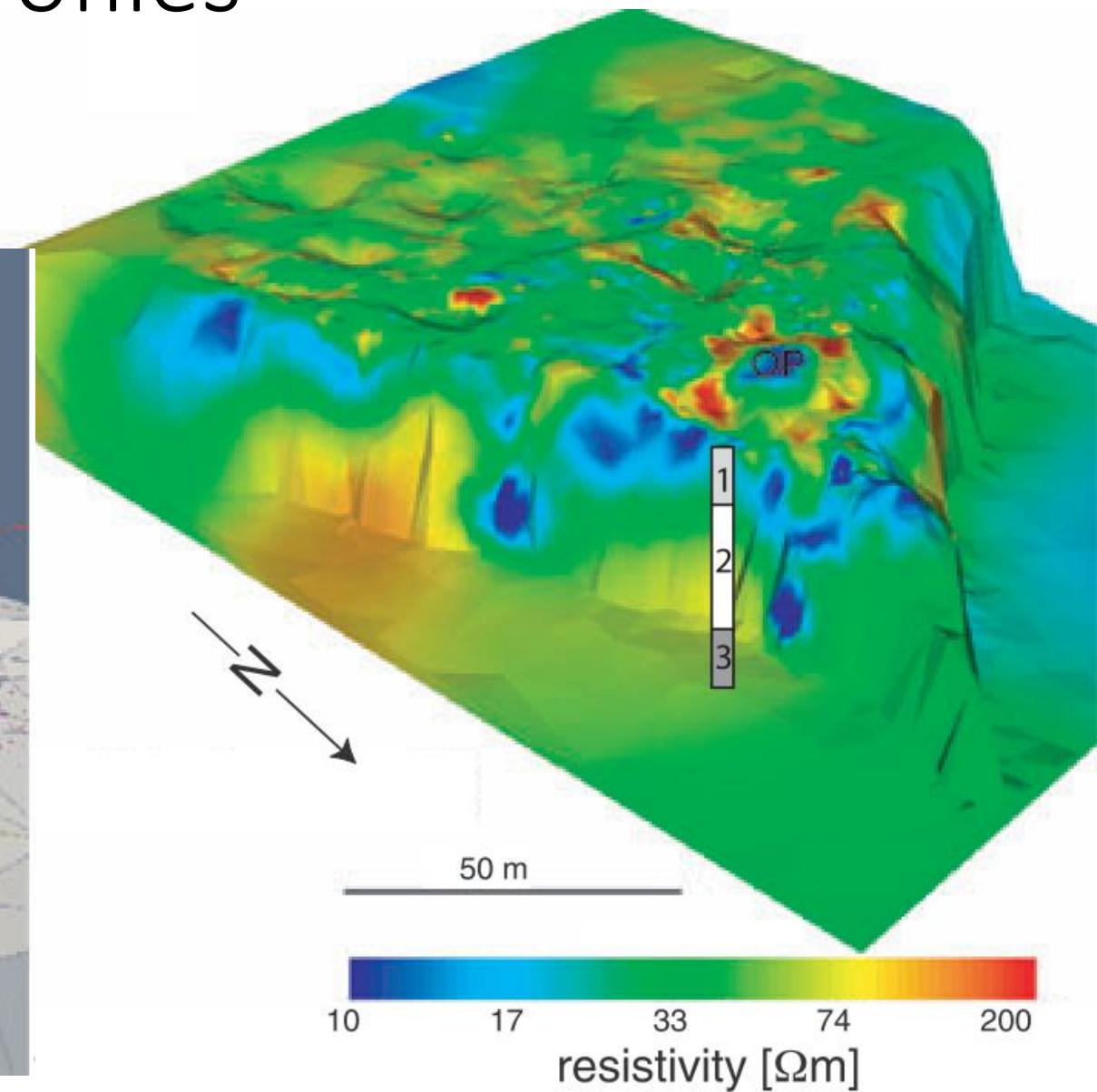
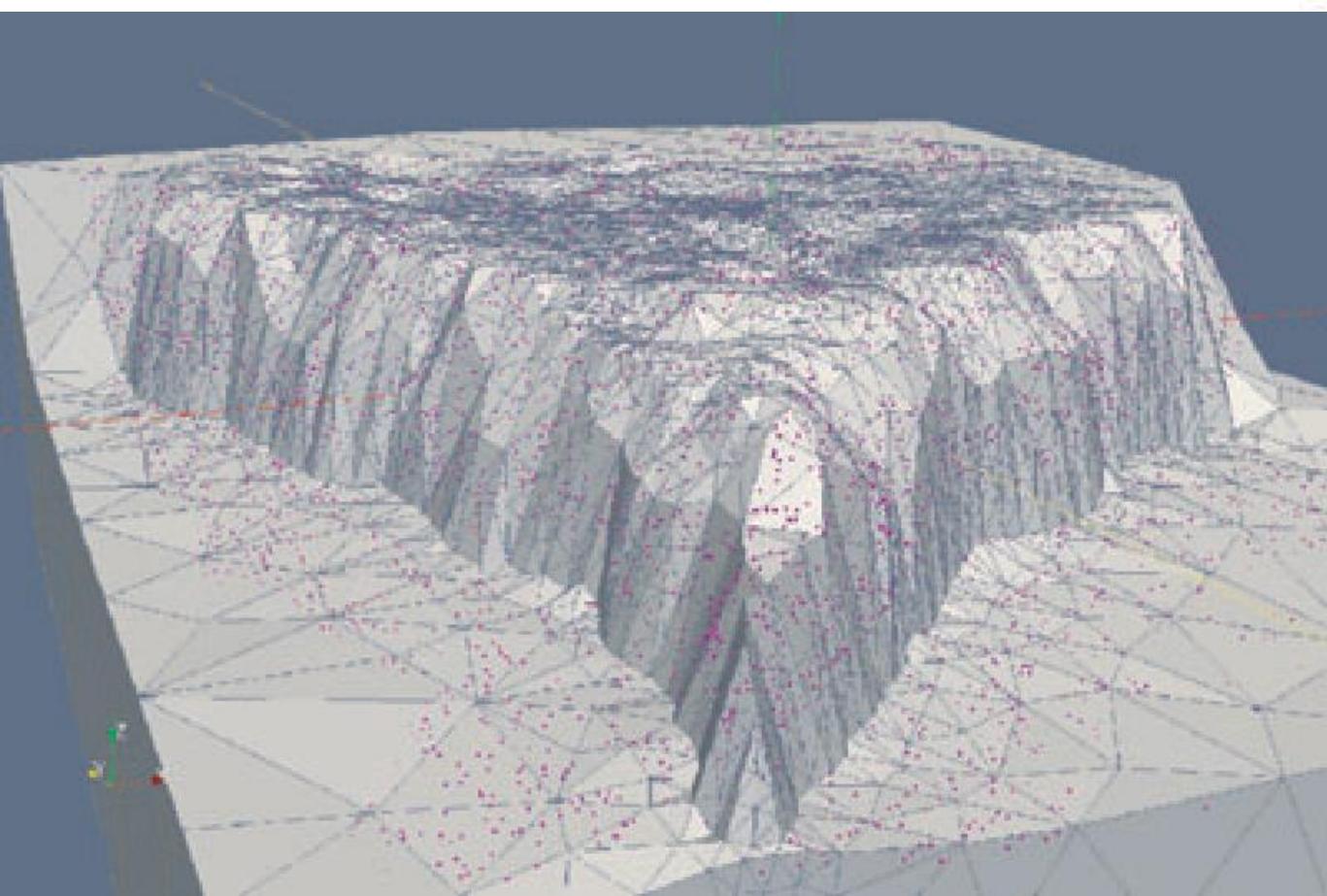


3D ERT by multiple 2D profiles



3D ERT by multiple 2D profiles

Udphuay et al. 2011

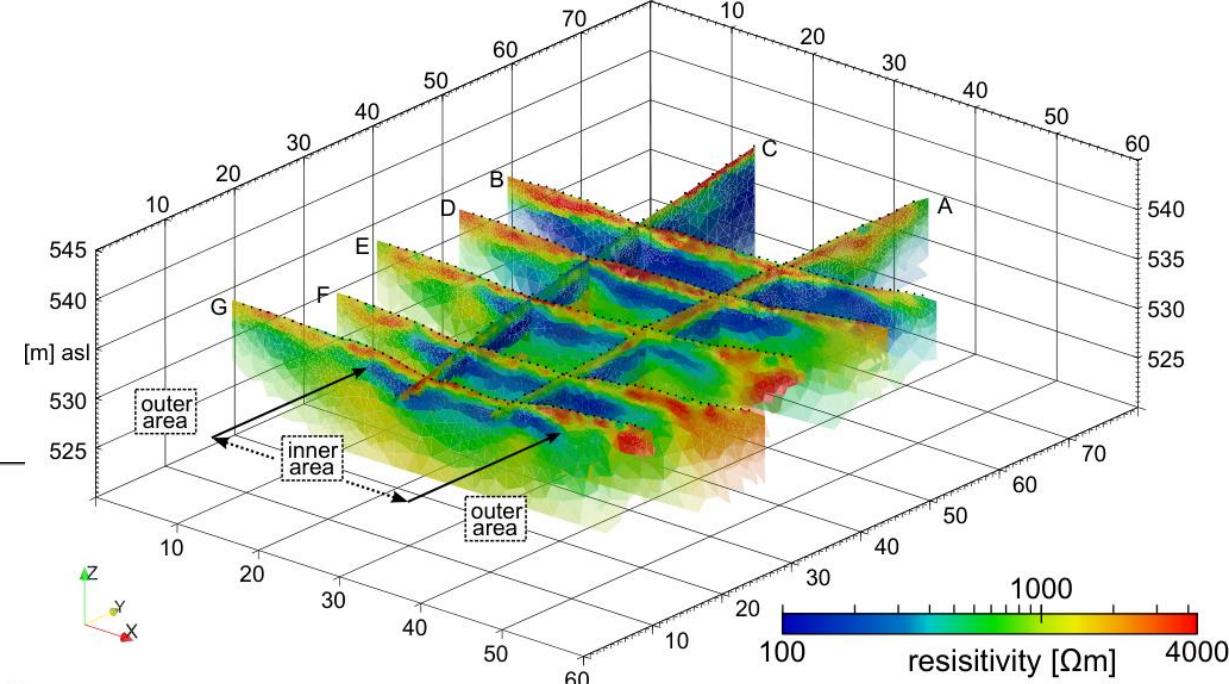
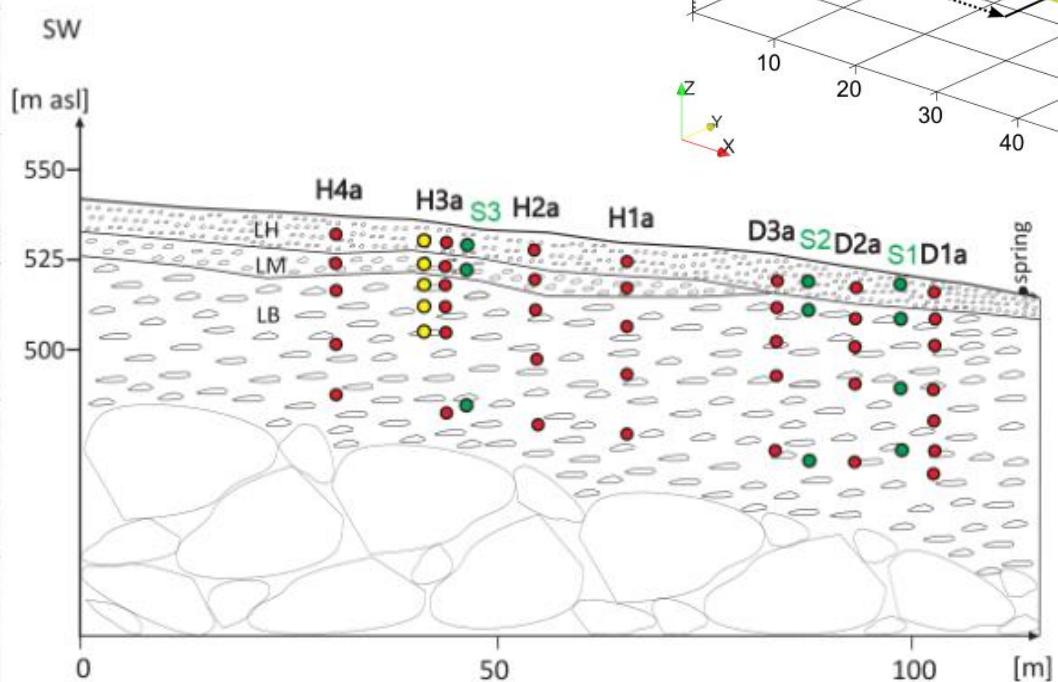
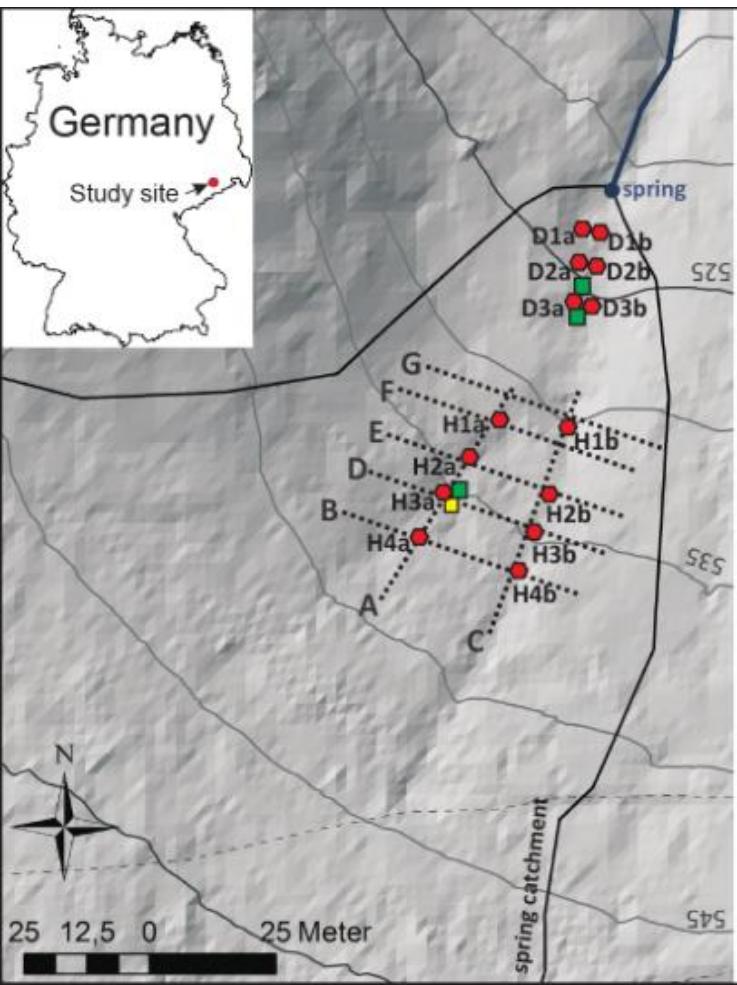


Geophysical monitoring

- Target: physical processes in the subsurface
e.g. water infiltration, solute/contaminant transport
- Repeated measurements with same layout
repetition time: minutes (lab), days (crop scale), months-years (annual)
- ERT method specifically suited (fixed electrode layout)
- Problem: changes are often small compared to overall distribution
- Focus on changes instead of absolute images
→ Sophisticated inversion approaches (difference inversion)
- → Notebook on Timelapse ERT

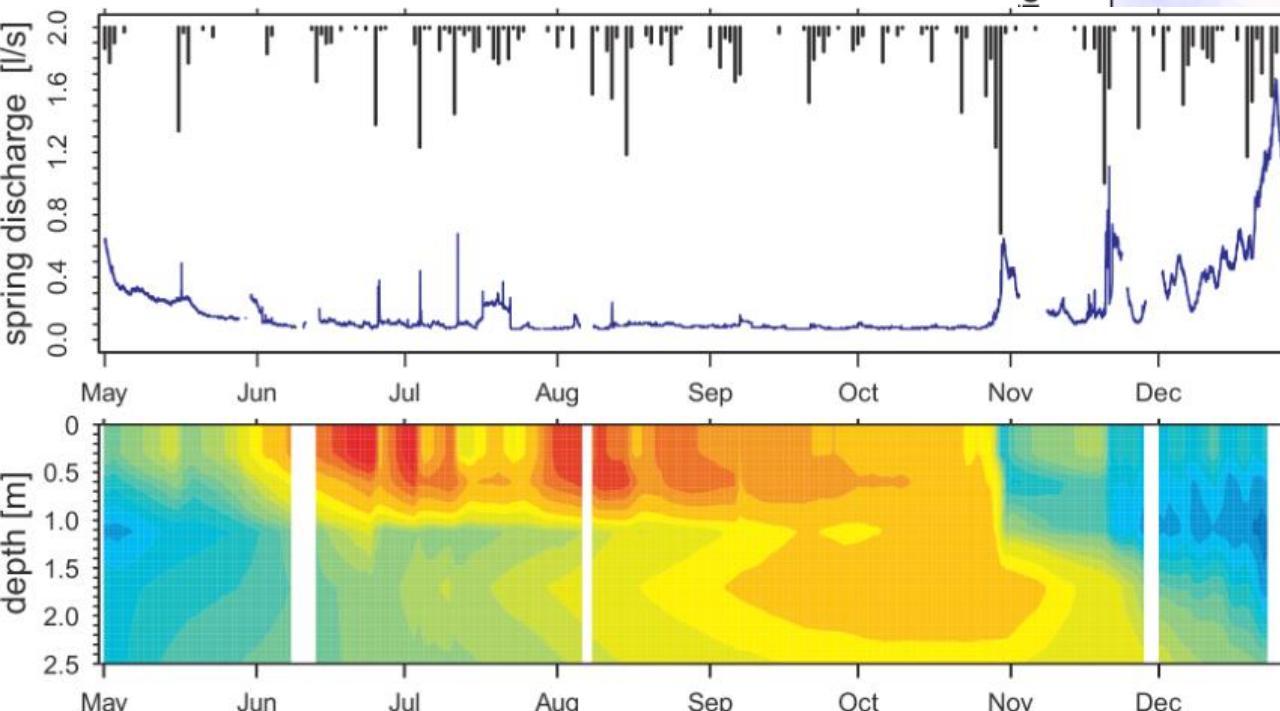
ERT monitoring

Hydrological test site Mulda (TU Dresden)

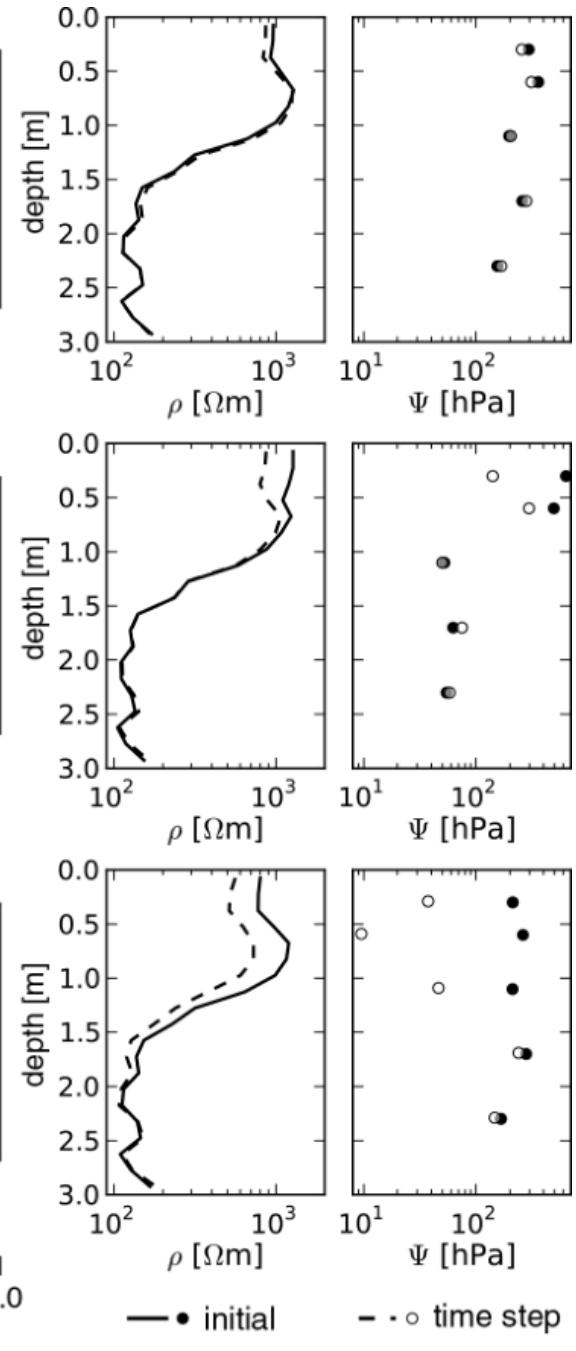
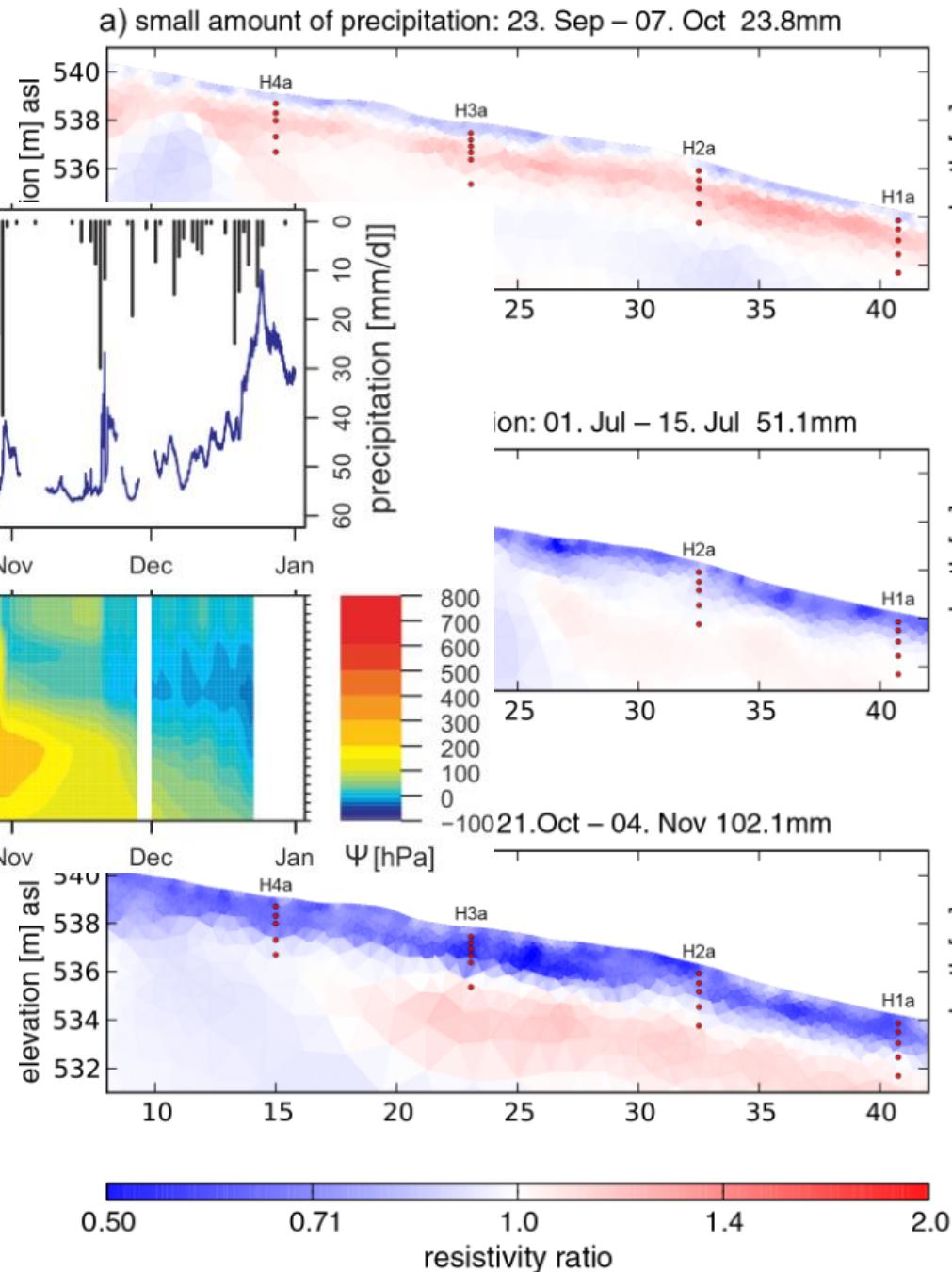


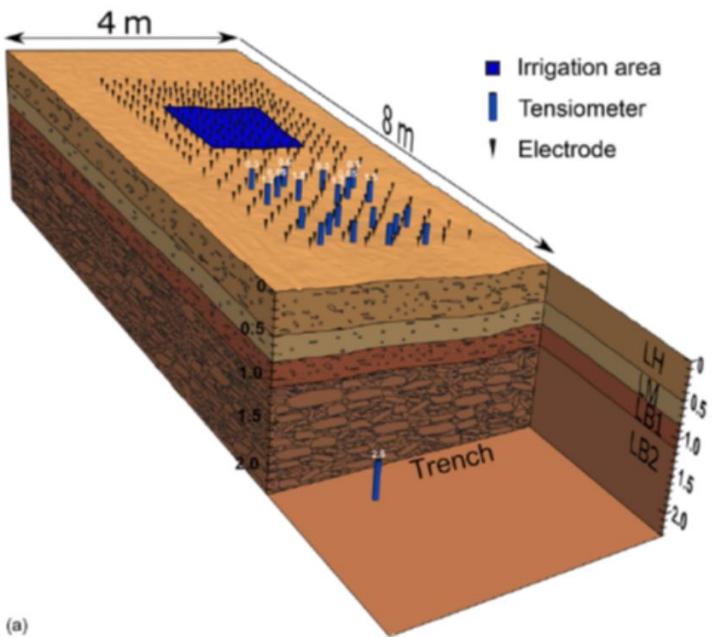
Water infiltration in hill slope
Mini catchment
Important for flood forecasting

ERT monitoring

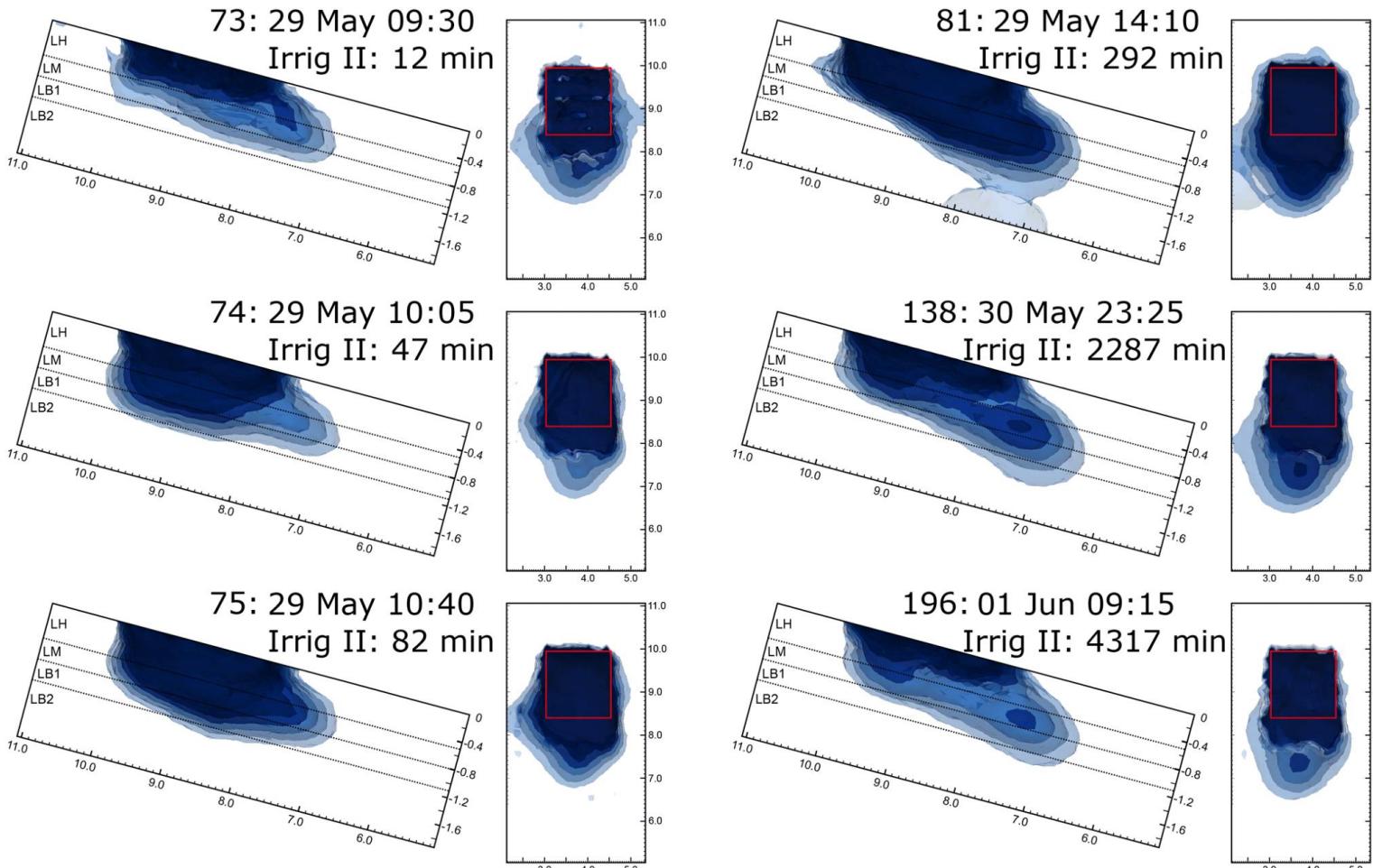


How does infiltration work
depending on precipitation?

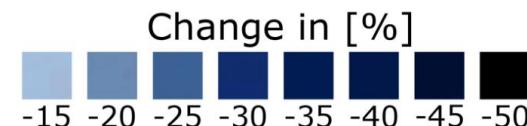




Infiltration monitoring

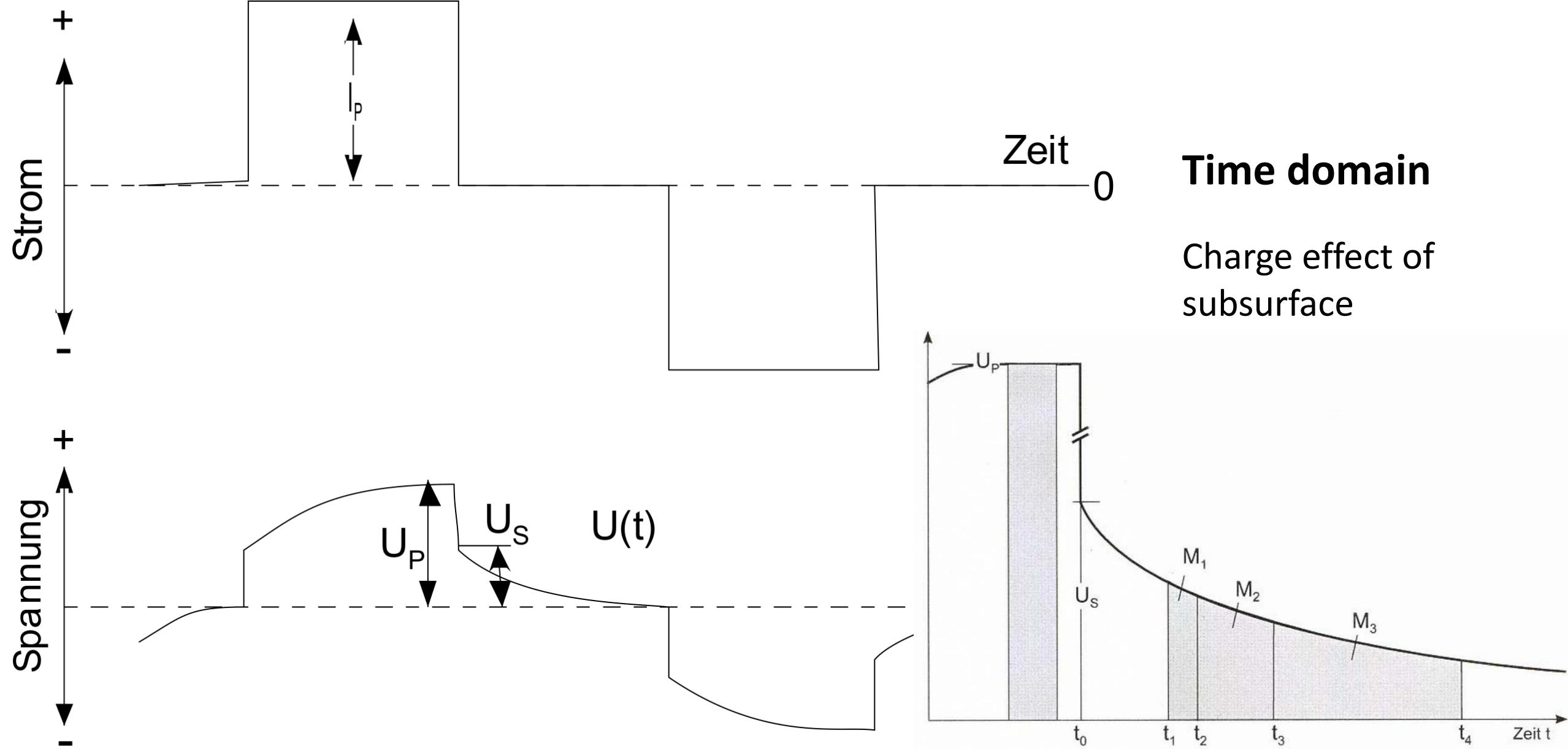


How does a very strong
Precipitation infiltrate?



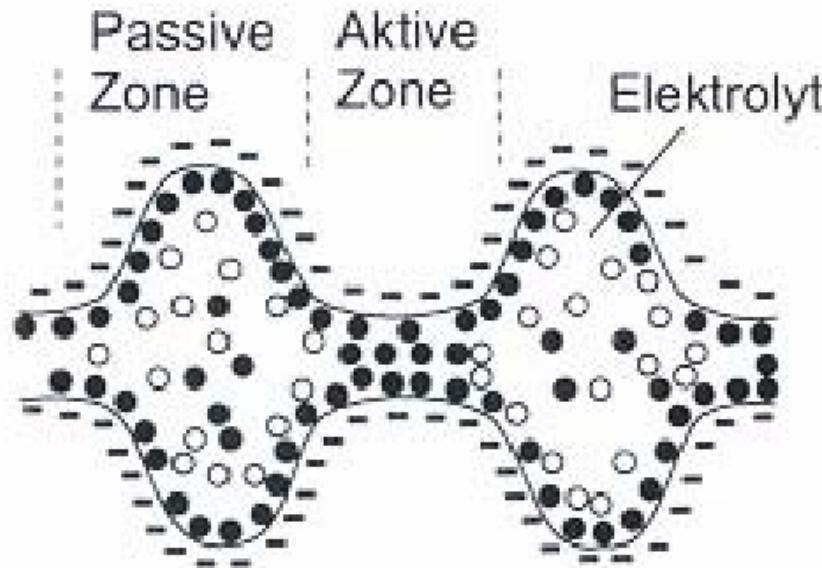
Hübner et al. (2017)

Induced polarization

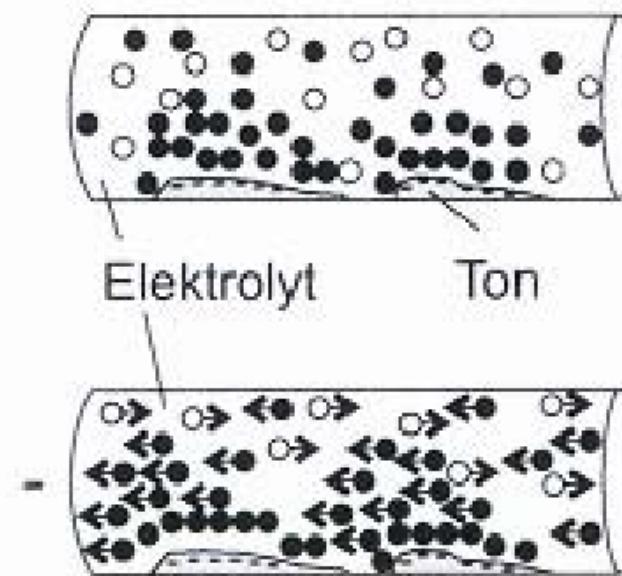


Induced polarization: petrophysics

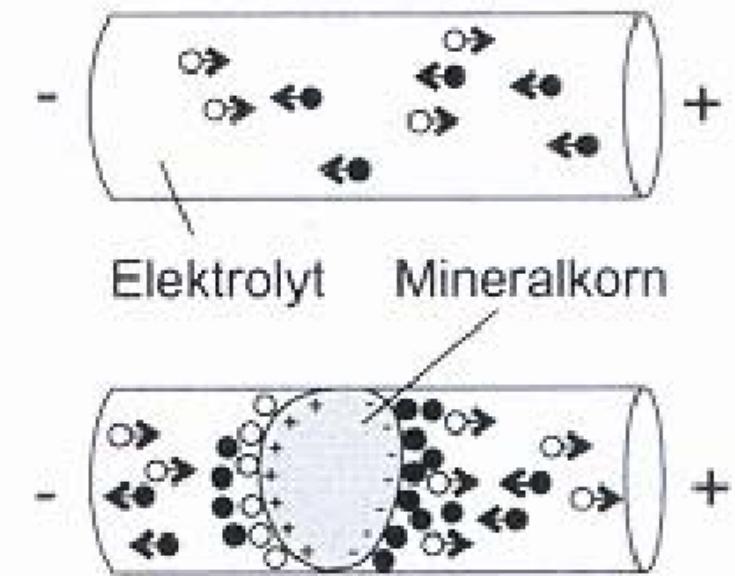
Porenraumverengung



Tonminerale



Elektronenleiter



- Neg. Oberflächenladung
- Kationen
- Anionen

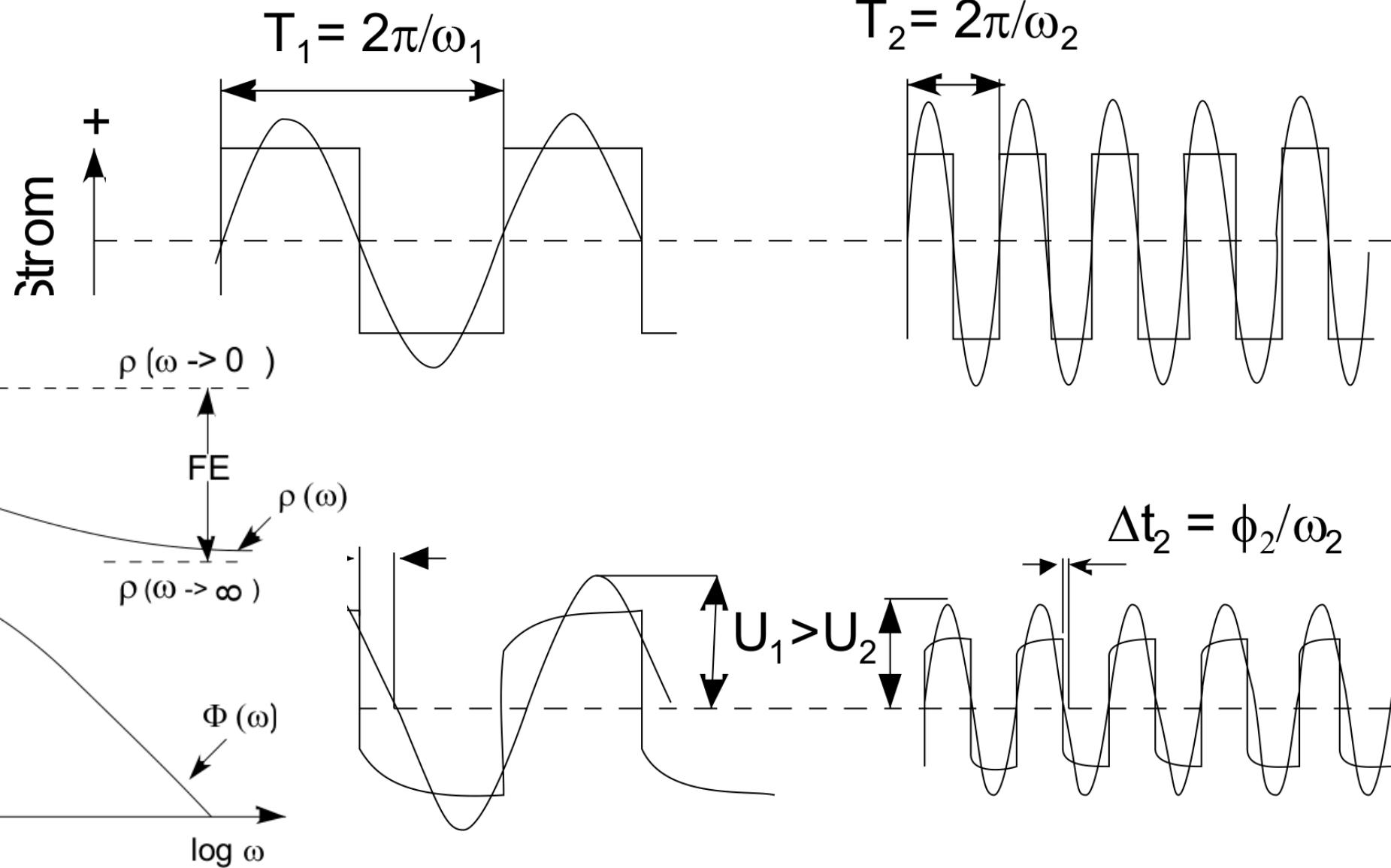
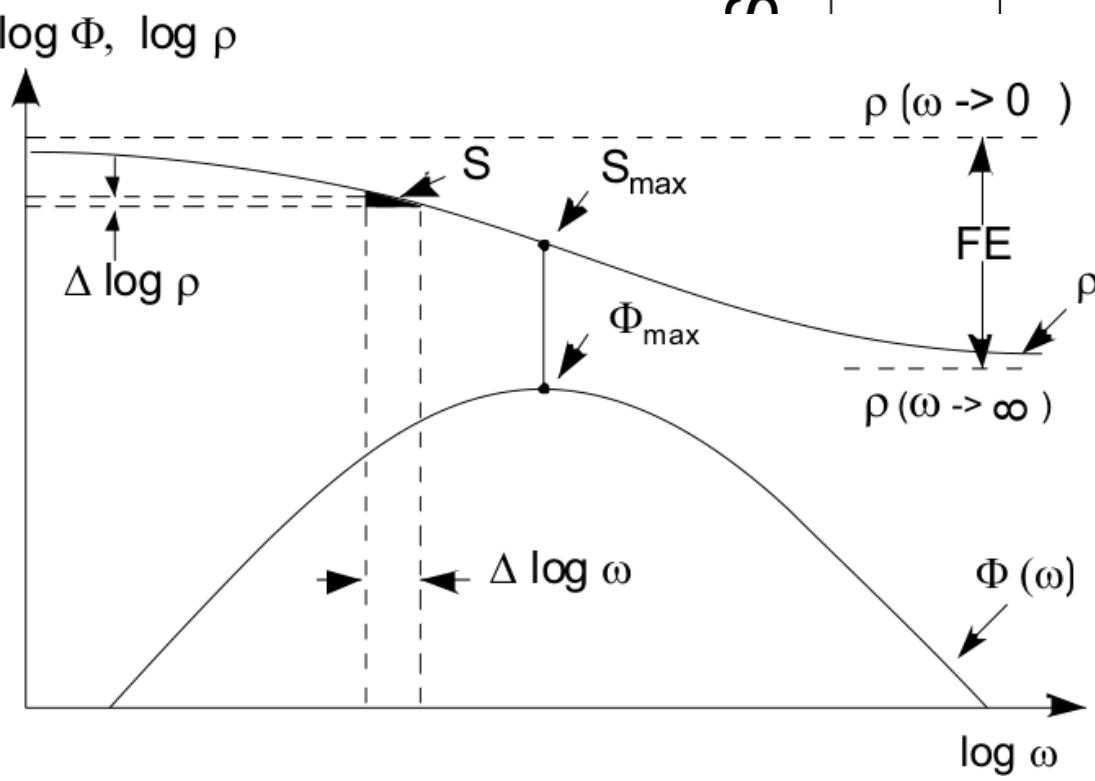
Applications:

- Mineral explorations (electronic conduction)
- Hydrogeophysics (porespace, clay content)

Induced polarization

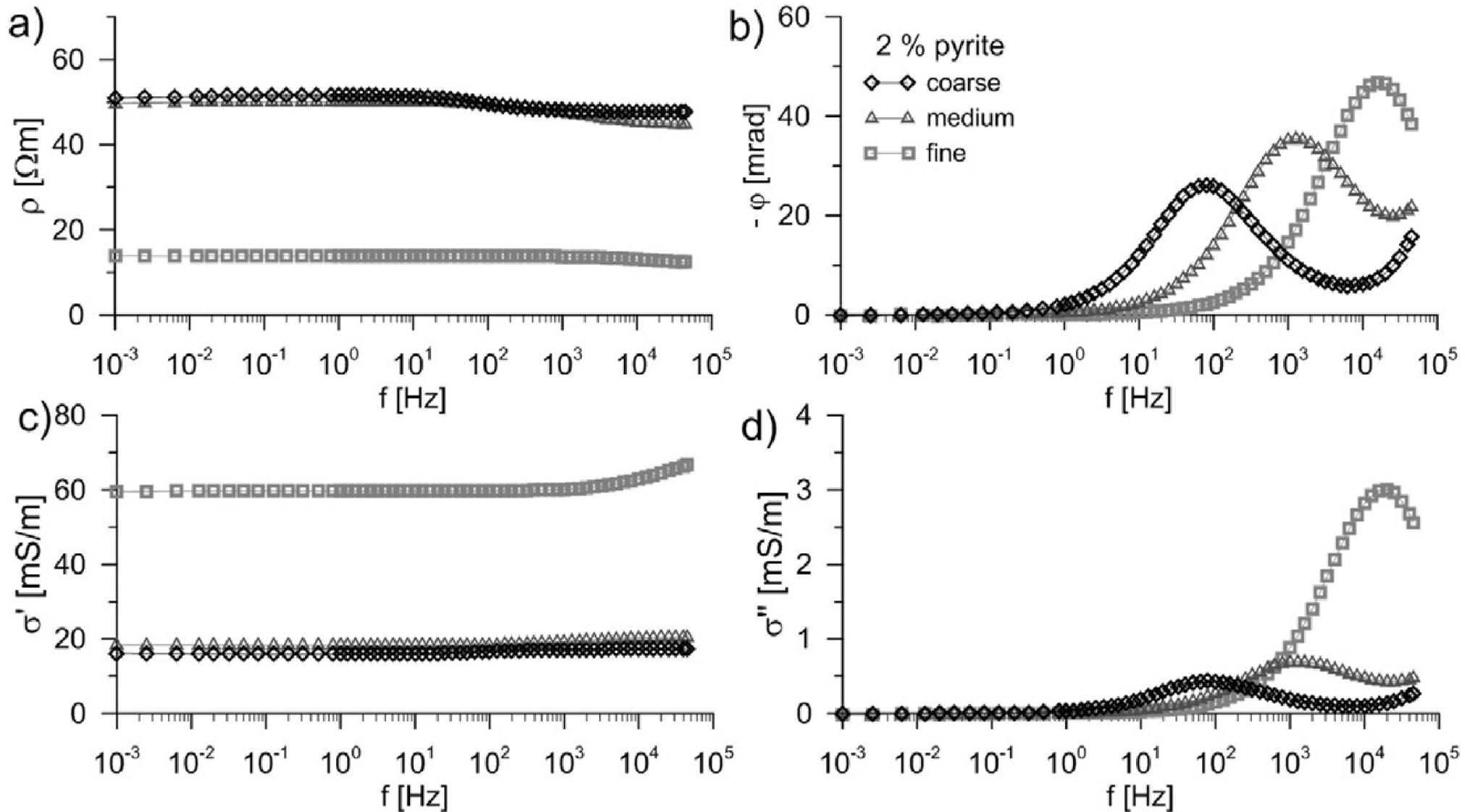
Frequency domain

Phase shift between current and voltage
Depends on frequency

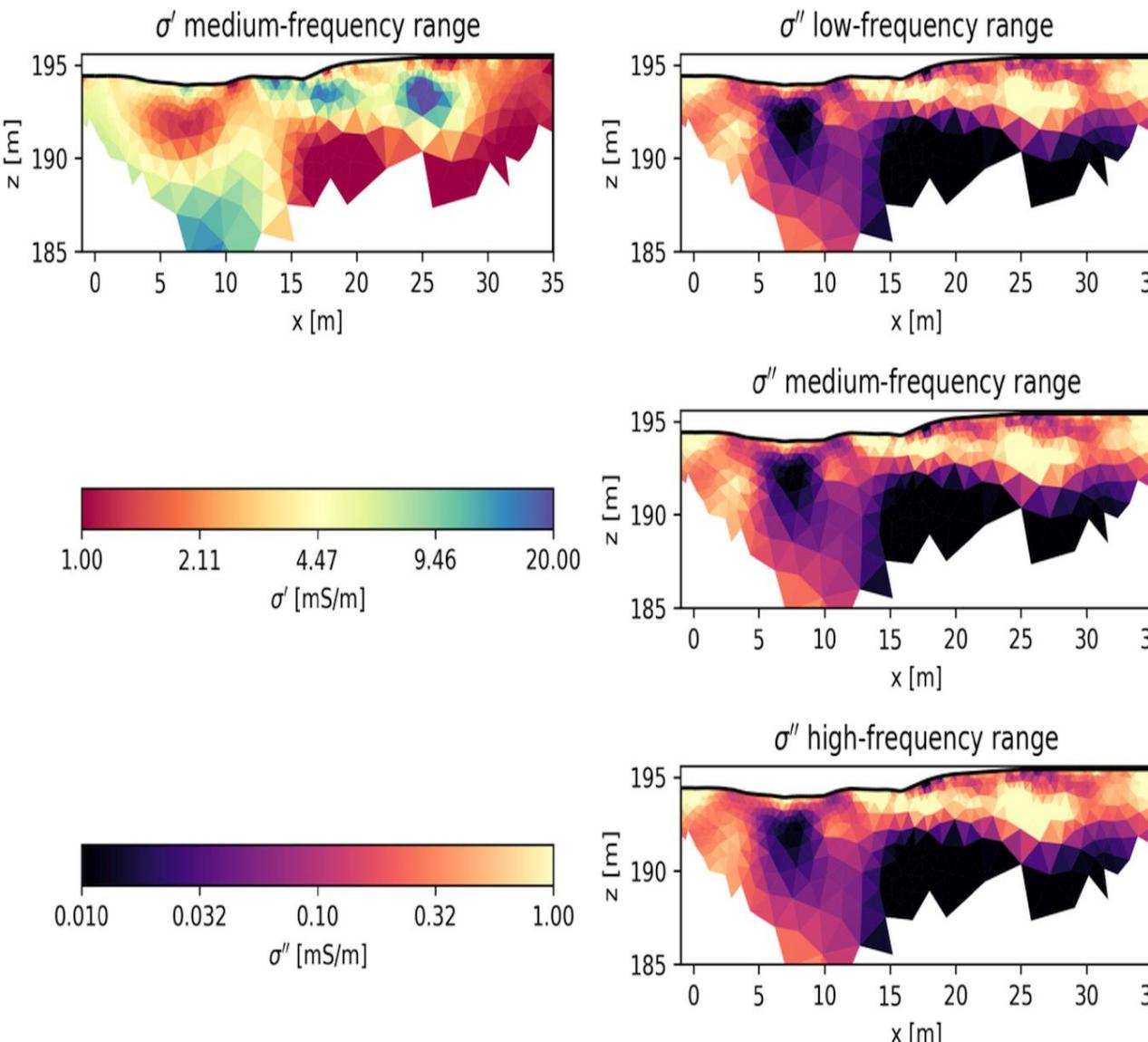


Spectral Induced Polarization (SIP)

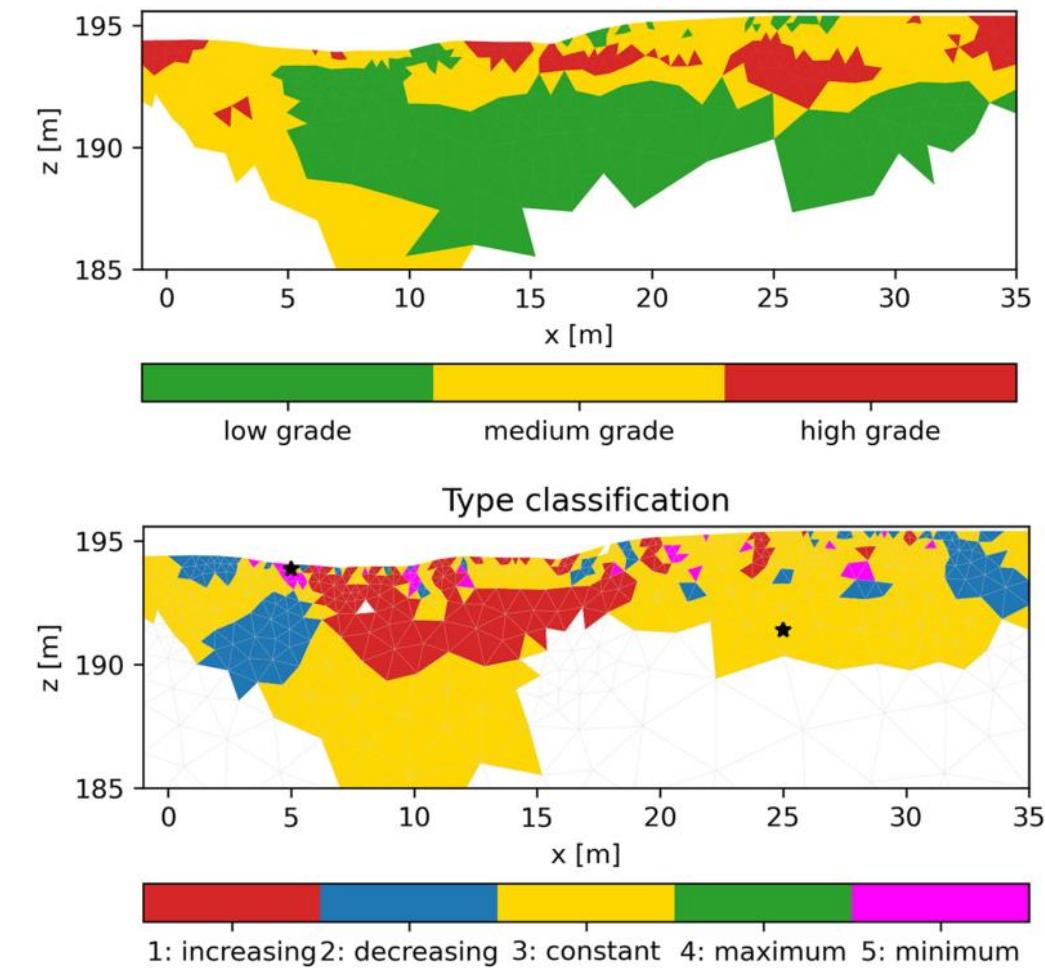
1. Strength:
amount of
polarizable
material
2. Frequency
grain or
pore size



Induced polarization: field example



Field SIP measurements on slag heaps in Harz



Wrap-up

- ERT can also be done in 3D with more effort
combination of 2D profiles possible
- In the crosshole environment 3D ERT is more widespread
- Counteract ambiguity
- Timelapse ERT (monitoring) can see much smaller changes
- Phase shift between current and voltage provides valuable info