TRUST 4.2 Integrated use and interpretation of geophysical and non-geophysical data

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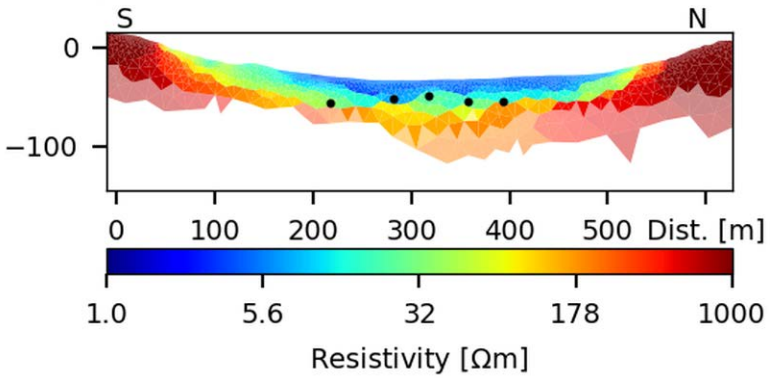

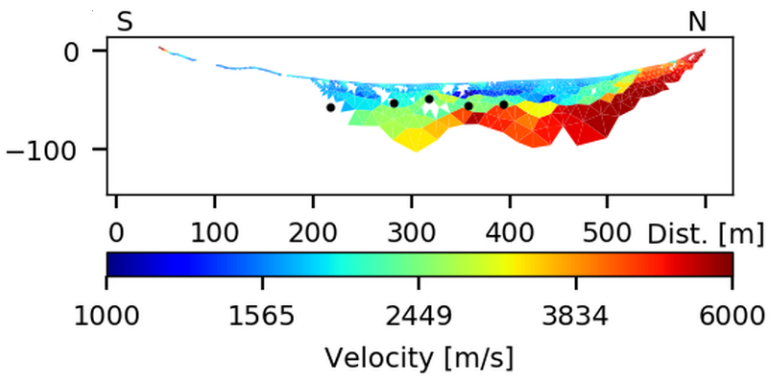

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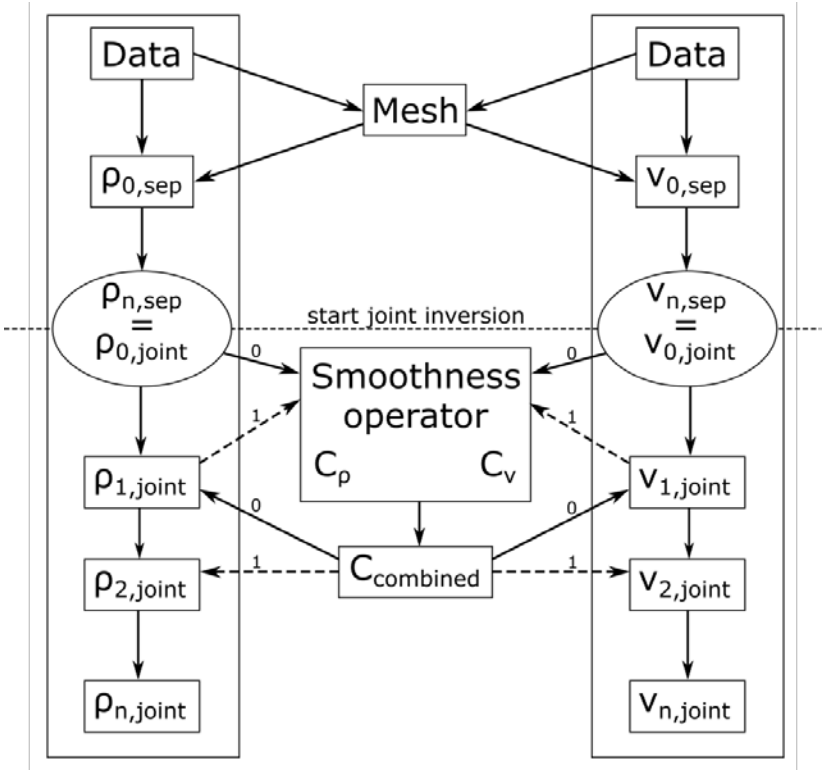
Project Overview

- Main objectives:
  1. Increase reliability of geophysical models
  2. Repeatable and objective joint interpretation of different methods
  3. Incorporation of non-geophysical data
  4. Uncertainty estimates

- What has been done:
  1. Focus on ERT (electrical resistivity tomography) and SRT (seismic refraction tomography)
  2. Structurally coupled joint inversion up and running
  3. Implementation of cluster analysis as post processing step
  4. Assessment of model reliability
  5. Incorporation of borehole data
  6. Test on different synthetic models and field test sites

Joint inversion approach
Structurally coupled inversion

- Implemented in **BERT/GIMLi** software package by Thomas Günther and Carsten Rücker (www.pygimli.org)
- Assumption is a correlation of model parameter structure (seismic velocities and electrical resistivities)
- Works on regular and irregular grids
- Methods:
  - ERT + SRT (+ IPT*)
- This approach can be used for combining more than 2 methods (tested for IPT)



* Induced Polarisation Tomography

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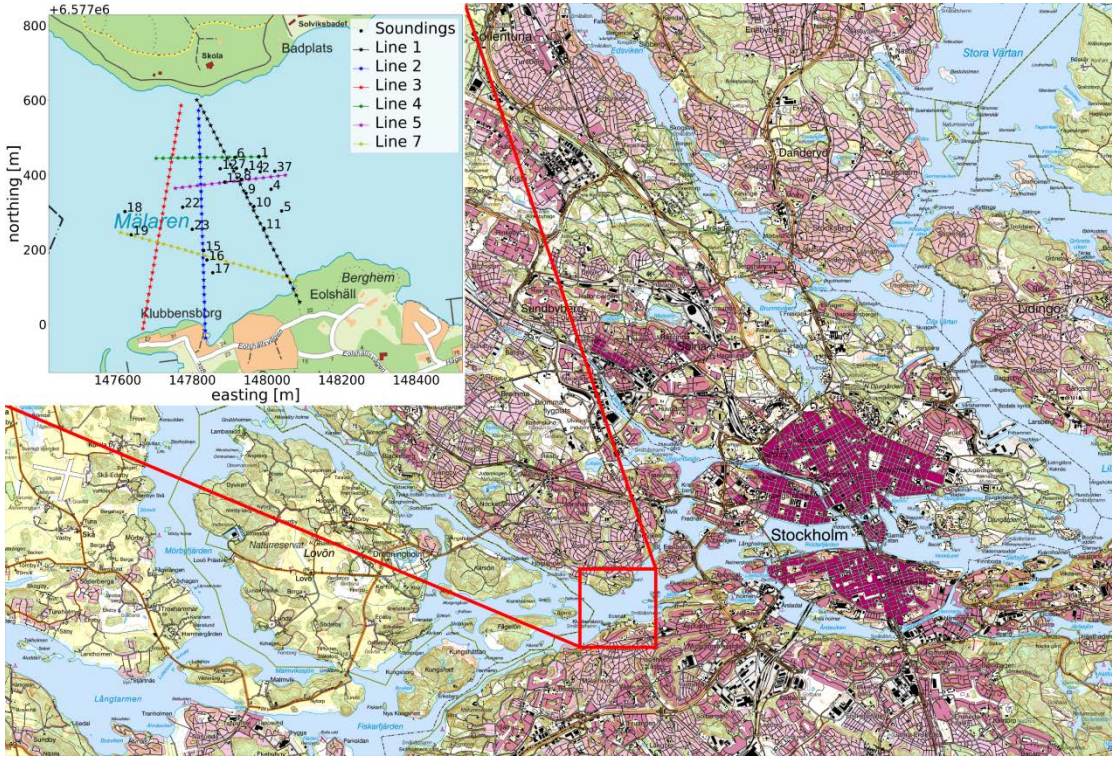
Example: Sewage tunnel pre-investigation Mälaren, Stockholm

- Tunnel below water passage between Hägersten and Ålsten
- Objective: rock quality estimation
- Focus:
  - Depth to bedrock
  - Weakness zones
- 6 profiles with 5m sensor spacing
  - 3 N-S: 600 m long
  - 3 W-E: 300 m long
- SRT measurements during night
  - Noise minimisation



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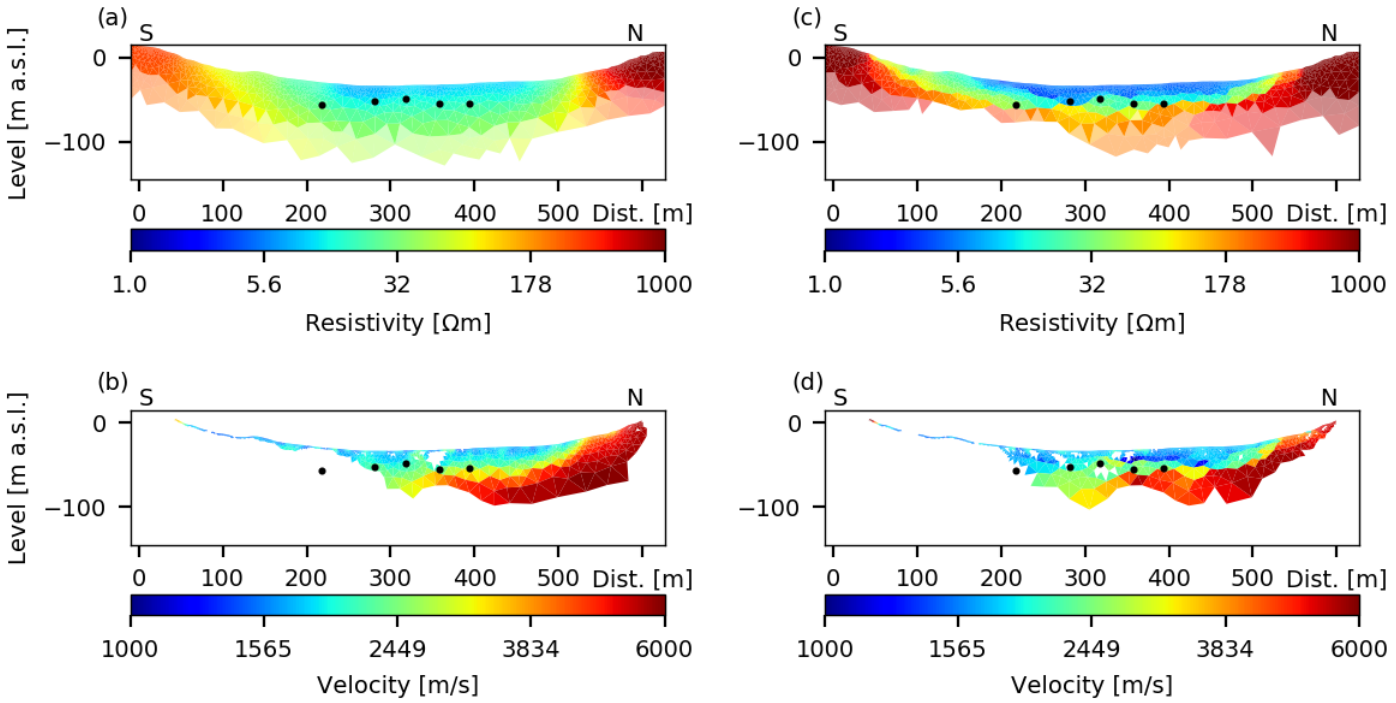
Example: Sewage tunnel pre-investigation Mälaren, Stockholm

- Bedrock depth (black circles) from geotechnical soundings
- Joint inversion performs better compared to separated inversion for bedrock depth estimation

Separated inversion

Joint inversion



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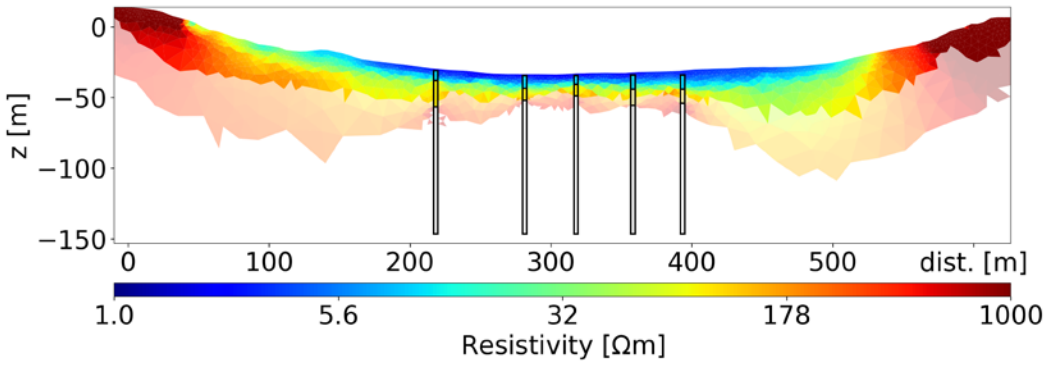
Incorporation of non-geophysical data

- Use of borehole information as additional constraints
- Geotechnical soundings → bedrock depth
- Approach:
  - Include borehole geometry as rectangles in mesh
  - Insert interfaces matching with geological interfaces
  - Horizontally coupled with surrounding
  - Vertically decoupled geologic units
  - If borehole resistivity logs available → use as start value for resistivity



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Visualisation of reliability
Example: Äspö HRL

Coverage as a reliability estimate

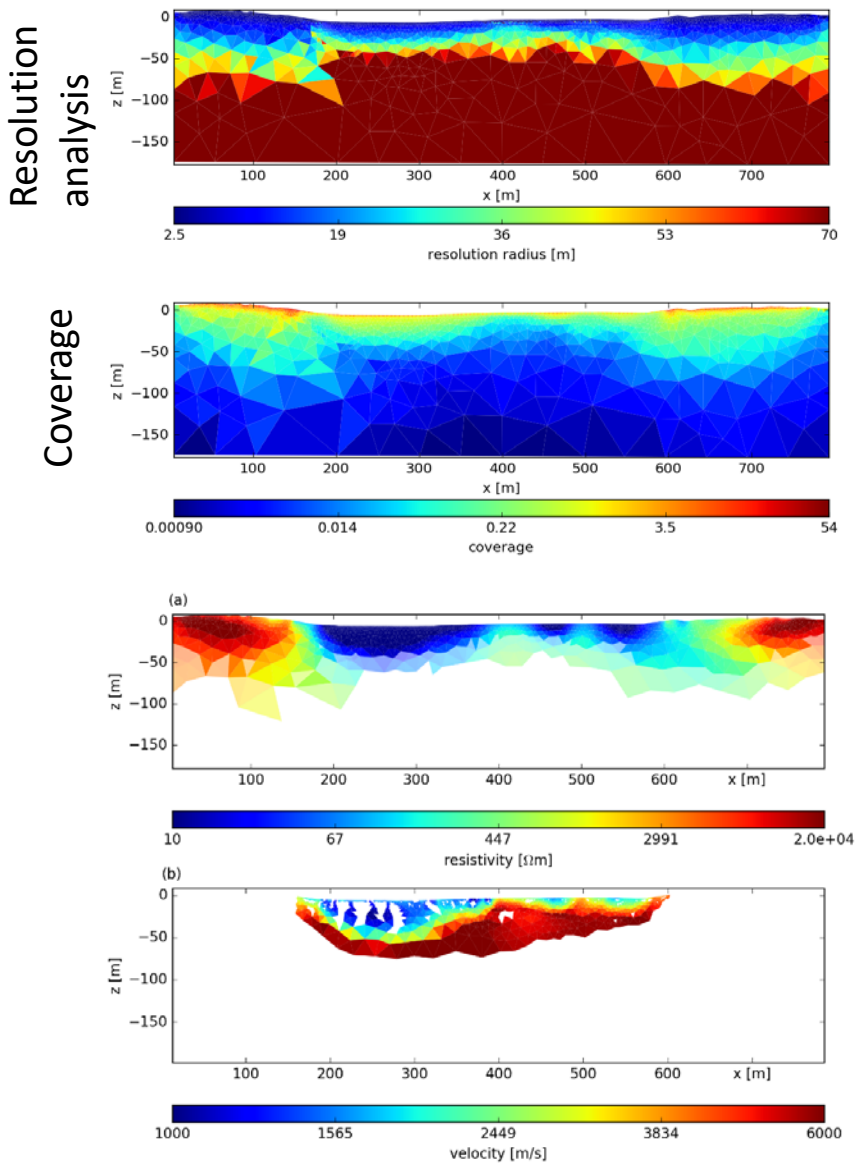
- Coverage
  - ➢ Summation of all sensitivities for a model cell
  - ➢ Poorly resolved model parts also show low coverage

Approach for ERT:

- Coverage mapped to range 0 – 1
- Definition of 2 thresholds
  - Standard: 0.7 and 0.4
- Fade out unreliable model parts using alpha-shading

Approach for SRT:

- Areas without ray coverage left blank



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Cluster analysis to aid interpretation
Example: Äspö HRL

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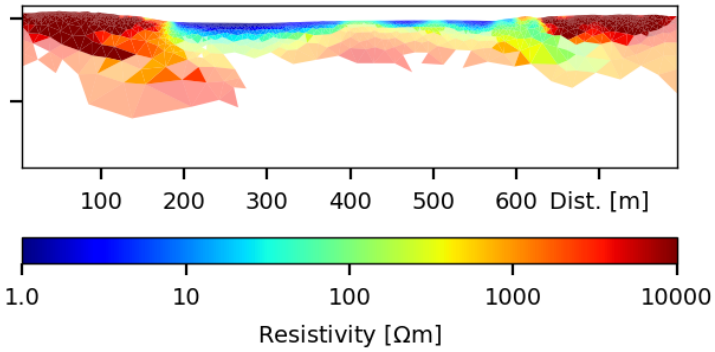
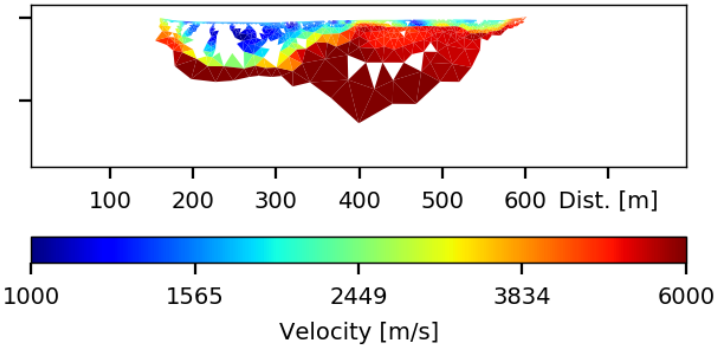
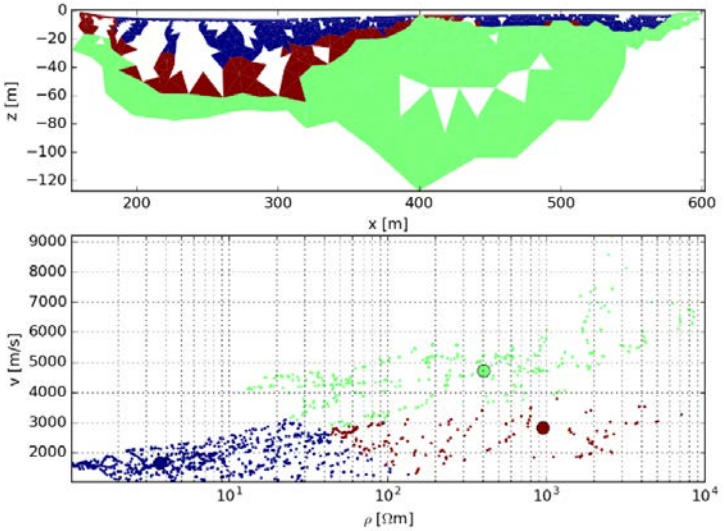
Transparent Underground Structure

Joint inversion models



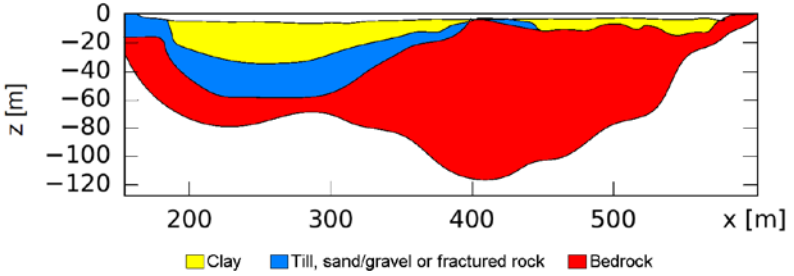


Cluster analysis of models



Mean Shift algorithm

Geological interpretation based on cluster analysis



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