Geophysical investigation of flood defence levees: Sandboil effect

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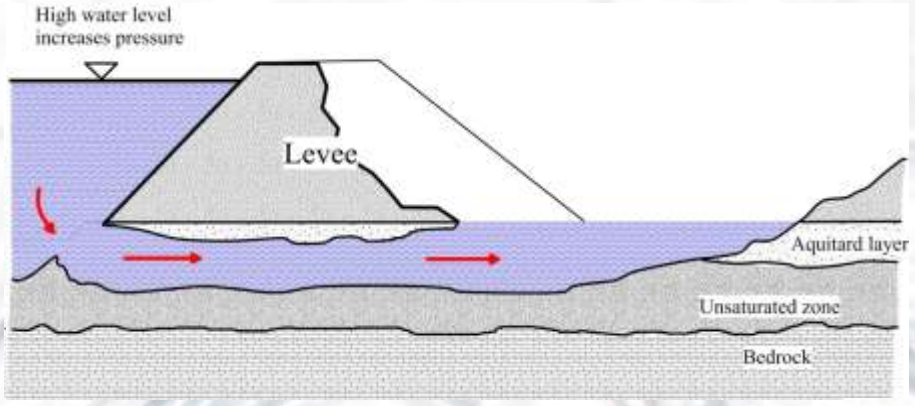
Outline

- Definition of the problems
- Research area
  - pumping house (1)
  - hunting-stand (2)
- Investigation methods
  - Resistivity (2D, 3D)
  - GPR
- Results
- Conclusion

Definition of the problems



- Different pressure on two sides of levee
- Groundwater flow towards leak in aquitard
- Start of erosion of granular material
- Upstream erosion
- Continuous ”pipe”, accelerated erosion
- Structural collapse by undercollapsing

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Problems

Research area (1)

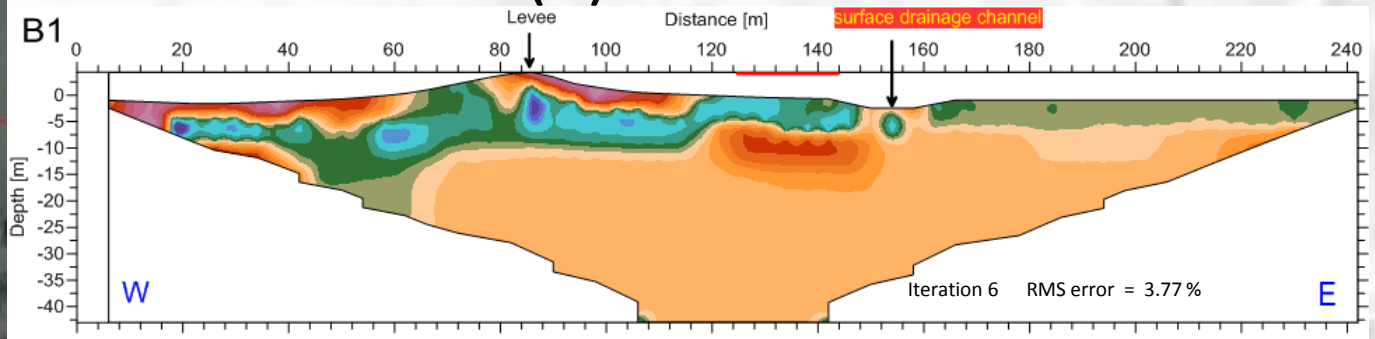
Research area (1)

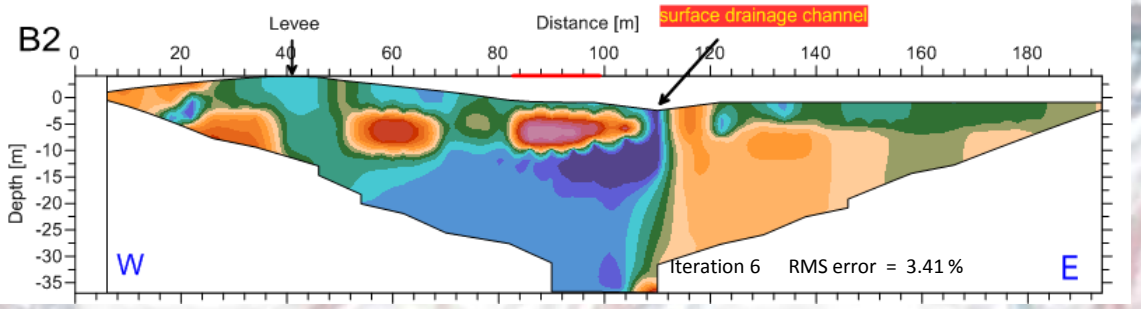
<u>2D geoelectric survey lines:</u>
Data acquisition system: AGI SuperSting
Array type: Schlumberger Inv.
Electrode spacing: 2 m

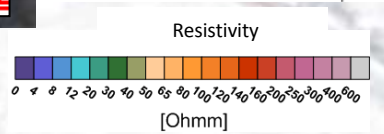
A1 ⇒ 700 m
A2 ⇒ 52 m
A3 ⇒ 44 m
A4 ⇒ 92 m
A5 ⇒ 324 m

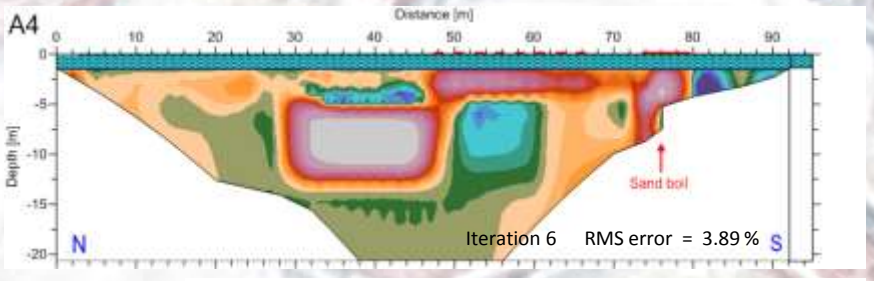
B1⇒ 236 m
B2⇒ 188 m

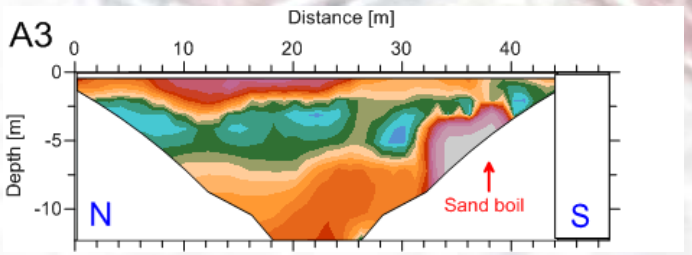
Results (1)











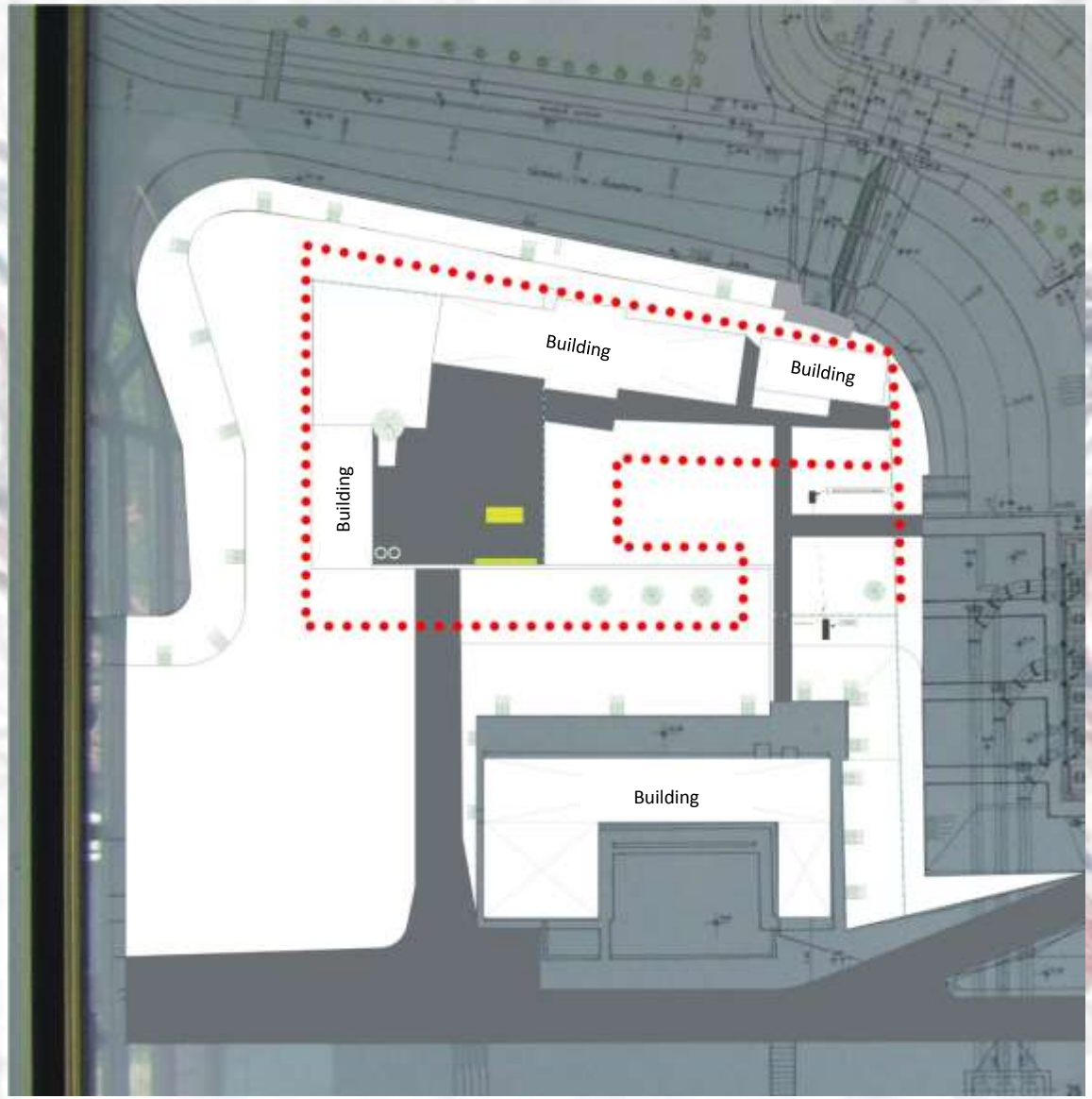
2D data processing:

- RES2DINV
- Least squares inversion
- Topography correction

Research area (1)

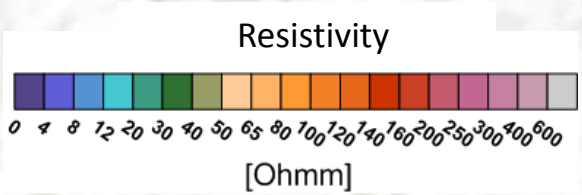
<u>3D geoelectric array system:</u>

- Array type: dipole-dipole
- Number of electrodes: 99 pieces
- Electrode spacing: 2 m

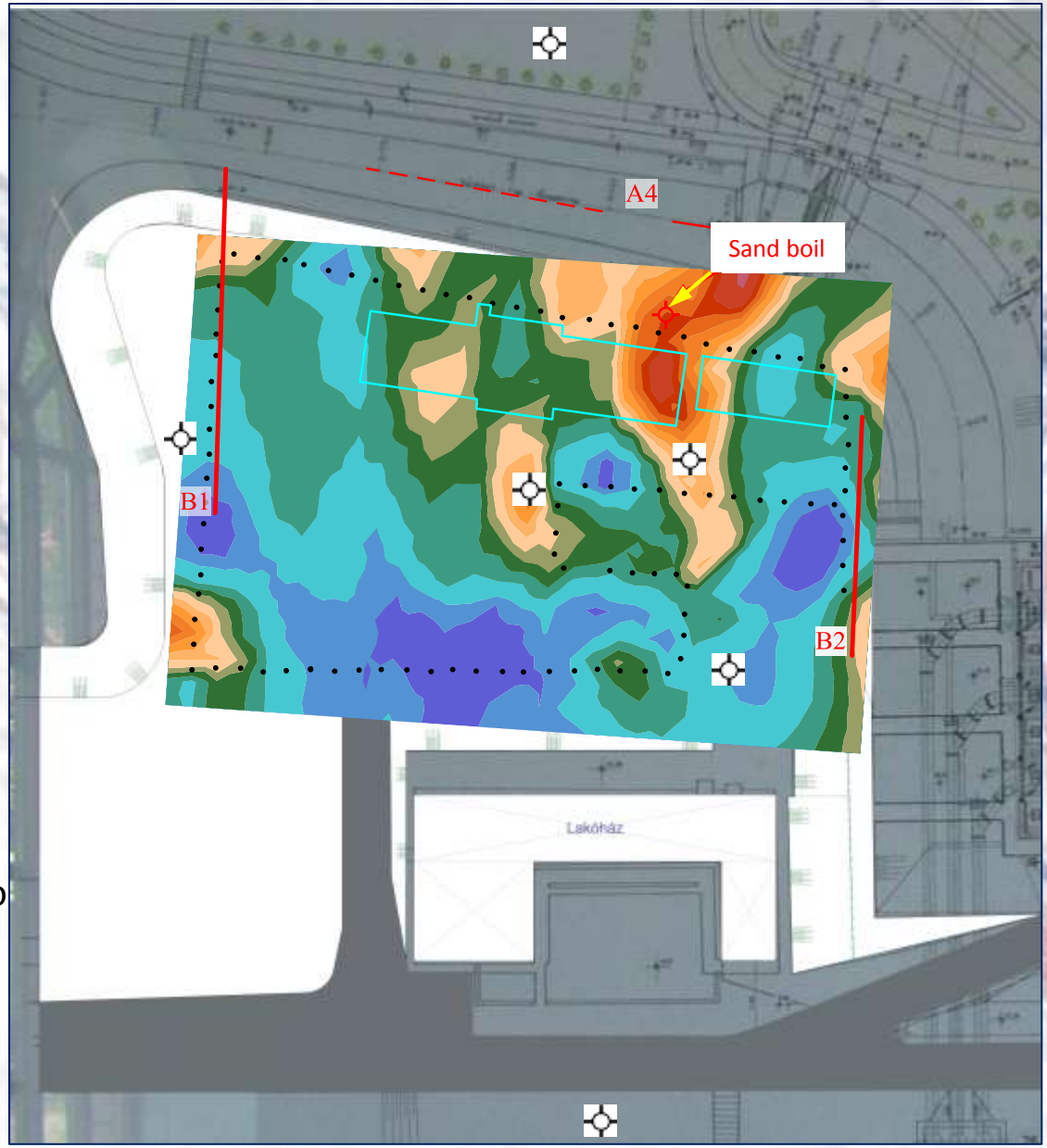


Results (1)

- Geophysical inversion was performed by ERTlab Solver software
- Incorrect data were eliminated
- Finite difference algorithm used for pre-modelling
- Weighted least-squares inversion with 5 iterations
- RMS error = 2.3 %



- High resistivity zone in 5 meter depth nearby sand boil
- Red and pink colours (from 140 Ohmm to 600 Ohmm) typify for coarse sediments.
- Based on these results we could propose sites of CPT and borehole spot



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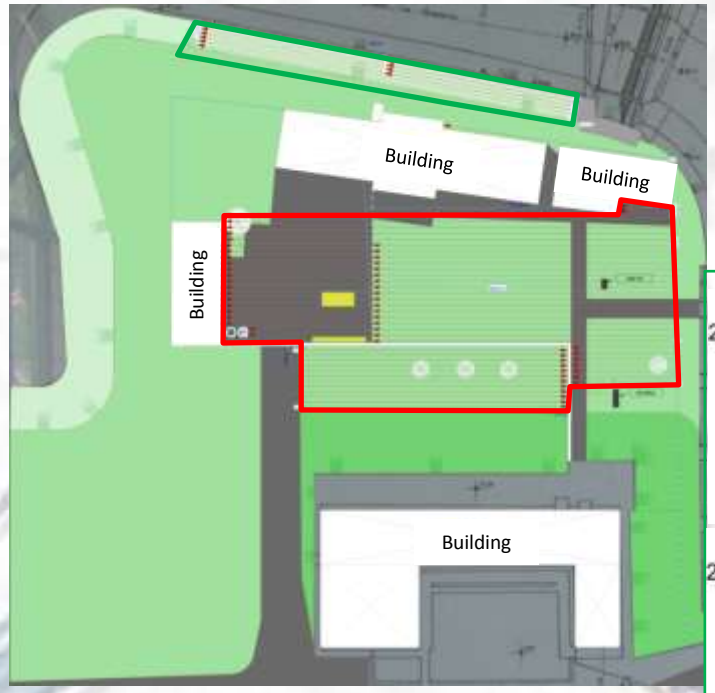
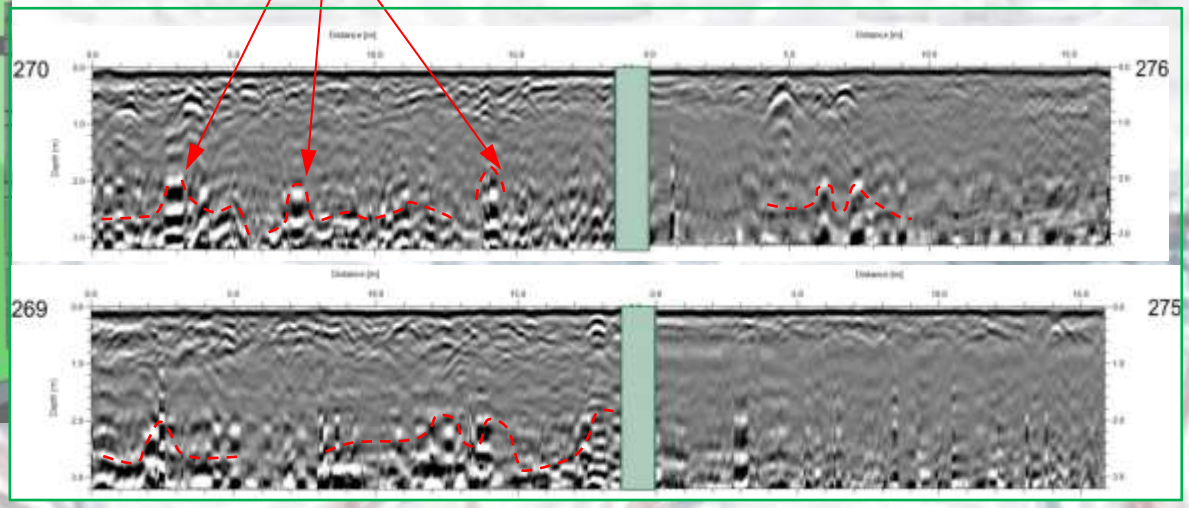
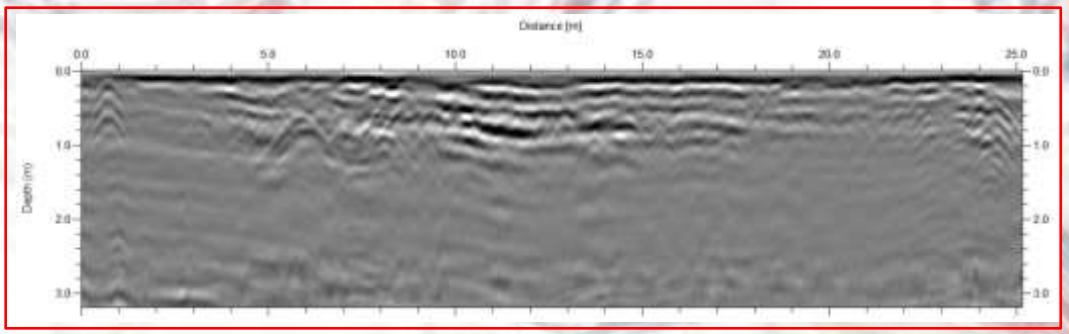


Crack (uplifting)





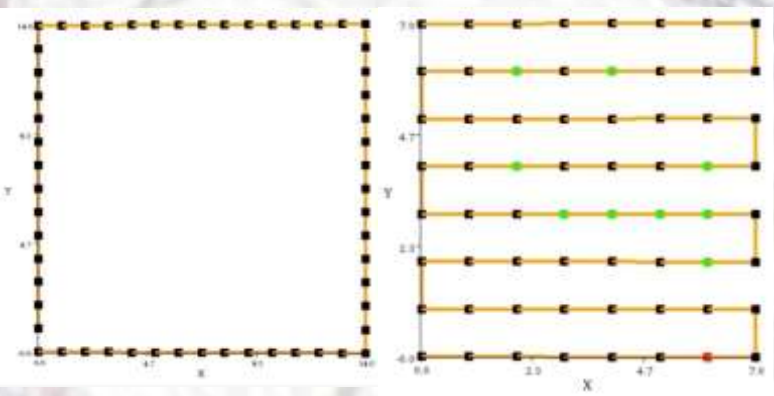
GPR investigation:

- Main unit: GSSI Sir 3000
- Choosen frequency: 200 MHz
- Line spacing: 0.5 m
- RadART 3.05 software
  Time zero correction
- Global background removing
- Programmed gain control
- Bandpass filter
- Horizontal filter
- Smoothing
- Time-depth conversion

- GPR data confirmed the results of resistivity measurements
- Poor reflection of deeper zone on the yard of pumping house ⇒ clayey sediments

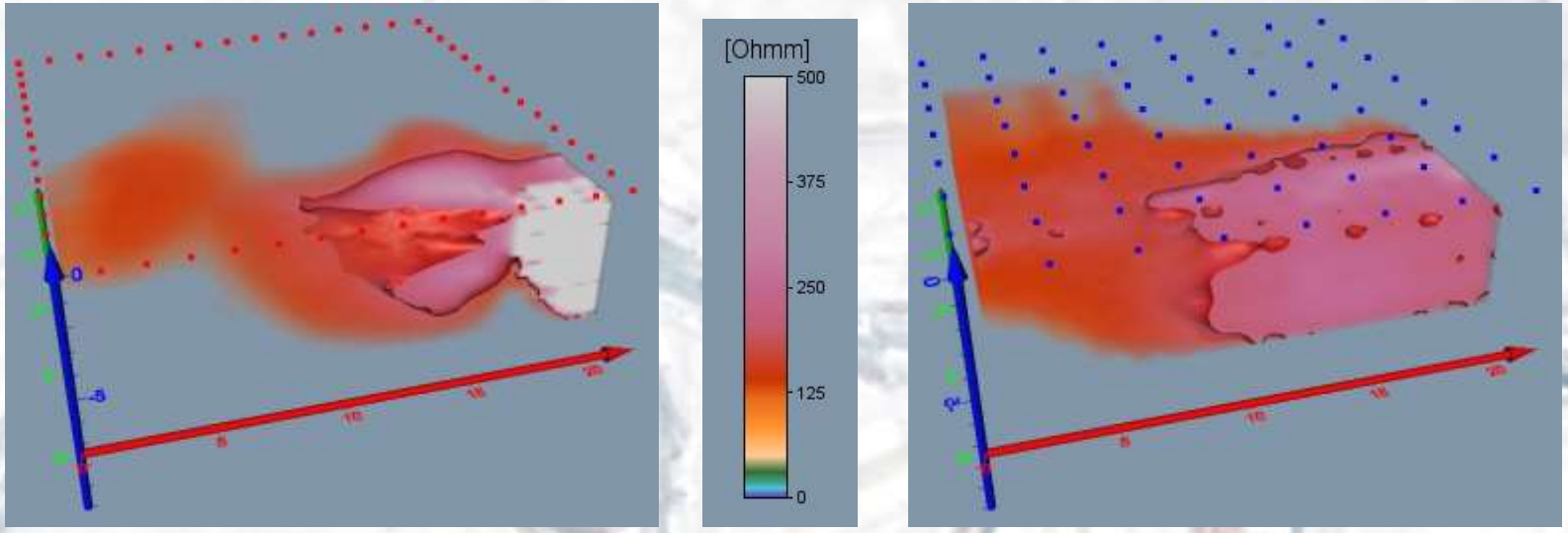
Research area (2)

- hunting-stand concentrated mapping of sand boil
- 2 array type and 2 different electrode settings for find the deepest penetration with highest resolution
- first setting of measurment was square profile with 56 electrodes (1.5 m spacing) and another one far away from the area
- second 3D measurement performed in net-shape with 3 m electrode spacing



Pole-dipole
Mixed gradient and dipole-dipole

Results (2)



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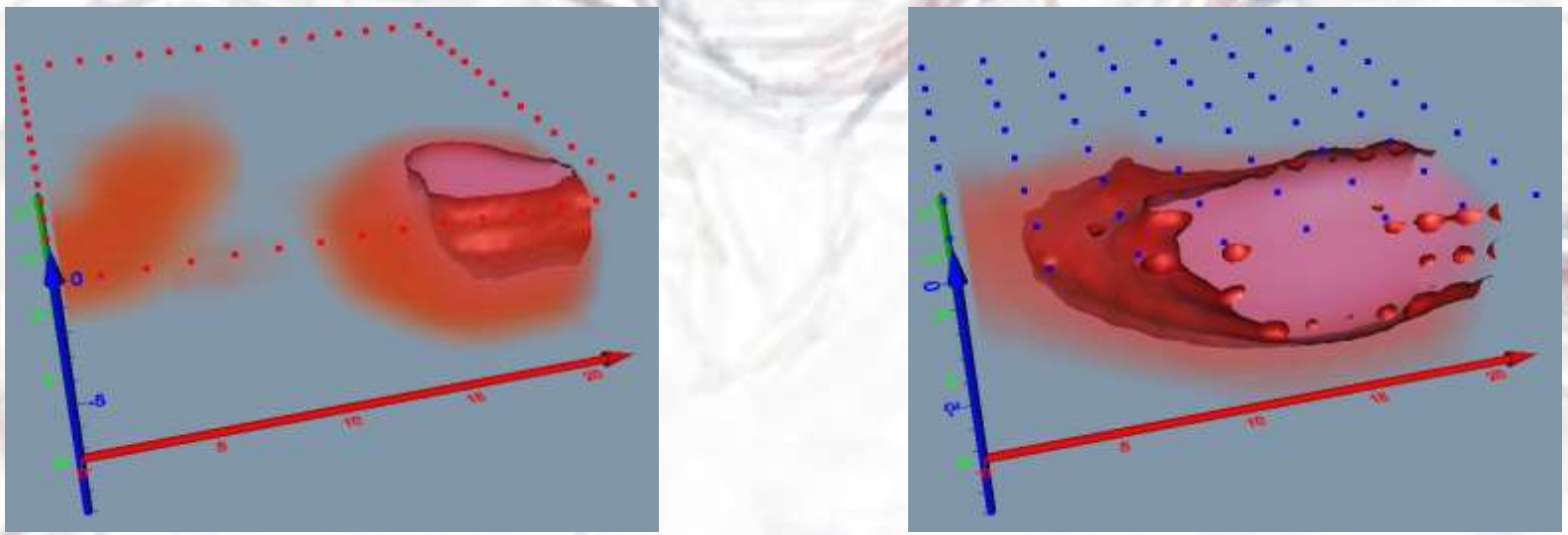
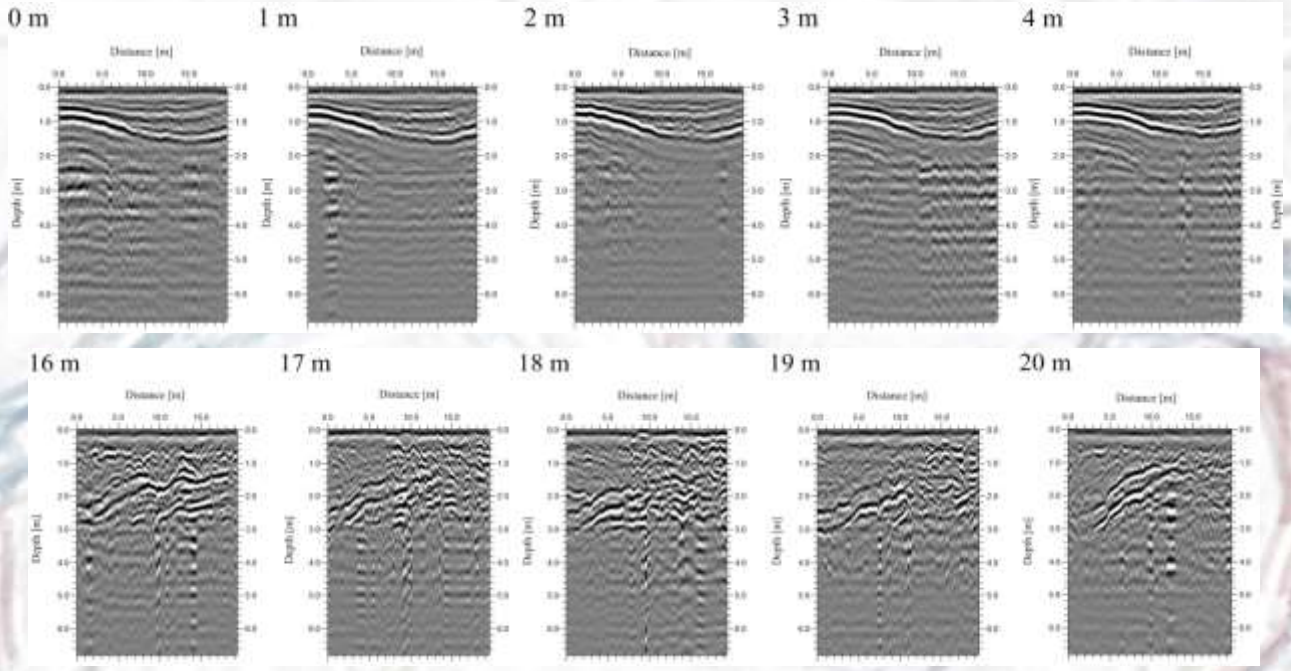


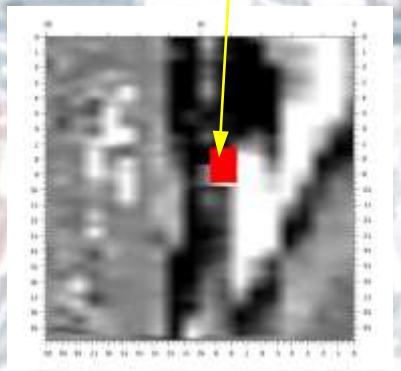
Pole-dipole

Research area (2)

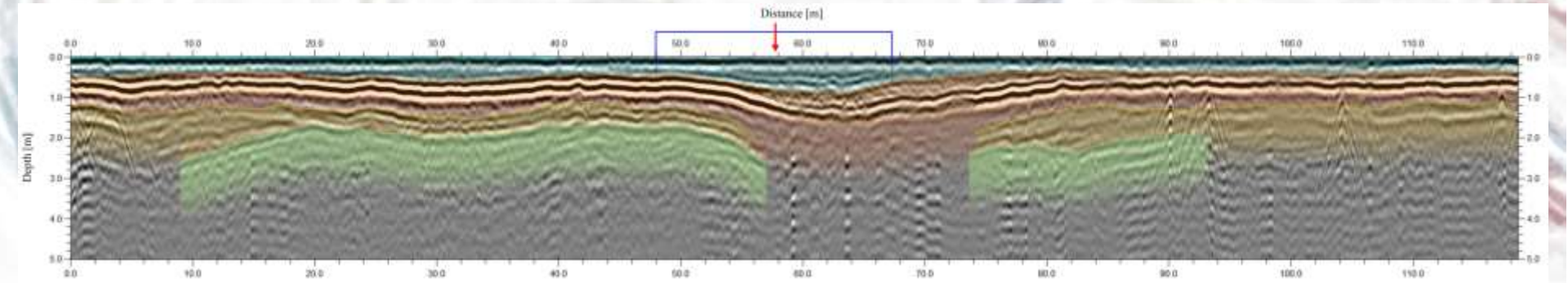
- GPR survey was performed in parallel lines with 1 m spacing (area size: 20 m x 20 m)
- Data collected with SIR-3000 and 200 MHz antenna
- 120 m long control line between study area and levee

Results (2)





Depth 1.3 m



Conclusion

Pumping-house (area 1)

- high permitivity zone could be detected in B1 and B2 lines
- 3D result can help to determine the changes in surround of sand boil
- Based on these results we could propose sites of CPT and borehole spots
- GPR sections show a lot of cracking nearby sand boil

Hunting-stand (area 2)

- net-shape electrode setting with dipole-dipole array type give us optimal depth of penetration and good data
- found a high reflection continuous layer in nearsurface
- the deeper layer (with lower reflection) interrupted

Thank you for your attention!