68th EAGE Conference in Vienna

Subsurface Geophysical Surveys to Civil Engineering, Geotechnical and Environmental Applications

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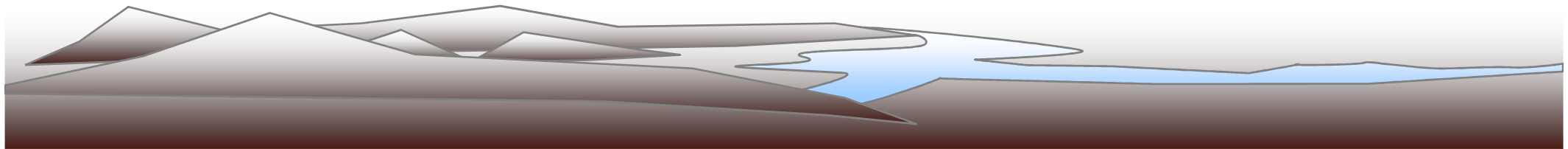


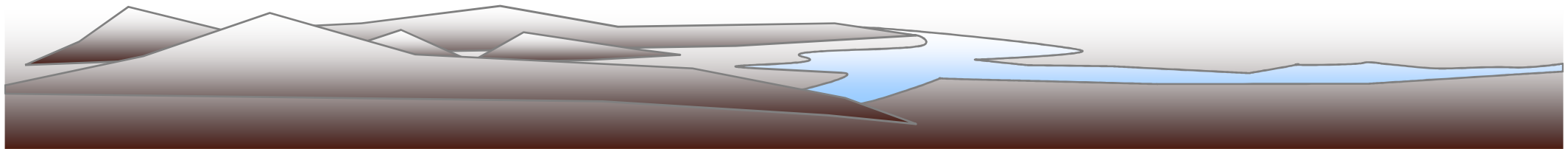
Geophysics to subsurface applications

PBG geophysical services

- soil investigations
- pre-investment recognition of building foundation
- groundwater prospecting
- investigation of soil and groundwater pollution
- detection of buried man-made objects

(related to the paper scope and the scope of the Session/Conference)

- detection of underground voids and caverns
- investigation of landslides and slopes
- evaluation of stability of dams and dikes



ERT method

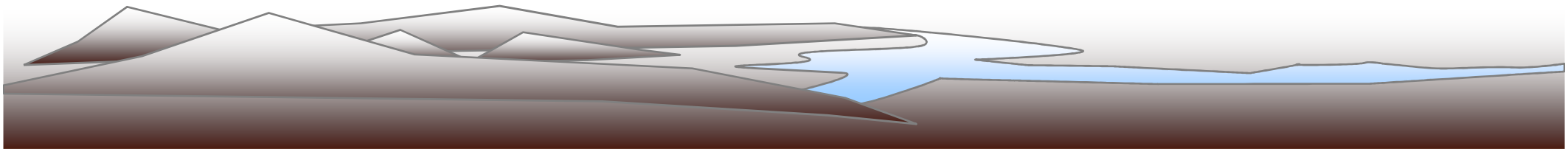
Electric Resistivity Tomography (ERT) method:

- multi-horizontal resistivity profiling of the subsurface
- called also resistivity imaging
- automated acquisition of field data (2D or 3D)
- advanced processing and interpretation procedures

- used in Poland for several years (AGH University of Science and Technology, PBG, Geofizyka Toruń)

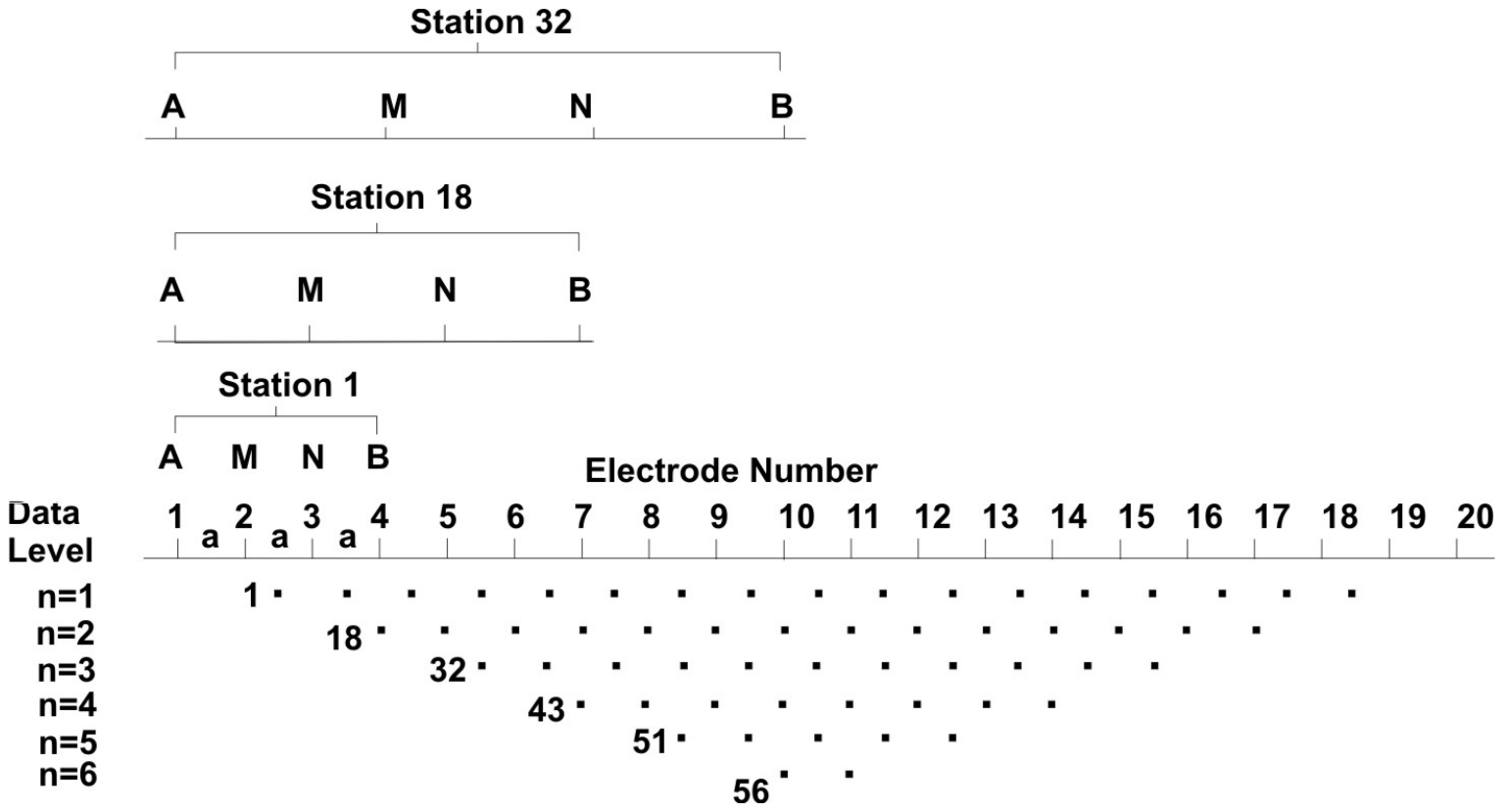
- depth range up to a couple of dozen meters (depending on soil lithology, saturation)

- Equipment: ARES, Resistivity Tomography System by GF Instruments



ERT acquisition scheme

The spread is moving along the profile and the electrode spacing is being increased for successive data level (depth horizon)

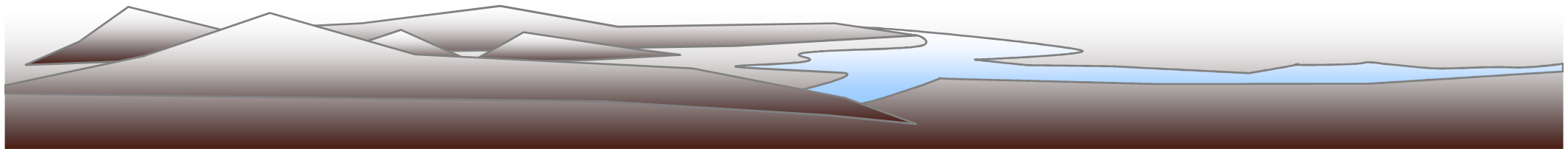


EM conductivity method

Electromagnetic (EM) Conductivity method:

- imposed, alternating magnetic field generates a secondary magnetic field in soil (a component of EM field)
- strength of the generated field is proportional to electrical conductivity of soil
- the measurement system consists of a transmitter coil (antenna), a receiver coil and a control unit
- usually apparent conductivity (reciprocal - resistivity) and in-phase (imaginary part of phase – relates to magnetic properties of investigated features) values are measured
- depth range is usually up to six meters (depending on soil saturation, composition, compaction, salinity of pore water)

- Equipment: CM Conductivity Meter by GF Instrument



Case study on engineering/geotechnical

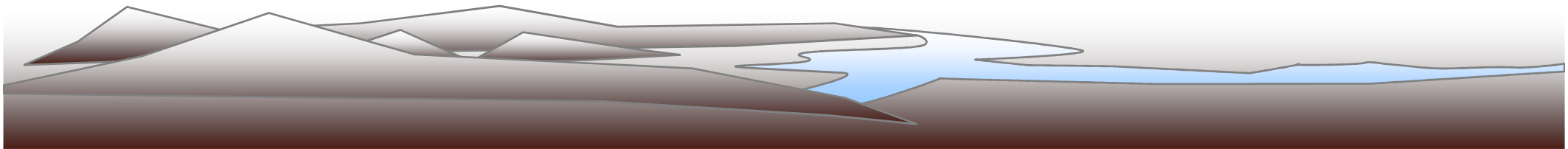
- the goal is detecting hydrogeological windows in a sealing layer of clay

- the layer separates two aquifers

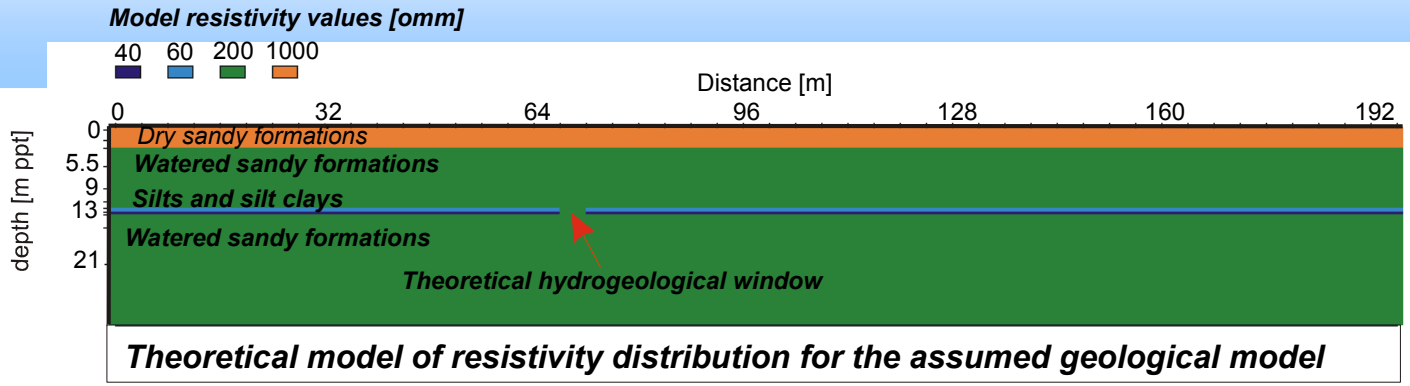
- a multi-storey office building is to be located at the studied area

- in case two aquifers are interconnected (through the windows) a constant and sufficient water supply is ensured

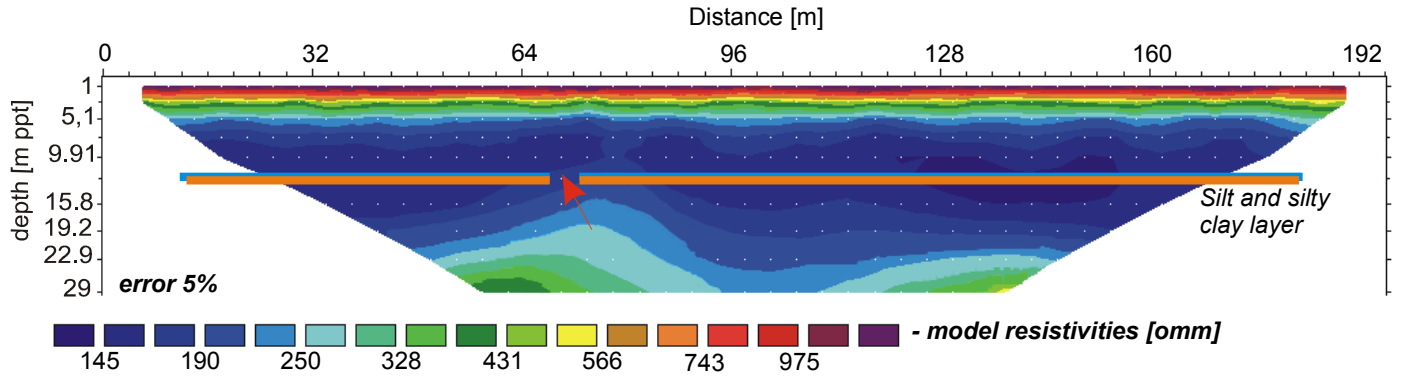
- ERT method was selected to solve the question, but field measurements were preceded by synthetic modelling



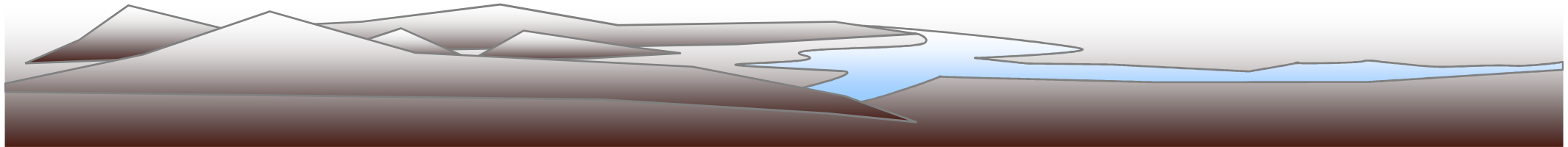
ERT synthetic example



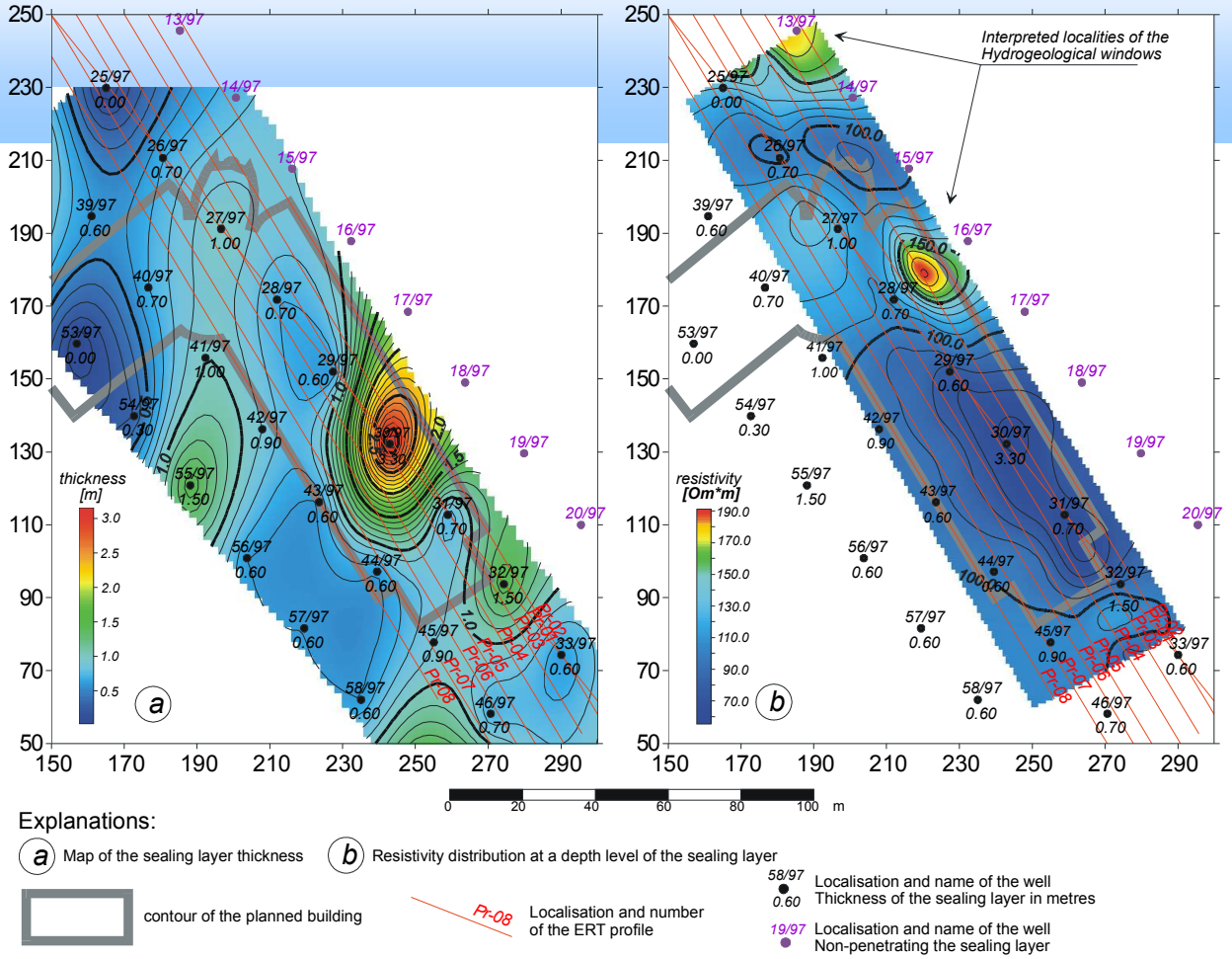
Theoretical model of resistivity distribution for the assumed geological model



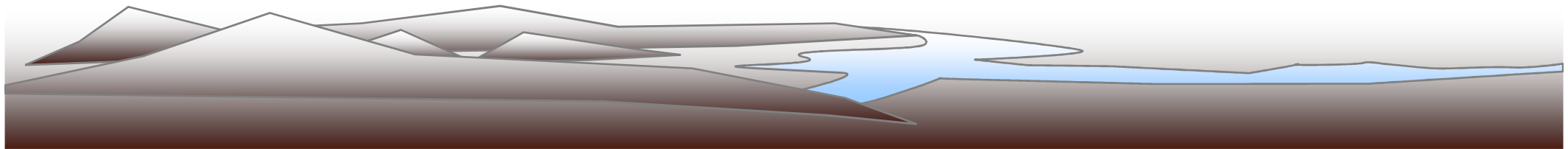
Resistivity distribution after four succeeding iterations



ERT survey



Increased resistivity anomalies (right) match hydrogeological windows after drillings. The slice is at average depth of the sealing layer According to drillings.



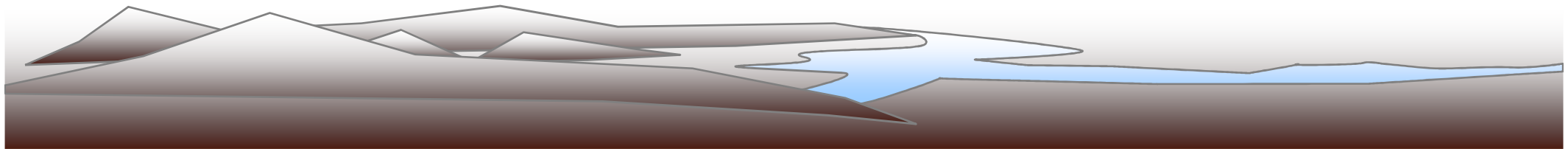
Environmental case study

- There were two goals to be achieved using EM conductivity survey:

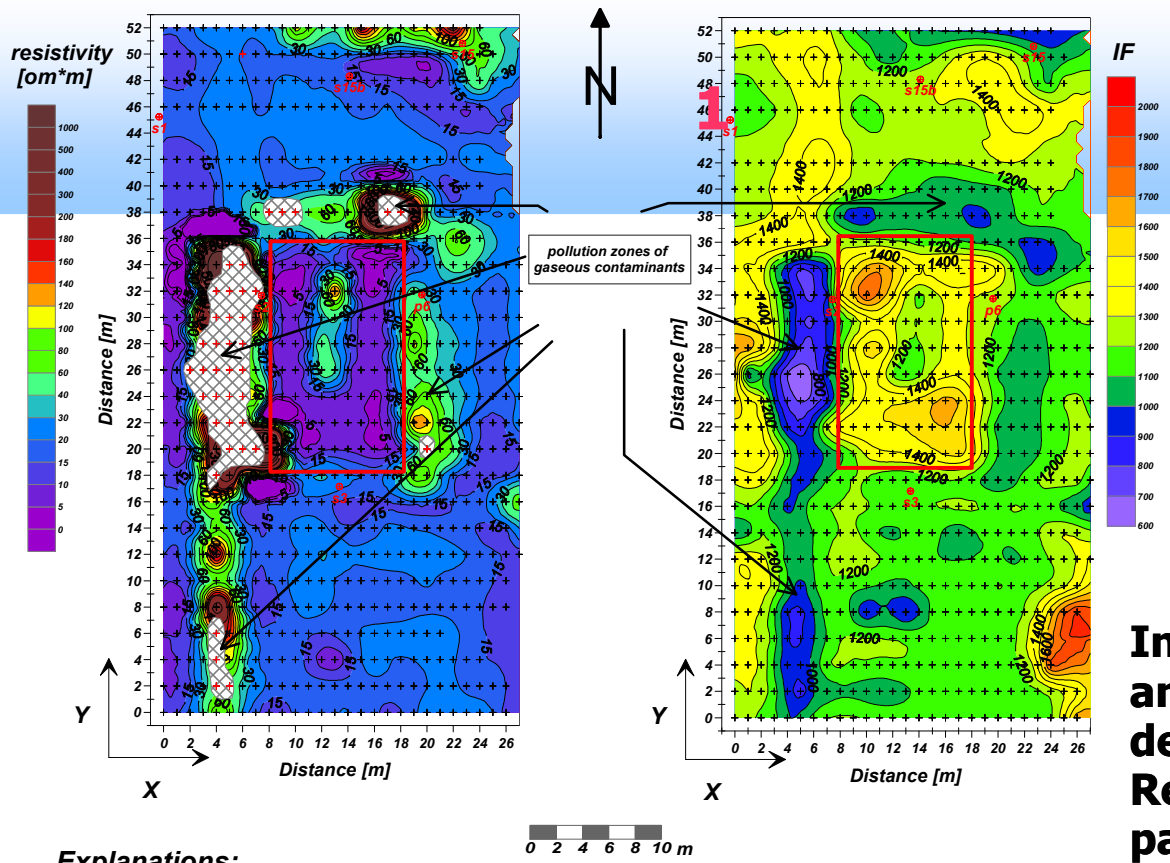
- first, localisation of areas where hydrocarbon (gas pitch) contamination is present,

- second, localisation of a concrete, underground gas pitch storage, which (leaks) may be a contamination source to surrounding soil.

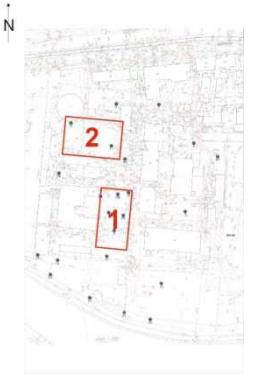
- The measurements were conducted in a rectangular grid (where feasible), over area where gas pitch contamination of soil was found in piezometers



EM conductivity survey



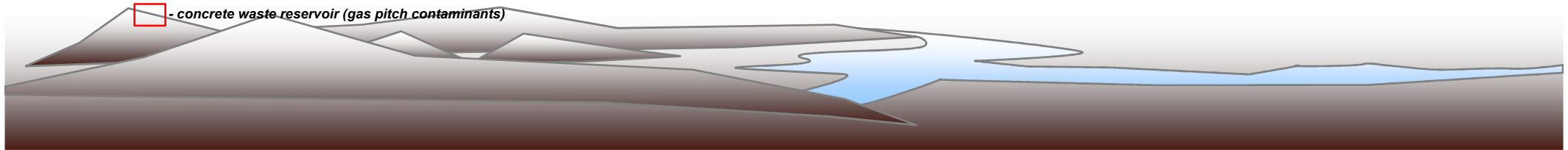
Old gas works



Increased resistivity anomalies (left) and low IF parameter zones (right) denote gas pitch contamination. Rectangular shaped anomaly in central part (low resistivities and high IF values) match concrete reservoir outline. Gas pitch contamination leaks from the reservoir, as confirmed by piezometers.

Explanations:

- *measurement stations (penetration depth up to 6 metres b.t.s.).*
- *rejected measurement stations (>10 000 om*m, out of the reading range likely due to pollution presence)*
- S1 *- piezometers*
- *zones of resistivities exceeding the instrument reading range (polluted soil)*
- *concrete waste reservoir (gas pitch contaminants)*



EM conductivity survey

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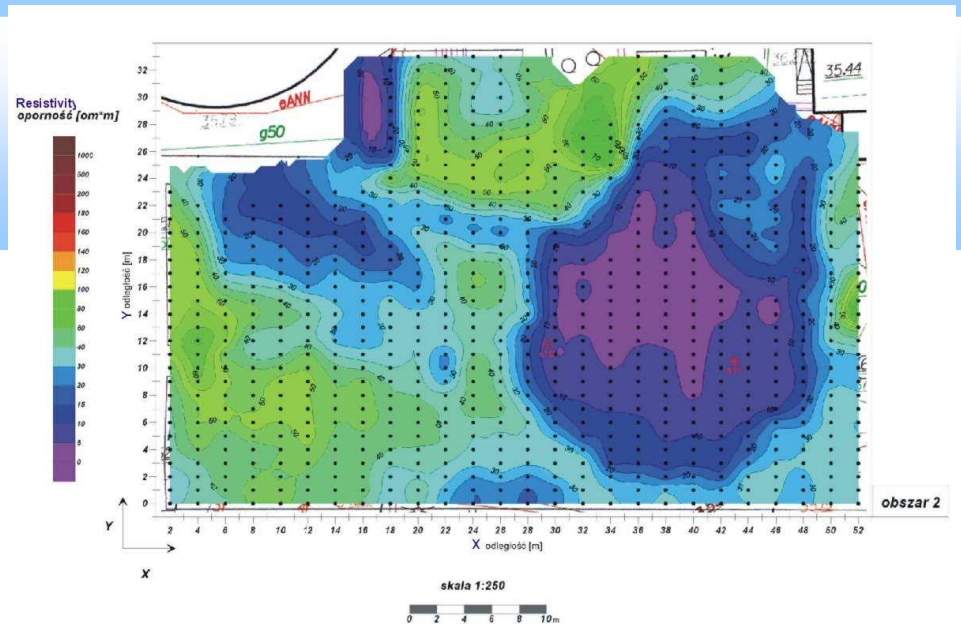
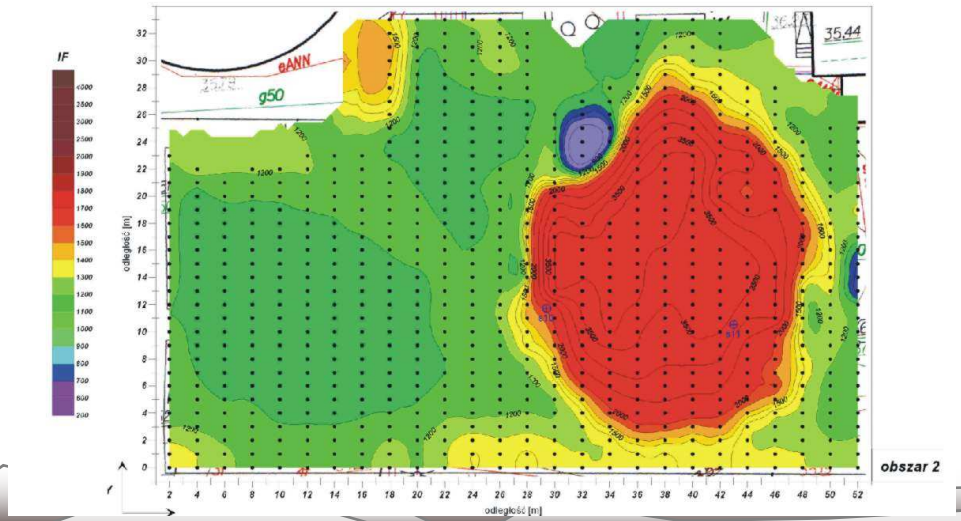
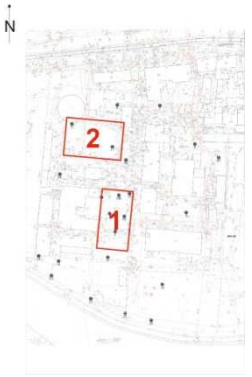




Old gas works



Increased resistivity anomalies (top) and low IF parameter zones denote gas pitch contamination. Oval shaped anomaly in right part refers to a concrete reservoir (gas pitch storage) outline. The leak has been confirmed by wells.

Conclusions

- ERT method has proven to be successful in detecting hydrogeological windows, aquifers and sealing layers

- The use of horizontal resistivity sections is very useful to recognise hydrogeological conditions and design drilling of new wells

- EM conductivity method is an efficient tool to detect hydrocarbon contamination and underground, concrete installations