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EUROPEAN UNION
North-West Europe
RAWFILL
European Regional Development Fund

Co-funded by the Walloon region

Introduction to Electrical Resistivity Tomography (ERT) and Time-Domain Induced Polarisation (TDIP or IP)

Principles: Target properties

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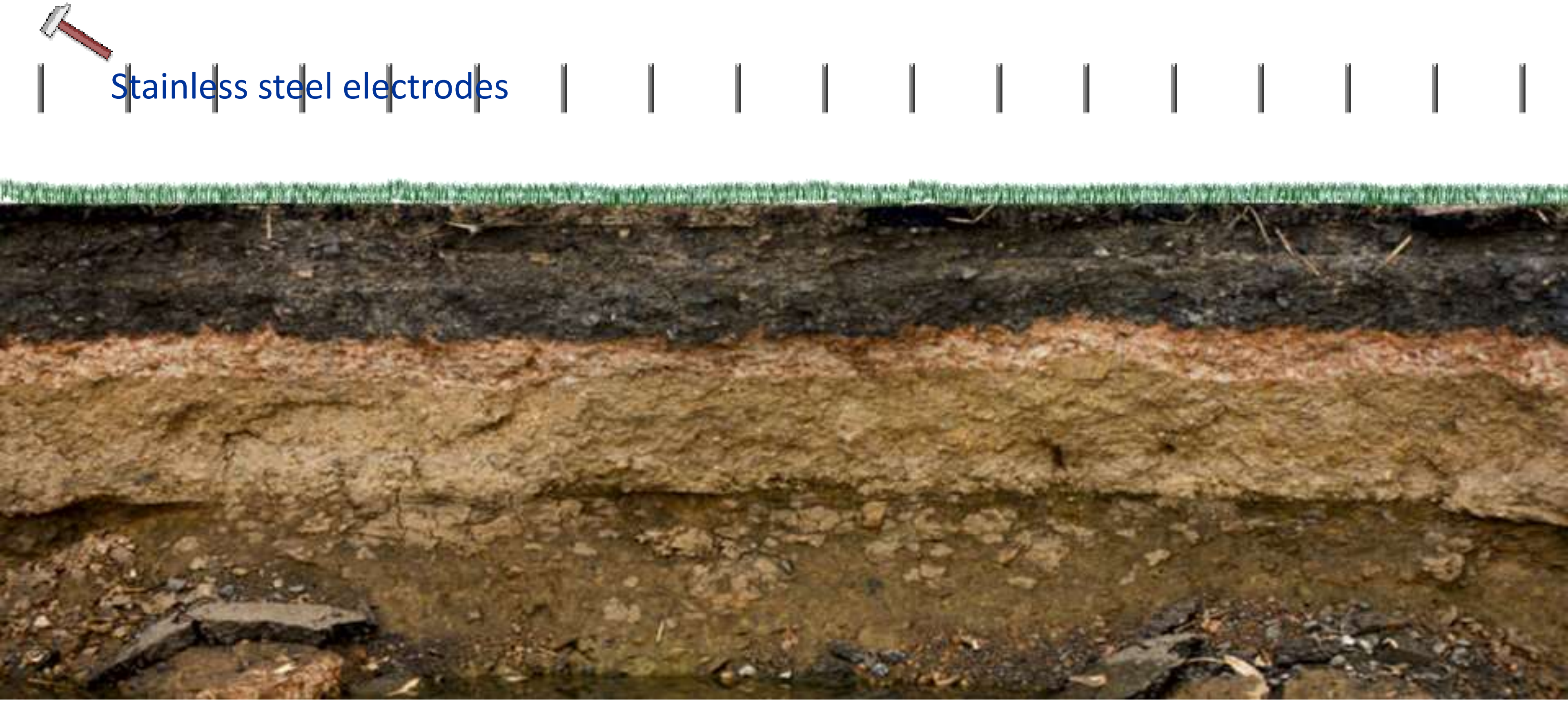
Electrical Resistivity Tomography (ERT)	Time-Domain Induced Polarisation (TDIP or IP)
Target property: Electrical resistivity, ρ (Ohm.m) Quantifies the resistance of a material to the passage of an electric current.	**Target property: Electrical chargeability, m_a (mV/V)** Quantifies the electrical energy storage of a material
Sensitive to: water/fluid content of a soil, porosity, lithology, salinity	**Sensitive to:** clay/metal/(plastic) content, lithology

Principles: Data acquisition



Principles: Data acquisition

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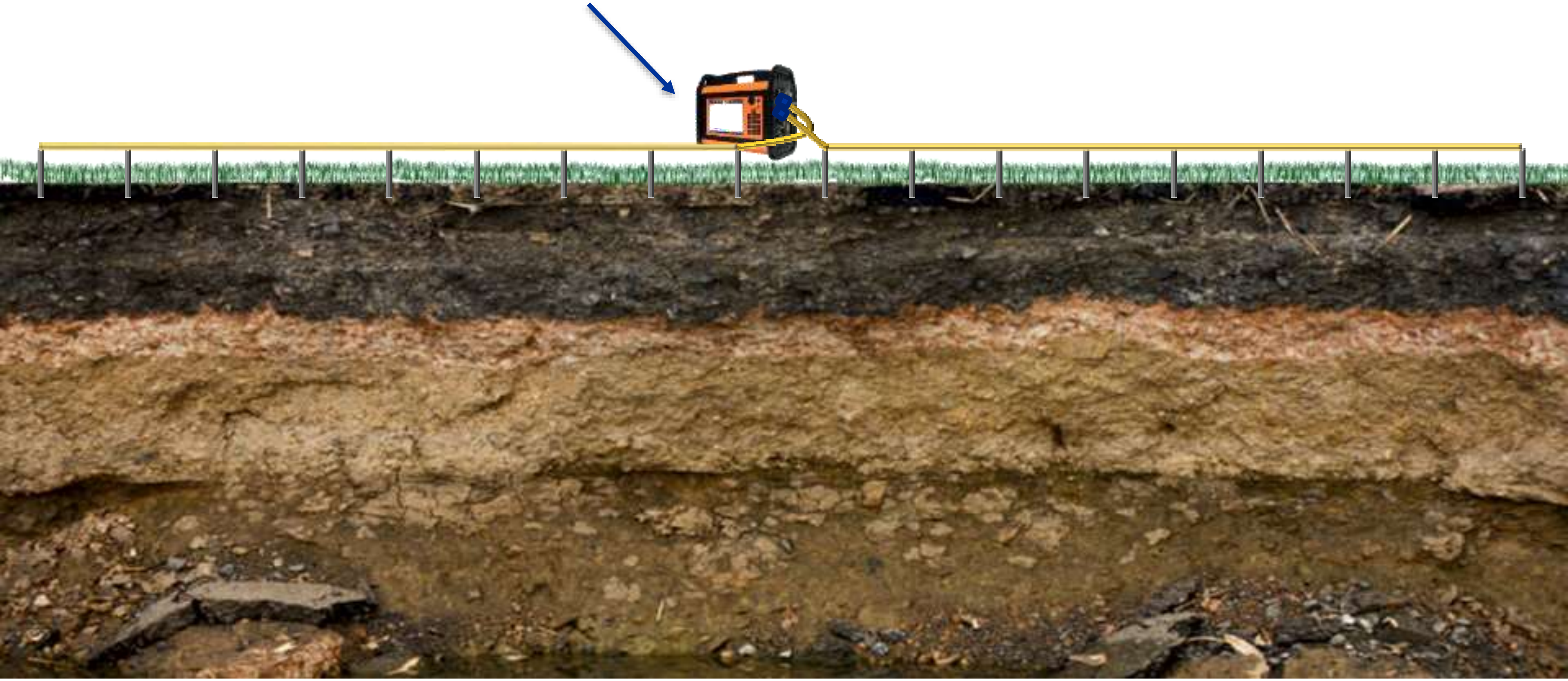

Principles: Data acquisition

Injection of a current of known intensity, I, at electrodes A and B

Principles: Data acquisition

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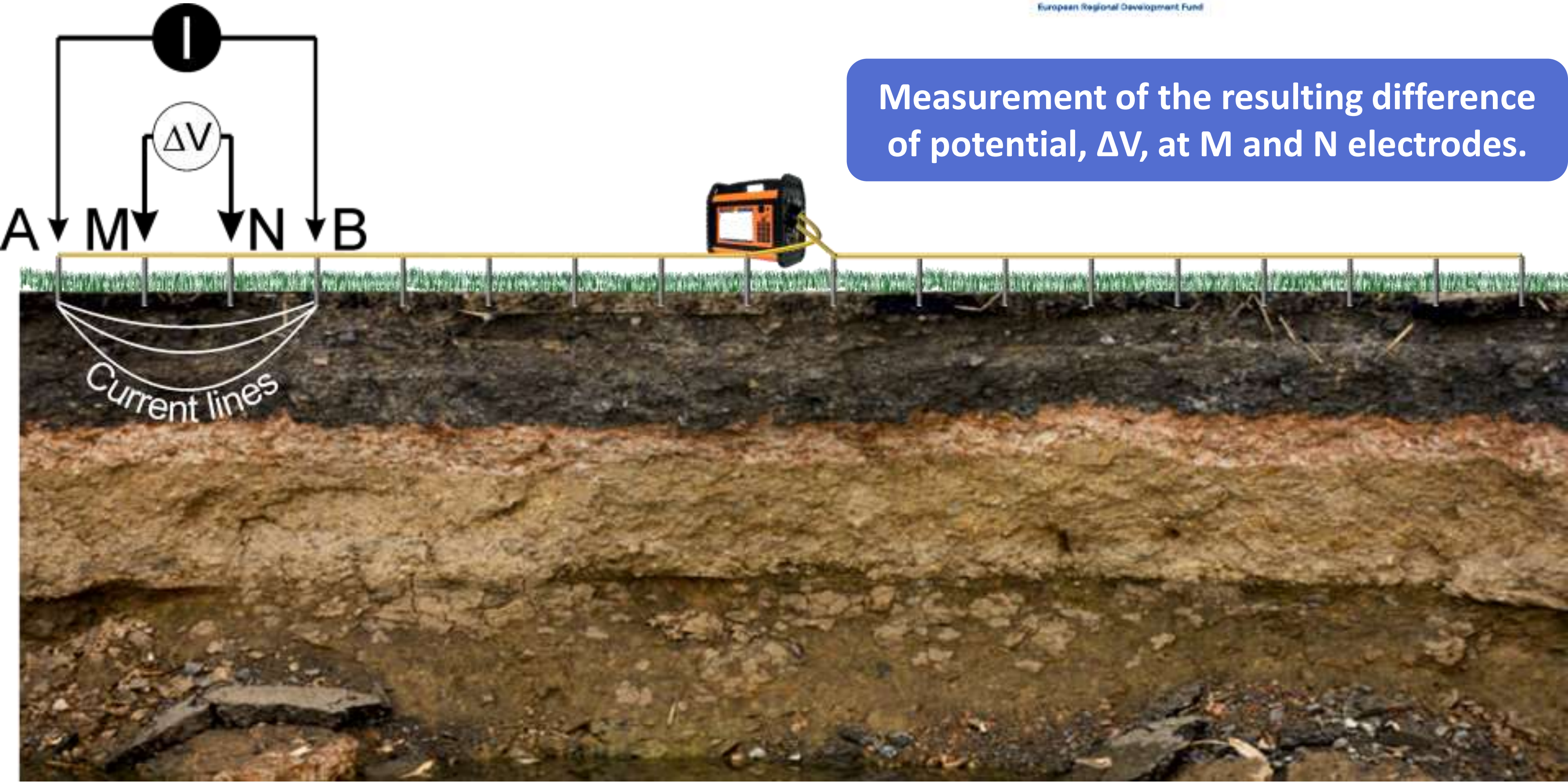
Measurement of the resulting difference of potential, ΔV, at M and N electrodes.



Principles: Data acquisition

ERT

Ohm's law:

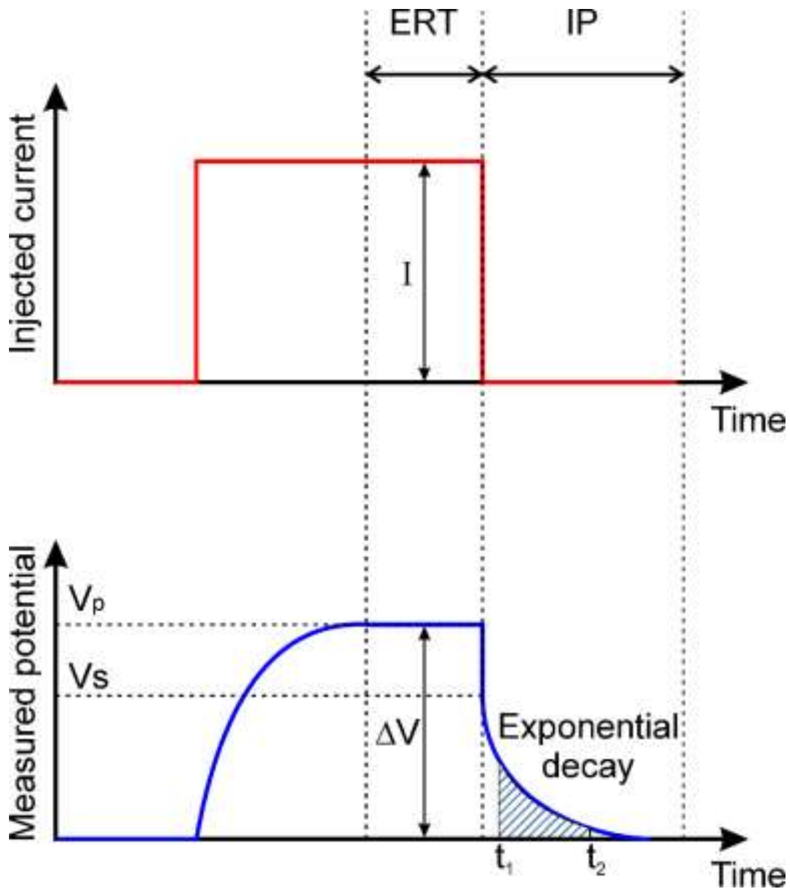
Electrical resistance: R (Ohm)

$$R = \frac{\Delta V}{I}$$

(Time-domain) IP

Apparent chargeability: $m_a \left(\frac{mV}{V}\right)$

$m_a = \frac{V_S}{V_p}$ and $m_a = \frac{1}{V_p}\left(\frac{1}{t_2 - t_1}\right)\int_{t_1}^{t_2} V(t)dt$



Principles: Data acquisition

Principles: Data acquisition

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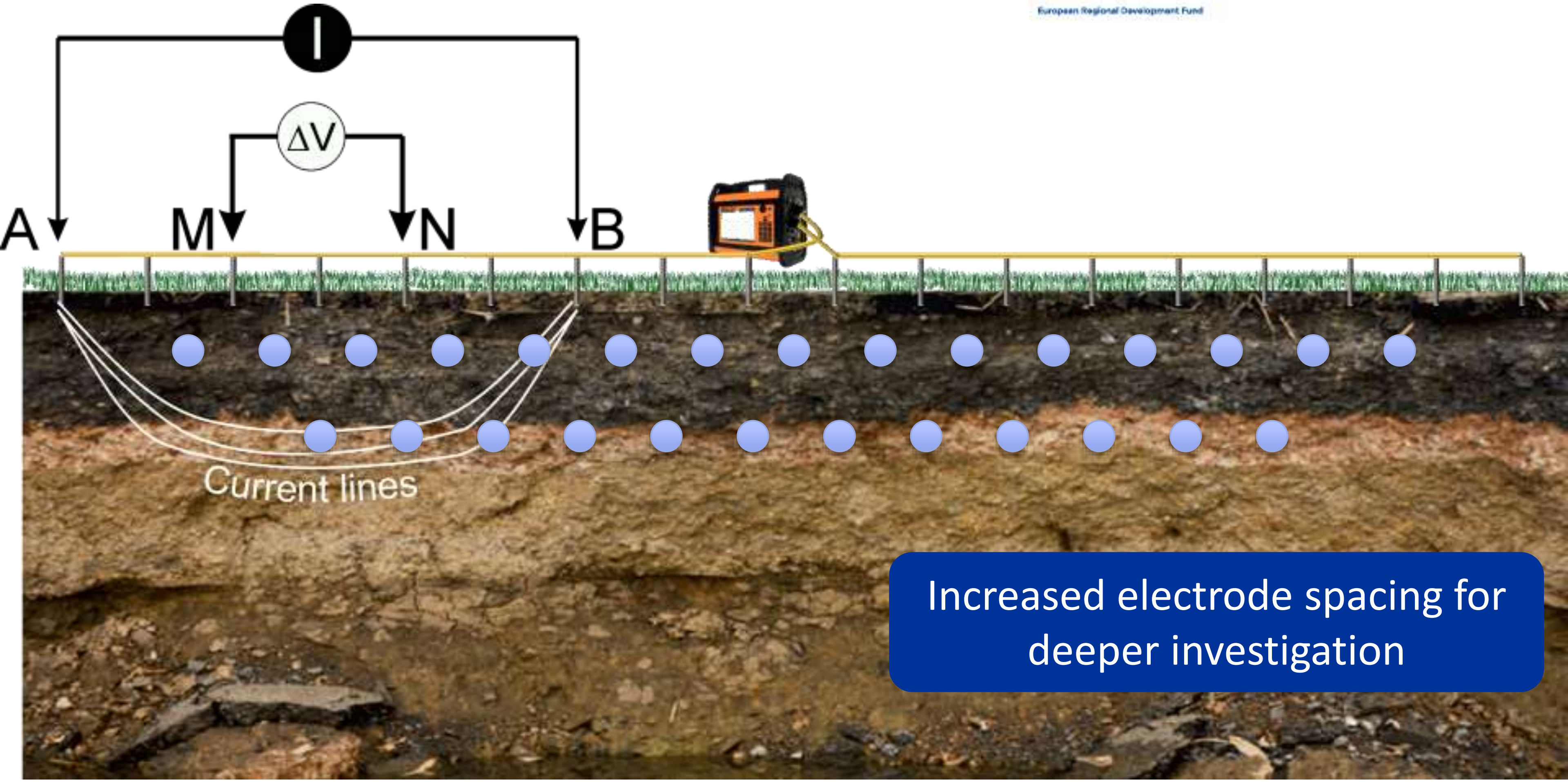
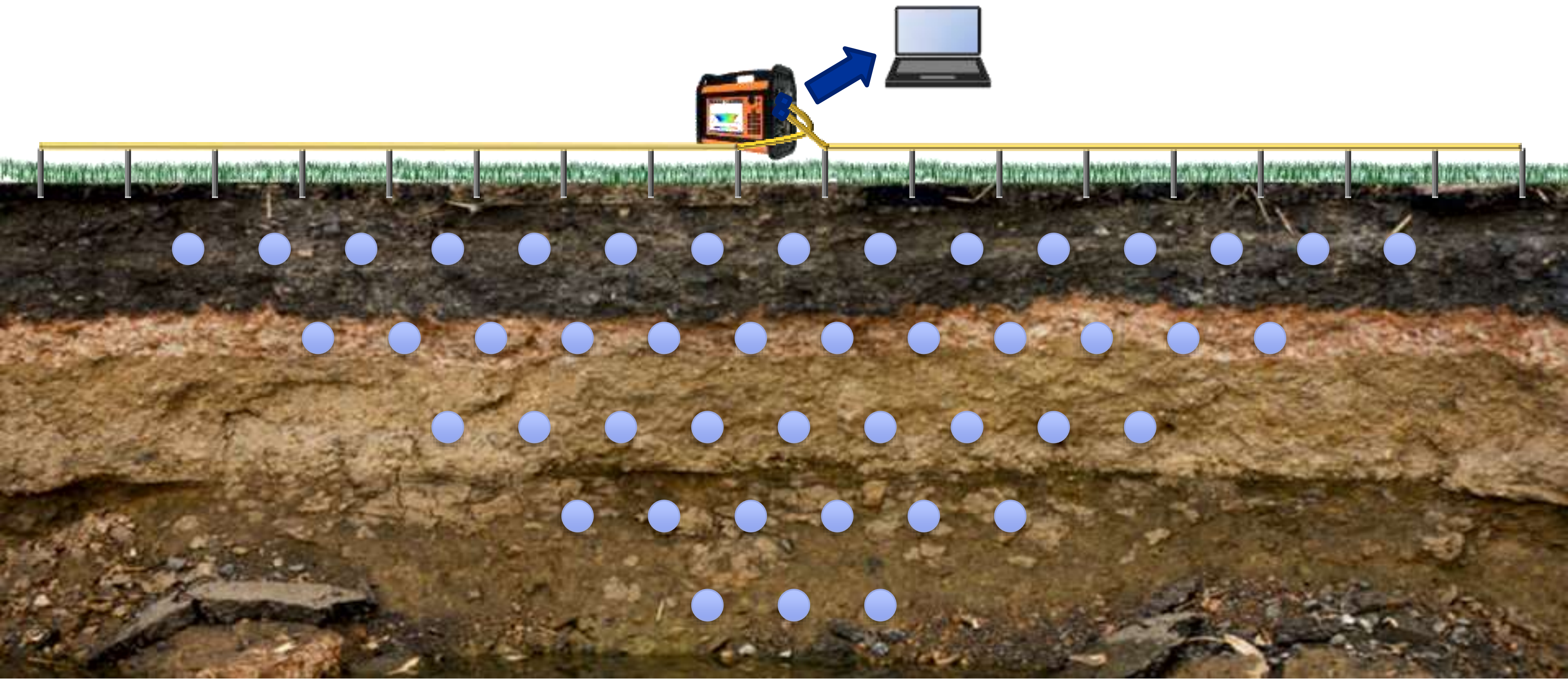


Increased electrode spacing for deeper investigation

...

Principles: Data acquisition



Principles: Data acquisition

At the end:

File uploaded from the resistivimeter

Electrical resistance R (Ω)

A	B	M	N		
1	4	2	3	0.0105782	6.368
2	5	3	4	0.081776	14.321
…					
1	19	7	13	0.075812	13.214

Electrode configuration

Apparent chargeability m_a (mV/V)

Sufficient to directly infer intrinsic soil electrical properties??

↓

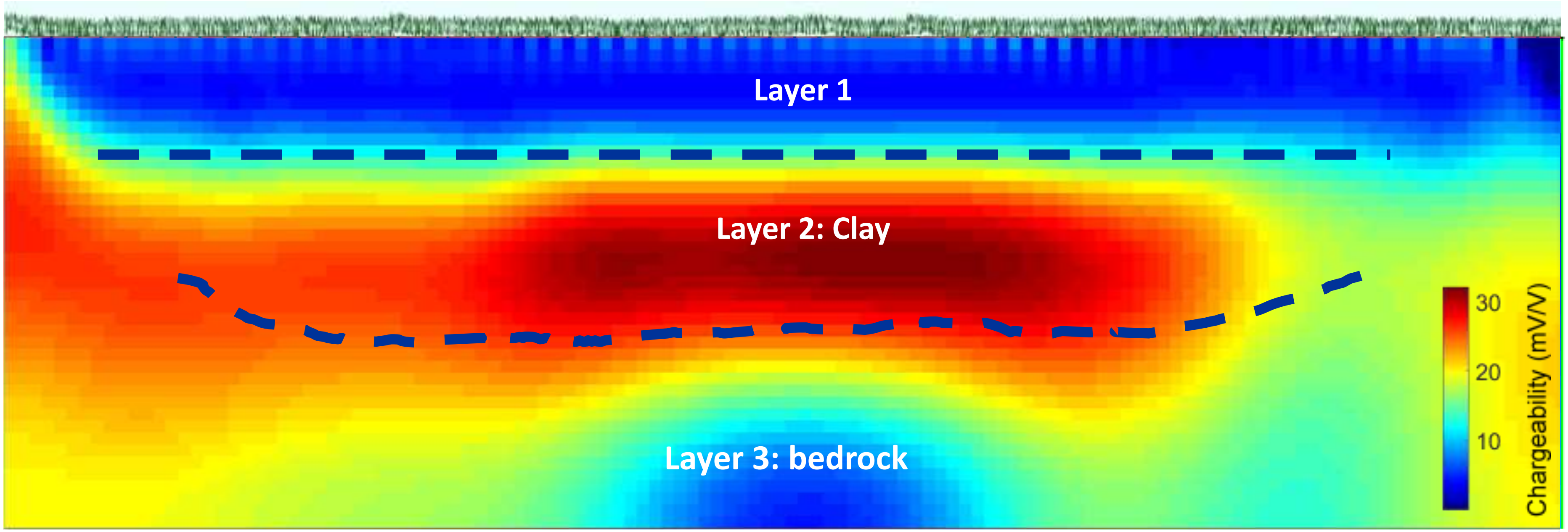
No! Because R≠ρ and $m_a \neq m$

↓

Inversion

Principles: Interpretation

- Detection of 3 layers with contrasting electrical properties
- Loss of resolution in depth and on the edges of the model



Practical considerations

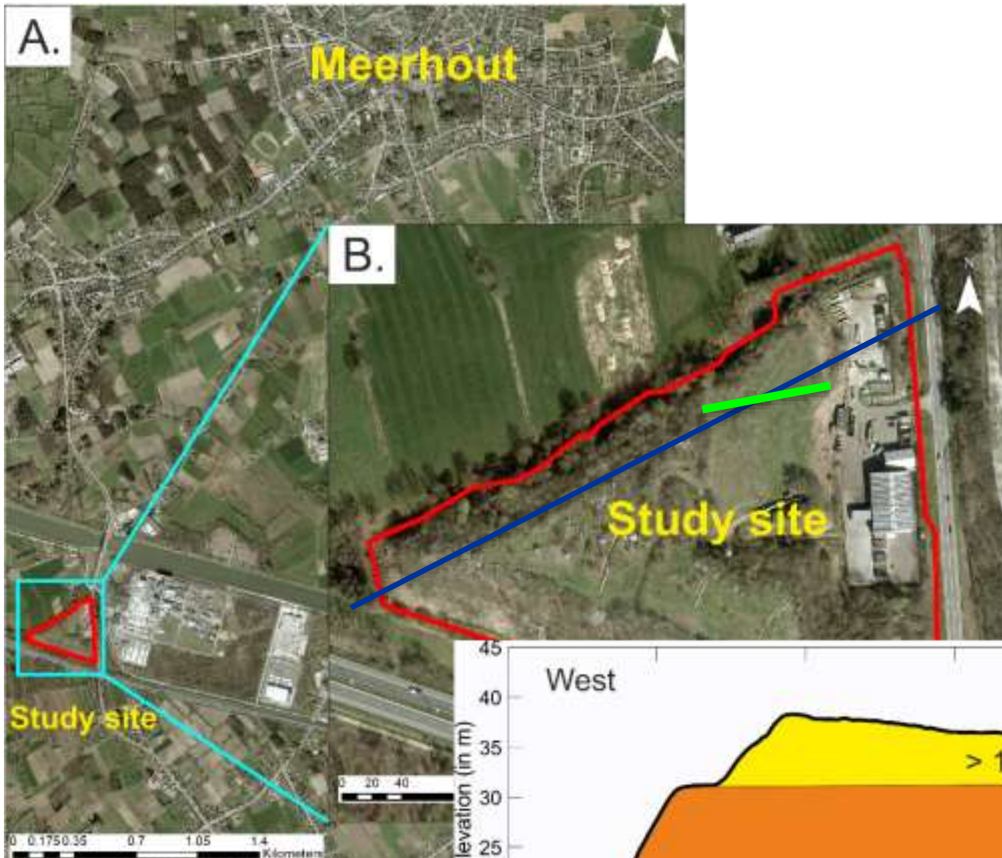
- Like all "surface" geophysical methods, ERT and IP suffer from limited depth of investigation and loss of resolution with depth
- Very important to ensure good quality of data and to quantify it
- Always appraise the reliability of models

Pre-investigation design, feasibility and appraisal studies should always be conducted to test different survey conditions and configurations

Applications

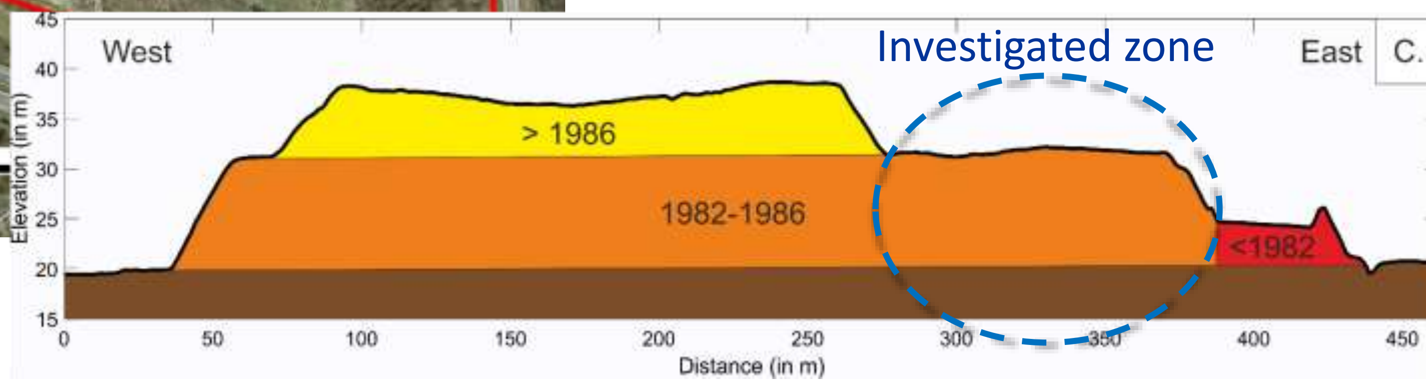
Landfill characterization

Meerhout landfill



ERT and IP profile:

- 110 electrodes spaced by 0.75 m
- Electrical current injection was setup to 2 s (delay of 0.8 s and acquisition of 1.2 s) and voltage decay was measured for 2 s after current shut down
- Dipole-Dipole with 'n' factor limited to 6



Meerhout landfill

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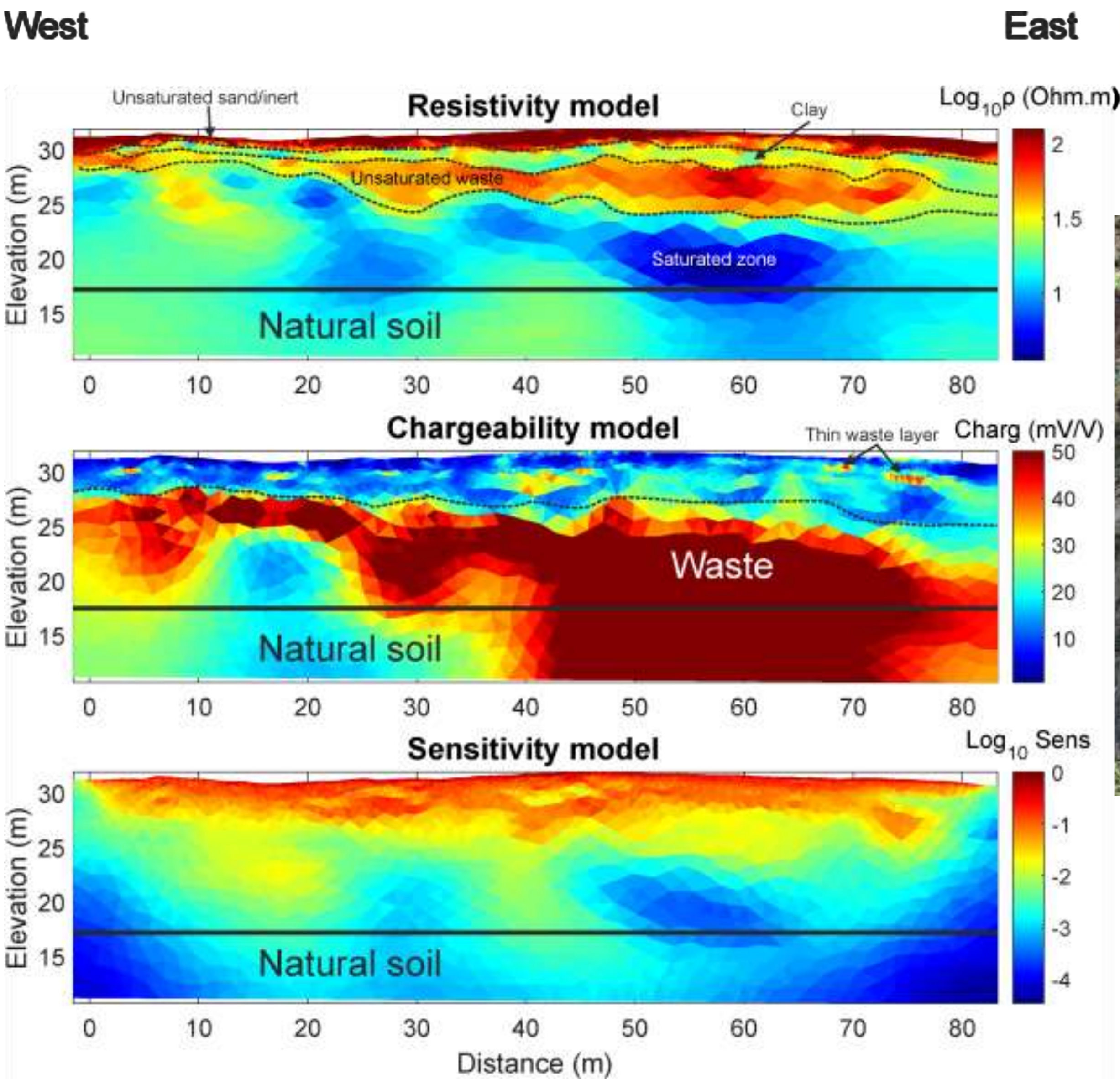
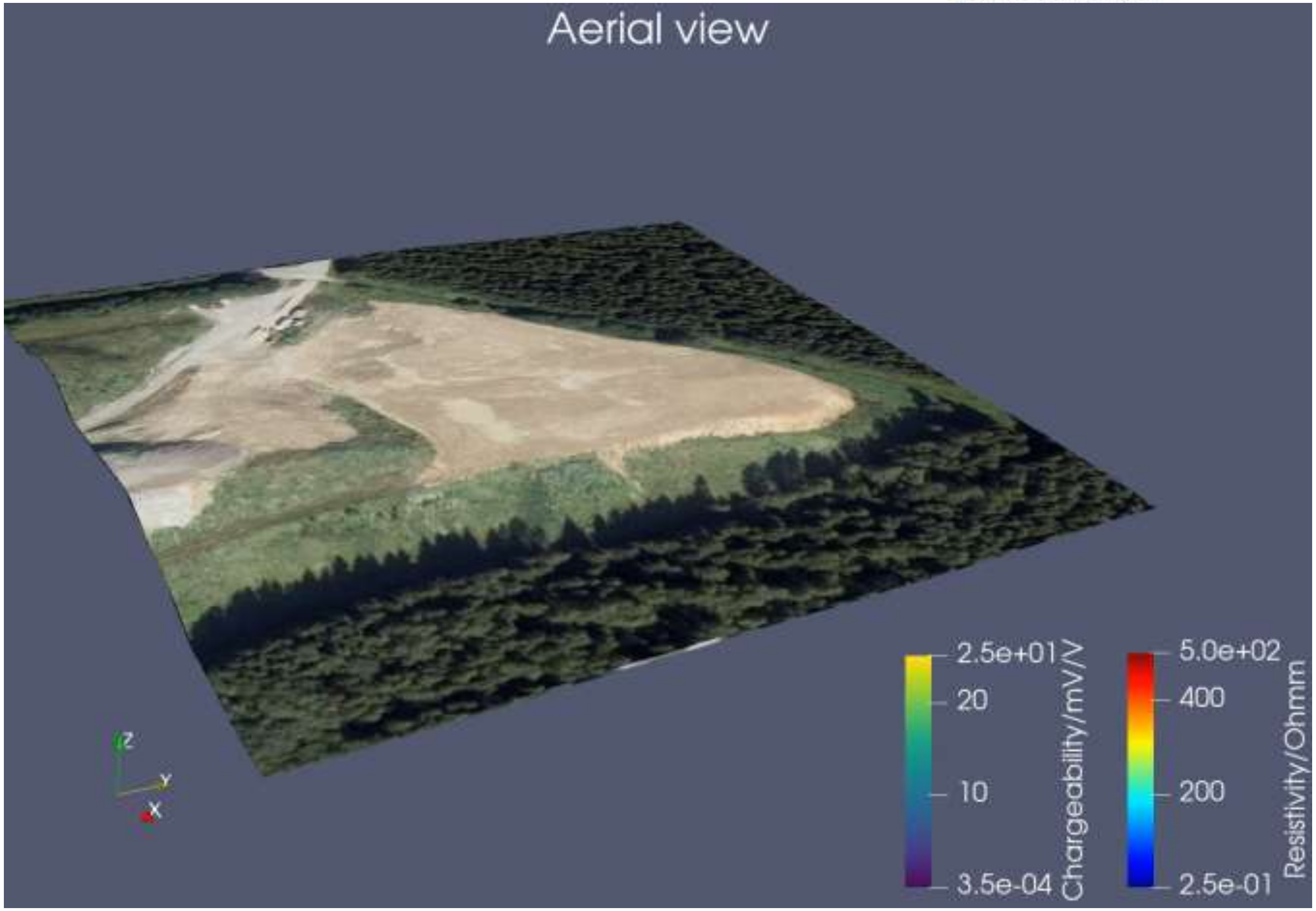
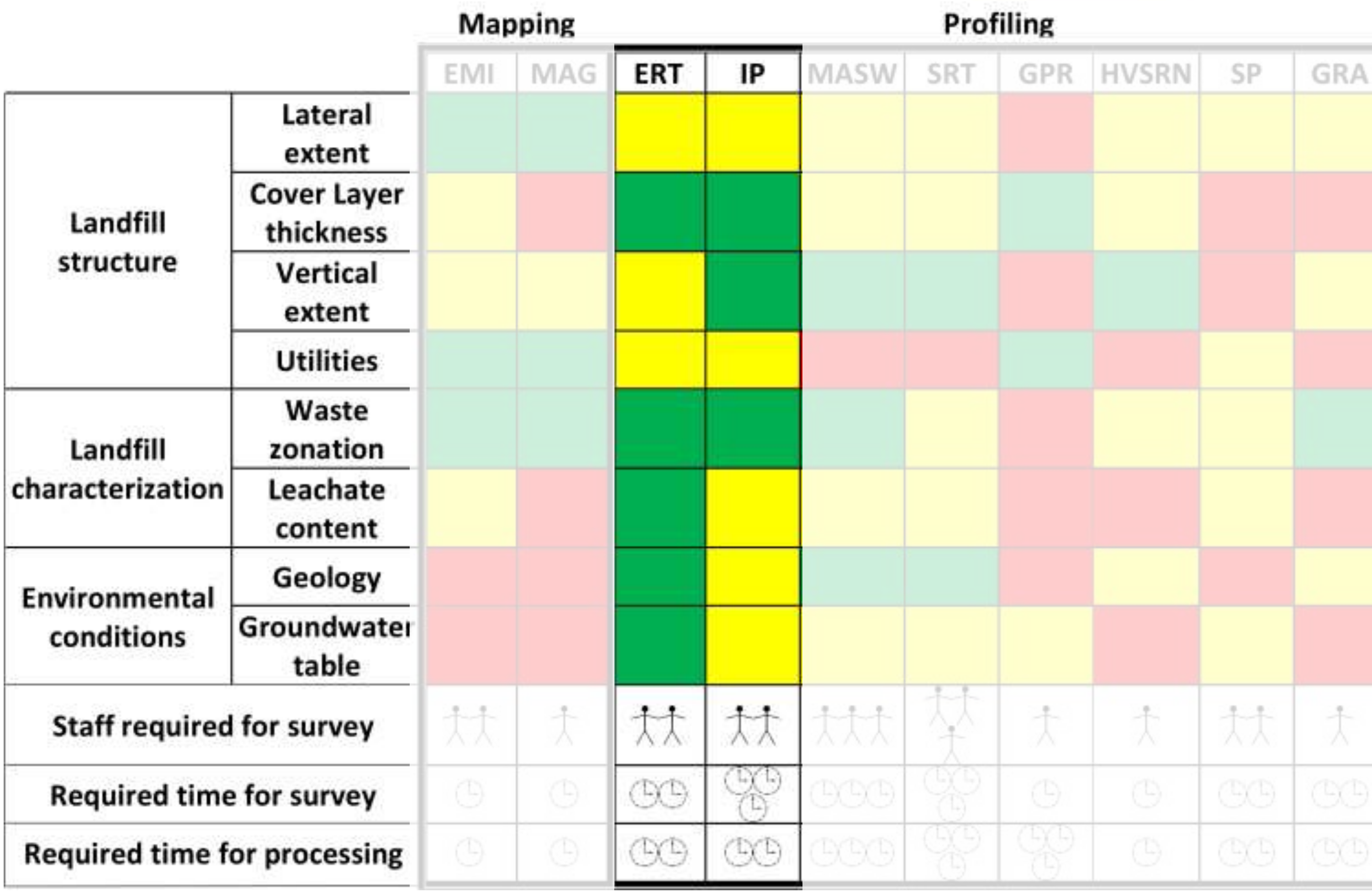


From 2D to 3D…


Aerial view
2.5e+01
20
10
3.5e-04
Chargeability/mV/V
5.0e+02
400
200
2.5e-01
Resistivity/Ohmm
Z
Y
X

Conclusions

Summary of application on landfills



Pro and cons

ERT
• Simple and robust
• High variability of electrical resistivity
• Cost-effective
• Sensitive to water content
• 2D, 3D and 4D images
• Non-unicity
• Non-trivial modelling
• Geological overlap

IP
• Detection of disseminated minerals
• Sensitive to clay and metal particles/objects
• Potential for quantification
• 2D, 3D and 4D images
• Same disadvantages as ERT
• Electrochemical phenomena are not yet well understood
• IP measures are slower and more expensive than ERT measures.

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Thank you!