Detailed 3D geological modelling at a contaminated stream using DC & TD SIP, geological and chemical data

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Acknowledgesments

Advancing GEOlogical, geophysical and CONtaminant monitoring technologies for contaminated site investigation.

Research institutions

DTU

AARHUS UNIVERSITET

GEUS

LUND UNIVERSITY

universitätbonn
Rheinische Friedrich-Wilhelms-Universität Bonn

KU THE UNIVERSITY OF KANSAS

Industry partners

Region Syddanmark

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ORBICON

Funding

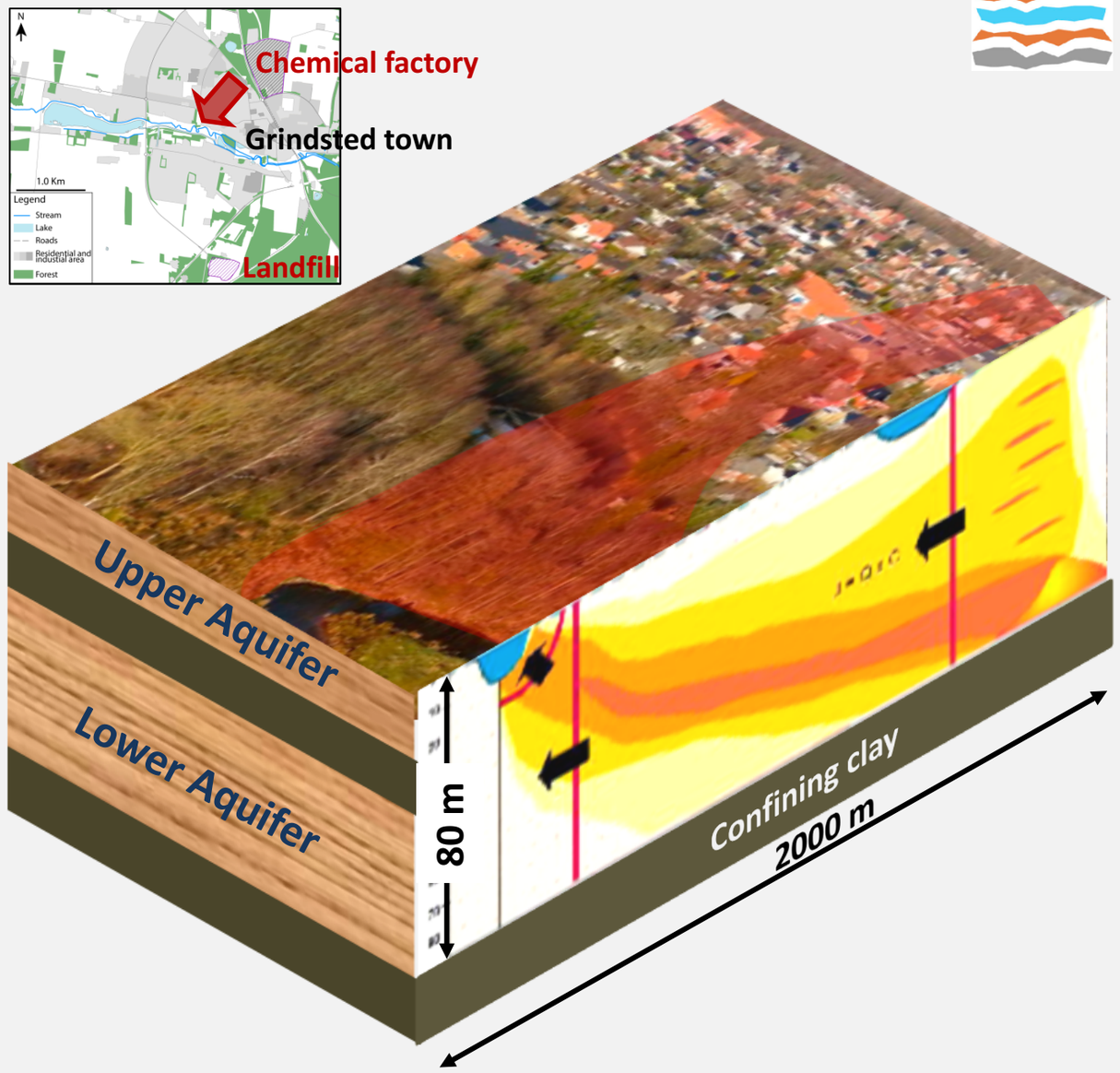
Innovation Fund Denmark

Innovation Fund Denmark

Background and motivation

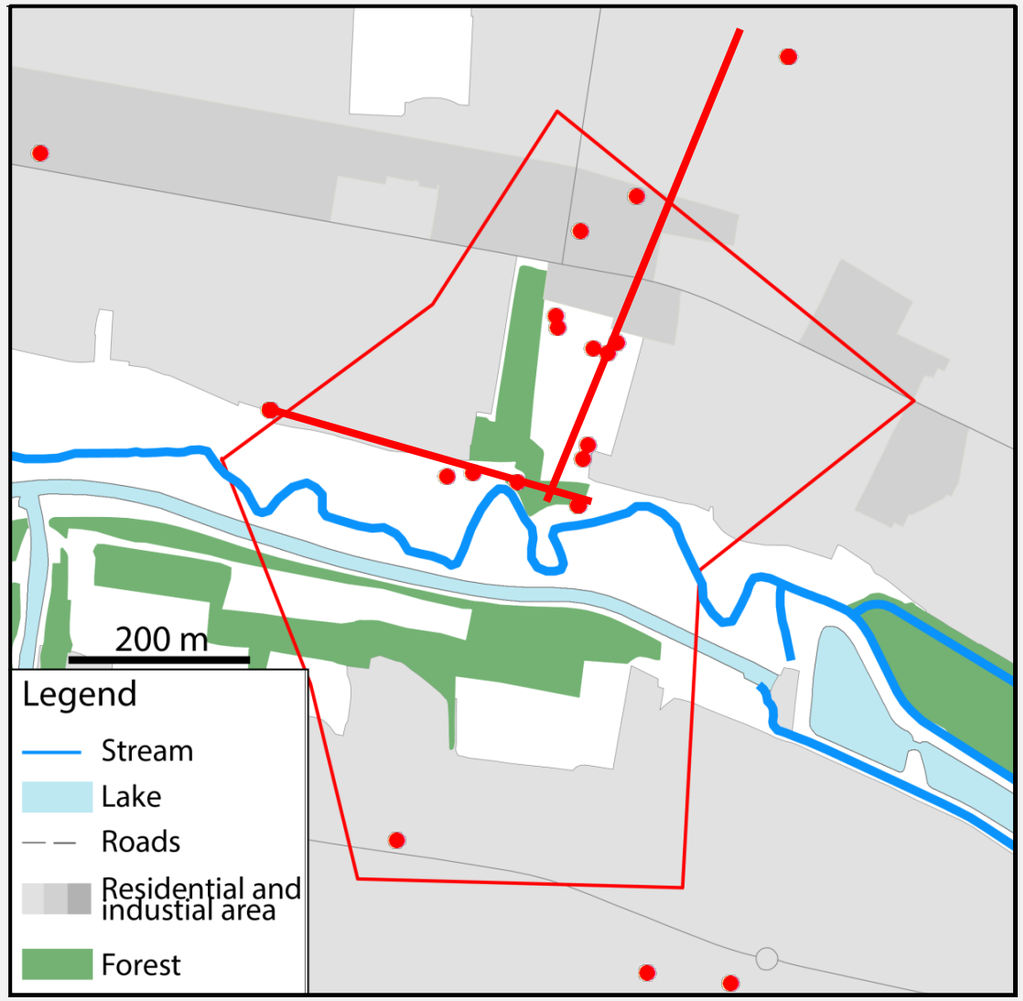
- The town of Grindsted is massively influenced by contaminants dumped by a pharmaceutical factory in the town.
- Investigations have shown that contaminants from the factory site discharge to the stream.
- An upper and lower aquifer is contaminated with different chemical compounds.
- Detailed groundwater flow and transport modelling are needed to unravel the flow paths.

⇒ **For this a detailed 3D geological model is required**



Data available for 3D geological modelling

- Borehole data
  - **Lithological logs** •



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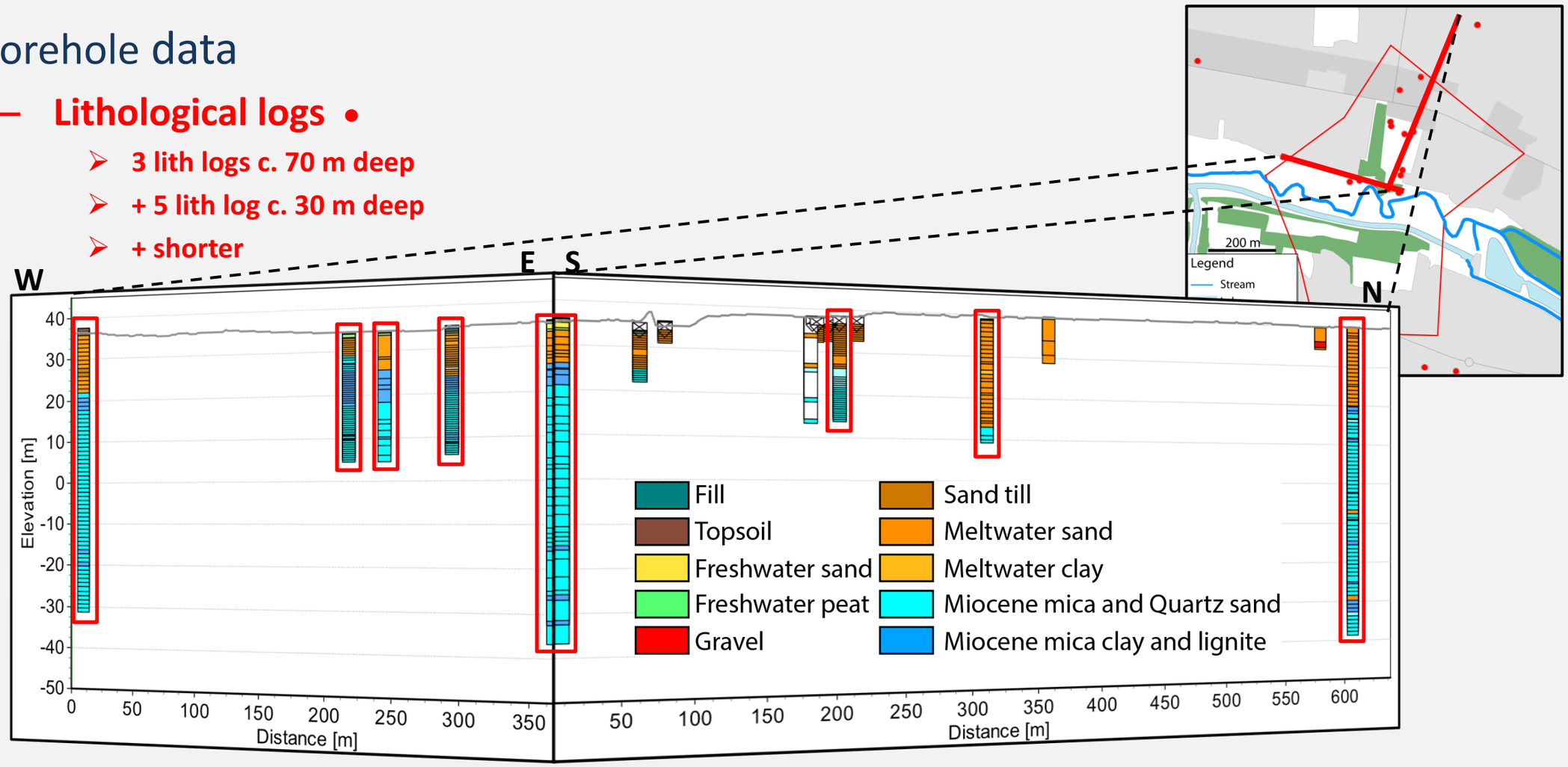
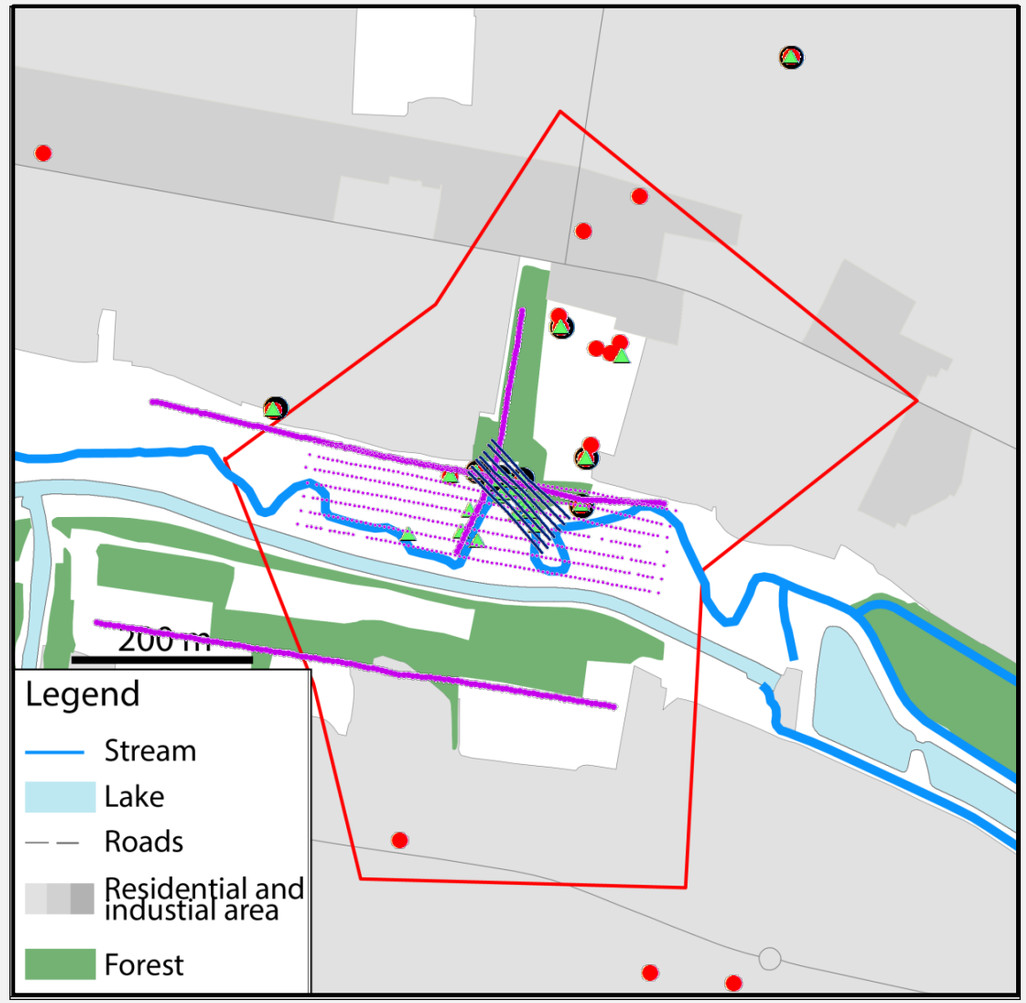
  - **Lithological logs**
    - **3 lith logs c. 70 m deep**
    - **+ 5 lith log c. 30 m deep**
    - **+ shorter**



Data available for 3D geological modelling

- Borehole data
  - **Lithological logs** •
  - **Hydraulic head data** ●
  - Electrical conductivity from water samples ▲
- Geophysical data
  - EMI survey using DUALEM-421S
  - DC resistivity & Time domain spectral IP
    - **5 m electrode spacing, 3 long profiles** ——
    - **5 m electrode spacing, 7 profiles** ····
    - **2 m electrode spacing, 7 profiles** ——

Data collection using a modified ABEM LS Terrameter in gradient array.



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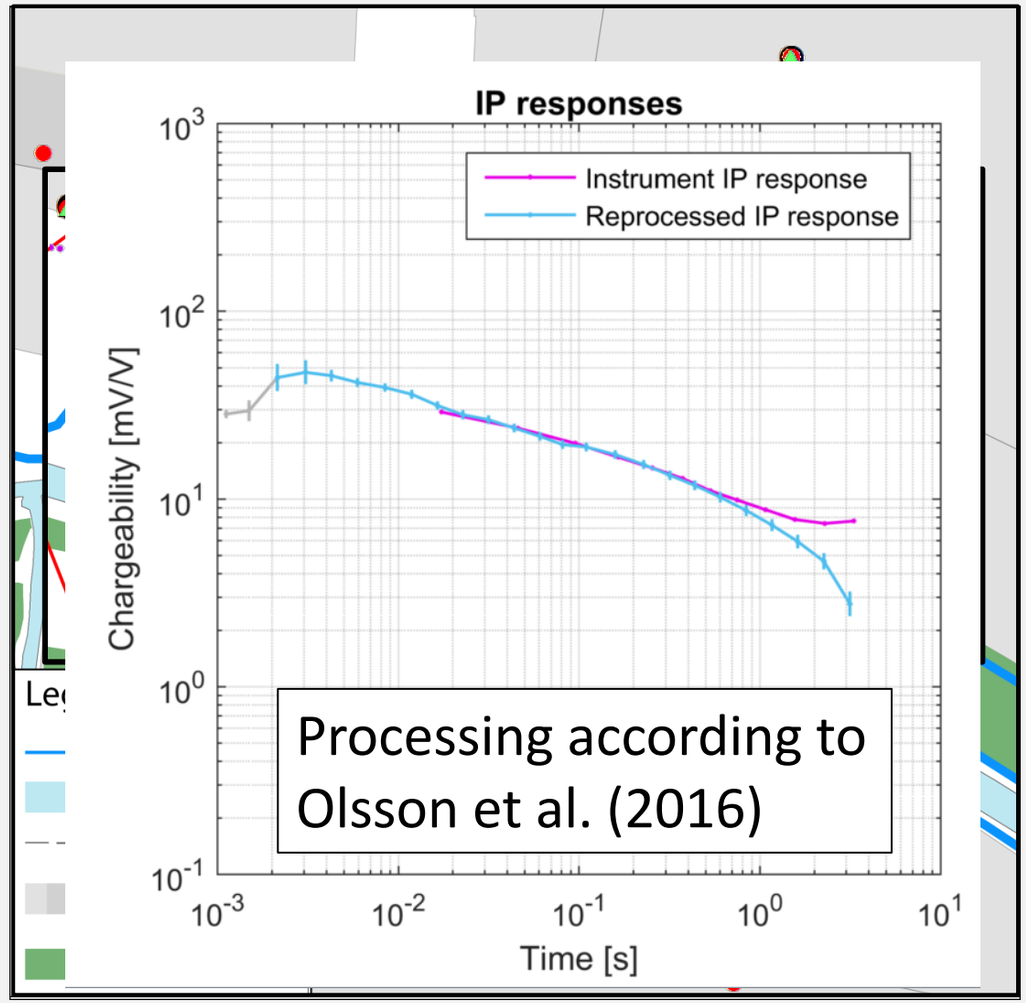
Data collection using a modified ABEM LS Terrameter in gradient array. TD SIP data in 36 log-spaced gates in 1 ms-3.9 s.



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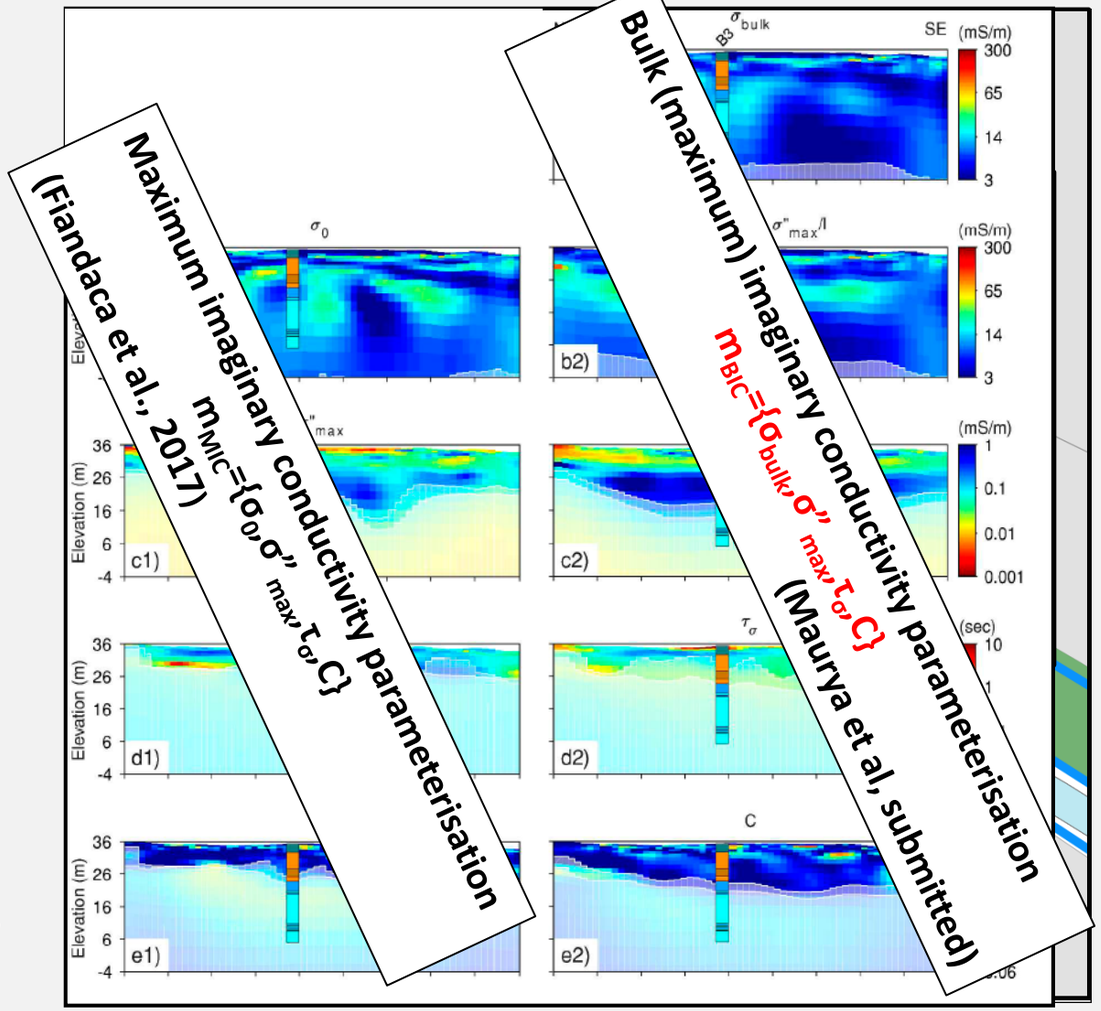
Data collection using a modified ABEM LS Terrameter in gradient array. TD SIP data in 36 log-spaced gates in 1 ms-3.9 s. Inversion using a Cole-Cole re-parameterisation, m_{BIC}, a further development of m_{MIC}



The 3D geological modelling ch

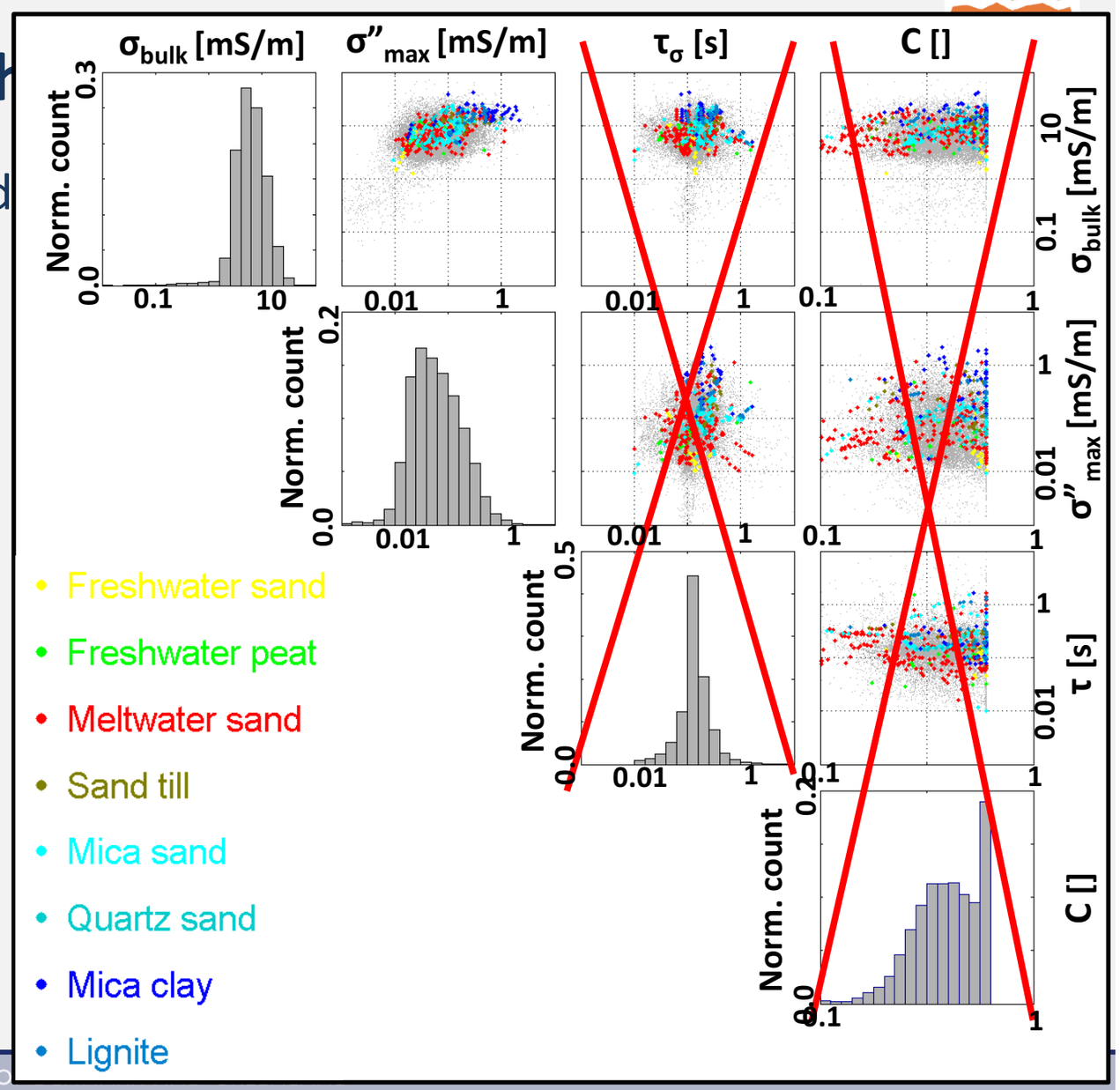
- Modelling clay layers in contaminated sediments using DC & TD SIP data
  - Which parameters to use:

    Bulk electrical conductivity, σ_{bulk}

    Maximum imaginary conductivity, σ''_{max}

    ~~**Relaxation time, τ_σ**~~

    ~~**Frequency exponent, C**~~



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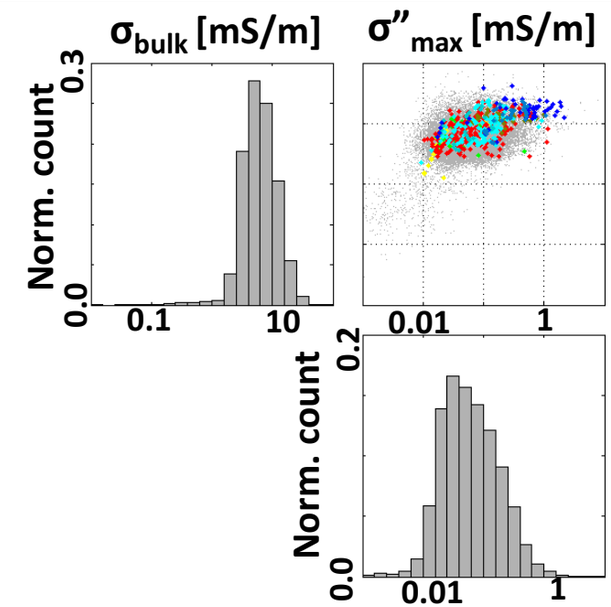

- Freshwater sand
- Freshwater peat
- Meltwater sand
- Sand till
- Mica sand
- Quartz sand
- Mica clay
- Lignite

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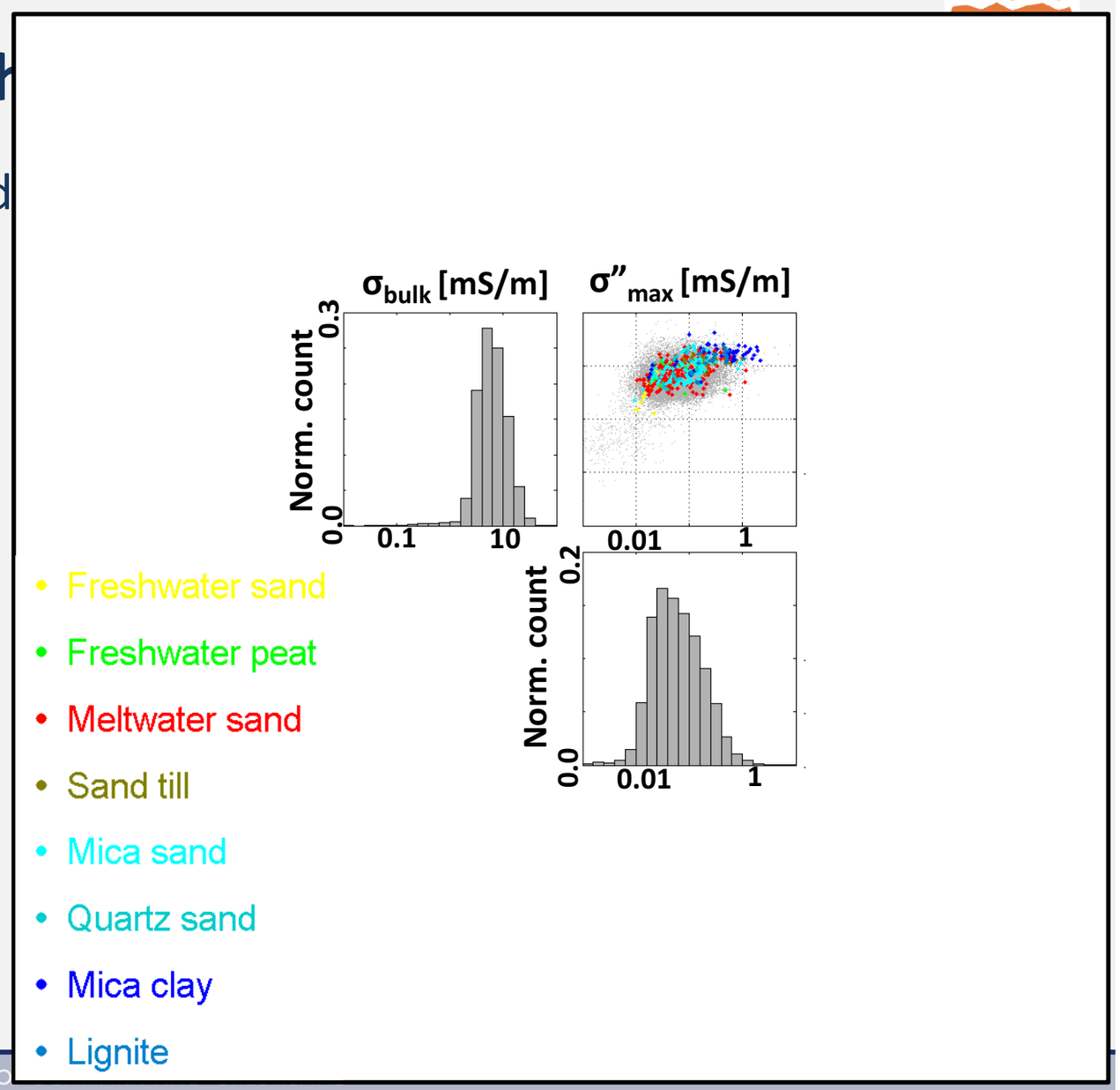

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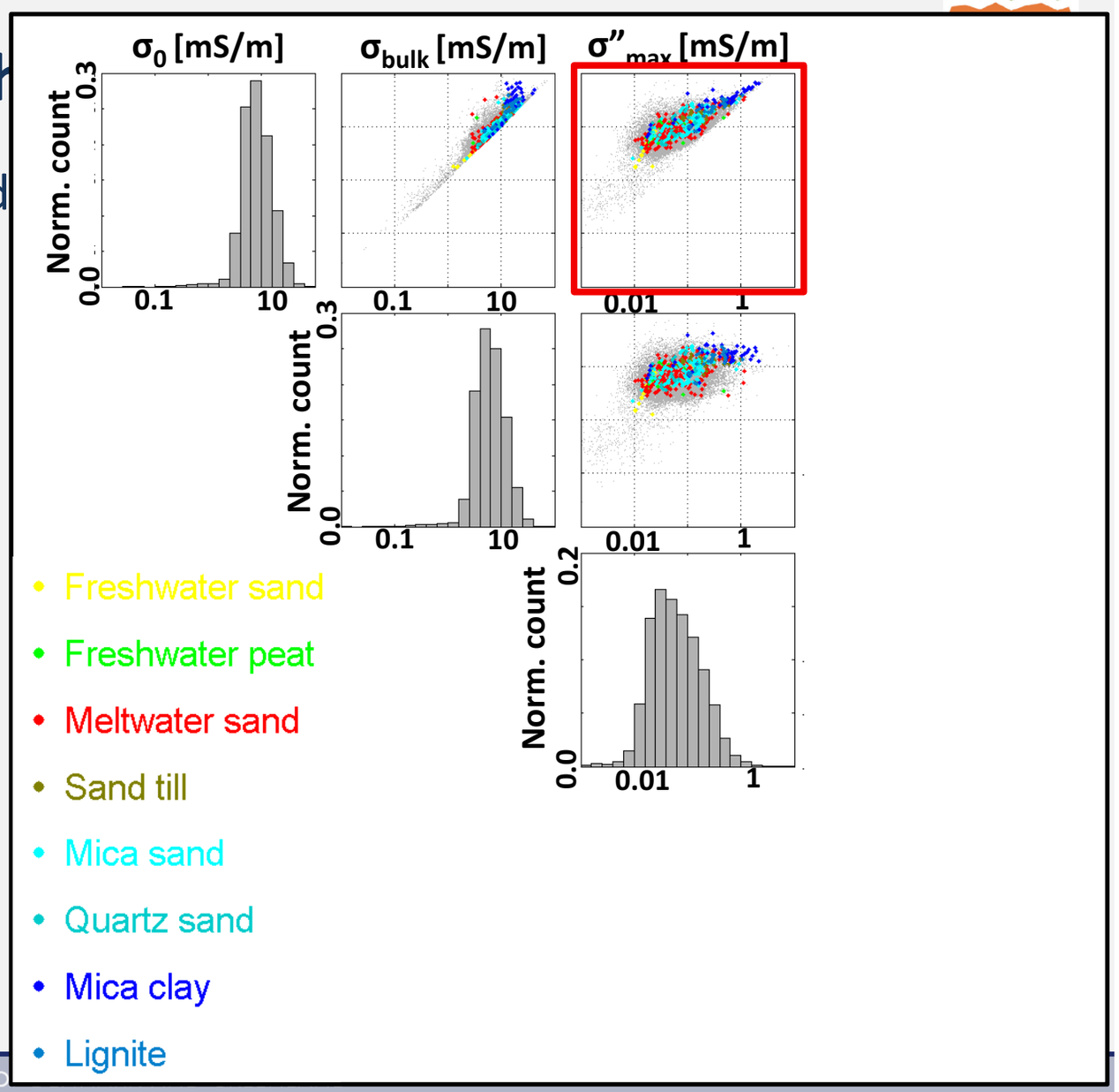
    Calc. total electrical conductivity , σ_0
  - For geological modelling we prefer

    Resistivity = $1/\sigma_0$

    Bulk resistivity = $1/\sigma_{bulk}$
  - Relation to lithology



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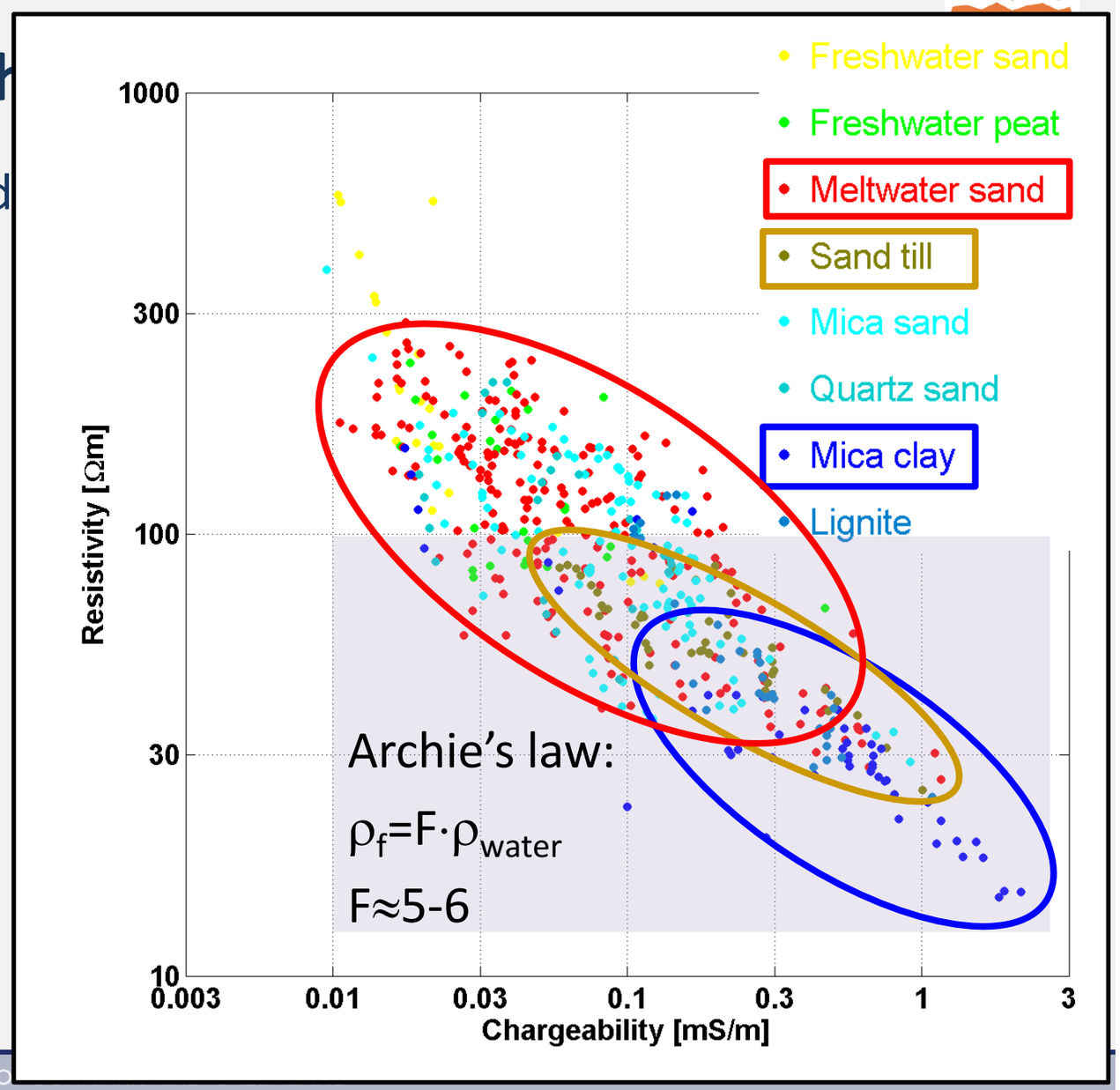
  - Point out contaminated areas using EC from water samples



The 3D geological modelling challenge

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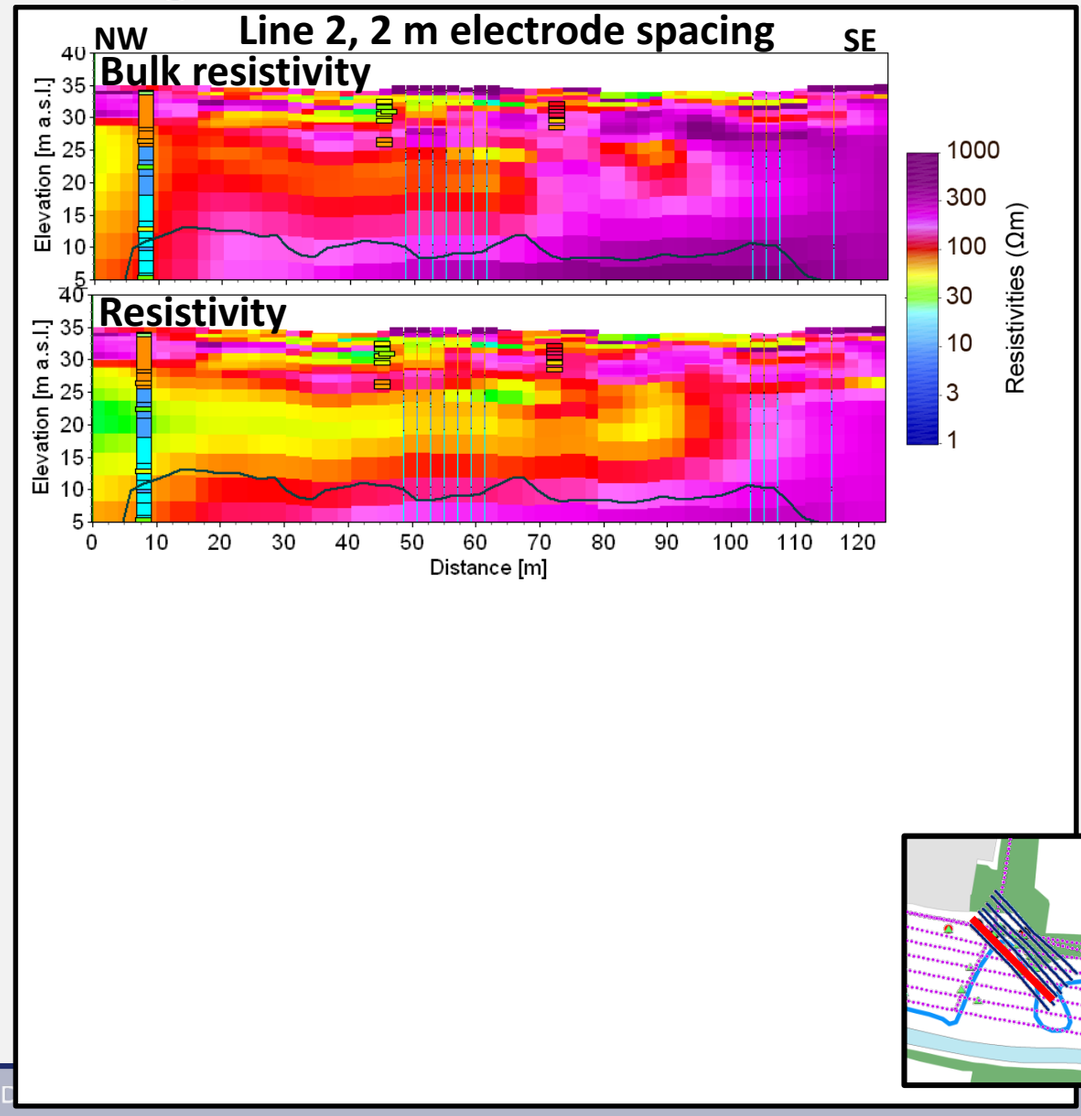
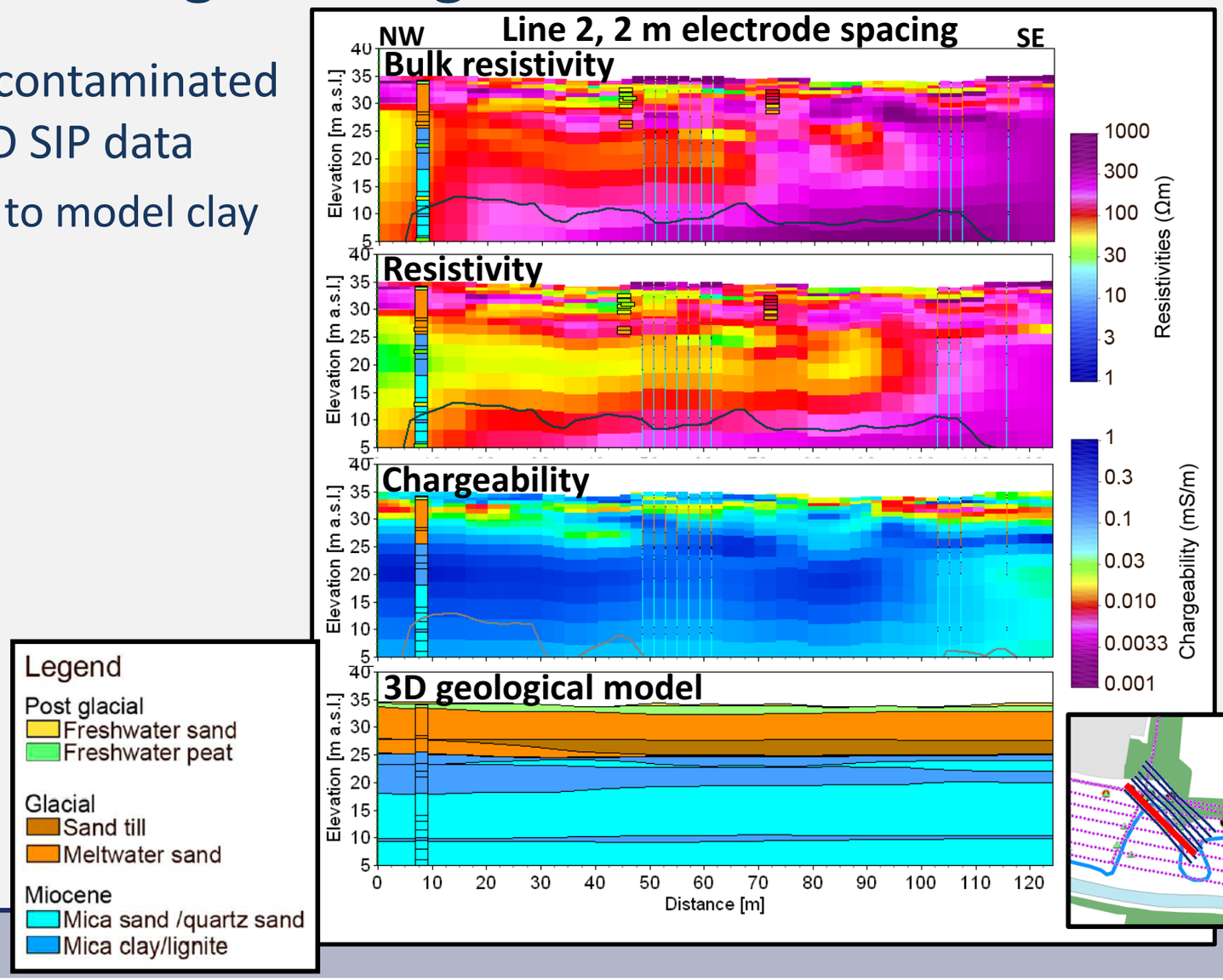


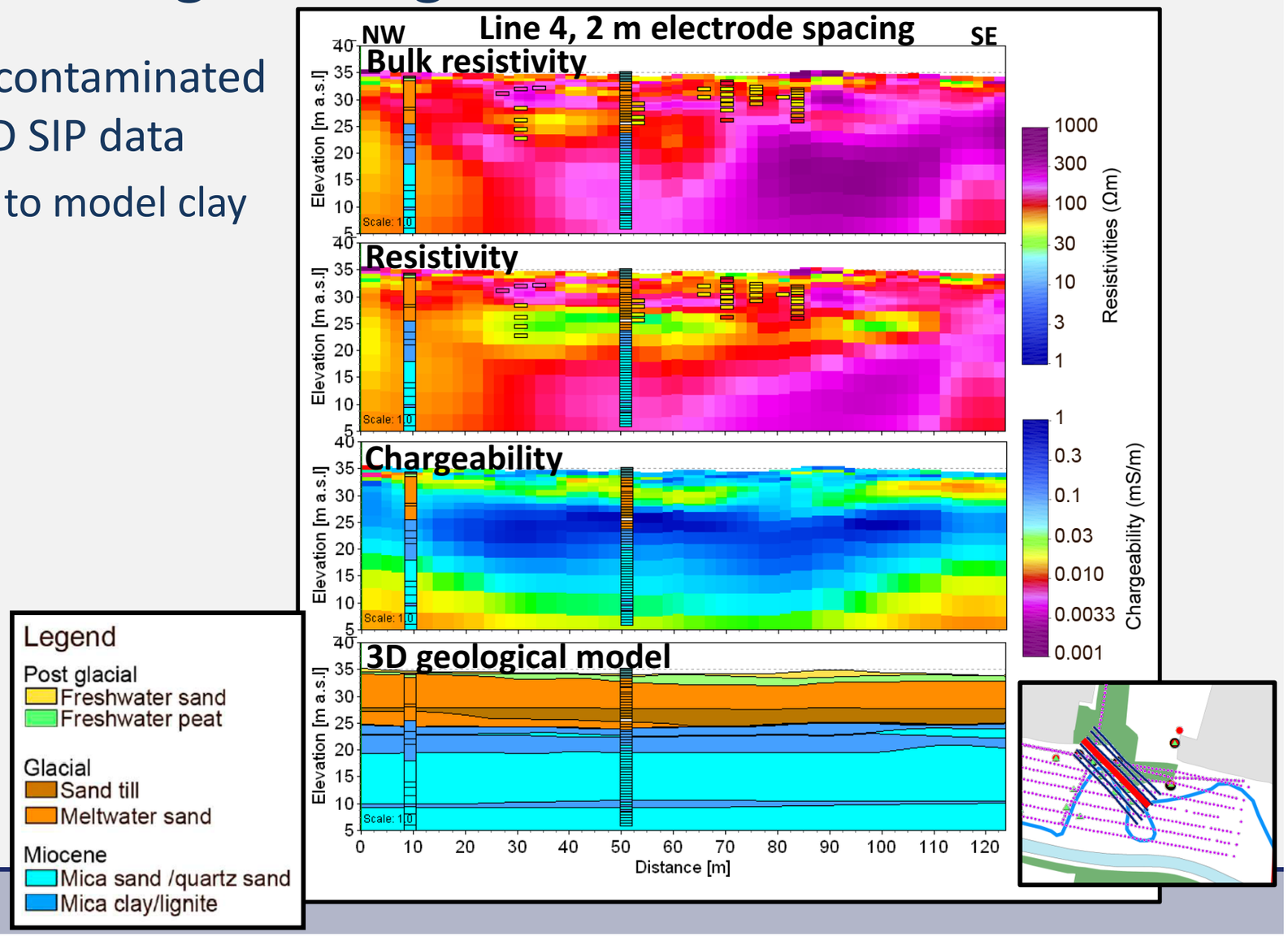
The 3D geological modelling challenge

- Modelling clay layers in contaminated sediments using DC & TD SIP data
  - Combine information to model clay layers



The 3D geological modelling challenge

- Modelling clay layers in contaminated sediments using DC & TD SIP data
  - Combine information to model clay layers
  - Resolution



The 3D geologic

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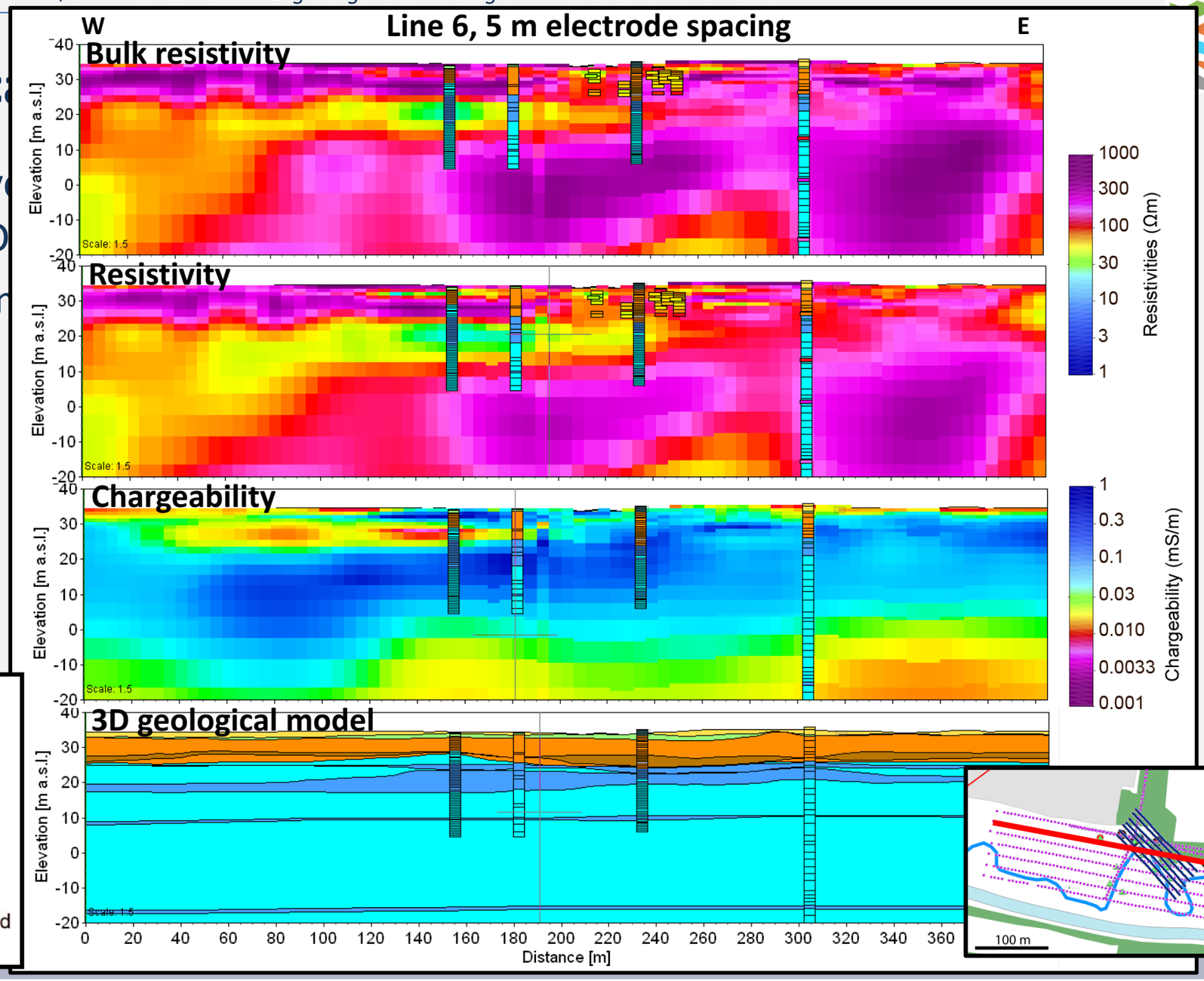
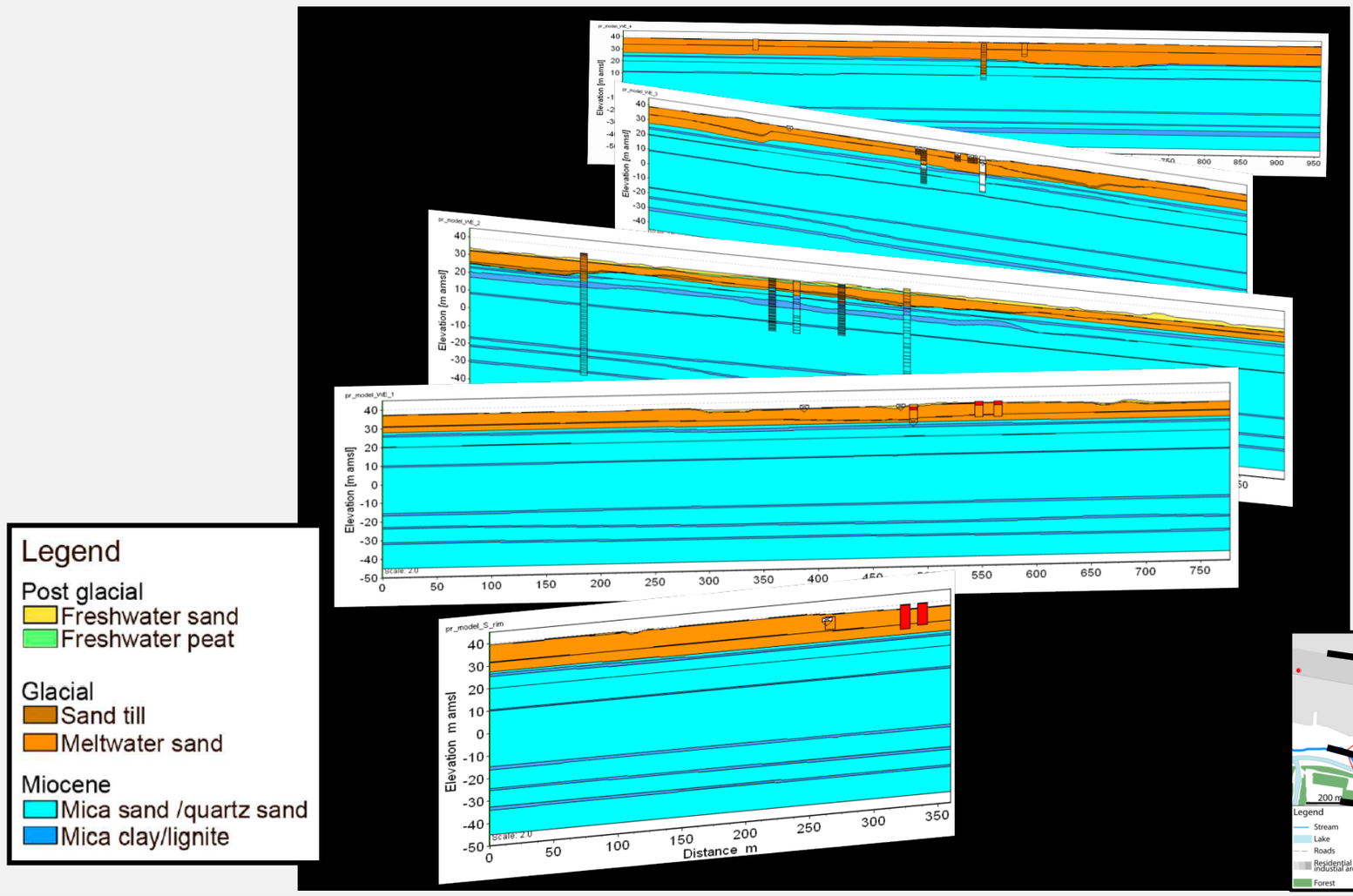


The 3D geological model - results



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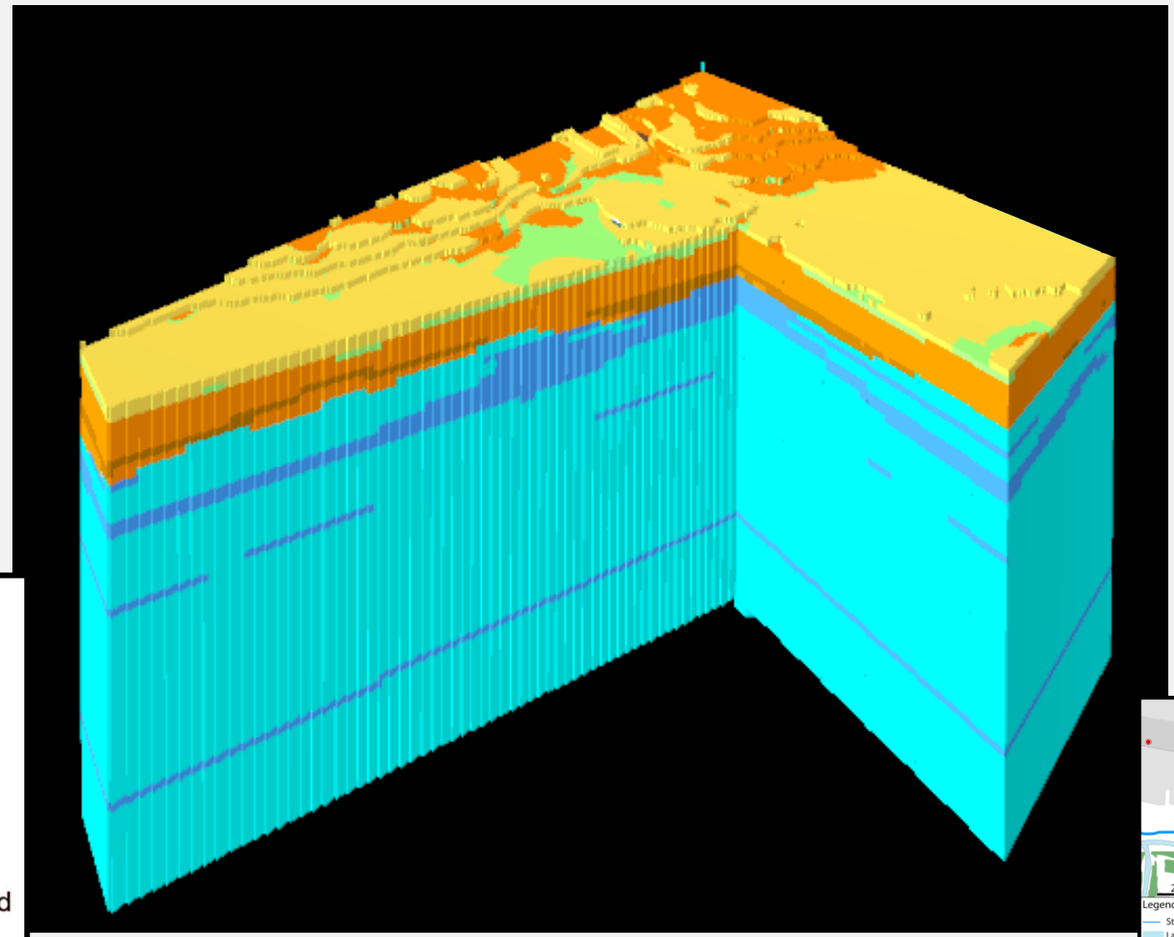

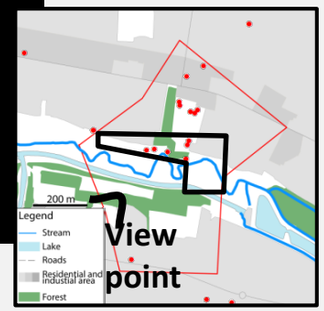

Thank you for your attention