



Co-funded by the Walloon region

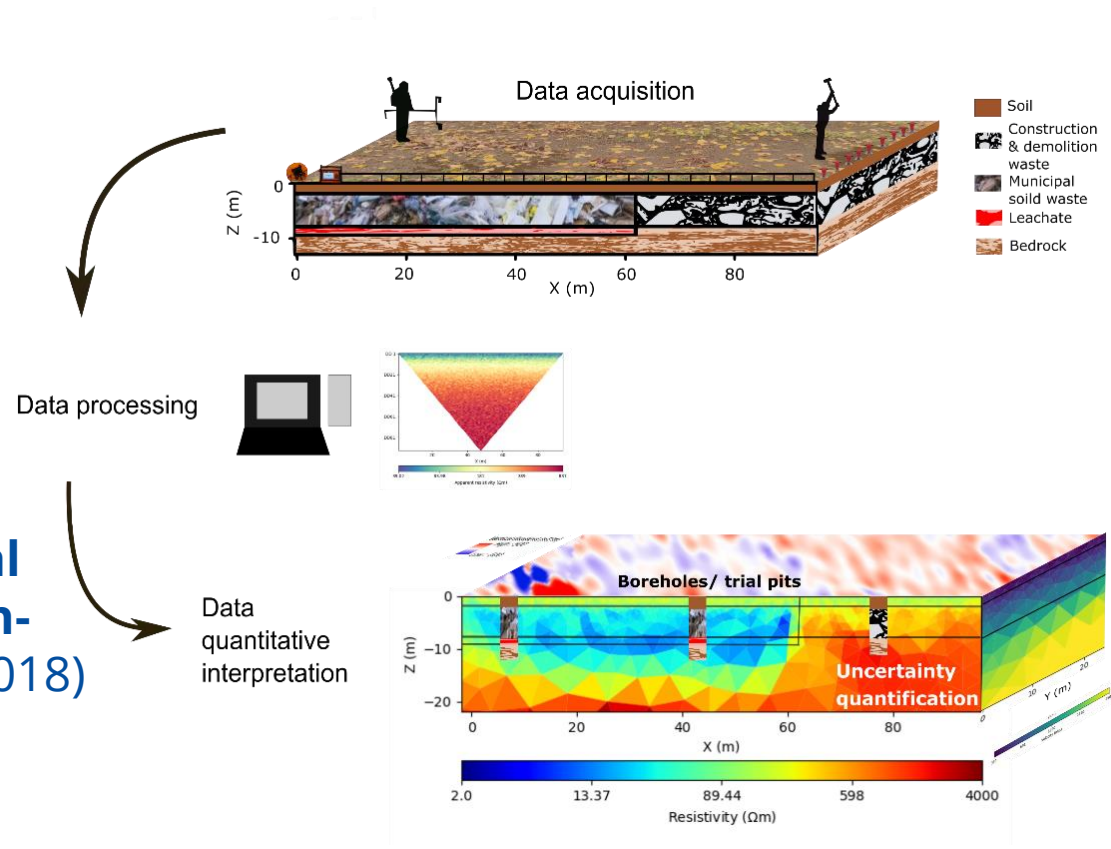
Geophysical characterization of past- metallurgical sites: La Campine case study

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Uliège, Belgique



What is geophysics?

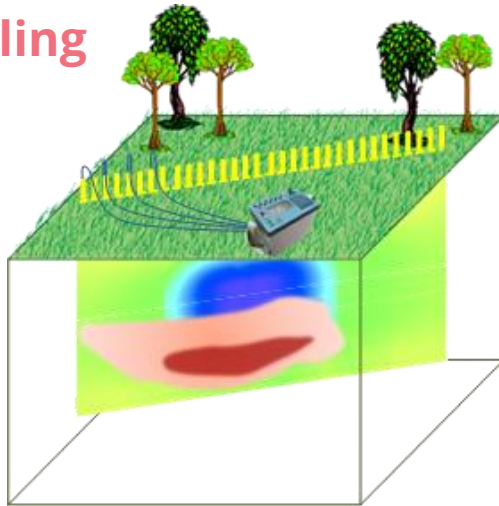
- **Characterization below the ground surface of:**
 - geology
 - structures
 - contamination
 - human artifacts
- **Mapping** variations of **physical properties** measured with **non-invasive** technologies (EEGS 2018)



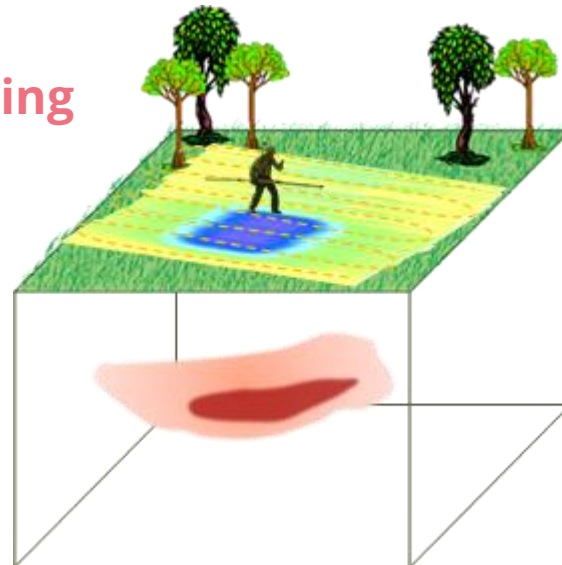


Geophysical methods used

2D/ 3D profiling



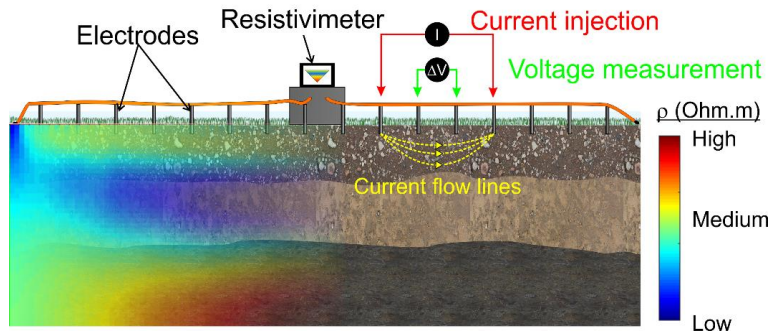
2D mapping





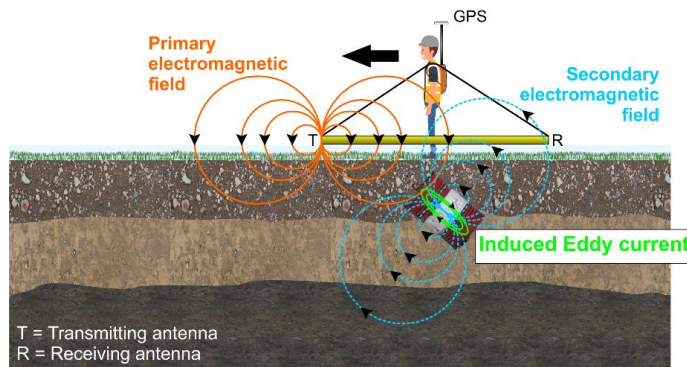
Geophysical methods used

Profiling methods

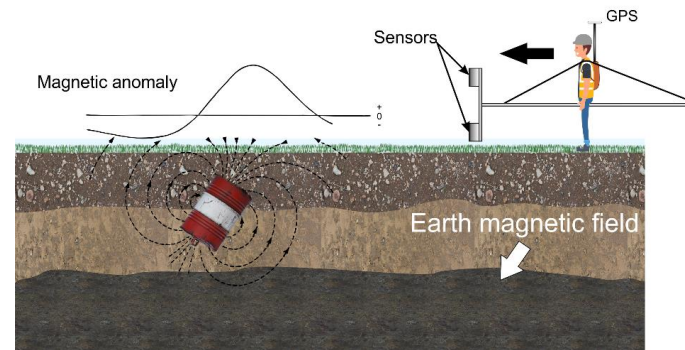


- Electrical Resistivity Tomography (ERT) - **resistivity**
- Induced Polarization (IP) - **chargeability**

Mapping methods



Electromagnetic Induction (**EMI**) – **conductivity**



Magnetometry – disturbances in the Earth's magnetic field



La Campine site



- Campine nv and Campine Recycling nv
- 1899: start of industrial activities
- Site is still in operation
- Two landfills present (slags and other production waste)





La Campine site: (historical) activities



- Manufacturing of antimony
- Treatment of ores
- Production of copper
- Manufacturing of lead and lead red
- Recycling of metals





La Campine site: (historical) activities



the company was licensed for the expansion and further exploitation of a lead and antimony processing company. Until today, lead is used in the production unit, where lead alloys are produced by recycling lead waste and lead batteries in a blast furnace process. In the antimony production unit, crude antimony oxide or antimony metal is converted into pure antimony trioxide in converters (furnaces)





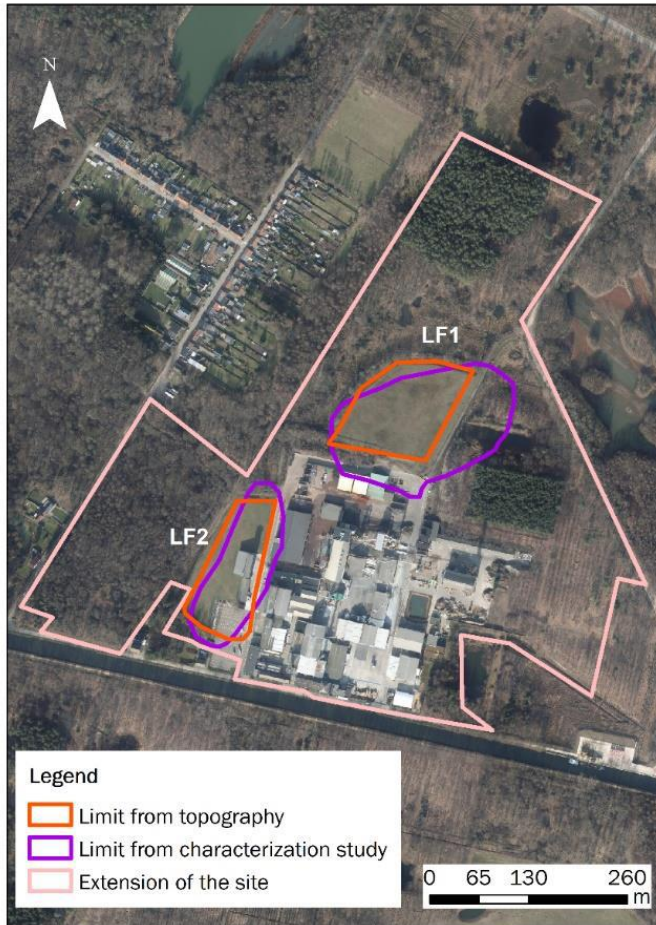
La Campine site: On-site deposits

- Northern deposit: former peat pit (+- 1,5 ha)
 - Western deposit: former clay pit (+- 1 ha)
- Waste: mainly slags and old batteries





La Campine site

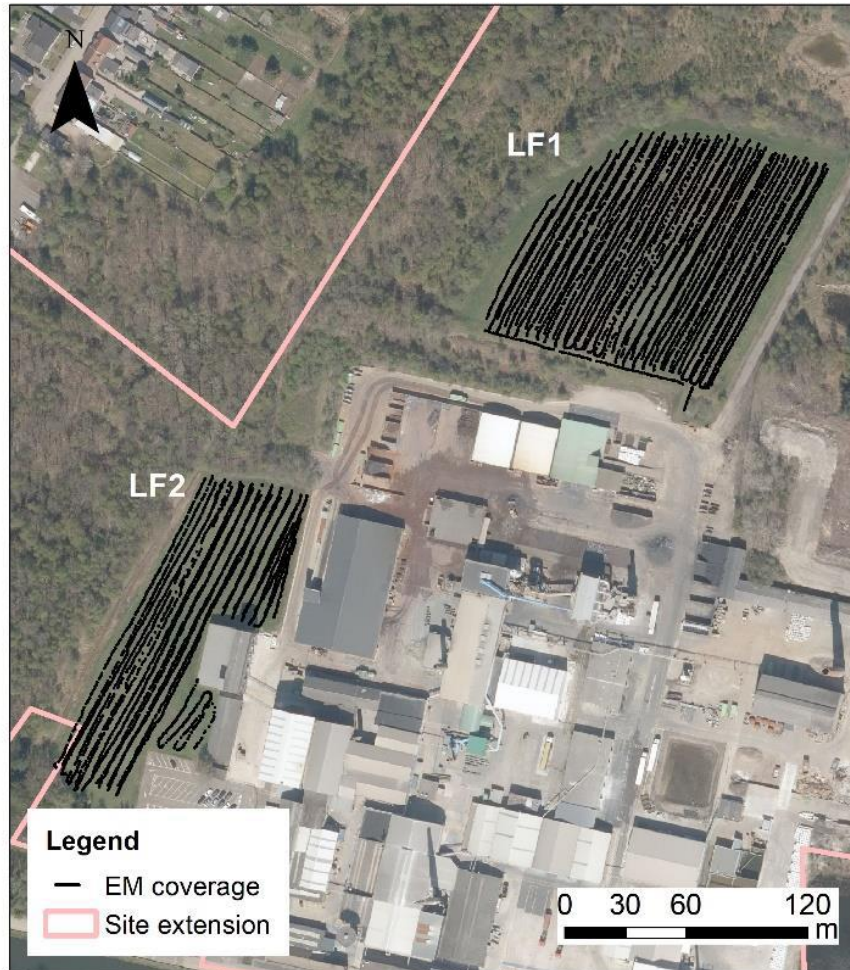


The additional site La Campine is composed by two closed landfills LF1 & LF2

Covered by a plastic geomembrane preventing the use of invasive methods (ERT & seismic)



Electromagnetic mapping (EMI)



Mapping method without direct contact with the ground



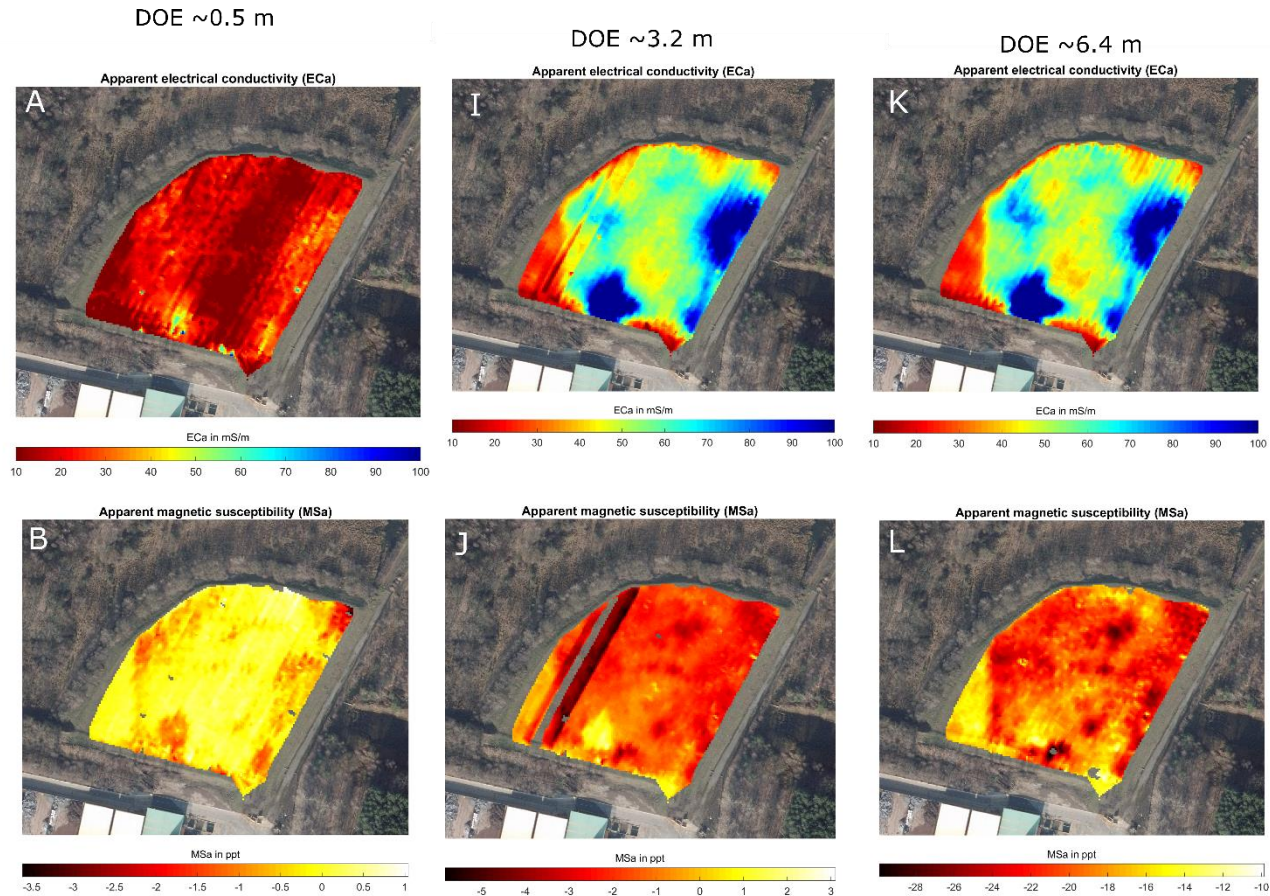
Apparent electrical conductivity mapping

LF1 – ECa mapping

ECa increases below
1.6 m.

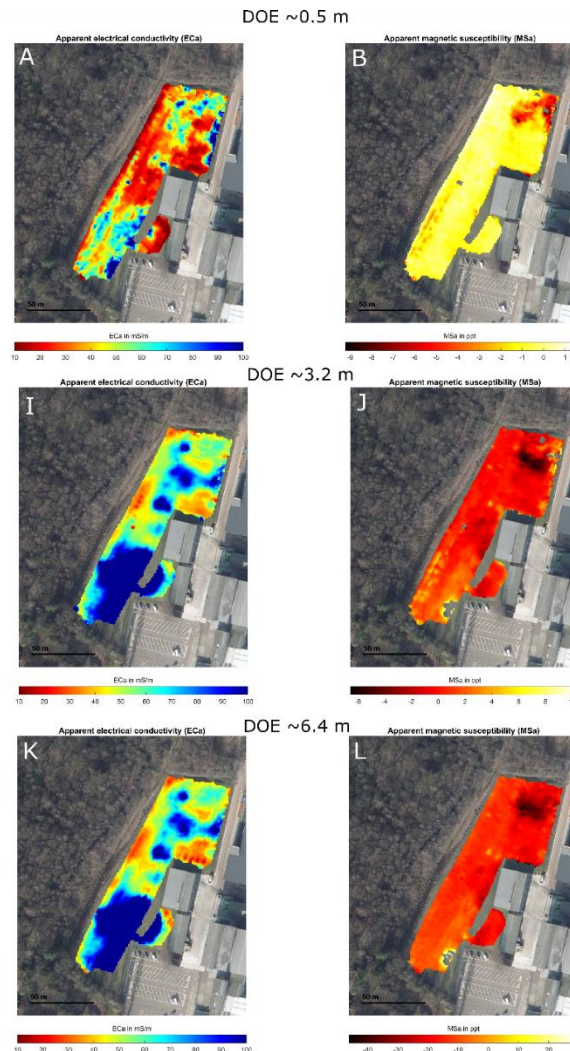
Two spots with higher
conductivity could
highlights the waste
deposits.

Magnetic susceptibility
is homogeneous with
low values.





Apparent electrical conductivity mapping



LF2 – ECa mapping

ECa increase below but the cover of LF2 is less homogeneous than LF1.

The southern conductive area and several conductive patches in the north could be linked to

Magnetic susceptibility is homogeneous with low values.

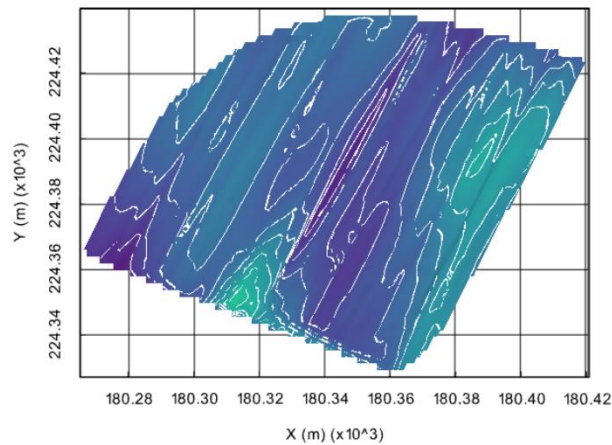


Electrical conductivity 3D model

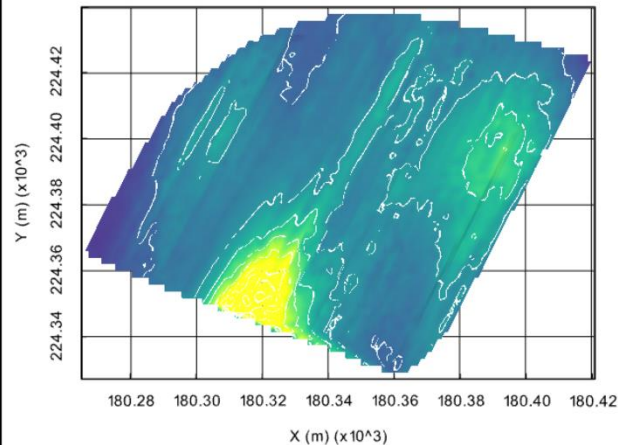
> LF1

3D inversion of electromagnetic mapping using EMagPy
 > Estimation of the real EC layer by layer

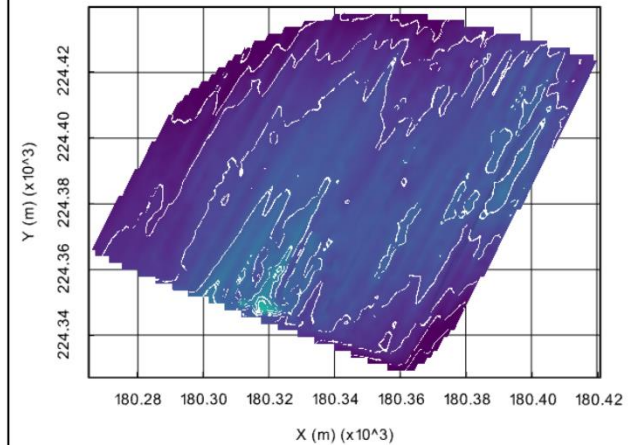
Elevation: 29.4- 30.9 m



Elevation: 26.7- 28.2 m



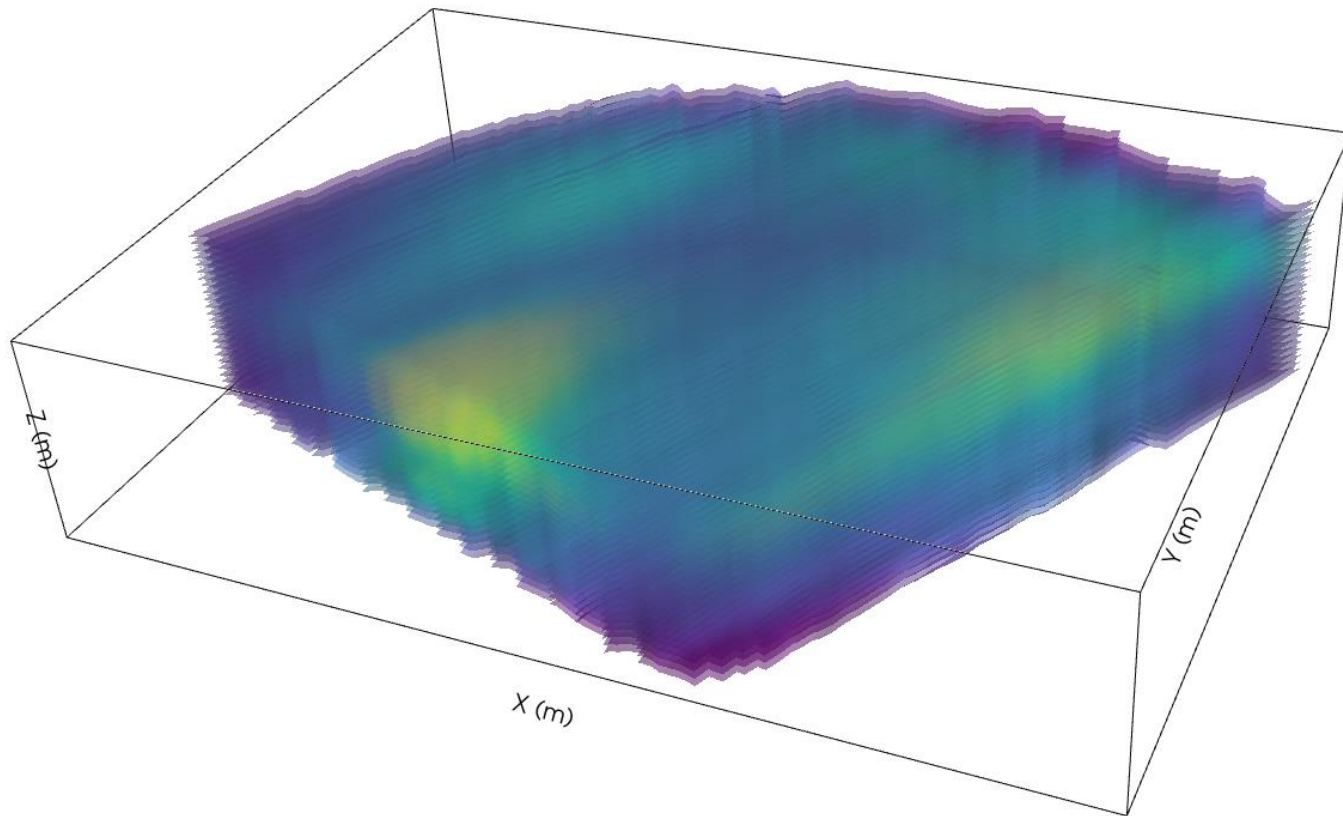
Elevation: 23.1- 24.6 m





Electrical conductivity 3D model

> I C1

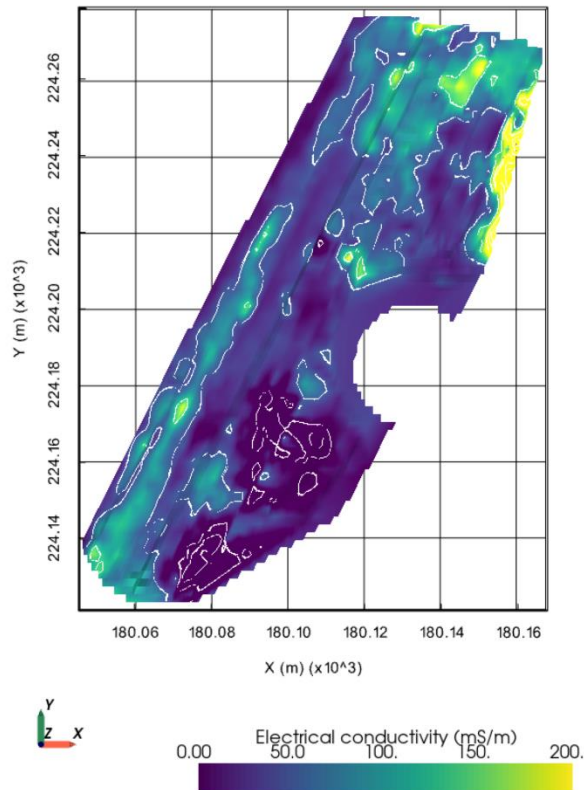




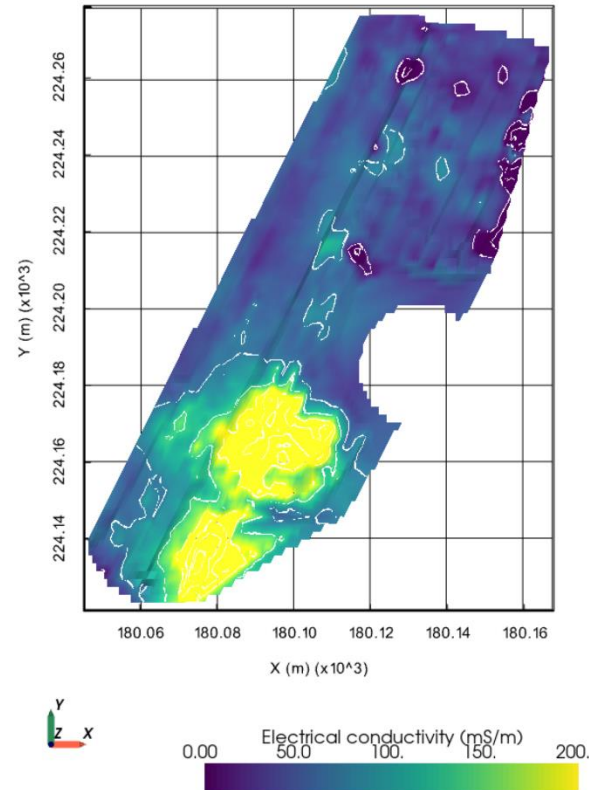
Electrical conductivity 3D model

> LF2

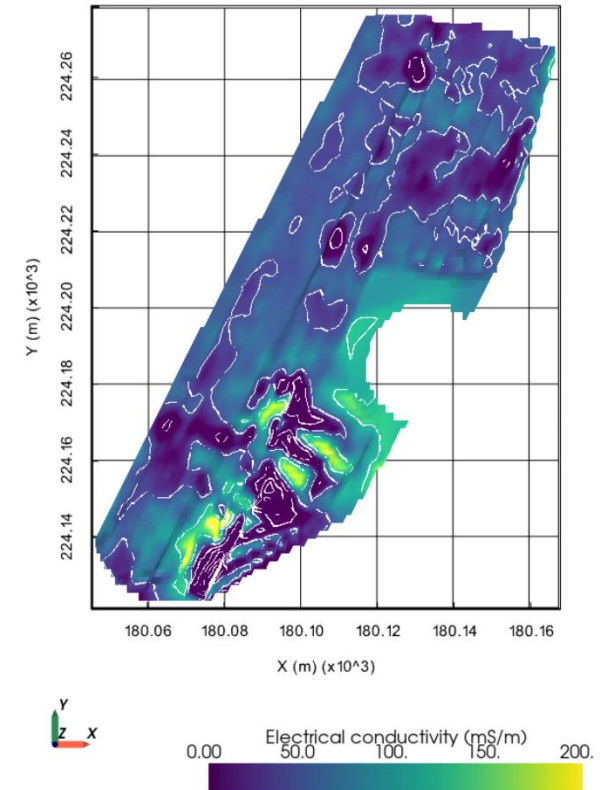
Elevation: 27- 30.5 m



Elevation: 23.8- 27.2 m



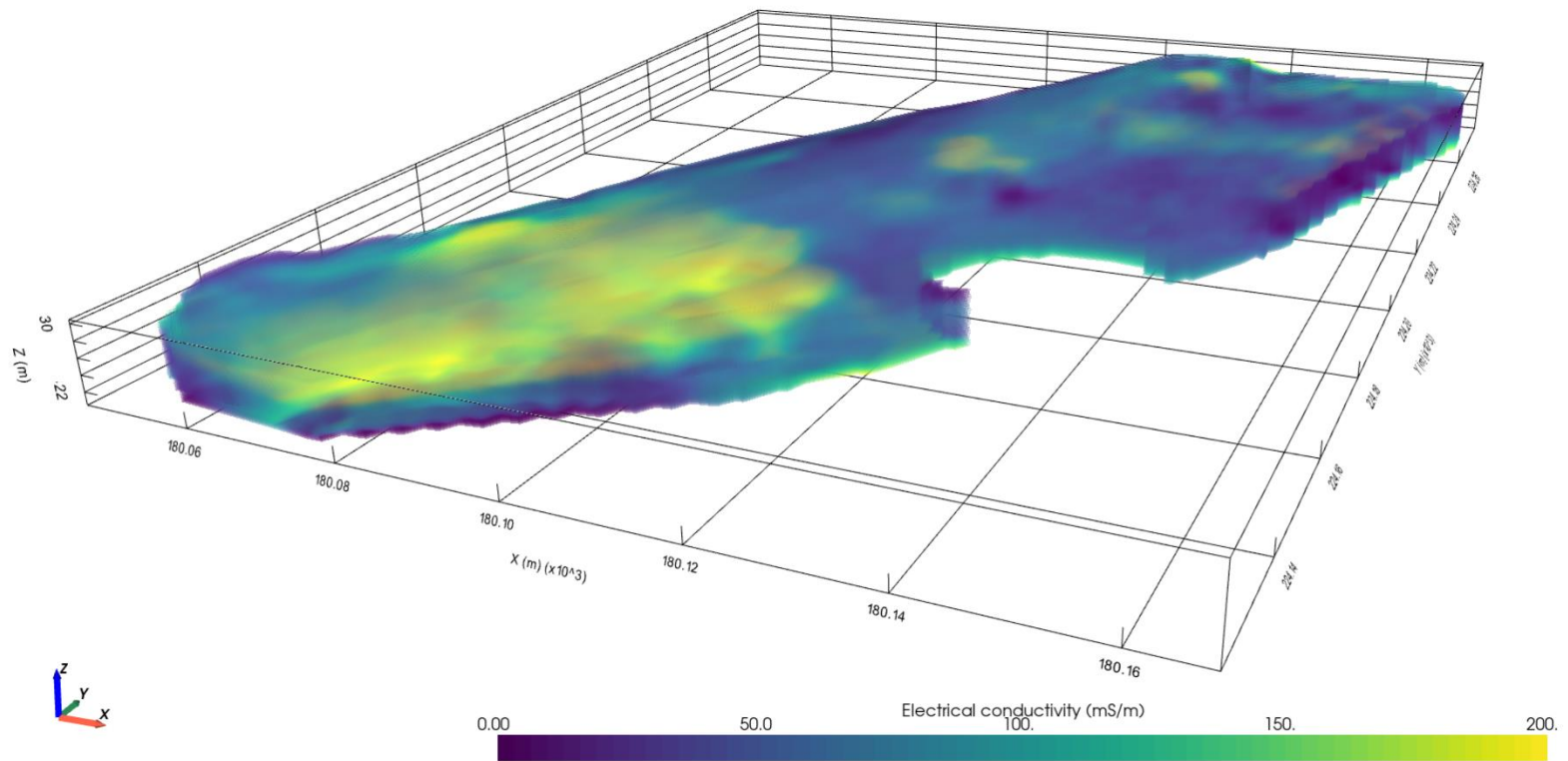
Elevation: 20.8- 24.2 m





Electrical conductivity 3D model

> I F2





Field samples

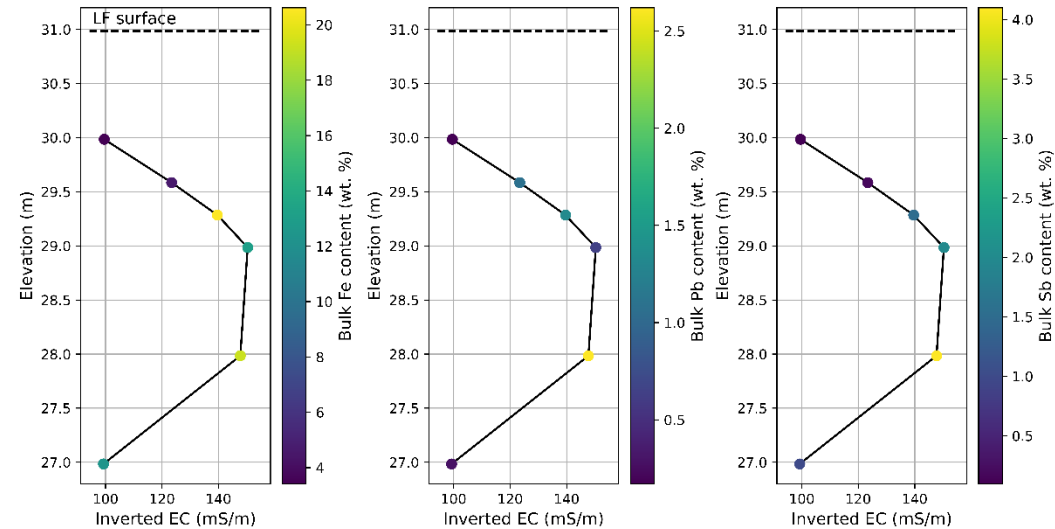
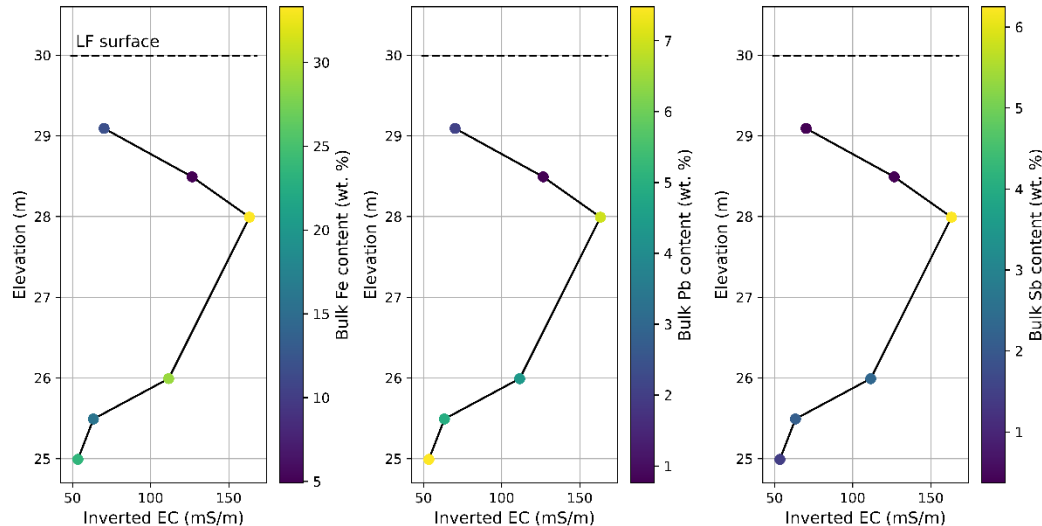




Geochemistry & Electrical conductivity

Inverted electrical conductivity increase with the bulk Fe content but not with Pb and Sb content

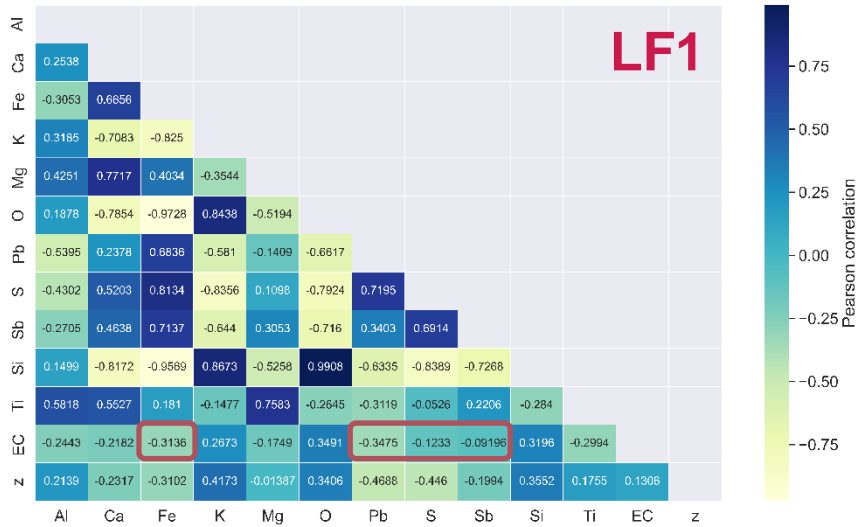
B6 – LF2



B3 – LF1

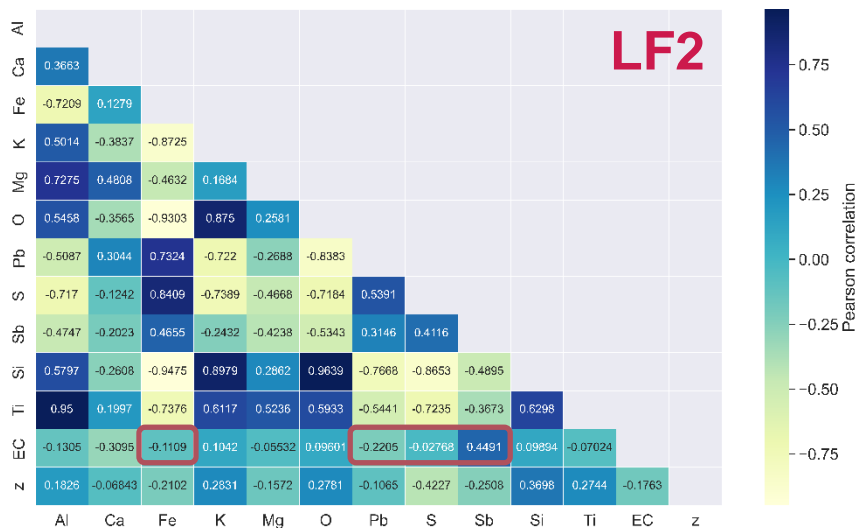


Correlation analysis and RAPIDM classification



Correlations between EC and geochemical elements are used to identify 2 classes for LF1 and LF2

Class 1 (C): larger concentrations of Si, K and O. Consistent with clay composition.

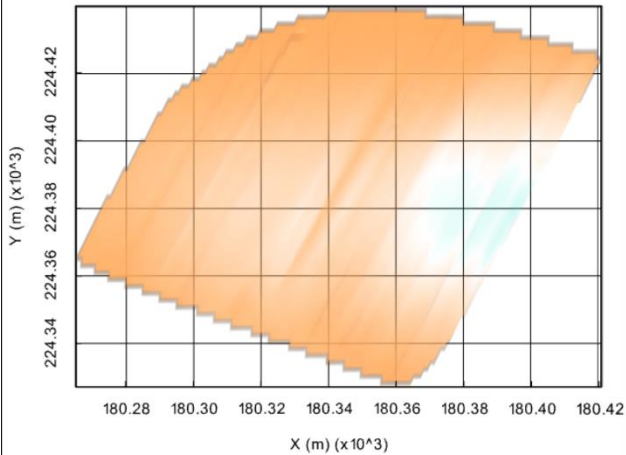


Class 2 (AW): composed of Fe, S, Pb and Sb. Presents larger concentrations of Ca in LF1. In agreement with anthropogenic waste.

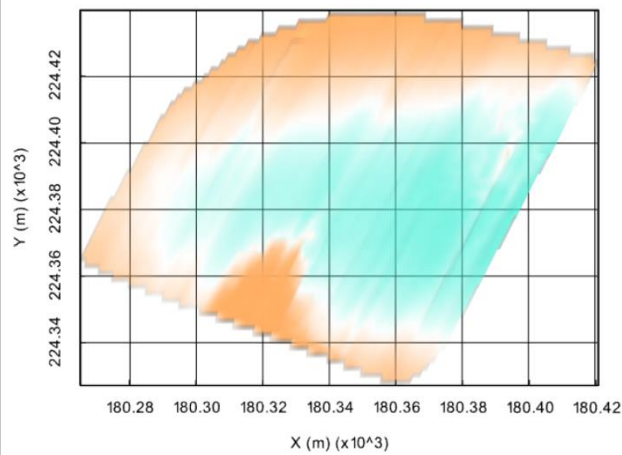


RAPIDM of LF1 deposit

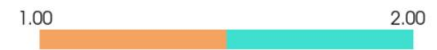
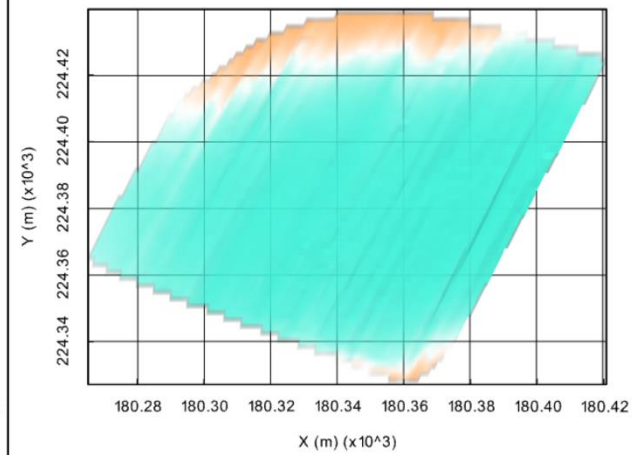
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Elevation: 23.1- 24.6 m



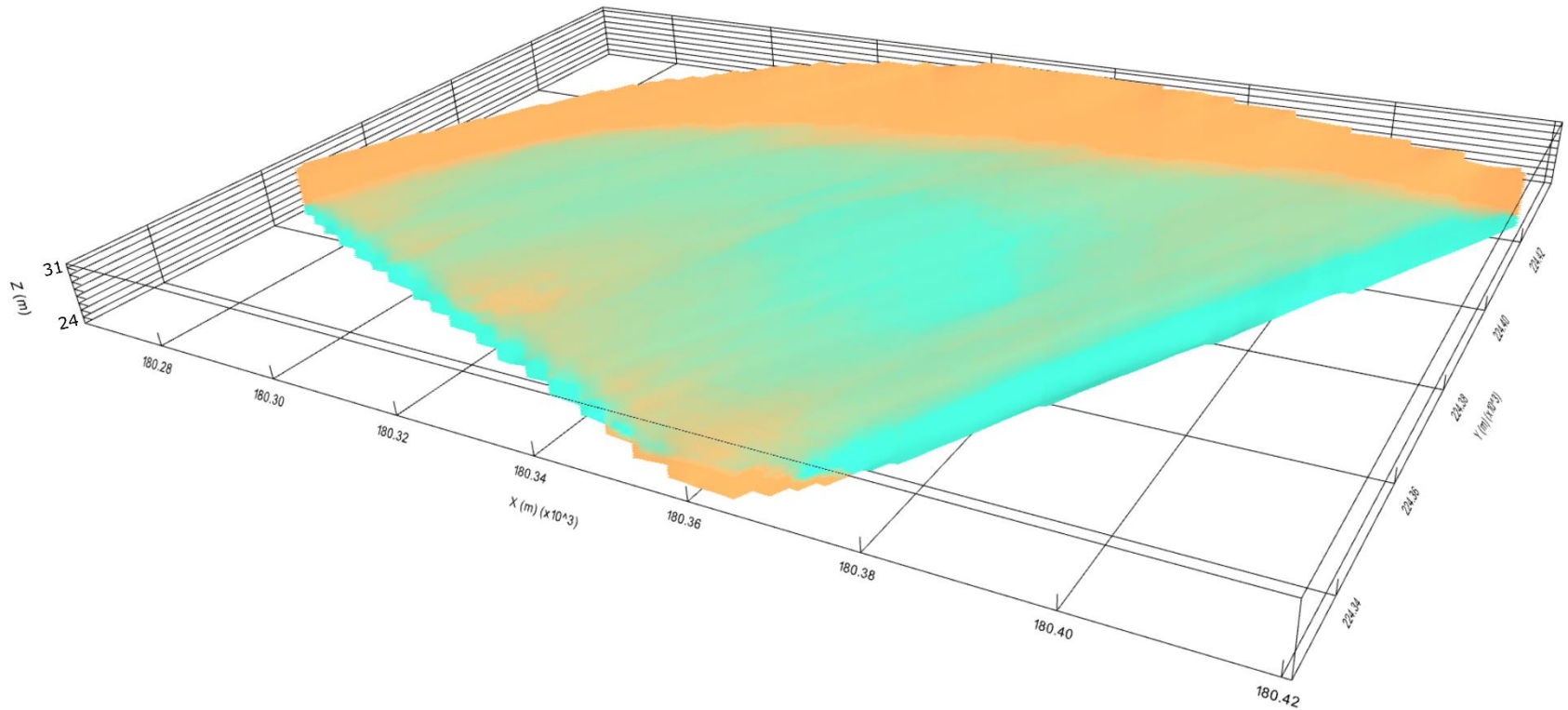
Class 1 (Clay)

Class 2 (Anthropogenic Waste)

The correlations results are integrate into a probabilistic approach to interpret our 3D inverted models of the landfills



RAPIDM of LF1 deposit



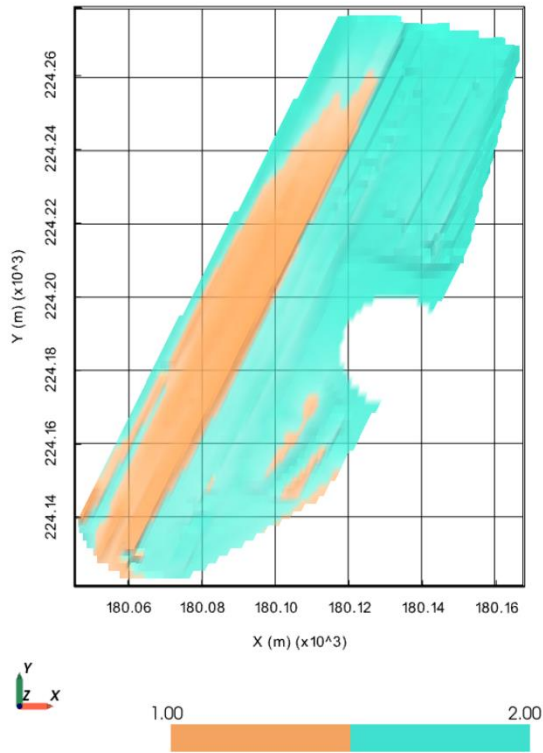
Class 1 (Clay)

Class 2 (Anthropogenic Waste)

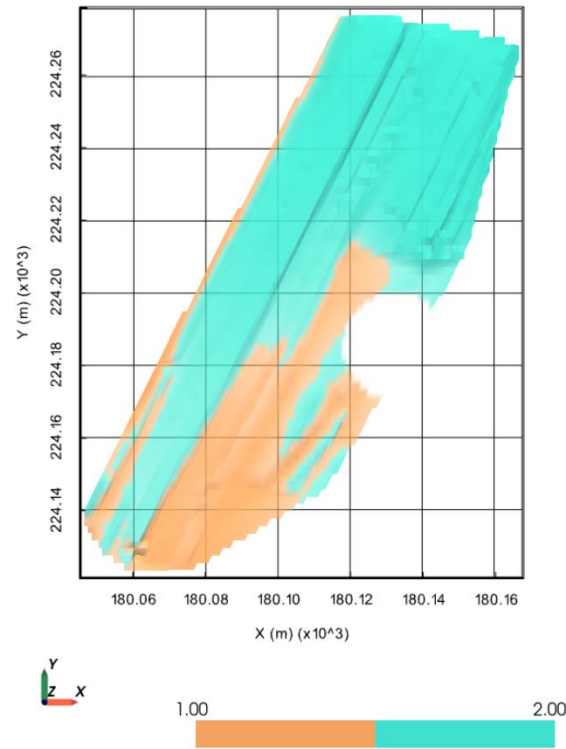


RAPIDM of LF2 deposit

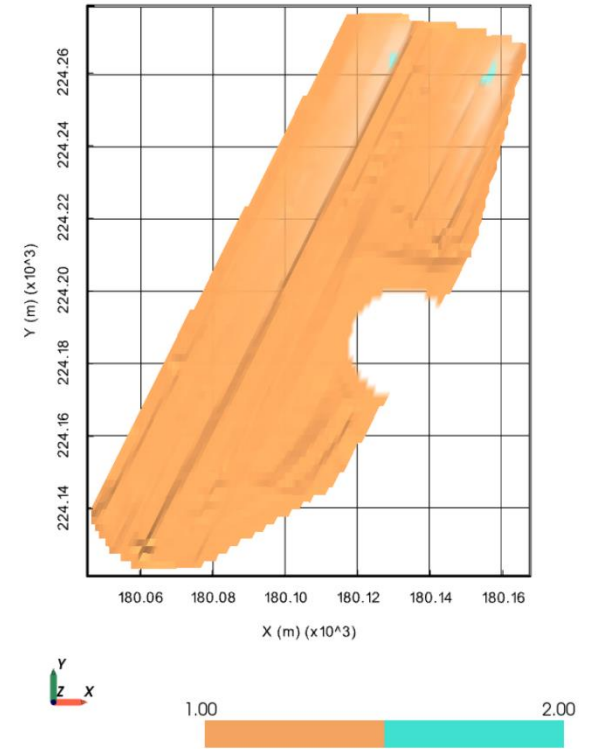
Elevation: 27- 30.5 m



Elevation: 23.8- 27.2 m



Elevation: 20.8- 24.2 m

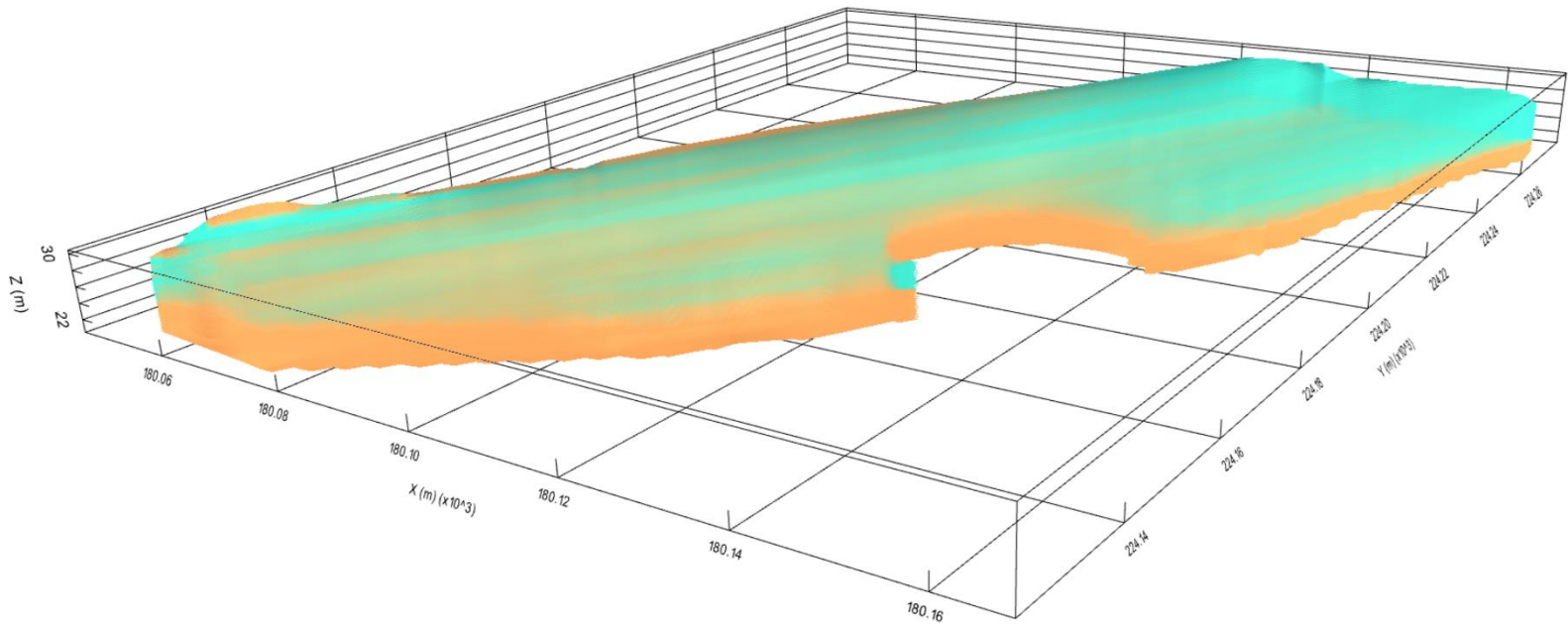


Class 1 (Clay)

Class 2 (Anthropogenic Waste)



RAPIDM of LF2 deposit





Conclusion



La Campine deposit study demonstrate the **NEW-REGENERATIS geophysical approach feasibility over covered deposits.**

While a geomembrane prevents the use of ERT or Seismic method, we adapted the methodology to **electromagnetic mapping**:

- 1) An extensive EMI survey covered the entire deposits;
- 2) Geophysical inversion permit to transform apparent electrical conductivity to real electrical conductivity for a 3D layered model;
- 3) Geochemical analysis provide insight of EC meaning to define correlation between EC and deposit composition;
- 4) Using a probabilistic approach the **EC 3D model** is transform into a **RAPIDM** model

Interreg



EUROPEAN UNION

North-West Europe

NWE-REGENERATIS

European Regional Development Fund

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Thank you!