IP signature of metallic particles: lessons learnt from field and laboratory experiments

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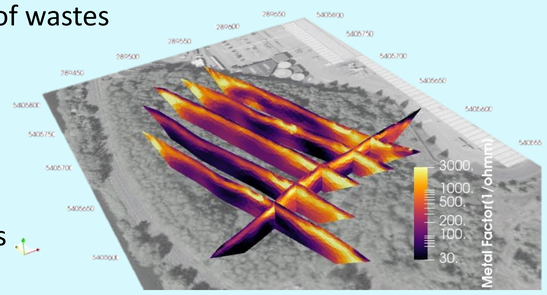
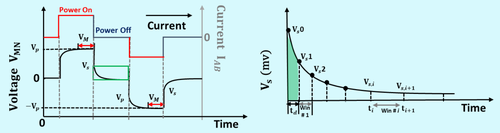
Field geophysical survey

Goal: Localization of layers/volumes of wastes

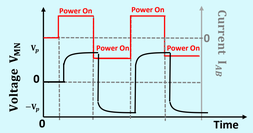
Measured parameters:

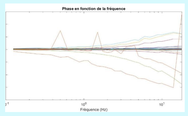
- $(\rho, M) \Rightarrow MF$: Metal Factor
- Fullwave form TDIP measurements

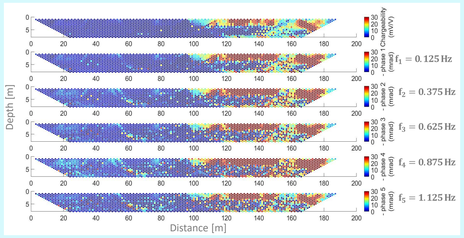


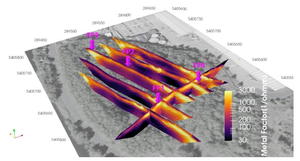


- FDIP measurements using harmonic frequencies from square signal









Targeted sampling, based on geophysical field results:

- Number of boreholes
- Depths of samples

Laboratory study
Real samples from field site

Goal: Build correlations with field geophysical measurements

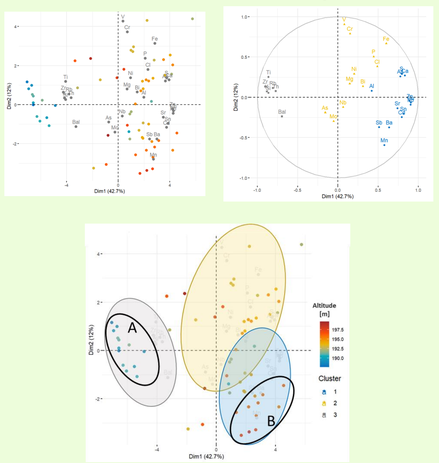
Measured parameters:

- Chemical composition and concentration: XRF analysis
- Granulometry
- Nature of metallic grains

- SIP in the lab : test of existing petrophysical relationships or building of new petrophysical relationships

Challenge: Representativity of SIP lab measurements?

PCA and Cluster Analysis



Field scale interpretation

Goal: Maps of layers with metals nature and/or concentrations, with associated uncertainties

Ideas of implementation:

Petrophysical approach

Apply
Lab petrophysical relationships
using
field FDIP measurements

Challenge: uncertainty estimations?

Probabilistic approach

Cluster analysis on geochemical dataset
+
Geostatistical interpretation of data

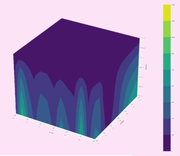
Correlation approach

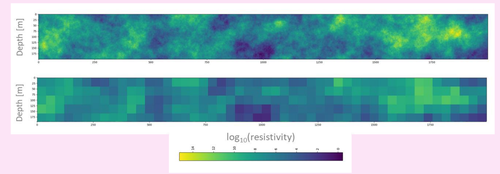
Use correlation found with real lab samples taken from the field at the field scale

Challenge: Apply lab correlations to field data

Upscaling approach using Bayesian inversion scheme

→ Generate a set of resistivity field analogs, resolved at y scale
→ Use petrophysical relatioships to solve targeted parameter at y scale for the set of field analogs





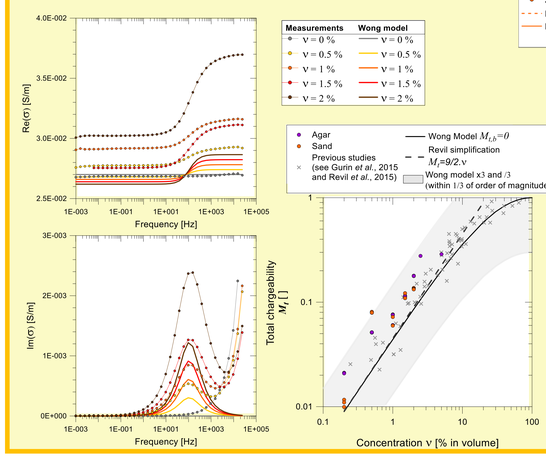
Laboratory study
Artificial samples

Goal: Test existing or build new petrophysical relationships (e.g. Wong, 1979)

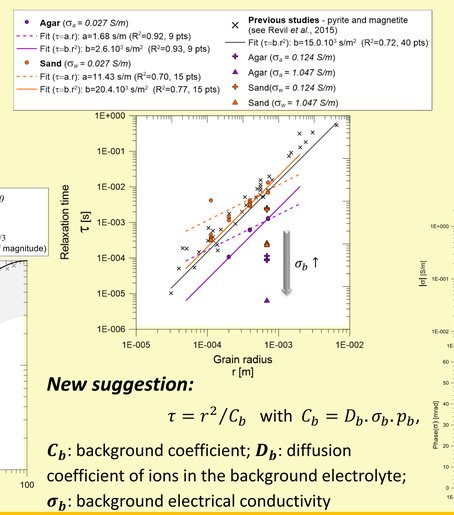
Measured parameters:

Concentration

Wong model: $M_t = 1 - \left(1 - M_{t,b}\right)\frac{2(1-\nu)^2}{(2+\nu)(1+2\nu)}$



Grain size



New suggestion:

$$\tau = r^2/C_b \quad \text{with} \quad C_b = D_b.\sigma_b.p_b,$$

$\boldsymbol{C_b}$: background coefficient; $\boldsymbol{D_b}$: diffusion coefficient of ions in the background electrolyte; $\boldsymbol{\sigma_b}$: background electrical conductivity

Ionic strength

- Increase of salinity → Increase of f_{relax}
- Linked with metallic grain size determination