Geostatistical electromagnetic inversion for landfill modelling and characterization

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Introduction

The characterization and modelling of landfills conventionally relies on a limited number of discrete observations from borehole drillings and excavations, which are often too spatially sparse to reliably capture the characteristic heterogeneity of these deposits.

Electromagnetic induction (EMI) surveys have been successfully applied to the qualitative characterization of landfill deposits associated with mine tailings, and urban and industrial waste, since they are suitable to characterize landfill deposits due to the sensitivity of the measured subsurface properties to changes in waste composition and conditions.

However, the direct interpretation of geophysical measurements from landfills remains challenging due to the large variety and heterogeneity of deposited wastes.

This work aims to contribute to detailed characterization of the spatial distribution of subsurface properties within landfill deposits.

Method

Geostatistical inversion emerges as powerful tool to improve the landfill characterization from geophysical data, as it provides a framework to data integration and incorporation of a model for the spatial variability of the targeted subsurface properties, allowing to infer their spatial distribution and associated uncertainty in a more reliable way (Fig.1).

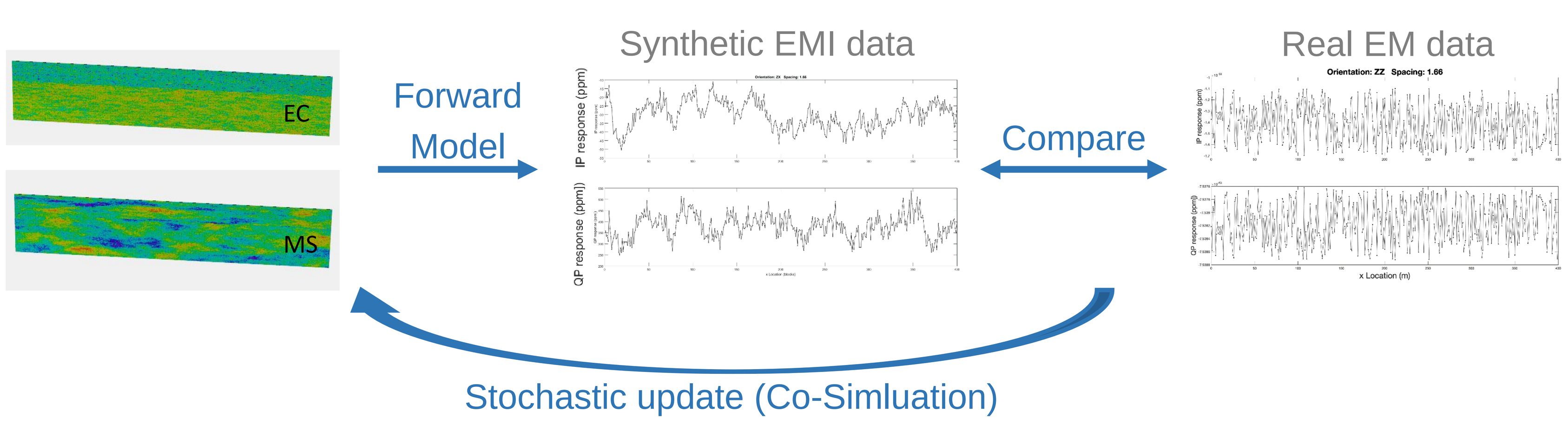

Fig.1- Stochastic sequential simulation of Electrical Conductivity (EC) and Magnetic Susceptibility (MS).

The **iterative geostatistical inversion** (Fig.2) used in this work is based on three main ideas:

- The method is an iterative geostatistical inversion using well-log data, spatial continuity (semi-variograms) and real EMI data.
- Model generation with stochastic sequential simulation and co-simulation.
- Global optimization driven by the misfit between real and synthetic electromagnetic data.

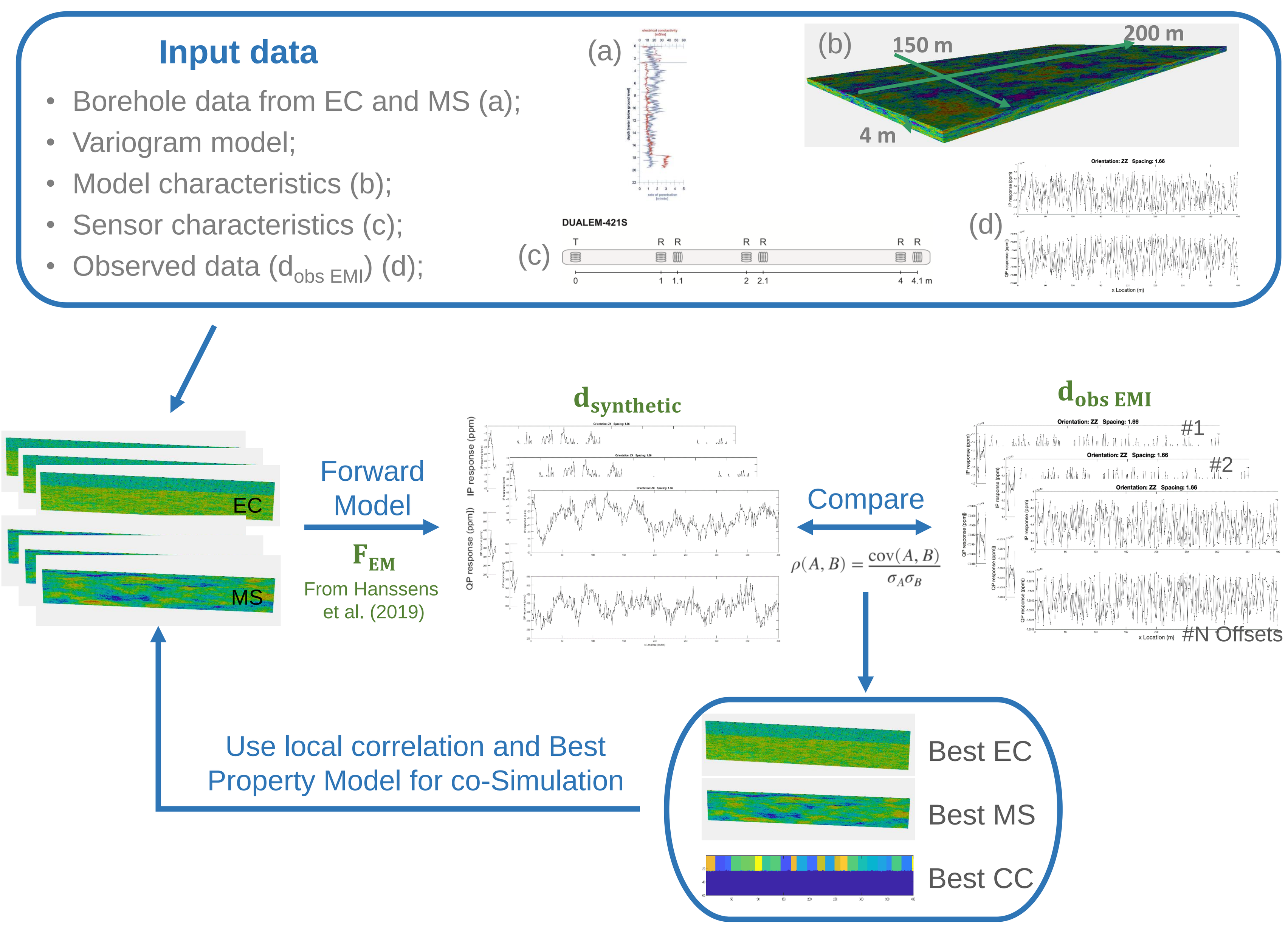

Fig.2- Geostatistical Electromagnetic Inversion (GEMI) proposed in this work.

Data

This work presents the first results of a new geostatistical EMI inversion applied to a synthetic landfill dataset (Fig.3) created based on real data observations made at a mine tailing from the Panasqueira mine (Portugal), which the main production is copper and wolfram.

Panasqueira mine tailing

Material	Porosity (%)	Particle Density g/cm^3
Fine shaly-sands material (2.80-0.05)	49.4	2.825
	49.4	2.802
	49.3	2.773
Mean	49.3667	2.797
Gravel from fine to coarse quartz schist (19.00-1.00)	51.4	2.937
	51.2	2.897
	51.5	2.869
	51.1	2.865
Mean	51.3	2.892

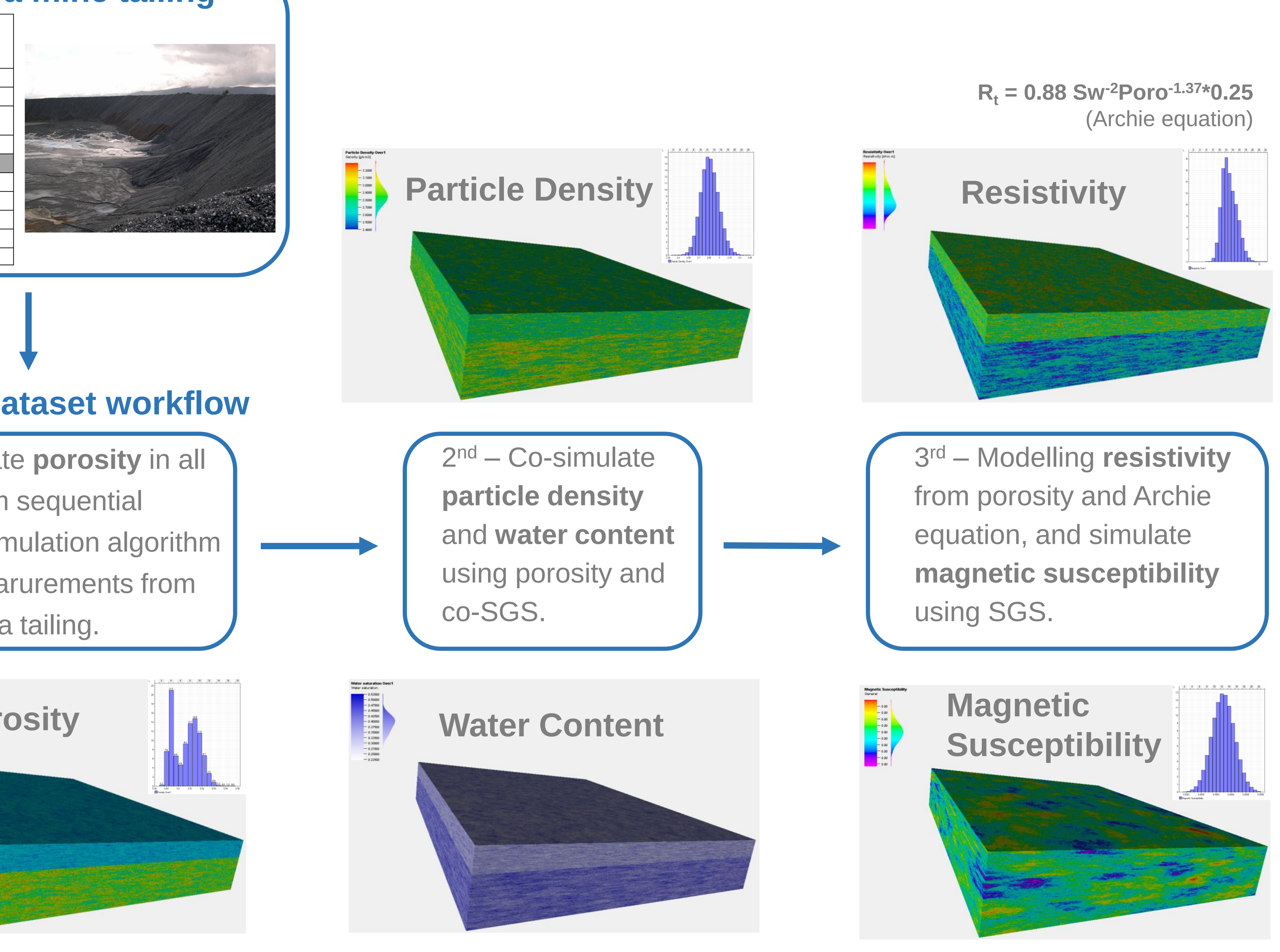

Fig.3- Synthetic landfill dataset created based on real data observations made at a mine tailing.

Results

Were simulated in each iteration 16 2D models of EC and 16 models of MS, in a total of 6 iteration. At the end of each iteration, were created the best models of EC and MS using all the 16 models from that iteration and also the best local correlation coefficients (Fig.4).

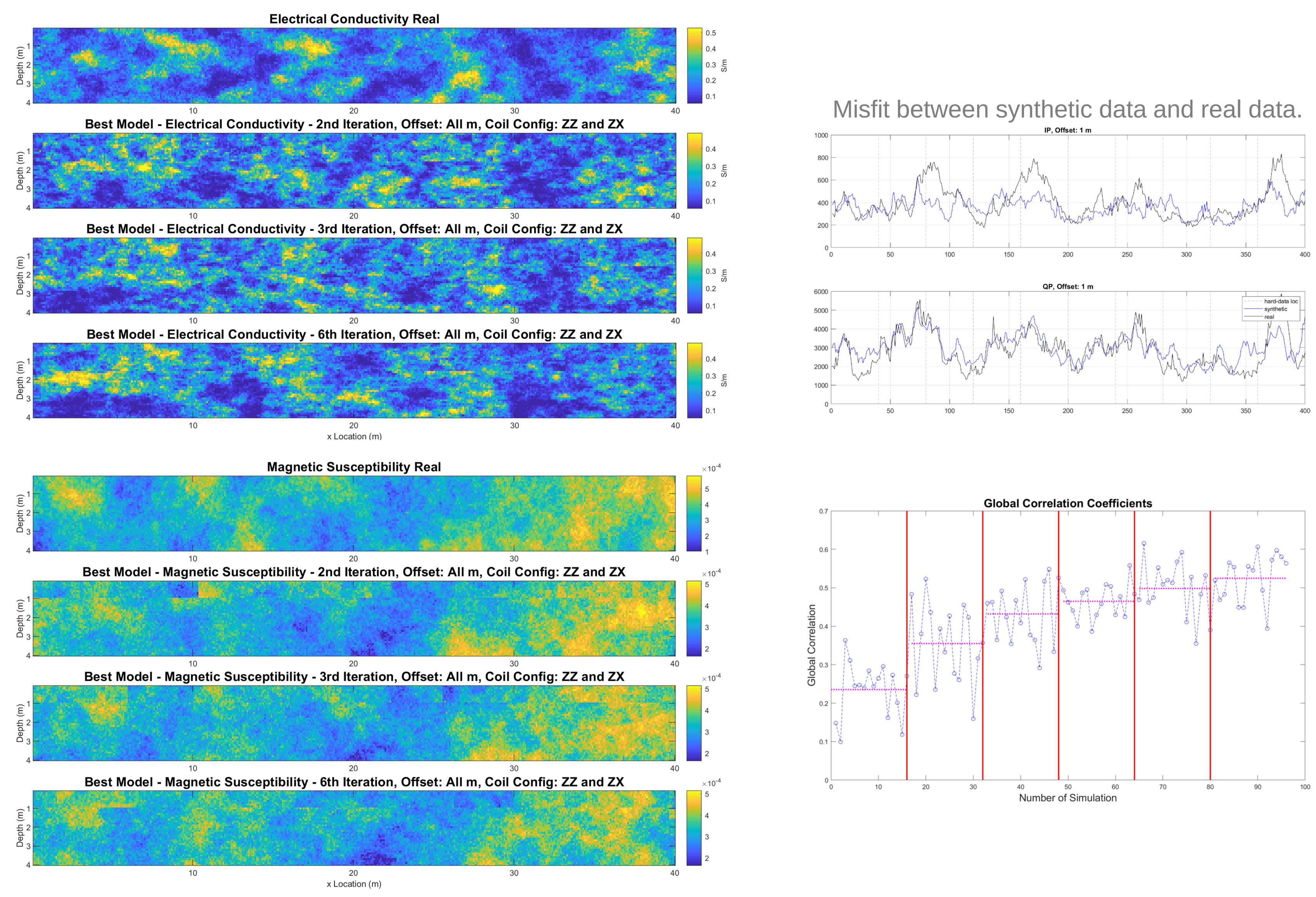

Fig.4- Best 2D simulated models of EC and MS; Global Correlation Coefficients per iteration; and misfit between synthetic data and real data. .

Conclusion

This new methodology represents an advancement in quantitative landfill modelling using EMI survey data and can be universally applied to characterize waste deposits of different types and nature, which is not only relevant to assess the potential for landfill mining but also to evaluate associated environmental risks.

Acknowledgements

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