

Retrieval of anisotropy parameters for geostatistical regularization in electrical resistivity tomography: Advancing subsurface characterization

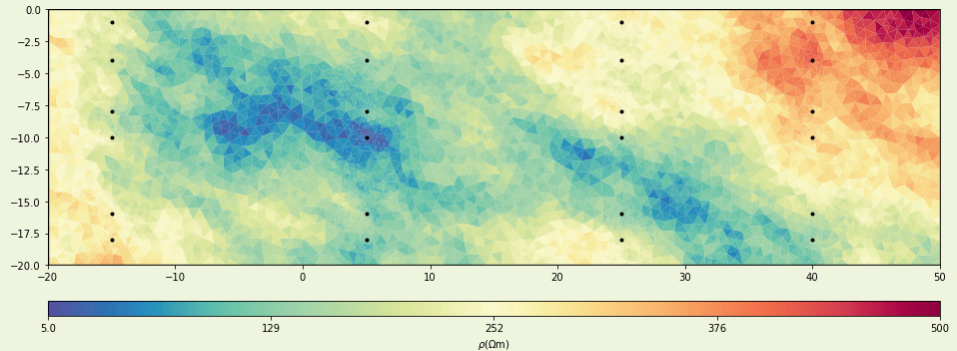
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Motivation

Can we image the subsurface more accurately by accounting for anisotropy?

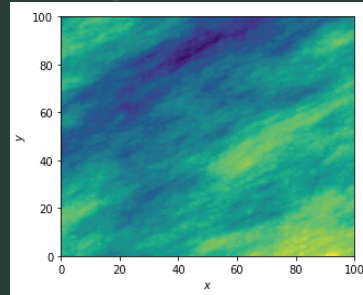
This work brings together borehole data and geostatistical regularization to improve Electrical Resistivity Tomography (ERT) results.

Synthetic Resistivity Random Field

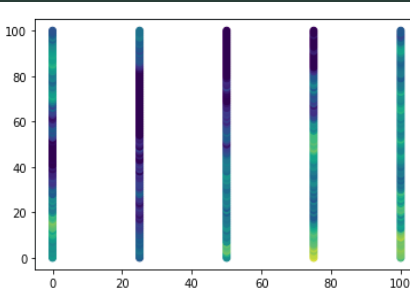


Methodology

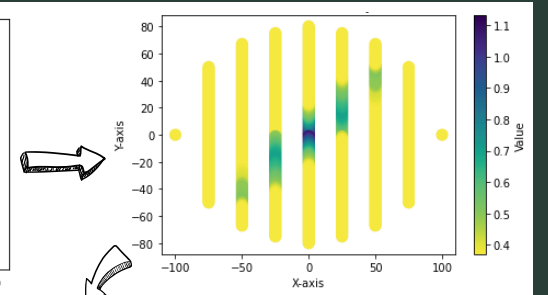
Spatial Random Field



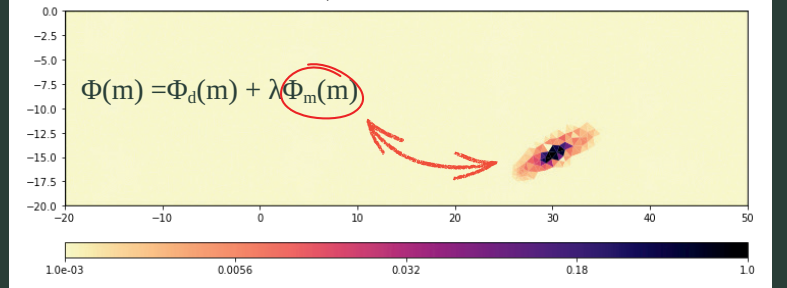
Sampled Spatial Random Field



Covariance Map



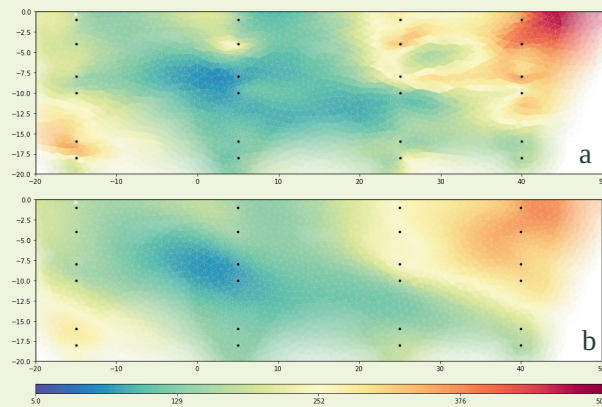
- Synthetic models with Spatial Random Fields simulate geological scenarios.
- Anisotropy parameters are retrieved by fitting theoretical variogram models to experimental directional ones from borehole data.
- Constructed covariance matrix is used to regularize the inversion process through $\Phi_m(m)$.



Selected cell depicting regularization footprint

Results

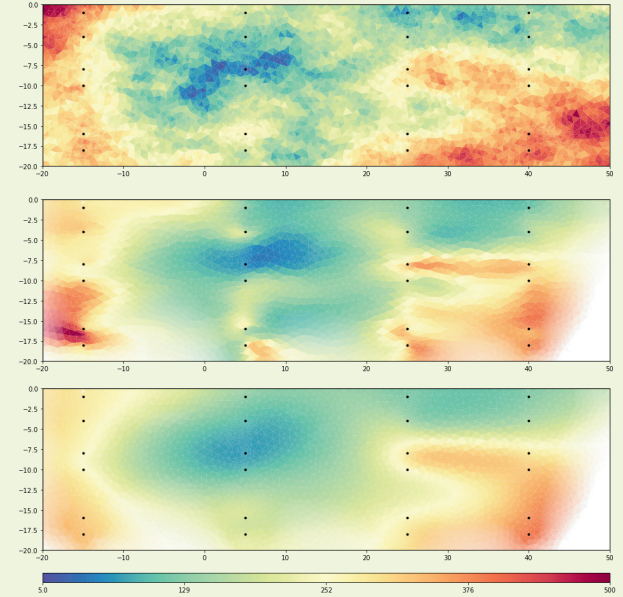
- Improved inversion image, reduced noise, closer to ground truth, particularly in scenarios with well-informed priors.
- The method effectively captured zonal correlations, even with limited prior knowledge.



a) Isotropic, b) geostatistical regularization inversion results.
The reference model is in the motivation section

Take home message

- Anisotropy is important when inverting ERT measurements.
- Geostatistical regularization is effective on rendering anisotropic media.
- Not critical on selecting the exact anisotropy parameters.



Example of isotropic media. From top to bottom, reference model, isotropic inversion, with geostatistical regularization

References

- C. Jordi, et al, "Geostatistical regularization operators for geophysical inverse problems on irregular meshes," Geophysical Journal International.
- C. Rücker, et al, "pyGIMLI: An open-source library for modelling and inversion in geophysics," Computers & Geosciences.
- Müller, et al, GSTools v1.3: a toolbox for geostatistical modelling in Python, Geosci. Model Dev.

