Probabilistic Cover-Basement Interface Characterization in Cloncurry, Australia, using Magnetotelluric Soundings

Hoël Seillé[1], Gerhard Visser[1], Jelena Markov[1], Janelle Simpson[2]

[1] CSIRO Deep Earth Imaging FSP, Perth, Australia

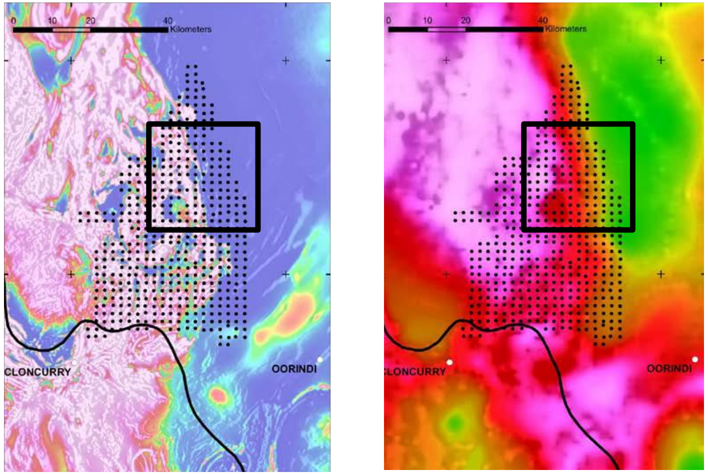
[2] The Geological Survey of Queensland, Brisbane, Australia

Contact: hoel.seille@csiro.au

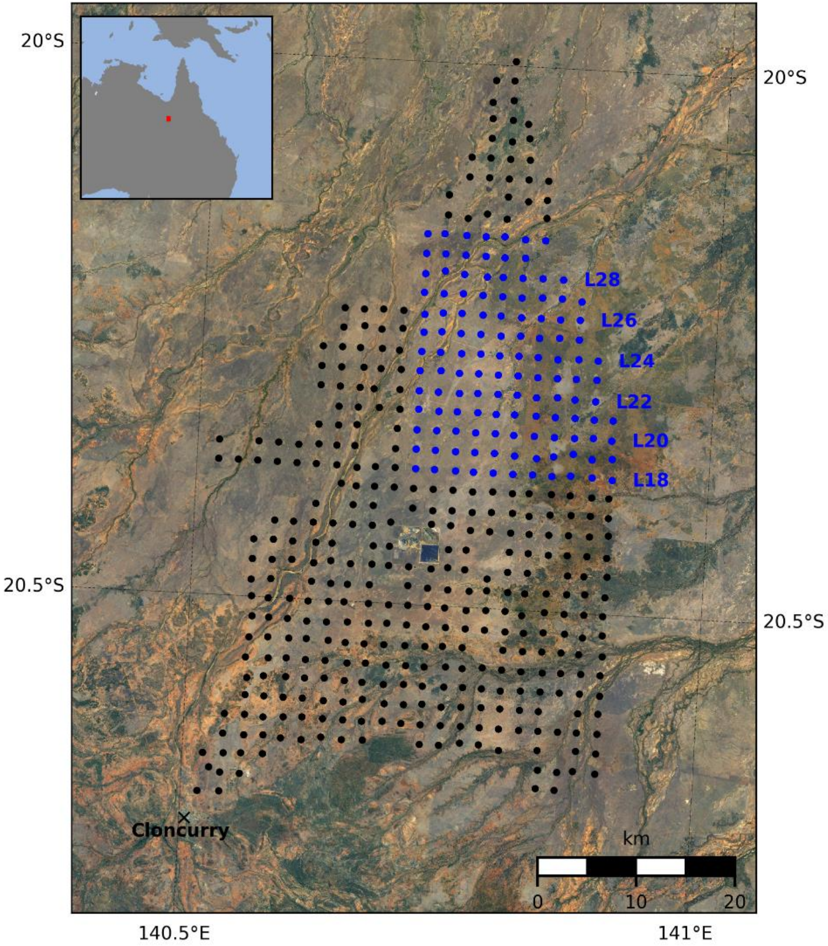
Introduction

- Area under a sedimentary cover / regolith
- NS major geological boundary observable in the potential field geophysical data
- 122 MT sites selected (blue points), spaced ~ 2km

Magnetic Gravity

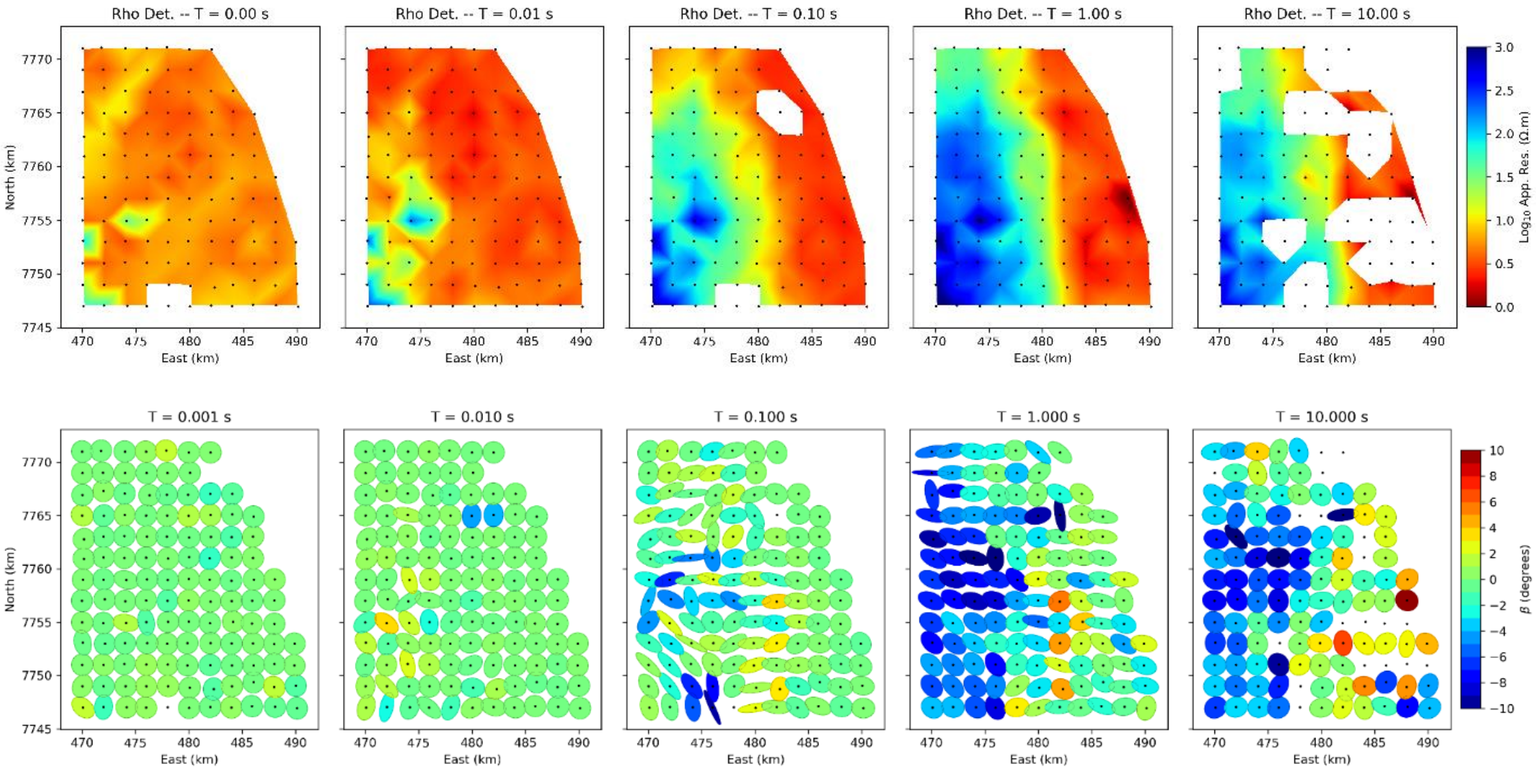


Wang, Duan, and Simpson (2018)



MT Data

Apparent resistivities and Phase Tensor



- Clear EW division, related to the NS running fault.
- Resistive basement clearly observable in the western part of the survey.
- 1D behaviour suggested by phase tensor ellipses for T < 0.1s (skew angle beta < 3 degrees; Caldwell et. al., 2004).

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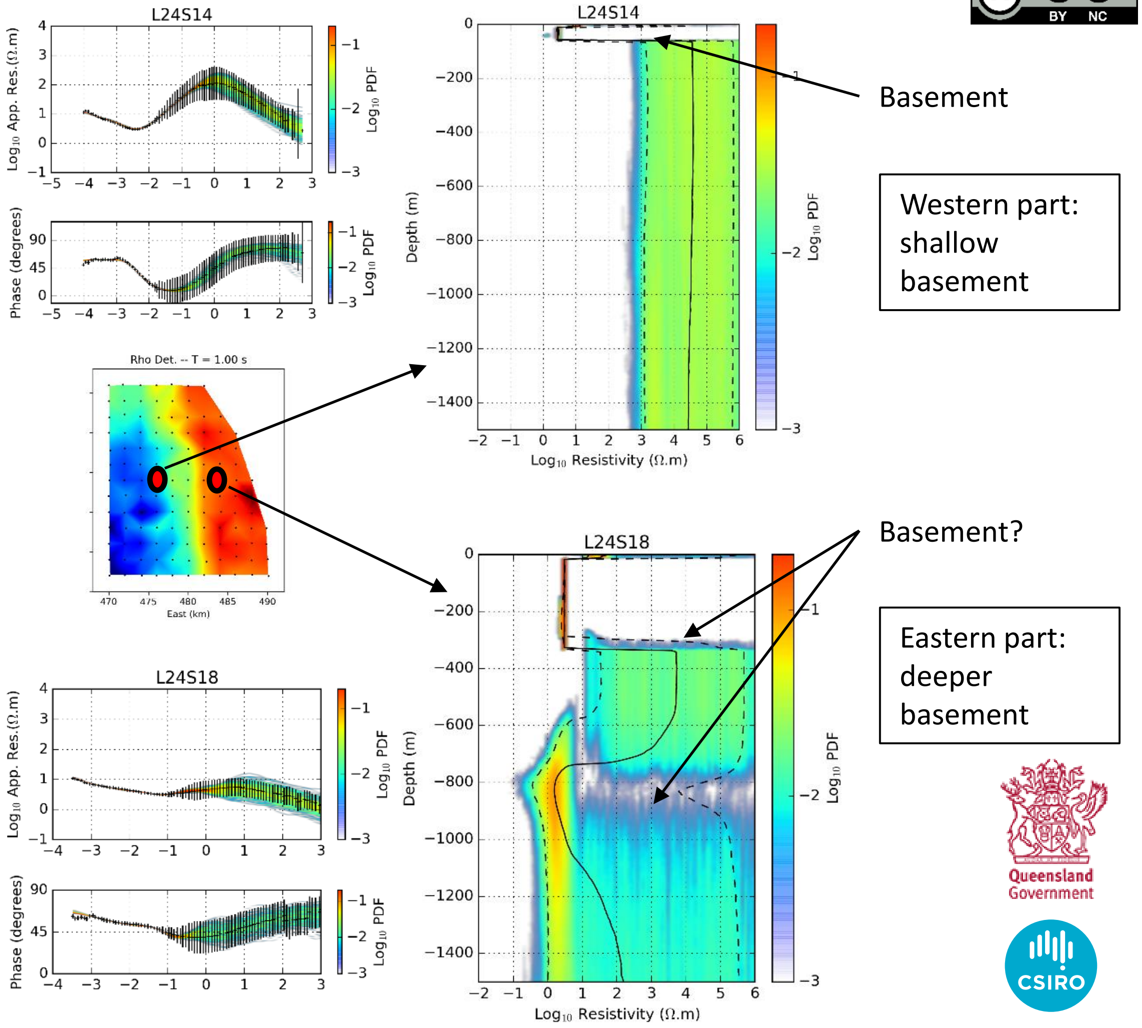
1D probabilistic inversions

1D trans-dimensional Markov chain Monte Carlo sampler, designed to account for non-1D effects present in the data (Seillé and Visser, 2020).

→ **In presence of 2D/3D effects the data uncertainty is increased to compensate for the wrong assumption on the 1D-ness of the data.**

→ **1D MT probabilistic inversions results are represented as ensembles of 1D models for each site, each of them satisfying the data within its uncertainty.**



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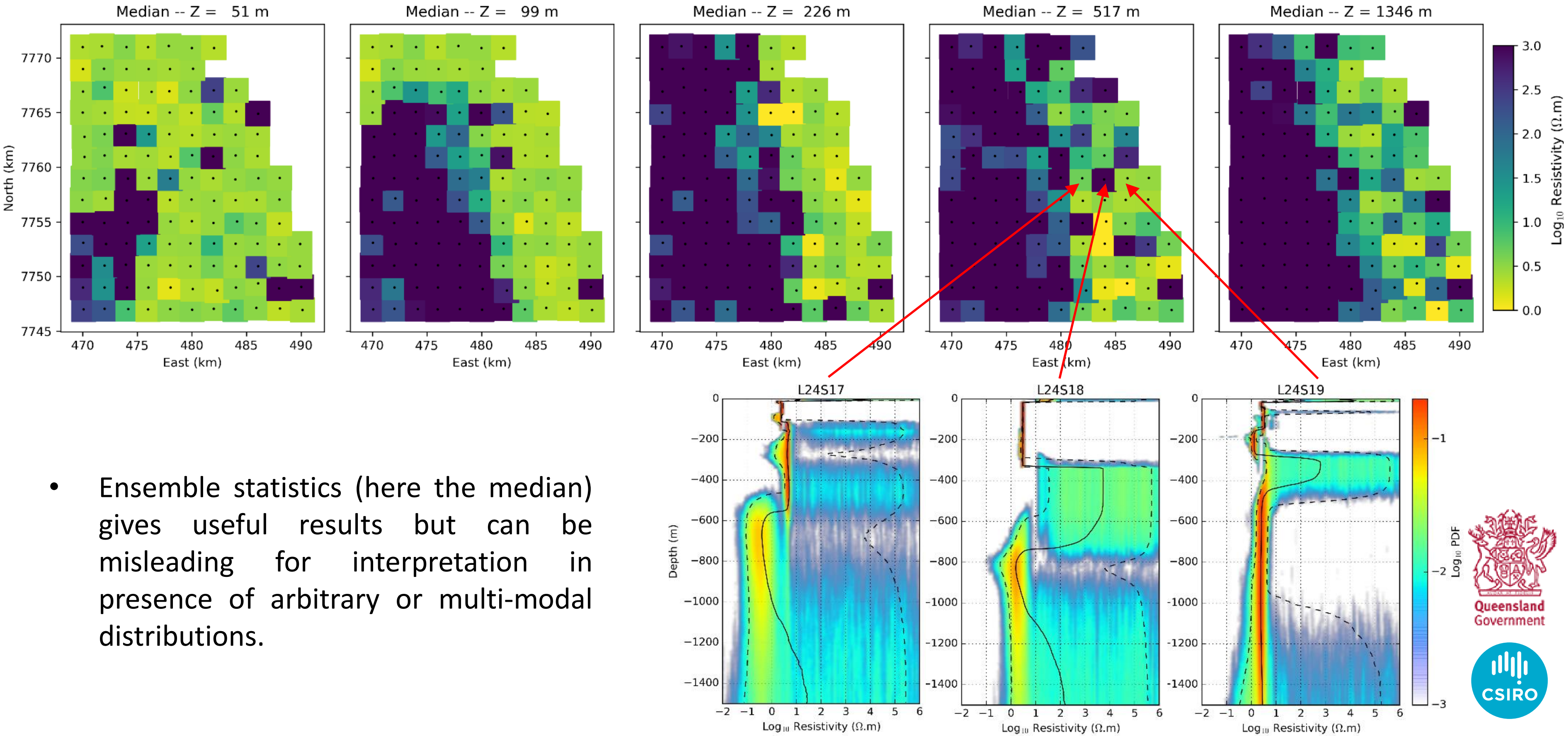
1D probabilistic inversions



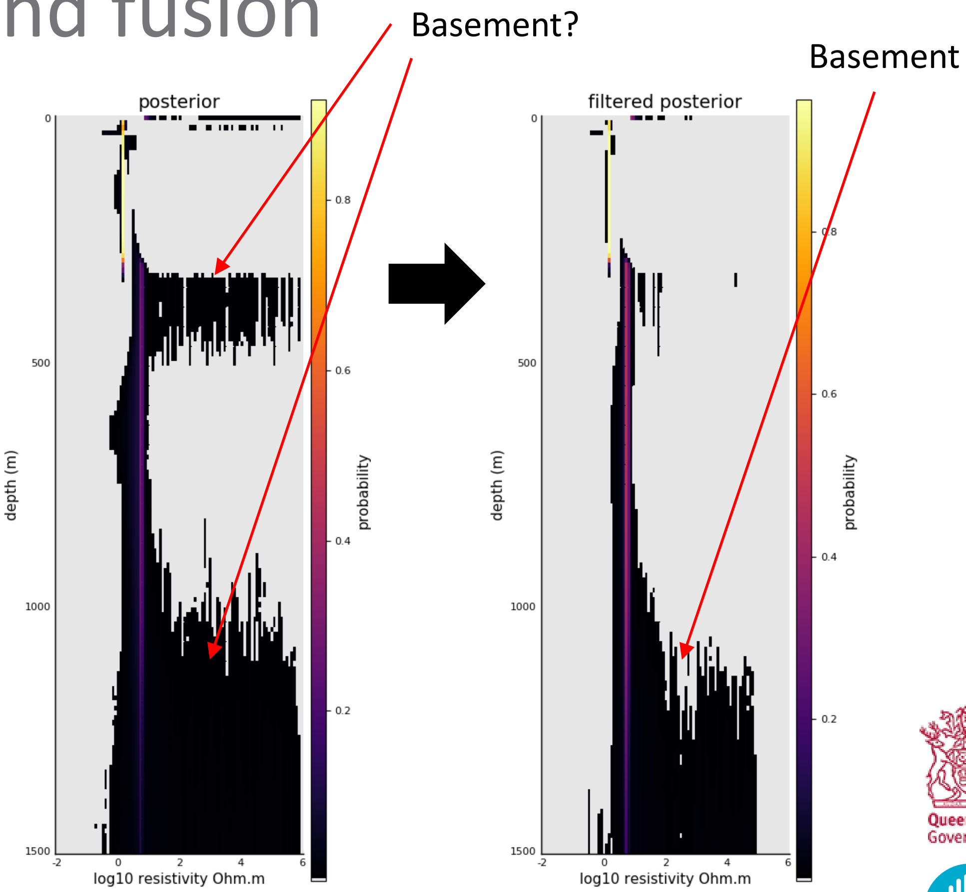
- Ensemble statistics (here the median) gives useful results but can be misleading for interpretation in presence of arbitrary or multi-modal distributions.

1D ensemble analysis and fusion

- The distribution of resistivity of all the 1D model ensembles is analysed to define prior knowledge on lithologies' resistivities and their probable sequence

- The 1D ensembles are filtered to keep the most probable 1D models given the previous assumption we derived on the lithologies, using a Bayesian Spatial Ensemble Fusion algorithm (Visser, 2019; Visser et. al., →https://meetingorganizer.copernicus.org/EGU2020/EGU2020-4388.html)

- In that example most of the models of the ensemble that present a resistive layer around 400m are filtered out.



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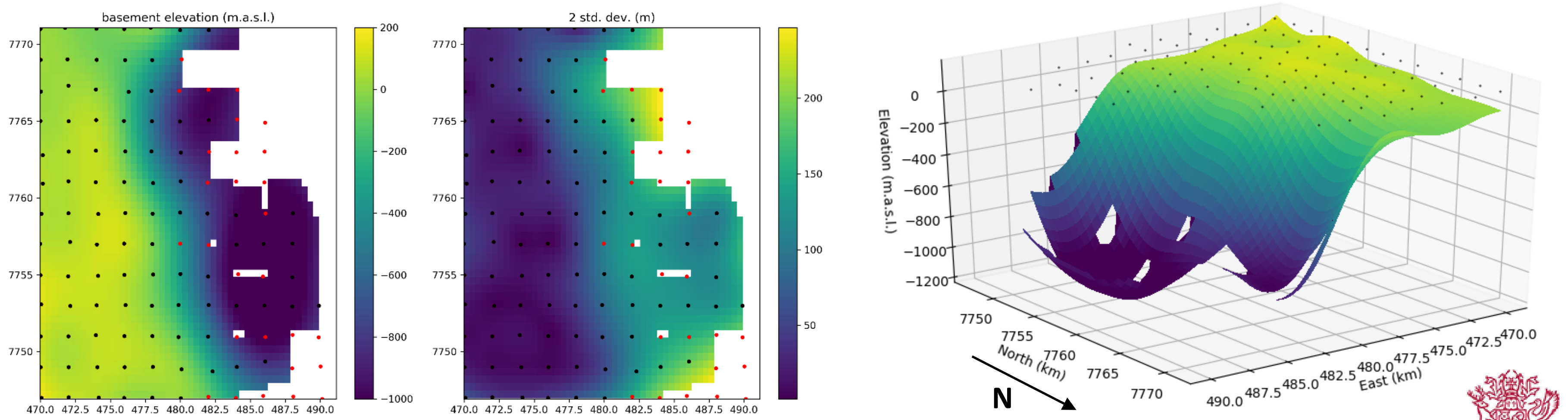
Basement imaging: Preliminary results

- Each sounding provide an independent distribution of depths at which the basement is estimated. Some soundings have no or too few estimates to be included in the interpolation (red points).
- Interpolation between these estimates is performed to produce a surface and associated uncertainty.



→ **The transition between the shallow basement on the West and the deep basement on the East is likely to be controlled by a sharp subvertical contact. Interpolation using constraints from fault location to obtain a more geologically realistic result is ongoing.**

Conclusions

- Preliminary results show that the workflow we presented has the capability to provide significant information in terms of structures and uncertainty, even in a 3D context.
- The basement structure on the western part of the survey is relatively well constrained by the data. On the eastern part the basement appears to be located at depths > 1000m.
- Ongoing work:
  - Include petrophysical and geological information during the ensemble filtering.
  - Include AEM data to better define the shallower part of the basement between the MT sites.
  - Assimilation of different sources of information about the depth to basement and knowledge about geological structures (faults) during the interpolation of the estimates (Visser and Markov, 2019), to recover a more geologically realistic depth to basement surface.
  - Comparison with existing 2D/3D results to assess the relative merits of different approaches.

Parallel ongoing research:

- Results to be used in conjunction with 2D/3D deterministic MT inversions (structurally constrained inversions, Seillé and Visser, 2019).

References

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