



3-D DC soundings to image aquifers in fractured basalt of Djibouti

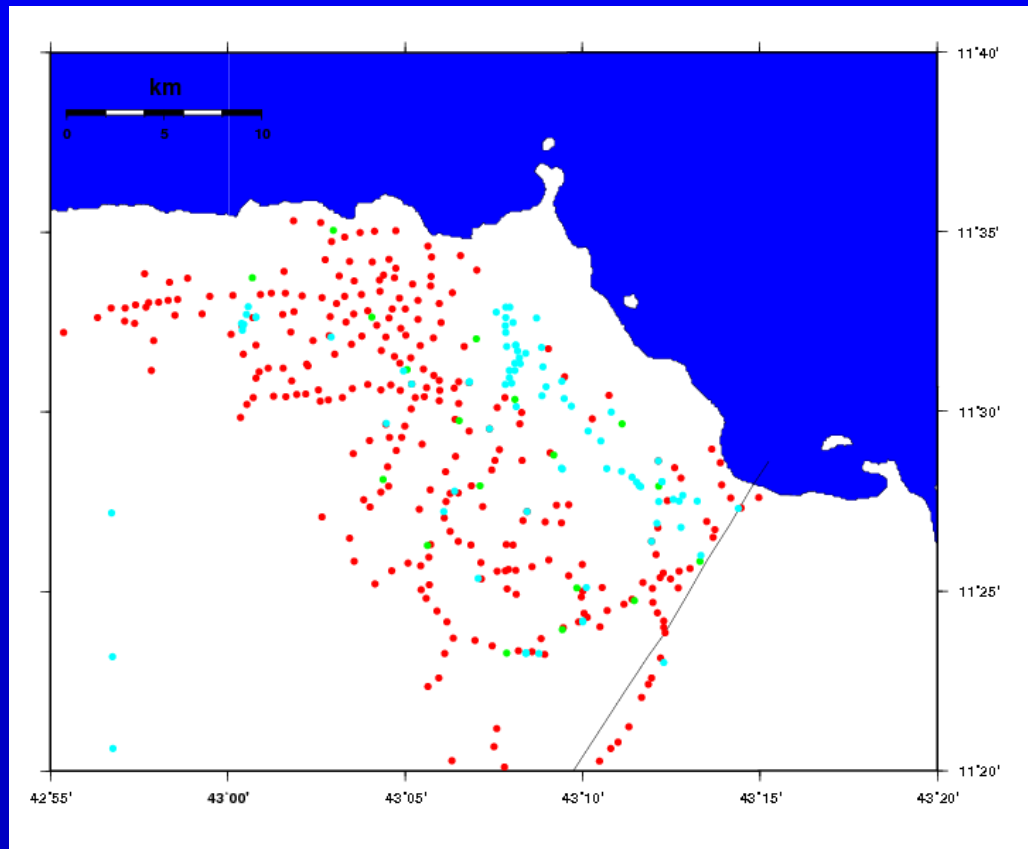
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Summary

- **Available geophysical data in the aquifer of djibouti area**
- **3D approach for the characterization of complex structures**
- **Difficulties encountered during the development of the 3-D DC inversion code**
- **Validation of our new 3-D imaging tool: Application to synthetic data**
- **3D DC inversion: Application to real data, Djibouti aquifer**
- **Work in progress:**
 - ✓ **Faster 3D imaging tool: Parallelisation of the code**
 - ✓ **Application to recently acquired high-resolution DC data (electrical tomography)**

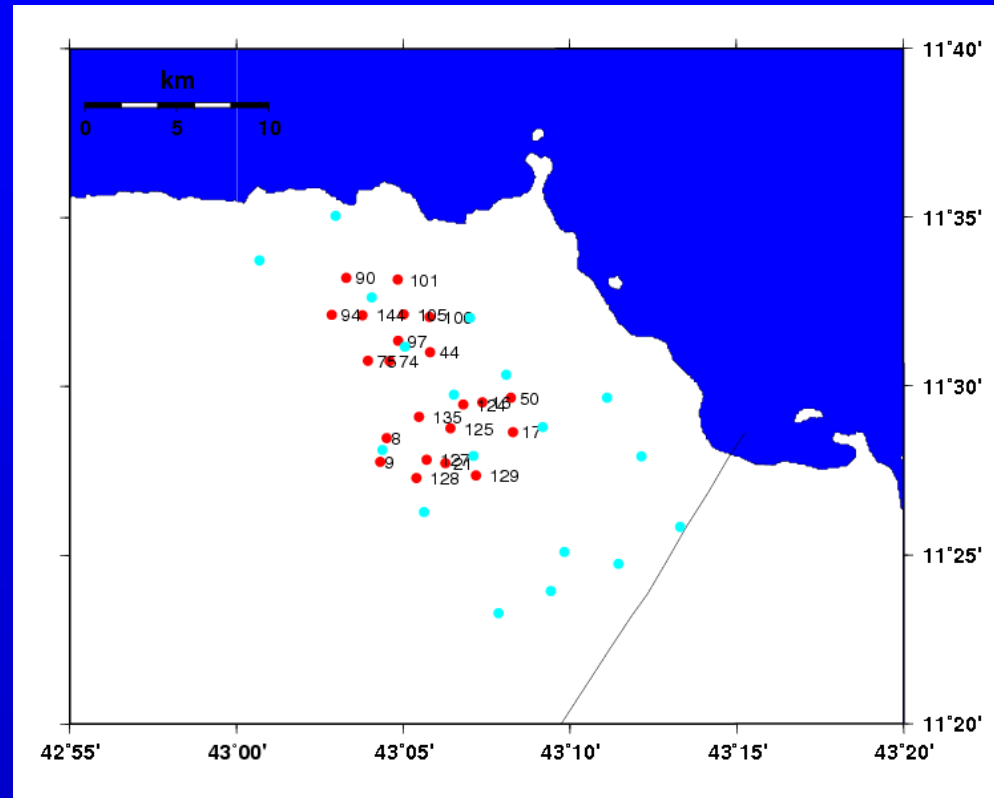
Available geophysical data in the aquifer of djibouti area

- We have:
- 280 DC sounding (red circles)
 - 18 MT sounding (green circles)
 - Plus boreholes (blue circles)



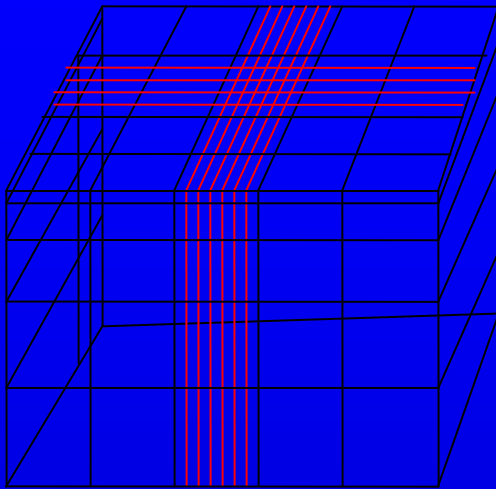
Available geophysical data in the aquifer of djibouti area

Location map of the study area. The red circles are the location of the DC sounding considered in this study and the blues circles are MT/CSMT soundings.



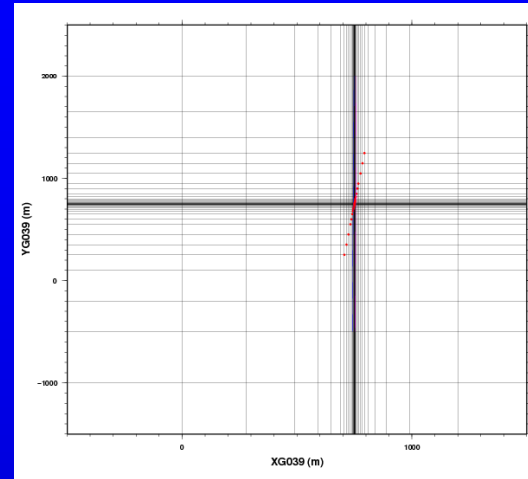
3D approach for the characterization of complex structures

Grid for forward modelling

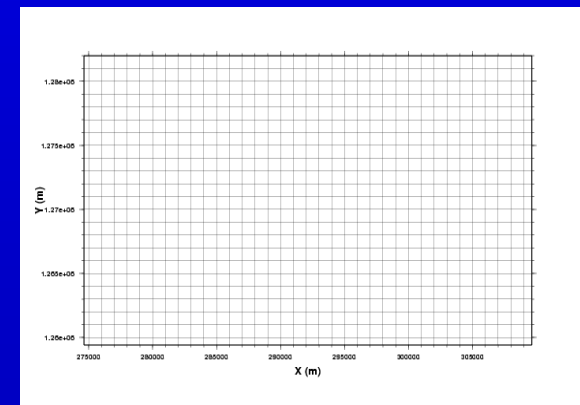


3-D discretization grid for forward modelling (red lines) and inversion (black lines)

The 3-D inversion approach considered is based on the minimisation of a misfit function between all DC sounding sites and the 3-D response computed with the forward code by K Spitzer (1995). Different grids are necessary to combine numerical accuracy and proper discretization of the area



2-D discretization Grid for forward modelling

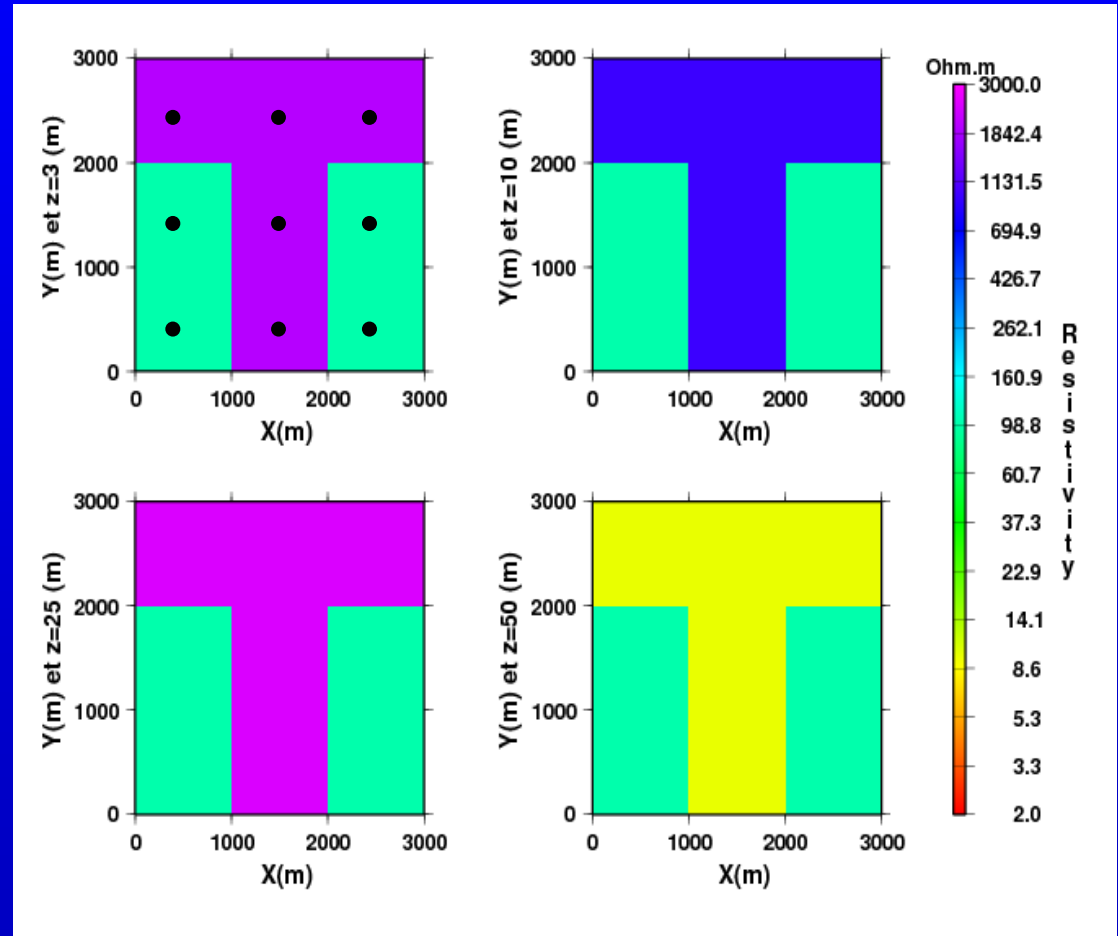


2-D discretization grid for inversion

Validation of our new 3-D imaging tool: Application to synthetic data

Case 1: Regular distribution of DC soundings (1 per mesh)

Synthetic model:
3D structure with a T shape

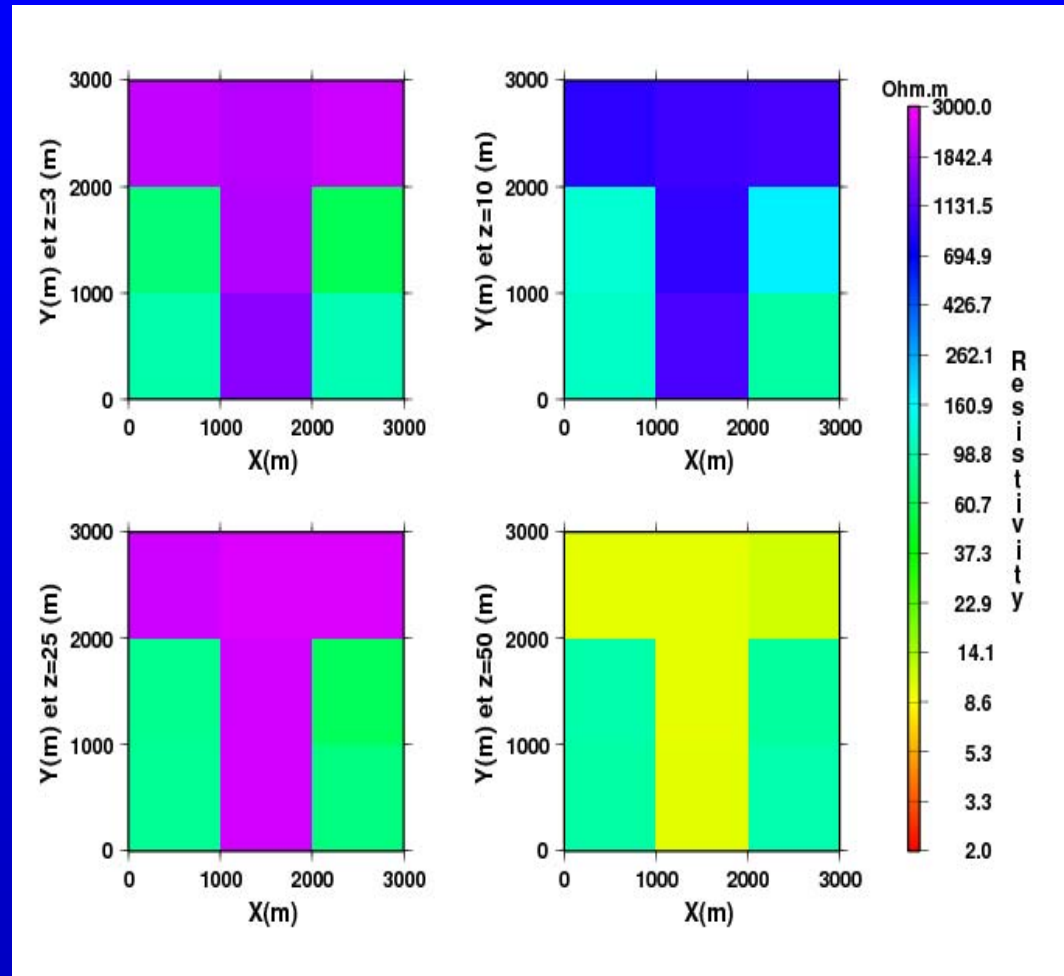


Case 1: Regular distribution of DC soundings (1 per mesh)

Result:

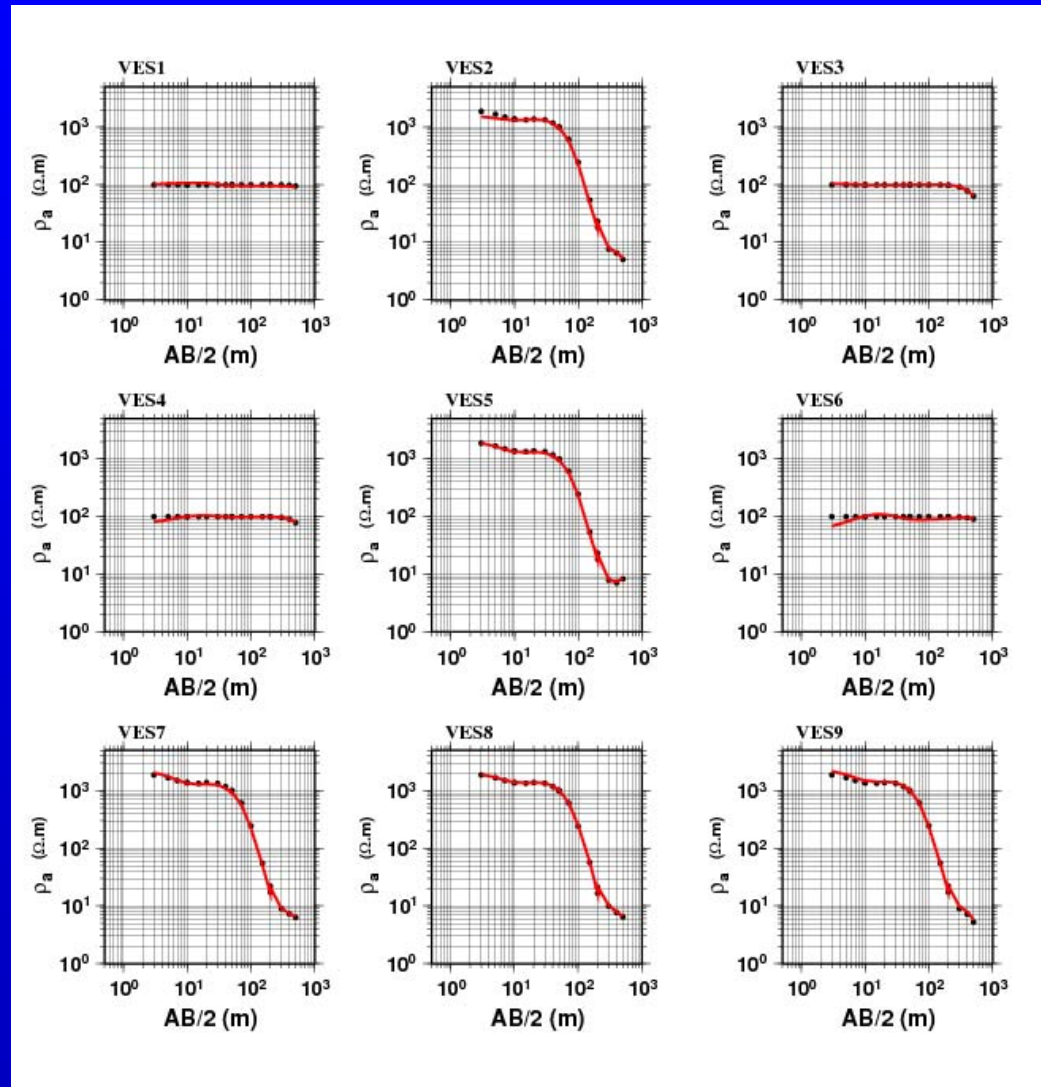
**The best fitting model
obtained.**

RMS misfit = 1.95



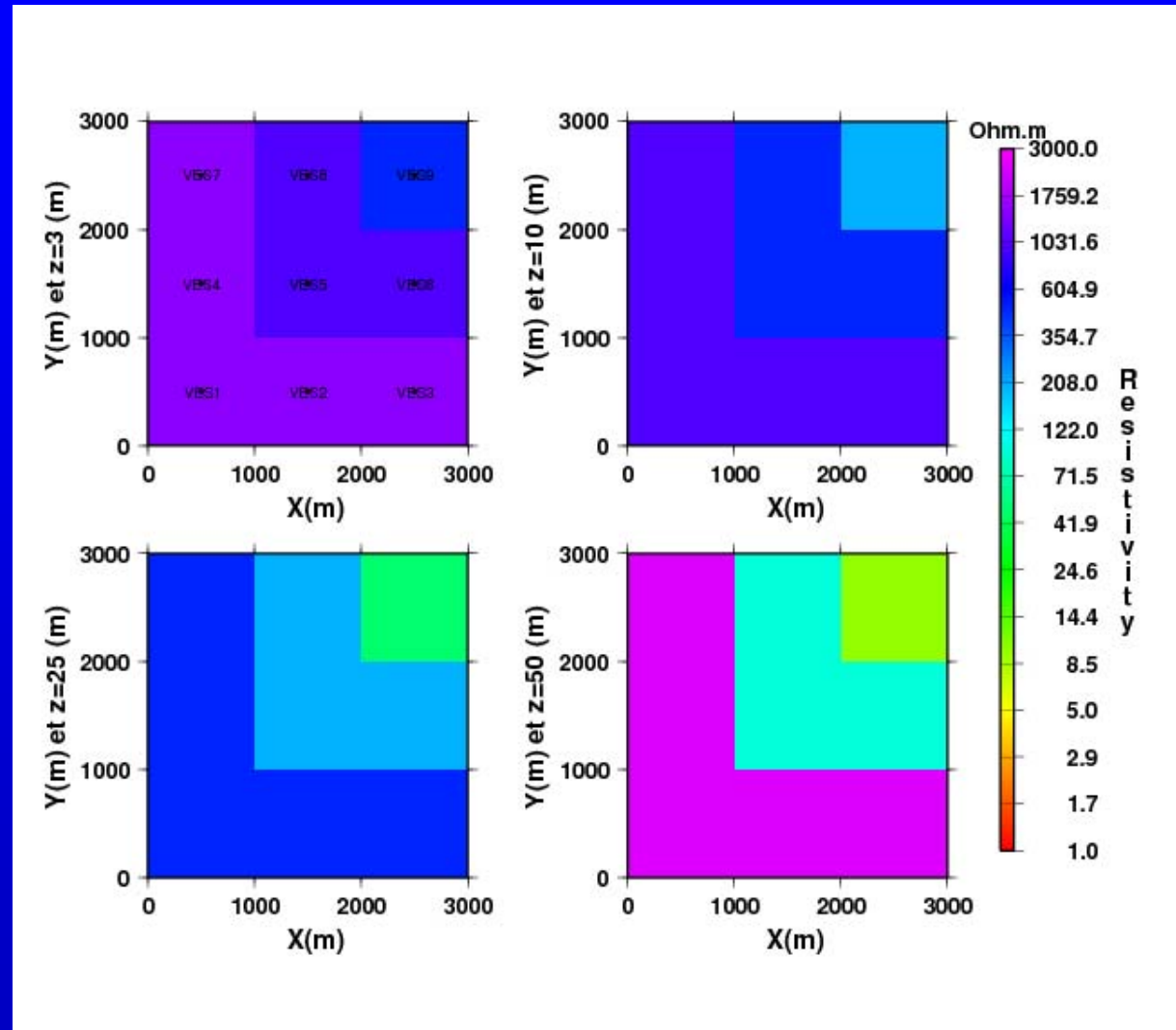
Case 1: Regular distribution of DC soundings (1 per mesh)

Response of the model compared to each DC sounding.



Case 2: Regular distribution of DC soundings (1 per mesh)

Synthetic model:
3D structure with a L shape

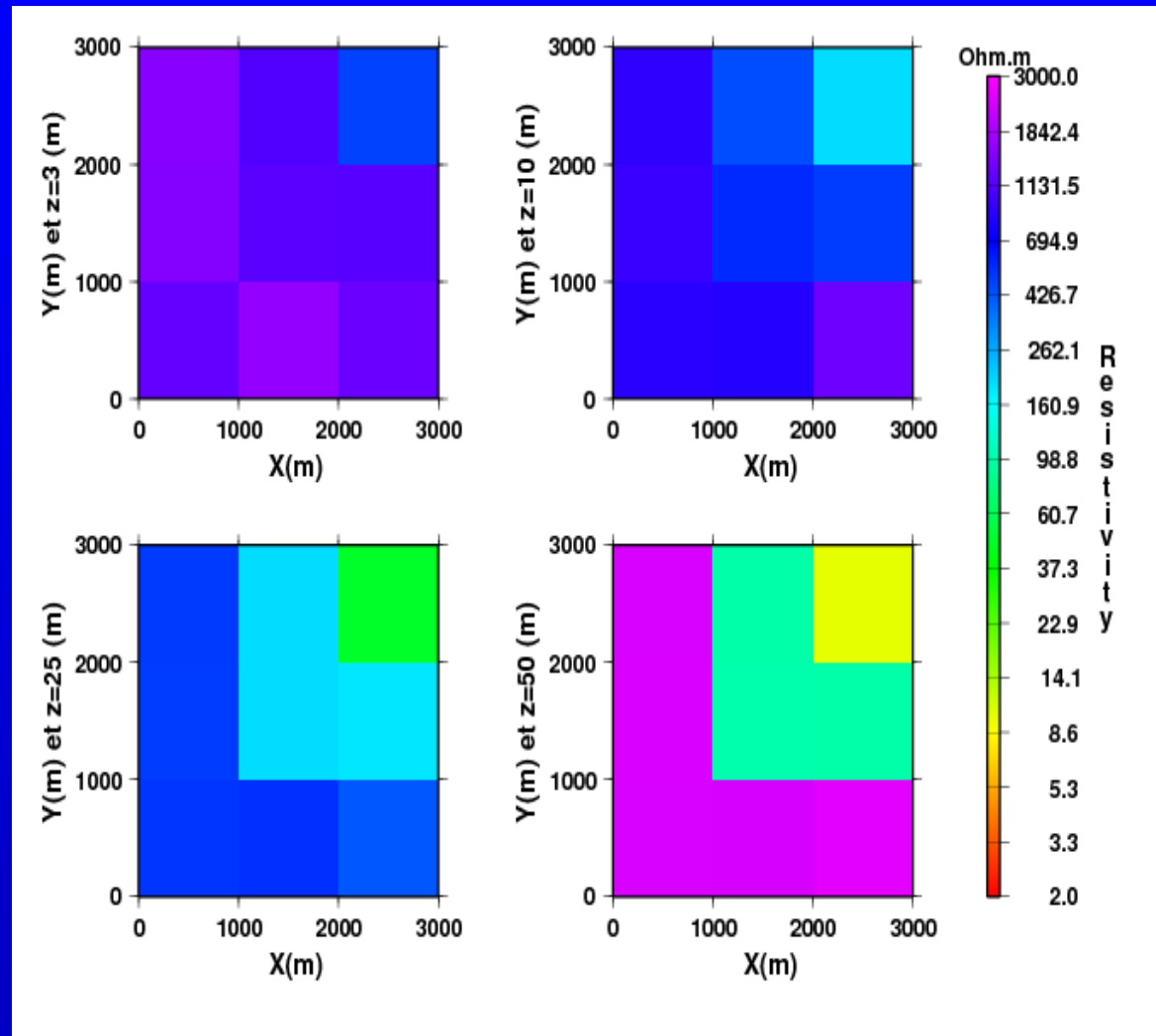


Case 2: Regular distribution of DC soundings (1 per mesh)

Result:

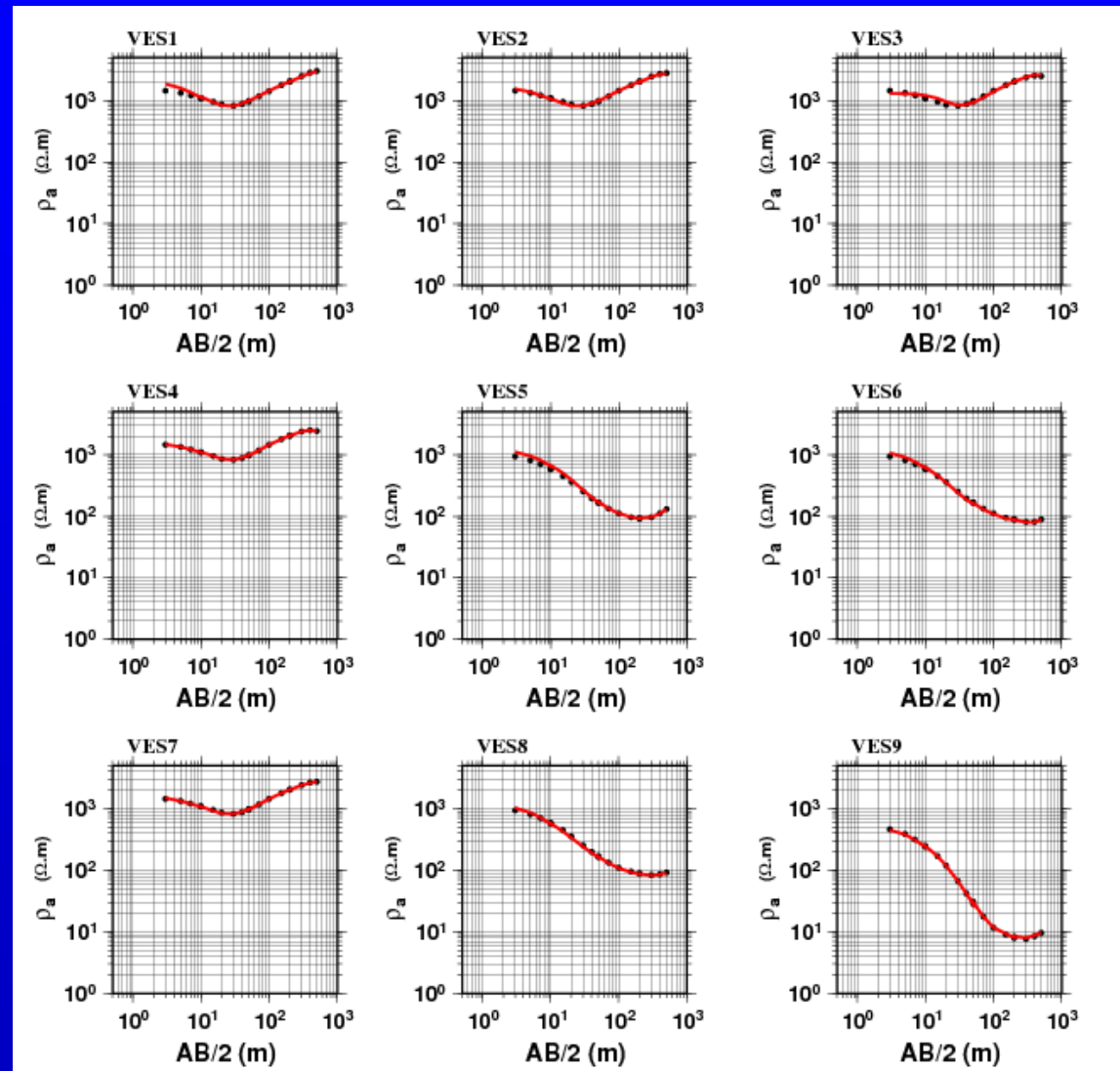
The best fitting model
obtained.

RMS misfit = 0.99



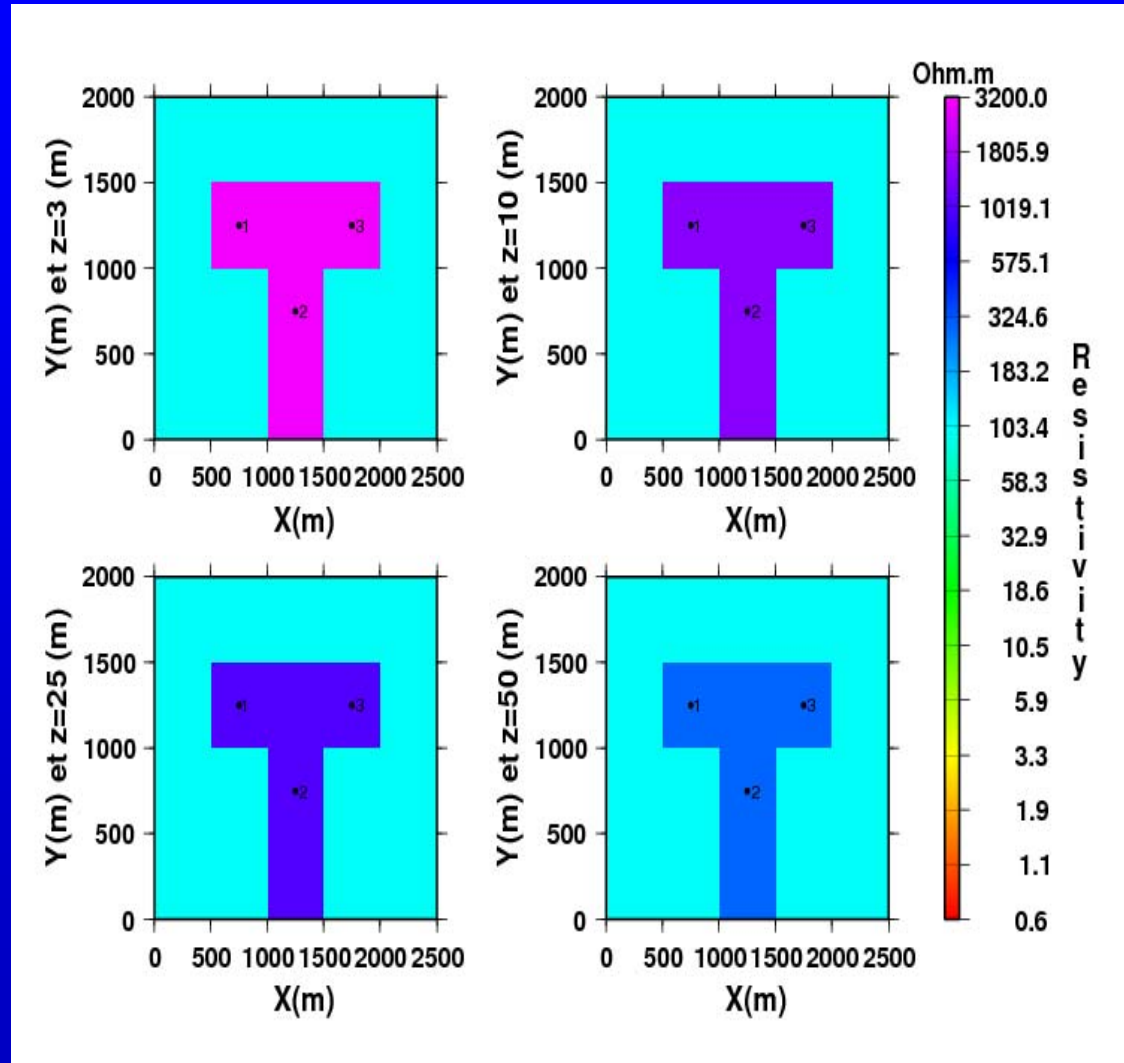
Case 2: Regular distribution of DC soundings (1 per mesh)

Response of the model compared to each DC sounding.



Case 3: What happens in case of sparse data?

Synthetic model and inversion with 3 DC soundings only

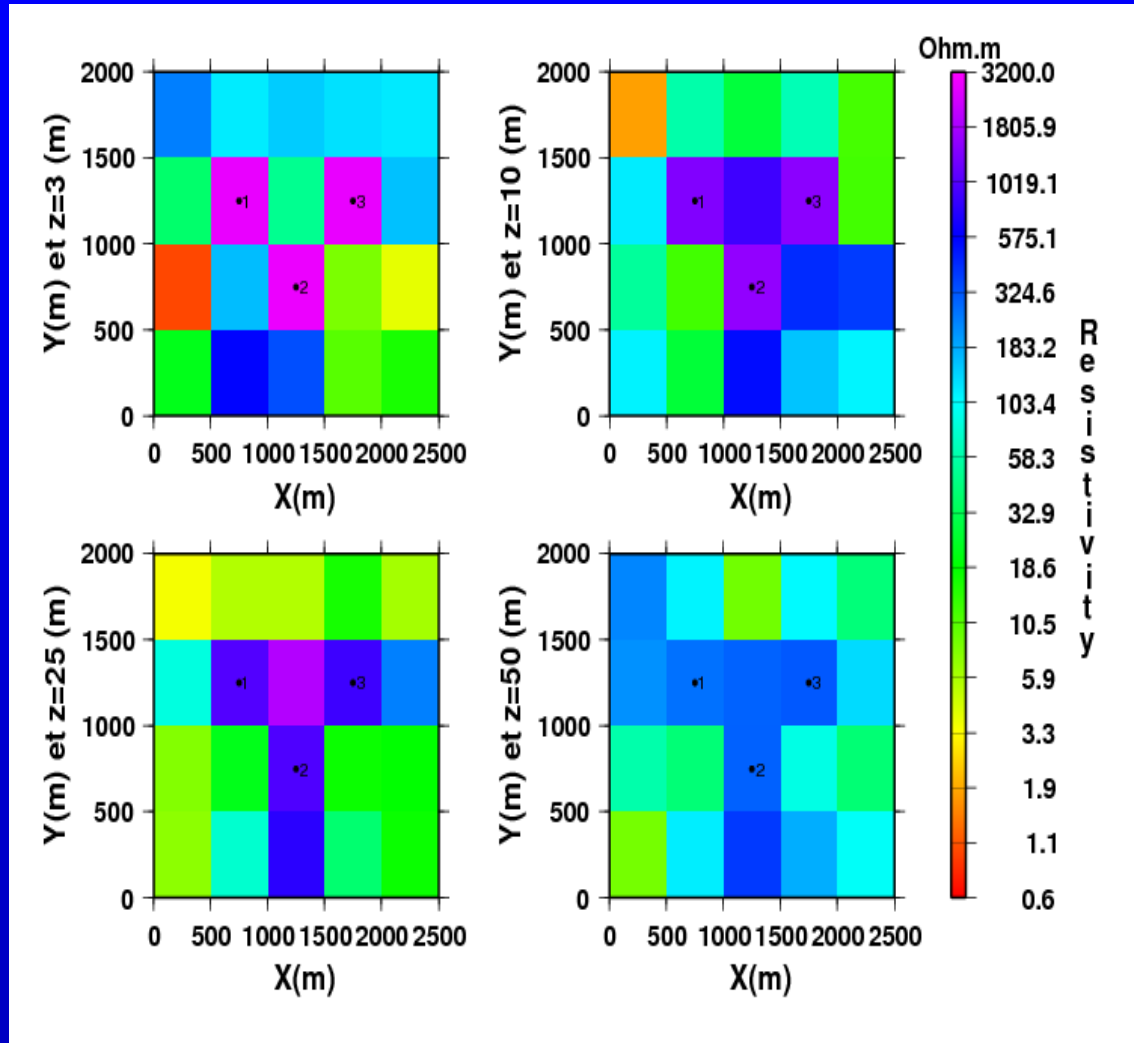


Case 3: What happens in case of sparse data?

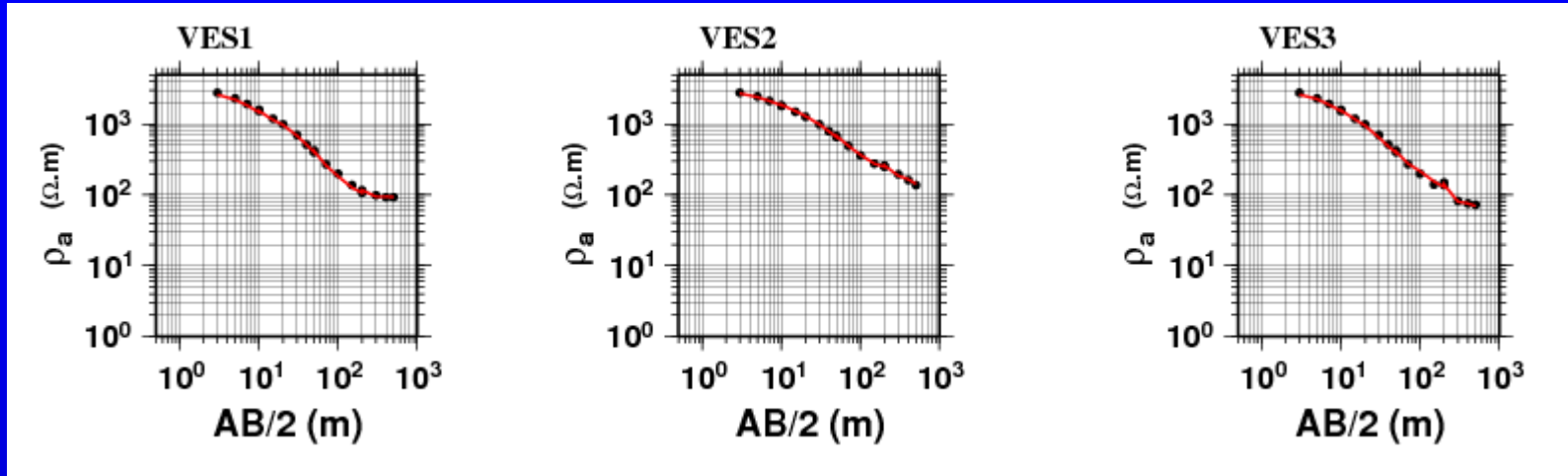
Result of the inversion:

Despite the small amount of data to constrain the model, the shape of the anomalous body can be identified.

RMS misfit=1.088



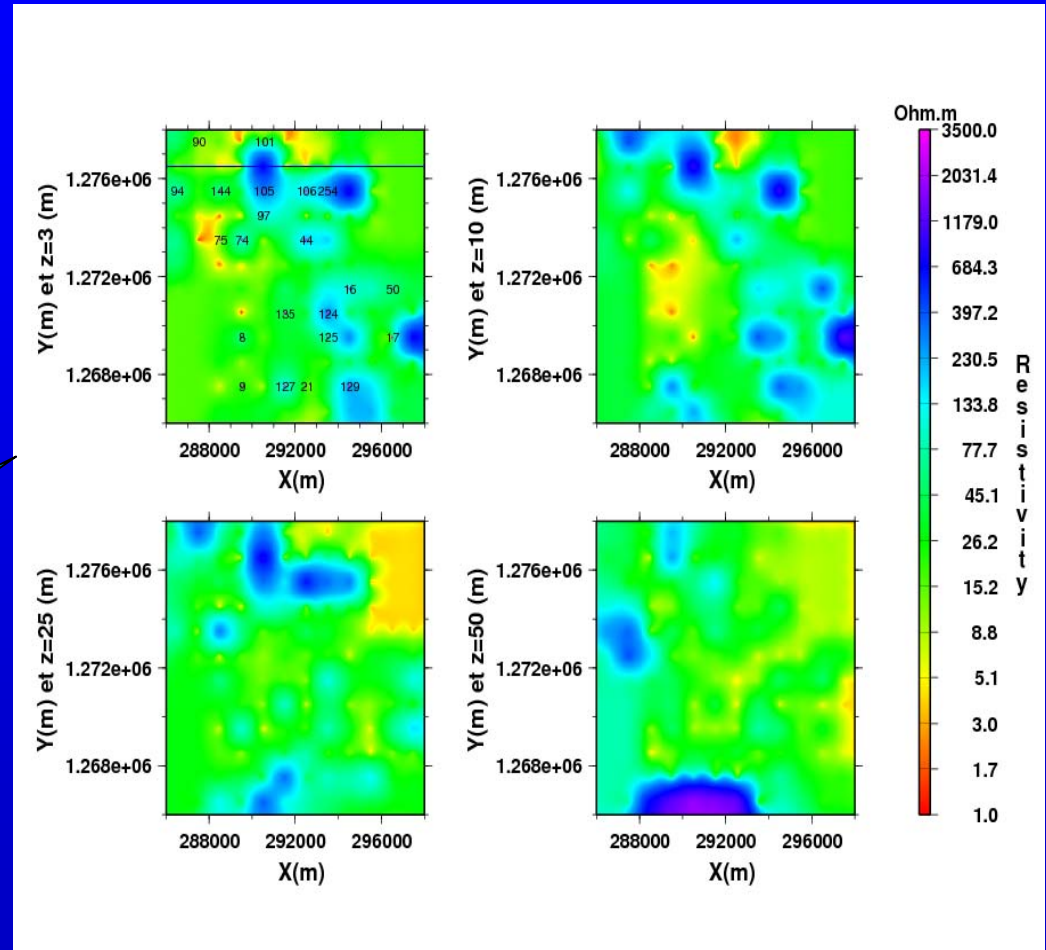
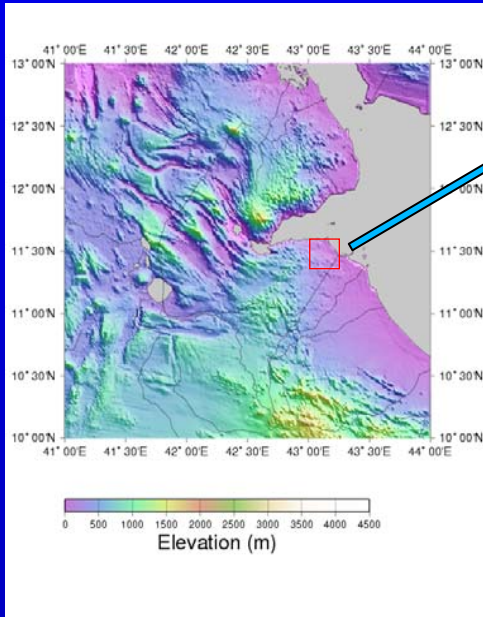
Case 3: What happens in case of sparse data?



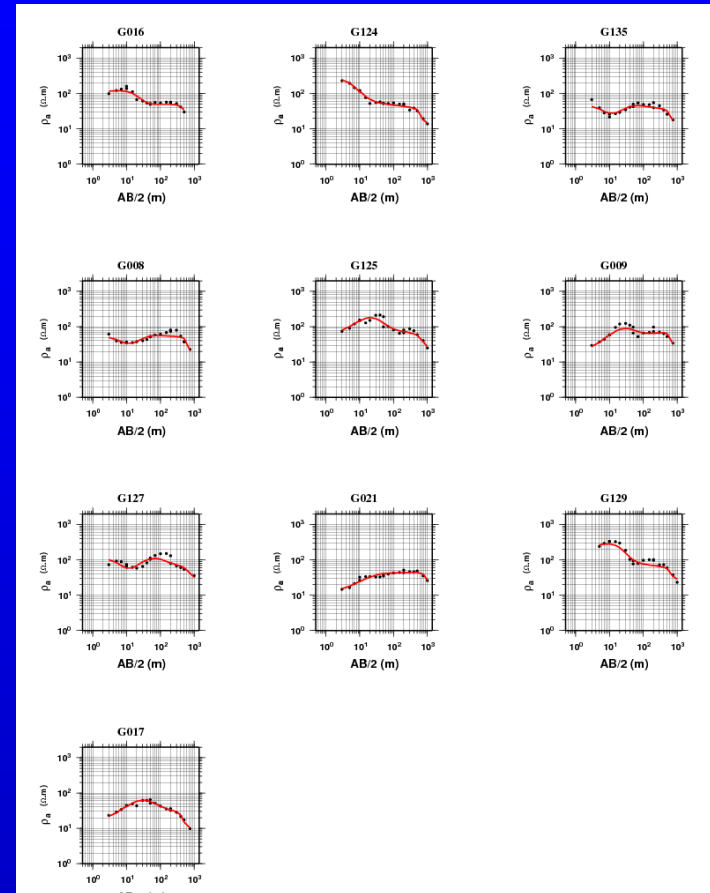
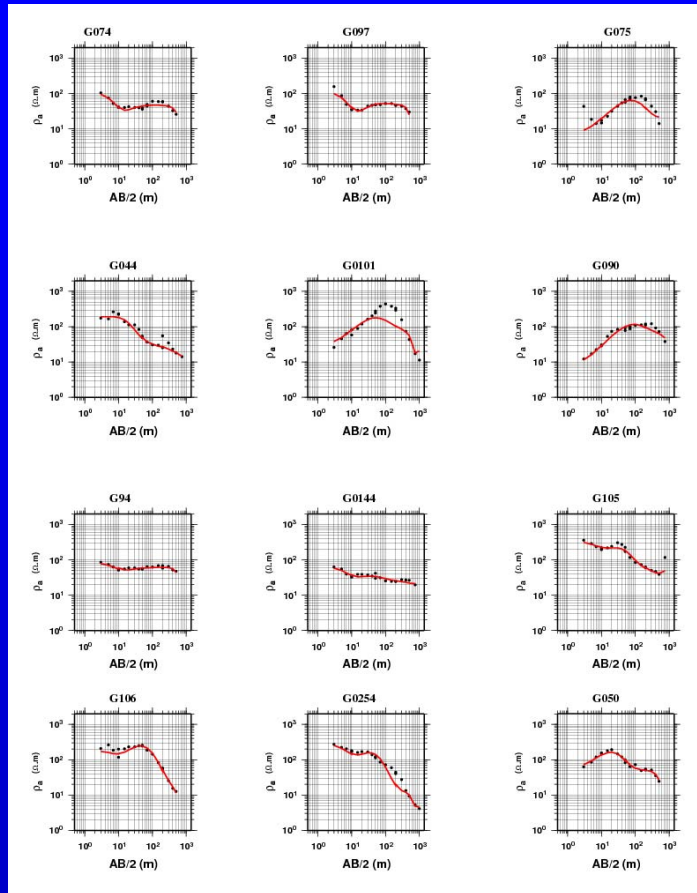
Response of the 3D model at each DC sounding

Application to real data: Djibouti Aquifer

Starting model:
Model obtained of the 1D
inversion
Result of the 3D inversion
RMS misfit=3.823

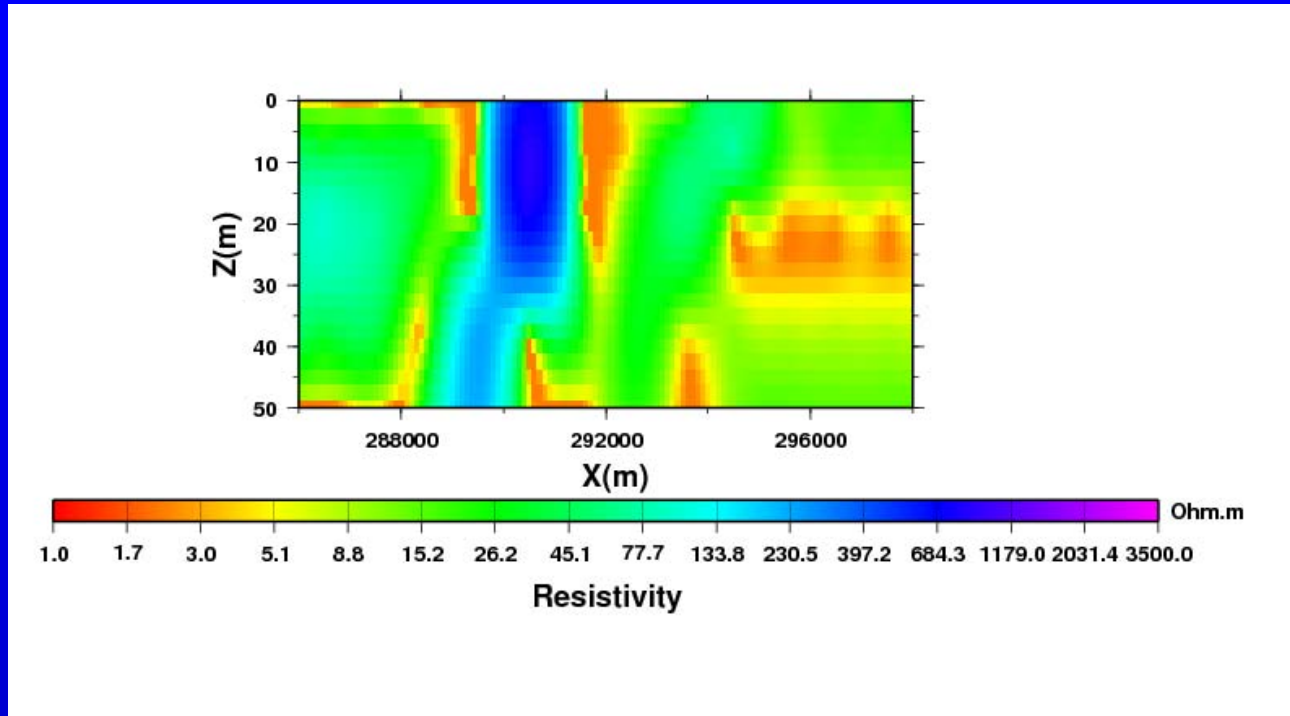


Application to real data: Djibouti Aquifer



Response of the 3D model at each DC sounding

Application to real data: Djibouti Aquifer



Vertical cross-section across the 3-D model.

Perspectives

- **In order to get a solution faster, we are currently developing a version of the code running in parallel on several computers.**
- **Once this new version is operationnal, we will apply our 3D inversion code to the tomography data (high resolution data) recorded in 2007 (Atar experimental site).**