Geocap practical excercises

Open the Geotools™ database 'GeocapBackup' in Geotools™. An MT data set from a recent surface exploration program over a geothermal prospect is loaded into this database. The geothermal prospect is located on an island with several inactive volcanoes in the area.

1. Evaluate all stations

Create an MT apparent resistivity map of Zxy, Zyx and the Invariant (ZINV) at 10,000 Hz. Scroll through the apparent resistivity vs frequency up to 0.3 Hz. ('Layers' pane on the right, click '+'.)

Q01: Briefly describe the general behavior of the resistivity with increasing frequency. Is there a general directional trend to be seen in the maps?

Create an MT phase map of the *xy* and *yx* components at 10,000 Hz. Scroll through the phase vs frequency up to 0.3 Hz.

Q02: Briefly describe the general behavior of the phase with increasing frequency. Can you say something about the dimensionality of the MT data.

Create an MT parameter plot map of the induction arrows at 10,000 Hz. Scroll through the induction arrow vs frequency up to 0.3 Hz.

Q03: Briefly describe the general behavior of the induction arrows with increasing frequency. Is there a general directional trend apparent in the maps? If so, what electrical strike direction can be defined?

Create another parameter plot of the polar diagrams at 10,000 Hz. Scroll through the polar diagrams vs frequency up to 0.3 Hz.

Q04: Describe the behavior of the polar diagrams at frequencies 0.01, 0.1, 1, and 10 seconds. What does the behaviour indicate about the dimensionality of the MT responses at these frequencies? Can you define a directional trend? Is this directional trend in correspondence with the electrical strike direction as defined in Q03? Does a comparison with the induction arrows help to resolve the 90 degree ambiguity in the strike direction of the polar diagrams?

Q05: Based on the observations made in Q01 to Q04, where and how would you orientate 2-D profiles for further 1-D and 2-D inversion modelling? Create these profiles and attach the associate stations to the profiles. Try to define three parallel profiles roughly the same distance apart.

Q06: Is it necessary to rotate the responses for 2-D inversion using this/these profile(s)? If so, to which orientation should the responses be rotated? Rotate the responses (Go to 'MT Survey', right click the data > 'batch tools' > 'rotate'.)

Commented [W1]: Include this in the course notes

2. Prepare the data for inversion

Open the MT stations associated with the profiles in the 'Data analysis' mode. Use the 'rho+' option to check the consistency of the apparent resistivity and phase responses at each of the stations and mask the outlier data points (select 'Mask').

Q07: Describe the apparent resistivity and phase trends in the station responses. What do they suggest about the resistivity structure of the subsurface?

3. 1-D inversion

Create smooth and layered 1-D inversion models of the MT stations associated with the profiles.

Q08: Describe and motivate the 1-D inversion strategy used (e.g., number of layers, choice of curve (component) inverted).

Create resistivity cross-sections with the layered and smooth 1-D inversion models. Save as a *.png. (Right-click the profile > Create section > Cross-section. Add the two layers using the 'Layers' pane.)

Q09: Describe the structures in the modelled resistivity cross-sections.

4. 2-D inversion

Create 2-D inversion starting resistivity models for the three profiles in the 'Items' pane (Right-click the profile > Create 2D model) including topography. Use the experience you gained during the forward modelling exercises and experiment with different meshes, initial (*a priori*) resistivity and inversion parameters. Report your best model for each profile as a*.png of the resistivity cross-section. (Hint: make sure the corresponding items of the 'MT Surveys', 'Horizons' and '2D Models' are selected in the 'Items' pane.)

Q10: Test your starting mesh by running forward calculations and assessing the shape of the apparent resistivity and phase of the forward responses of the MT stations. How should they look if the mesh is suitable? What other parameter could be used to test your inversion mesh with?

Q11: Give the geometry mesh parameters (e.g. a screenshot of the 'Geometry Parameters' will do). Why did you choose to use these parameters?

Q12: Report the 'Inversion Parameters' used for your best model. Motive your choice for these inversion parameters.

Q13: Compare 2-D modelling results for TE-mode only, TY-mode only and both TE- and TM-mode inversions. What is the effect on the model results of including the Tzy component in the inversion?

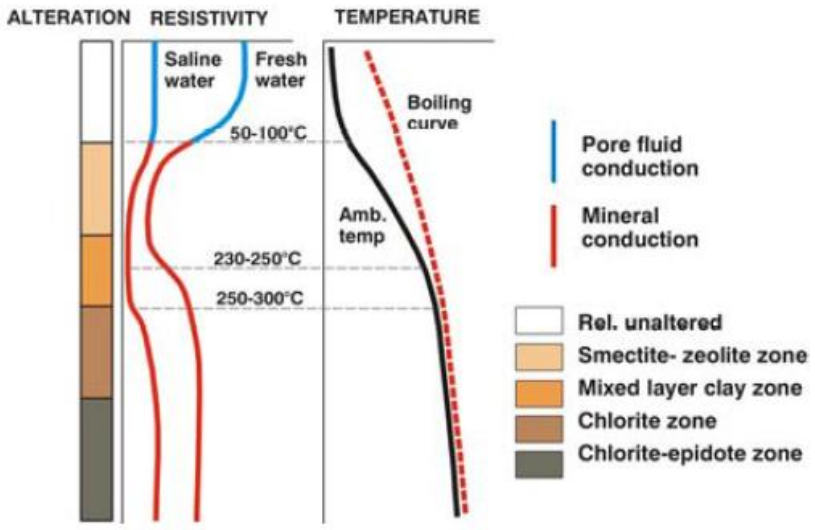
5. Comparison between 1-D and 2-D inversions

Compare the 1-D model cross-sections with the 2-D inversion models. You can, for example, make a resistivity cross-section of the 2-D inversion model with the 1-D layered models overlayed in the same plot.

Q14: Describe the similarities and differences between the 2-D inversion models and the 1-D layered models. (Provide a *.png of the resistivity cross section evaluated.)

6. Geological and geothermal interpretation of inversion models

During exploration geological mapping, clay alteration mineralogy was mapped. Their presence was validated in two recently drilled wells. As you know, the specific clay minerals formed by hydrothermal alteration are dependent on the temperature regime (see figure below).

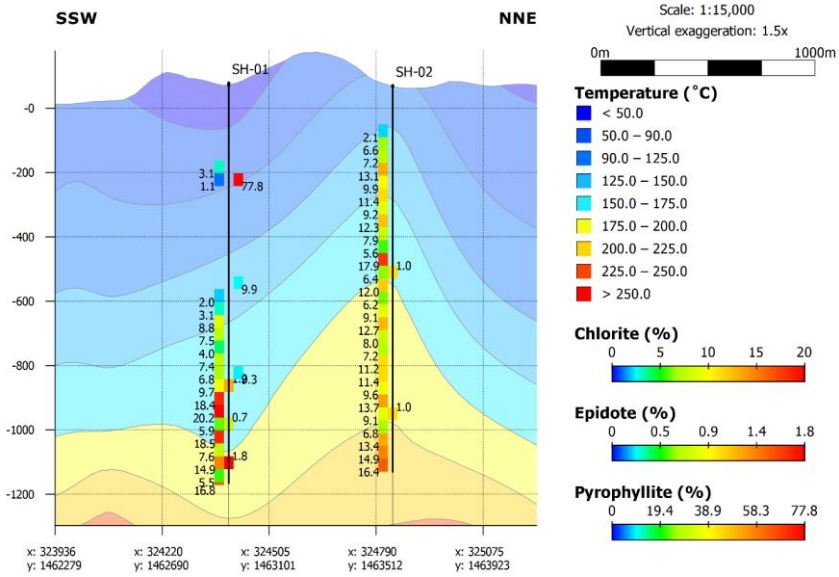


Q15: Given the relationship between temperature and resistivity as indicated in the figure above, predict the temperature profile of the resistivity cross-sections. Draw isotherms on the resistivity cross-sections where reasonable to do so and explain your reasoning.

In the cross-section figure below, isotherms as measured in two exploration wells in the area are shown. The clay alteration minerals found in these two wells are plotted in the figure as well.

Q16: Do the temperatures in the wells correspond with the temperatures estimated on basis of the modelled resistivity? What does a good or poor correspond-

ence between the temperature estimates mean for your interpretation of this geothermal system? Discuss.



.