EOSC 454 Lab #4

DC Electrical Resistivity

Date: Mar 10, 2009. Due: March 17, 2009.

1 *Introduction*

In this lab you will be performing forward and inverse modelling of DC electrical resistivity.

2 *Forward modelling of DC resistivity data*

1. Start by double clicking the **dcip2d-model-maker.exe**. On the dialog box that pops up, change the log background conductivity to -2, to create a background of 0.01 S/m (100 Ohm-m).
2. Add a buried geologic block by drawing a box in the center of the model and use the dialogue that pops up to fine tune details as follows: (x1, x2, z1, z2, conductivity, slope) = (80, 120, 20, 35, 0.1, 0.0). This creates a block with conductivity of 0.1 S/m (10 Ohm-m).
3. Save this synthetic model of the earth with a new file name such as **"block1.mod"**.

   dipole-dipole modelling
4. Discretize the model by clicking the "mesh" toolbar icon. Set the parameters for a dipole-dipole survey, with nmax=6, a-spacing=15m apart, IP is off, and mesh params = 2, 2.
5. Proceed with the forward calculation by clicking the F tool-bar button. Finally, view the resulting raw data - click the model viewing button.

   pole-dipole modelling
6. Use the same discretization parameters as above, except use pole-dipole (R).
7. **Questions**: Print the pseudo-sections for the dipole-dipole and pole-dipole data. Do they look the same? If you were to try to interpret the location of the conductor based solely on the pseudo-section, how would your estimated location and size of the block change based on each pseudo-section?

3 *Effect of small surface conductors*

In this section you will explore the effects of small conductive bodies located at the surface on the resulting potential distribution.

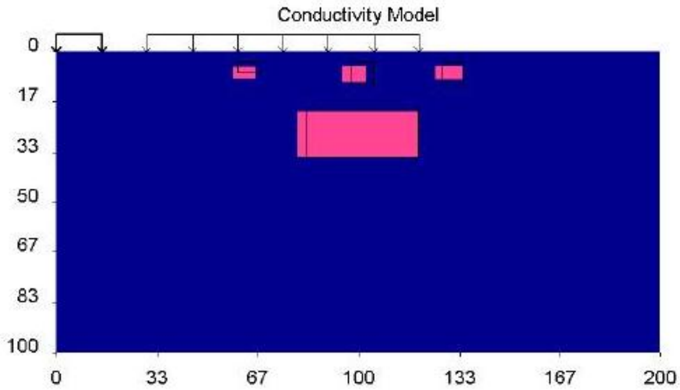

Figure 1: Three small surface conductors positioned above the main conductive block.

1. Using the model-maker gui, modify your block model to contain three small surface conductors with a conductivity of 0.1 S/m above the main block (see figure 1).
2. Forward model this model using both dipole-dipole and pole-dipole (R) surveys. Print the resulting pseudo-sections.
3. What is the effect of the small surface conductors on the data? How has the signal from the main conductive body changed?

4 Saturation of DC resistivity data

In this section you will increase the conductivity conductive body and view the effect on the resulting data.

1. Using the model maker, right click on the conductive block to change its conductivity. Using conductivity values of 10 Ohm-m, 1 Ohm-m and 0.1 Ohm-m, compute the forward model and print the resulting pseudo-sections.
2. **Question:** As the conductivity of the block increases, does the apparent resistivity present in the pseudo-section correspond to the increase of the conductivity?

5 Synthetic Inversion of DC resistivity data

In this section you will perform a synthetic inversion of the DC resistivity data collected using both dipole-dipole and pole-dipole configurations.

For each data-set (dipole-dipole and pole-dipole), the steps for the inversion are:

1. Using the DCIP2D Dataviewer GUI, assign a standard deviation of 5% and a Minimum of 0.0001. Next, add Gaussian noise to the data using the same parameters (note, this is a two-step process). Save this data file.

2. Launch the **dcip2d-gui.exe**, this is the front end for the inversion.

3. Use the default settings for the inversion, but set the initial and reference models to the correct background of 100 Ohm-m.

4. Save the inversion settings, then hit the Run button.

5. Print the inversion results. **Questions**: How does the resulting inversion model compare to the true model? How well does the predicted data match the observed data?

6. Perform a synthetic inversion using the pole-dipole data generated using the model with the 10 Ohm-m conductive block. How does this inversion model compare to the dipole-dipole inversion?

7. Perform a synthetic inversion using the dipole-dipole data generated from the model containing the small surface conductors. Assign a standard deviation and corrupt with Gaussian-noise.

8. How does the inversion result change with the presence of the surface conductors? Are all three of the surface conductors recovered in the inversion model?

9. Using the dipole-dipole data collected using the 0.1 Ohm-m conductive block (computed in the saturation of DC resistivity section), perform a synthetic inversion. How does the recovered conductivity of the block compare to the original 0.1 Ohm-m starting model?

6 *Exploring non-uniqueness*

1. Using the 10 Ohm-m block model and the dipole-dipole survey configuration, perform a synthetic inversion by varying the alpha parameters. With $\alpha_x = 100$, how does the inverted model change? Does the model the predicted data still match the observed data? Explore the effects of changing the other alpha parameters (α_s and α_z).

2. Using the 10 Ohm-m block model, perform a synthetic inversion with a different starting and reference model (make sure the alpha parameters are set to the default). Set both the starting model and reference model to be 10 Ohm-m.

3. Does the recovered model using a 10 Ohm-m starting and reference model still recover the conductive block? What resistivity value does the inversion recover in the region surrounding the block?

4. You should notice that the recovered model with this reference model recovers the correct background of 100 Ohm-m near the surface, but then fades out to the reference model at depth where the data have little influence. This can be used to estimate the depth of investigation of the DC resistivity survey.
5. Using the model-viewer, view the inversion model of the dipole-dipole measurements with the 100 Ohm-m starting and reference model. Using the Options→Depth of Investigation menu, select the inversion model computed using the 10 Ohm-m background. By varying the cut-off value you can restrict what is displayed in the inversion model to where it is similar. Create a plot that you think demonstrates the depth of investigation of the dipole-dipole survey.

Contact Elliot Holtham at *eholtham@eos.ubc.ca*, or drop by Room 332 in the Geophysics building for help regarding the exercises.