AMHERST COLLEGE

Department of Geology
Geology 41: Environmental and Solid Earth Geophysics
Lab 7: Tabletop Resistivity Study
Ground-truthing Electrical Methods

EQUIPMENT: **resistivity meter**
Cu electrodes
cables
12 V battery (freshly charged)
(2) sediment filled mud pans
meter stick or tape measure
spare fuse for power supply
spare AA batteries for multimeters
notebook
pen

We will use a simple resistivity meter to measure the apparent electrical resistivity of layers within a multilayer sediment model that is contained within a tabletop mud pan. In order to do this we will conduct a resistivity survey in each of the two pans. We will create a vertical resistivity profile by systematically expanding the electrode spacing of a Wenner array.

OUR SURVEY WILL BE CONDUCTED IN THE FOLLOWING MANNER:
We will work in a single group while conducting the survey. Be sure to rotate duties during the lab, so that everyone has a chance to do everything.

1) Using the instructions below, set up the resistivity meter and a Wenner array in one of the mud pans. Start with a narrow electrode spacing (2 cm) and systematically increase the electrode spacing (by 2 cm each time) until the electrodes get near the edge of the mud pan (22 cm).

2) Take a reading of voltage and current for each electrode spacing. Turn off the power supply, recompact the sediment near each electrode. Turn the power supply back on and take a second reading of voltage and current.

3) Conduct a similar survey in the other mud pan.

4) Measure the sediment thickness in both pans.

USE OF THE RESISTIVITY METER:

1) **DISCONNECT THE RESISTIVITY METER FROM THE POWER SUPPLY:**
The resistivity meter consists of two multimeters and a power invertor (converts 12 V DC into 110 V AC) that are housed in a small box. It is powered by a small 12 V battery. Before proceeding, make sure that the power supply is turned off and that it is disconnected from the battery. Before starting, clean the electrodes with steel wool so that they are shiny.

2) CONNECT THE CABLES TO THE RESISTIVITY METER: The meter is connected to the electrodes via cables that are made from speaker wire. The left multimeter is used as a voltmeter and the right multimeter is used as an ammeter (current meter).
The current electrode cables are marked with black tape at both ends. Plug the black lead of the current electrode cable into the **-COM** jack and the red lead into the **+V ma Ω** jack (right multimeter).
The potential electrode cables are not marked on either end. Plug the black lead of the

potential electrode cable into the **COM** jack and the red lead into the **V/Ω** jack (left multimeter).

3) PUT THE ELECTRODES IN THE MUD PAN: The 4 electrodes in a Wenner array are evenly spaced. Use a tape or meter stick to carefully measure the electrode spacing. Push the electrodes into the sediment to a (near) constant depth of approximately 2-3 cm. With your fingers compact the sediment around the electrodes to make better contact.

4) CONNECT THE CABLES TO THE ELECTRODES: In a Wenner array the current electrodes are on the ends and the potential electrodes are in the middle.
Check to see that the power supply is disconnected. Use the alligator clamps to connect the current electrode cables (black tape on wire) to the current electrodes. Use the alligator clamps to connect the potential electrode cables (black tape on wire) to the potential electrodes.
Even though the power supply is disconnected, only touch one electrode or electrode cable at a time.

5) TURN ON THE MULTIMETERS: Turn on both multimeters. The dial on the left multimeter (voltmeter) should be set at **~V** (**AC** should be visible in the upper left part of the meter display**)**. The dial on the left multimeter (ammeter) should be set at **4-40 mA**. Toggle the **SELECT** button to AC (~ will appear on the left of the display).
Note: the ammeter will automatically shut itself off after 5 minutes.

6) TURN ON THE POWER SUPPLY: Connect the battery to the power supply. RED lead to the battery **POS** terminal and BLACK lead to the battery **NEG** terminal. (Connecting the battery up backwards will blow a fuse on the power invertor) Turn on power supply (red switch on the left side of the resistivity meter), a red light should illuminate and a voltage and current should appear on the multimeters.

7) MEASURE CURRENT AND VOLTAGE: Let the meter stabilize for between 15 seconds and 90 seconds. Measure the voltage on the left meter and the current on the right meter.

8) TURN OFF THE POWER SUPPLY: Turn off power supply using red switch on the left side of the resistivity meter. Disconnect the power supply from the battery.

DATA REDUCTION AND ANALYSIS

1) For each of your measurements calculate an apparent resistivity. For a Wenner array:

$$\rho_{apparent} = 2\pi a \frac{V}{I}$$

a: Wenner electrode spacing
V: voltage difference across potential electrodes
I: current

As usual be very careful with units: for resistivity to be in Ω m, V must be in volts, I in amps and a in meters.

2) For a Wenner array and a constant resistivity with depth, the effective penetration depth is:

$$Z_{effective} = 3/2\ a$$

Make a plot of apparent resistivity (y axis) against $Z_{effective}$ (x-axis).
Use this plot to determine the true resistivity of the sediment in each of the mud pans.
Is the resistivity of the lower layer in each of the two mud pans higher or lower?
If the resistivity of the lower layer is lower, what is the maximum resistivity of that layer?
If the resistivity of the lower layer is higher, what is the minimum resistivity of that layer?

3) The effective depth to a horizontal interface can be estimated by the “cumulative resistivity“ method.

To do this:

Calculate the sum of apparent resistivities for each electrode spacing in an expanding array survey. For the narrowest electrode spacing this is simply the measured apparent resistivity at that spacing. For your second spacing it is the sum of the apparent resistivities at the two narrowest spacings, for the third it is the sum of the three narrowest electrode spacings, ...etc.

Plot the sum of apparent resistivities (y axis) against $Z_{\text{effective}}$ (x-axis).

Fit the graph with two linear segments. The first segment should pass through the origin. If the lower layer has a lower resistivity the slope of the second line segment will be lower, if the lower resistivity is higher then the slope of the second line segment will be higher.

The effective depth to the interface is at the intersection of your two line segments.

How does this compare with the layer thickness that you measured directly?