

**Resistivity Surveys**

1. Starting with the general equation for resistivity as a function of electrode node spacing:

$$\rho = \frac{2\pi\Delta V}{I} \frac{1}{\left(\frac{1}{r_A} - \frac{1}{r_B}\right) - \left(\frac{1}{R_A} - \frac{1}{R_B}\right)} \quad (1)$$

show that the equation for the apparent resistivity profile for a Wenner array is [10 pts]:

$$\rho_a = 2\pi a \frac{\Delta V}{I} \quad (2)$$

2. A VES survey using a Wenner array is conducted to determine the aquifer depth in a remote shale-filled basin. The file *hw6input.dat* has the electrode spacing,  $a$ , in column one (meters) and the measured potential drop,  $\Delta V$ , in column 2 (Volts). The measurements were all made with an input current of 1.5 Amps.

- Calculate and plot the observed apparent resistivity,  $\rho_a$ , versus the electrode spacing,  $a$ . [4 pts]
- Based on the observed profile, determine the resistivity of the two layers? [4 pts]
- Based on the values for  $\rho_1$  and  $\rho_2$ , is it likely that the survey has penetrated the aquifer? Explain your answer? [2 pts]
- Based on the electrode spacing used in the survey, estimate the maximum thickness of the top layer and explain how you arrive at this estimate. [2 pts]
- The theoretical apparent resistivity profile for a two layer structure measured with a Wenner array is calculated using the following equations:

$$F = \sum_{n=1}^{\infty} k^n \left( \frac{1}{\sqrt{1 + 4n^2 z^2 / a^2}} - \frac{1}{\sqrt{4 + 4n^2 z^2 / a^2}} \right) \quad (3)$$

$$\rho_a = \rho_1(1 + 4F) \quad (4)$$

where  $k = (\rho_2 - \rho_1)/(\rho_2 + \rho_1)$  is calculated based on the values of  $\rho_1$  and  $\rho_2$  determined above,  $a$  is the electrode spacing and  $z$ , is the unknown depth. The series summation converges after a small number of terms,  $n \geq 4$ , because  $k < 1$ .

Use these two equations to determine the thickness of the top layer, by trial-and-error comparison to the observed profile, and compare your best-fitting value to the value estimated above. Include a plot showing your best-fitting theoretical curve plotted on top of the observed profile. [8 pts]