Individual TBL # 5: Hutchinson and Barta (2000) Geophysical Applications to Solid Waste Analysis Geonics

DUE: Wednesday, November 16, 2016

Overview

In this case history, EM-31 data are acquired over landfills. The data delineate the contaminated areas and are also used to estimate the depth extent of the waste. In your career, it is possible that someone will provide you with a document like this. Rather than accepting everything that is presented to you as scientifically sound, you have enough background to raise questions and decide for yourself what is reasonable and what is questionable. That is, by understanding the fundamentals, you are in a position to think critically.

Instructions

Answer the following questions within the context of the 7 step framework. Your answers should be brief, and point form can be used where appropriate.

- Read the article:Hutchinson and Barta (2000)
- Answer the following questions before the in-class TBL

Resources

- Hutchinson and Barta (2000)
- GPG: Electromagnetic Methods

Q1. What is the question the authors are trying to answer?

Q2. What physical property are EM methods sensitive to? In this paper, what generates a contrast in this physical property?

Q3. On Figure 1 below, label the transmitter, receiver, primary magnetic field H^P, secondary magnetic field H^S, and eddy currents in the drawing below. Looking at H^P, draw the direction of the current in the loop. Looking at the fields in the target, draw the direction of the eddy currents. Remember Lenz's law! Given that the data is H^S/H^P, would the data in the figure be positive or negative? Explain your answer.

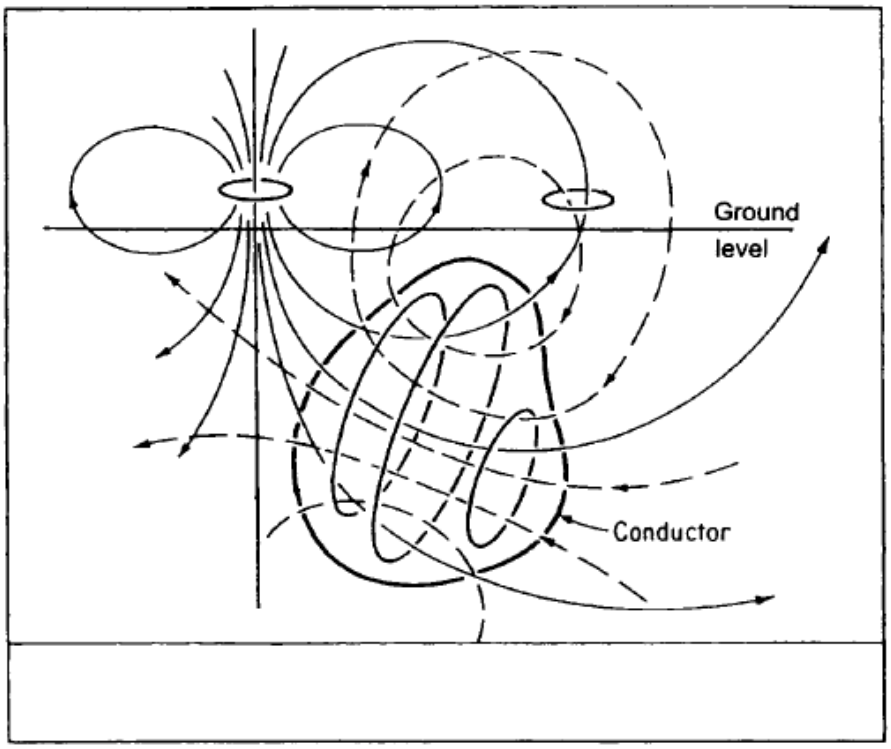

Figure 1: EM excitation

Q4. The following questions are about the survey equipment used.

a. What instrument is used for the EM survey?

b. What do the authors say are 2 pros and 2 cons of using EM surveys with this instrument for landfill investigations?

c. The instrument used records two values at each measurement location; what are those? How does the information from those two values differ?

d. Of the two values recorded by the EM-31 at each measurement location, which is used to make the apparent conductivity map in Figure 2 in the paper?

Q5. The following questions are about apparent conductivity.

a. What formula do we use to determine the final value of apparent conductivity? Refer to the GPGif needed.

b. What assumption is made when using that formula?

c. How would you explain apparent conductivity to a classmate?

Q6. The following questions are about depth of investigation.

a. According to the paper, how is the depth of investigation approximated?

b. Given that depth of investigation, would you be skeptical about the plotted thicknesses of waste in Figure 4 in the paper? Explain why or why not.

Q7. Consider the equation and response function shown in the figure below.

$$\sigma_a = \int_0^\infty \phi(z)\sigma(z)dz \tag{1}$$

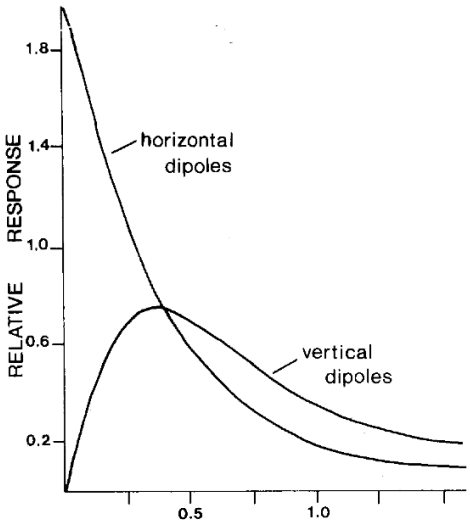

Figure 2: Response function of the EM-31 as a function of depth. Vertical dipole corresponds to horizontal coplanar system. Horizontal dipole corresponds to vertical coaxial system.

a. Describe a geologic scenario where a horizontal dipole orientation and a vertical dipole orientation would give **the same** apparent conductivities at a given measurement location.

b. Describe a geologic scenario where a horizontal dipole orientation and a vertical dipole orientation would give **a different** apparent conductivities at a given measurement location.

Q8. The authors carry out analysis to recover the lateral extent and depth of the waste. This allows them to compute the total volume of waste. In Figure 2 in the paper, the caption reads "higher conductivity values (> 40 mS/m) represent areas of buried waste." If you were in charge of this survey, how would you attempt to determine this threshold value?

Q9. To generate Figure 3, the authors introduce a normalized data representation using the equation $L = cx \log_{10}(\sigma_{app}/\sigma_{arb})$. What do you think c, σ_{app}, σ_{arb} in the equation are and what are their units? Given the information in the paper, how would you interpret L? (Note that x means *times*)