DEPARTMENT OF GEOGRAPHY & EARTH SCIENCE
Shippensburg University

Practical Exam for Neal Kerrigan

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Pick up: Friday, June 8 2012

Return: Friday, June 15 2012

The basis:
Geophysics is a science that integrates concepts across the disciplines of Physics, Mathematics, and Geology. Recent advancements in computer technology have made both geophysical field data collection and interpretation friendlier even to a new user. Unlike a few years ago, geophysical equipment now employ in-built software systems that enable communication between different equipment parts, considerably reducing the hitherto, long hours of manual data collection labor. Similarly, sophisticated interpretation software today have incorporated the physical and mathematical concepts that are needed to process and visualize geophysical anomalies in several dimensions. While these added advantages are plausible, there is still an area of concern, i.e. it is more possible now than ever, to collect data, process, and produce appealing visualizations that may be physically meaningless. In other words, a sound understanding of the theoretical concepts that leads to a good geophysical survey design, data collection and interpretation, remains critical for a student focusing on geophysics. You have already completed your thesis field data collection but you need to demonstrate an understanding of the connection between geophysical theory and practice. Thus, rather than send you back to the field, this exam is meant to test the limit of your understanding of geophysics concepts and the application of same to field investigations. This exercise is another step you take in partial fulfillment of your Masters Degree requirements.

General comments
Please refer to the departmental graduate website (http://www.ship.edu/Geo-ESS/Graduate/Exams/) for information and expectations about the exam. Your final report should be detailed and written in a professional manner as though intended for publication. You should clearly address the given tasks and include appropriate citations, where necessary. Be sure to include a list of all sources cited at the end.

Tasks

1. a. You are newly employed with Allied Geosciences Inc. as a field geologist. Your hiring decision was facilitated by the indication on your resume that you had geophysics experience. Your employer found your experience exciting because their agency has just been contracted to investigate a superfund site. The fate of underlying groundwater at this site has been a recent concern. You are tasked to design and execute a geophysical survey that would address the concern.

   First, visit the website http://www.epa.gov/superfund/sites/npl/pa.htm that lists "National Priorities List" (NPL) sites in Pennsylvania and select any site of your choice. Assume the selected site to be the one your agency wants you to investigate. Second, use a combination of GIS, GeoMapApp, or GoogleEarth, to create a map of your site. These programs will give you an indication of the geology and elevation at your site. Third, provide the site description including its climate, geology/physiography, and the specific problem that led to its classification as an NPL site. Finally, go about your major task as follows: Describe in detail how you would execute your geophysical task. Make sure to include information about (a) your survey design, (b) the choice of geophysical methods (at least two) to be used and why, (c) the methodology for each method, (d) data processing and interpretation techniques for each method, and (e) the strengths and limitations of each method. Be sure to include citations where appropriate.

   b. For **one** of your chosen geophysical methods above, discuss precisely, the theoretical framework, including mathematical formulations, upon which the method operates.

   c. It is understood that geophysics is just one means of assessing a contaminated groundwater site. Please discuss **one** other hydrogeologic means for assessing a contaminated site and compare it to geophysics. Your comparison should be in terms of environmental implications, costs, and overall efficiency.

   d. Geophysical anomalies generated at a site can only be interpreted meaningfully if the site geology is known. Please elaborate on the geophysics-geology connection.

2. Until recently, one-dimensional (1-D) interpretation of resistivity data was the norm. With computer advancements, 2-D and even 3-D interpretations have become the standard. You are provided with apparent resistivity data, collected using the Schlumberger electrode configuration. This data is for a single sounding point-the so-called "Vertical Electrical Sounding (VES)". Please access this data on the S drive @ S://Geo/Zume/Outbox/Pract Exams/Neal and locate the file name, VES data.TXT. (to access the S drive off campus, use "anchor.ship.edu). You will need computer software to carry out the inversion of the data. Here is a freeware that you can use: http://geophys.geol.msu.ru/ipi2win.htm

Download the IPI2win program to your computer and open it. On the "file" menu, click "New VES point". In the data entry page that opens, enter the data from the VES.TXT file into the corresponding fields. Click OK when you are done. A plot of your raw data is shown. Save or print page to add to your report later, then click OK to carry out the inversion. Your true resistivity model is produced. Save this figure for your report (please take note of the "RMS" in %). Next, go to "POINT" on the main menu and select "NEW MODEL". Notice that your original model is recalculated. Please save this figure as your final model (Note the final RMS).

Now that you have successfully produced a VES model, it is time for interpretation.

(i) Assume that this VES point was taken at your thesis study site, provide a reasonable interpretation of the final model in terms of geologic layers mapped by the current (hint: use your knowledge of how resistivity varies with geology). Make sure to include in your explanation significance of the "rms" values you noted with your original and final models.

(ii) You started above with the interpretation of VES data. Your next task is to provide a vivid description of the field method for collecting VES data with the Schlumberger array. Assume yourself to have actually performed this at your study site and are writing the methodology. In the process, explain the physical meanings of the fields; AB/2, MN, and Rho (apparent resistivity) that you used to accomplish your interpretation above.

(iii) Why do we refer to the raw resistivity data as "Apparent resistivity?

(iv) Provide a brief literature review of the VES method including appropriate studies that have employed the method and what for.

3. In the same folder that you found your VES.TXT file, you are provided with surface conductivity (mS/m) data of an area (in XYZ form). Please note that these data are made up so they may not represent true field conditions. However, the conductivity values are reasonably within known ranges for geologic and or soil conditions. Please locate the data on the S drive as usual, with the name, "Surface conductivity". In the GIS Lab, you will find the Surfer 10 contouring program. Use Surfer to create a grid and contour the data to produce a "surface conductivity" map. For your interpolation method, use "NATURAL NEIGHBOUR" and for the final color fill, use the "GEOLOGY" colors. Make the map looks professional: Label map axes, add a color scale, and make sure a reader knows what the map represents.

Use your final map to aid you in the following:

a) Provide an interpretation of the surface composition (rocks or soils) of the area represented by the map (hint: use any standard textbook chart of conductivity ranges for soils and rocks).

b) Based upon your interpretation above, design a geophysical survey that would involve the use of the galvanic-coupled electrical resistivity (ER) system (not the OhmMapper), GPR, and EM 34-3. I expect a good description of the design plan with transects shown on the map, of where you would run each method. If all 3 methods can go on the same transect, indicate so. In your description indicate clearly, the reason(s) for laying out a particular transect at a location and or, why a particular location is avoided (i.e. state clearly what limitation(s) you would face with any or all of the methods on this site). Would you recommend any of the methods over the others at this site? Please give a good reason.