National Exams May 2017

04-Geol-B10-2, Electrical Methods

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a CLOSED BOOK EXAM.
   No calculator is permitted.

3. Six (6) questions constitute a complete exam paper.
   The first six questions as they appear in the answer book will be marked.

4. Each question is of equal value. Select the questions where you can provide the most information when answering the question.

5. Each question should take about half an hour.

6. All questions require an answer in essay format. Clarity and organization of the answer are important. Please write legibly, as we can only grade what we can understand. Use diagrams wherever is appropriate.

04 – Geol – B10-2, Electrical methods

Examination Paper

Choose six (6) of the following ten (10) questions:

1. Describe the physical properties that electrical and electromagnetic (EM) methods are sensitive to. When interpreting the results of surveys, or planning a survey, it helps to know the physical properties of particular lithologies, deposits, or other subsurface features. Describe instruments that can measure these physical properties of hand or core samples in the laboratory or in the field. Discuss the weaknesses of these instruments and issues associated with the samples representing the subsurface values.
2. Describe three different geometric arrays used for electrical methods and list some of the advantages and disadvantages of these arrays.
3. Describe the instrumentation involved in a magnetotelluric survey, and the software used in processing and interpreting the data.
4. Electrical and electromagnetic surveys can also be undertaken in boreholes. Describe the modifications in the instruments, sensors, geometric configurations and deployment procedures that are made in order to get useful measurements. What are the strengths and limitations of each of the borehole systems you describe?
5. Describe the difference between the waveforms used in a time-domain induced polarization survey and a time-domain electromagnetic survey. If possible, detail the differences between the waveforms used by different electromagnetic instrument manufacturers. Comment on the significance of these differences.
6. Describe a situation (from mineral exploration, or engineering), where the self-potential method could be used to characterize the subsurface. Specify the geometric configuration and that would be appropriate for this situation, the anomaly that might be expected and how the data would be interpreted.
7. Aliasing is a common problem in electrical and electromagnetic geophysics. Explain what aliasing is and why it is a problem. Give an example of spatially aliased data and an example of temporally aliased data. In each case, what would be required to avoid aliasing?
8. Using the fact that the voltage, V, at a distance, r, from an electrode where a current, I, is injected into a half space of resistivity, ρ, satisfies the formula $V = I\,\rho\,/(2\pi r)$, derive the formula for the apparent resistivity for the Wenner resistivity array. This formula is simpler than the formula for the Schlumberger array. Why might the field crew prefer the Schlumberger array to the Wenner array when undertaking a sounding? If the field crew were measuring the apparent resistivity along a profile, why might the Wenner array be preferred?
9. Some electromagnetic instrument manufacturers build equipment that works in the frequency domain, while others build equipment that works in the time domain. List the advantages and disadvantages of frequency-domain electromagnetic equipment and time-domain electromagnetic equipment.
10. What is inversion modelling? Give an example of an inversion modelling algorithm or program, describe how it works: the inputs that are required and the outputs that are generated by the program. Give an example of when this type of program might be used in a geophysical program.