National Exams December 2017

04-Geol-A7, Applied Geophysics

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.
   Approved Casio or sharp 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. If you decide you do not want an answer marked, put a single line through your answer

4. Each question is of equal value.

5. Each question should take about half an hour.

5. 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. Drawing diagrams is strongly encouraged, as long as the diagram is explained.

Marking Scheme

Each of the six questions selected is worth 16.66 percent of the total mark.

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Examination Paper

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

1. Density is an important physical property in geophysics. Give some typical values for rocks, minerals or geotechnical/engineering materials. Explain why density contrast is important in gravity and give examples of positive and negative density contrasts. Density is also important in the seismic method; using formulae if possible, explain how density impacts the velocity of P and S waves and the reflectivity.
2. Explain how a seismic refraction survey is designed and executed and how the data are interpreted. Give an example of a situation when this method has been applied successfully to a geotechnical or exploration problem. Discuss whether other geophysical methods would or would not have been successful.
3. Describe a situation where magnetotelluric (MT) data would be useful and explain how you would go about planning a magnetotelluric (MT) survey, acquiring and processing the data and then interpreting the data. Make sure you explain how the acquisition parameters and processing and interpretation procedures you suggest are appropriate for the specific situation.
4. Give three examples of arrays or configurations used for resistivity surveying. In each case, describe the geometric configuration, how the array is moved throughout the survey. Describe the strengths and weaknesses of each array. Describe a case history of a survey, with specifics (or rough estimates if you forget or did not know) of the survey parameters. Also describe how the geophysicist would go about processing, displaying and interpreting the data.
5. What is the *chargeability* of a geological material? Explain details of the two main mechanisms that geophysicists use to explain chargeability (membrane polarization and electrode polarization). There are a number of ways of measuring the chargeability in time and frequency domain. For two of the ways, describe the equipment used, the quantities measured, the name given to the quantity measured and the units typically ascribed to the measurement. When units are dimensionless, explain how the quantities are estimated and/or expressed. Briefly describe one case history when chargeability surveys have been useful.
6. Explain why the magnetic anomaly of a body varies depending on the magnetic latitude. Discuss how this complicates interpretation and describe some common methods that people use to reduce or remove these complications. Specifically discuss the strengths and weaknesses of each of these methods.
7. Discuss important ways of displaying and enhancing geophysical data. In each case discuss how the particular display hinders or assists in the interpretation of the data.
8. Select three tools used for geophysical well logging surveys and describe what they measure, how they measure it, and what physical property contrasts they are sensitive to. Give an example of a situation where each tool would be applied to solve a problem.

9. Describe in detail one electromagnetic system. Describe one specific type of survey configuration, including how the source and sensor geometry changes (or not) during the survey; the transmitter waveform(s); the receiver sampling; the data normalization and/or reduction. List some advantages and disadvantages of the system compared with other systems. Draw an example of a profile that could have been measured in a survey and describe how the data would be interpreted.
10. Quantitative interpretation of geophysical data involves forward and inverse modelling. Explain the difference between these two types of modelling approaches. Discuss the strengths and weaknesses of each approach and give some example algorithms or programs for each approach. Describe how these modelling approaches might be used in a geophysical program. Describe an example if possible.