National Exams May 2016

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.

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.

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Examination Paper

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

1. Physical properties are important in electrical and electromagnetic (EM) methods. List the physical properties you think are important in each of these methods and explain why you think they are important. In each case, comment on the range of values and give some examples of typical values. Discuss the importance of physical property contrast in each electrical and EM method and the range of values that these methods can detect.
2. Describe the major differences and similarities between electrical and electromagnetic methods.
3. Describe how you would go about planning a magnetotelluric survey, acquiring and processing the data and then interpreting the data.
4. Give three different types of situations (e.g. different deposit types or other applications) where electrical and/or electromagnetic methods would be used. In each case discuss whether resistivity, induced polarization or electromagnetic methods would give a strong response and provide data that can be interpreted to solve an exploration or engineering problem. State which method would be more preferable in each of the three cases and explain why.
5. Describe the difference between time- and frequency-domain geophysical measurements and discuss their advantages and disadvantages, citing examples where appropriate.
6. Describe the self-potential (SP) method and how it differs from other electrical methods. Describe how SP surveys are acquired, planned and interpreted. Sketch an example of a typical anomaly, making sure to label all axes. Discuss theories that have been proposed to explain the cause of a self-potential anomaly. Give an example of how the method is used for exploration or engineering (e.g leaks or fluid flow).
7. Describe the principles and practice of the mise-a-la-masse method. Borehole mise-a-la-masse surveys are often described, but in Canada borehole electromagnetic methods are now used more extensively than mise a la masse. Give some reasons why this might be the case.
8. Describe in detail one *specific* type of electromagnetic instrumentation, paying particular attention to the source-receiver geometry, transmitter waveform, receiver sensor, receiver sampling, and any data reduction. Describe how this system deals with the "problem" of the primary field.
9. State in words and mathematically Maxwell's equations and the constitutive relations that govern electromagnetic induction methods. Outline common assumptions used to simplify these laws in geophysics. Describe the specific role of these laws in the generation of fields and the measurement of electromagnetic responses.
10. Quantitative interpretation of electrical or electromagnetic 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 exploration program.