National Exams December 2016

04-Geol-B10-1, Gravity and Magnetic fields

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. Put a line through a completed question you do not want marked.

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. Use diagrams wherever appropriate.

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. Choosing appropriate spatial (or temporal) sampling is important when designing a gravity or magnetic survey. Explain the concept of aliasing and how this impacts on the design of surveys.
2. The earth's magnetic field varies over many time scales from changes over a few milliseconds to changes over millions of years. Give the names of three types of magnetic field variations, the times scales over which they occur, and a brief explanation of the physics that causes the variation. Discuss how some of these changes can impact magnetic field surveys and how their effect can be minimized in survey planning.
3. Describe how you would go about planning and executing a gravity survey. Describe strategies for monitoring *and removing* drift and tidal variations.
4. What is the International Geomagnetic Reference Field: how it is estimated, how is it calculated? How is it different from the Definitive Geomagnetic Reference Field? How are these fields used in the processing of magnetic data and why is it important to deal with?
5. (i) Describe the physical principles for one type of gravity meter capable of measuring the Earth's gravitational field. The meter can either measure the entire field or the relative (anomalous) field. (ii) What is a gravity gradiometer, and what are the advantages and disadvantages of gravity gradiometry?
6. Explain the difference between induced and remanant magnetization, how the difference is quantified and how these two magnetizations are accounted for (or not accounted for) in the interpretation and modelling of magnetic data.
7. The vertical derivative and the analytic signal amplitude are two methods commonly used to enhance magnetic data. Discuss the advantages and disadvantages of each method and give two examples, one where the first vertical derivative would be more appropriate and another where the analytic signal amplitude would be more appropriate.
8. Discuss a case history where gravity methods have been used to solve a geotechnical or engineering problem. Discuss the reason why gravity methods might have been used rather than other methods, the survey procedure, how the data was processed and interpreted. What were the weaknesses of the survey and/or how might the survey be improved if it was repeated?
9. What is regional residual separation and why is it necessary? Describe in detail one method used to achieve this separation.
10. Explain what you understand by the concept of non-uniqueness in potential field geophysical methods. Using a mathematical formula for a gravity or magnetic anomaly, show how this non-uniqueness can arise. Give an example of how the problem of non-uniqueness can arise in geophysical interpretation and describe geophysical and geological ways that the non-uniqueness can be addressed.