National Exams December 2017

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. Select the questions where you can provide the most information when answering the question.

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. What is the physical property that is important for the gravity method? Describe a way that this physical property can be measured in the laboratory for a representative hand sample. What are the strengths and weaknesses of this method? Give some typical values of the physical property for two types rocks AND two minerals or two types of buried material.
2. The earth's gravitational attraction varies on its surface as a function of latitude as a consequence of two mechanisms. Use diagrams to explain the changes in strength and direction. In each case, do these mechanisms increase or decrease the gravity with increasing latitude?
3. Describe how you would go about planning and executing a magnetic survey. Describe strategies for monitoring *and removing* temporal changes in the magnetic field. Explain the reason why these changes occur.
4. i) Using a vector diagram explain how a nearby hill can result in an error when the Bouguer slab correction is applied to the vertical gravity at a station on a plane near the bottom of a hill. ii) Using a vector diagram explain how a nearby valley can result in an error when the Bouguer slab correction is applied to the vertical gravity at a station on a plane near the top of a valley. In both cases make clear whether the effect of the hill or valley increases or decreases the gravity measurement.
5. Describe the physical principles of operation for one type of magnetometer. What are the advantages and disadvantages of this type of instrument compared with other instruments?
6. According to Newton's universal law of gravitation, the attraction is always positive in the direction of the massive body. For measurements in an area with no topography, all massive bodies are below the Earth's surface. Explain then why negative gravity anomalies are possible. Give some examples of situations when the anomalies will be negative.
7. Why is the reduction to the pole procedure sometimes applied to magnetic data? Give details of how the procedure is executed. What are the weaknesses of the method? Describe alternate methods that might address some of the weaknesses.
8. Discuss a case history where magnetic methods have been used to solve a geotechnical or engineering problem. Discuss the reason why magnetic 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 a sun-shaded or sun-angle gravity or magnetic image? Describe how it can enhance certain geological features. What are the advantages and disadvantages of this display technique? Describe other data enhancement methods and their advantages and disadvantages.
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.