National Exams May 2019

18-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 later decide you do not want an answer marked, put a single diagonal line through your answer

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

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

1. Each geophysical method is sensitive to one or more physical properties. For each major method describe the more important physical property or properties and give examples of typical background values and the anomalous values that might be associated with the target of a geophysical survey.
2. Describe the physical laws that are important for the gravity method and explain how one instrument is used to measure the gravitational field at a location/point. Explain the difference between a relative and absolute instrument and whether the instrument you have previously described is relative or absolute. Describe a procedure that could be used to tie a relative survey to a national network of absolute gravity readings. Finally describe a procedure for correcting for the drift of a relative gravity instrument.
3. Geophysical methods are most commonly collected with the instruments and sensors on the ground or in an aircraft. However, it is also possible to collect geophysical data with sensors in the subsurface. Describe **two** different types of subsurface studies, giving details of the purpose of the survey, the survey specifications, the procedures for correcting the data (if necessary), and the procedures for processing and interpreting the data.
4. In exploration, geophysical data can be acquired at multiple scales, for multiple purposes, and at multiple stages of a project. Give specific examples of the types of surveys, the specifications and interpretation techniques that might be used on different projects for the following purposes: 1) continential-scale surveys for project generation; 2) regional-scale surveys for area selection; 3) property-scale surveys for target identification; 4) local scale surveys for target delineation.
5. In the magnetic method, one anomalous field is induced by the earth's magnetic field. Describe how and why the strength and orientation of the earth's field varies over the surface of the earth and how the induced field will differ at low, mid and high magnetic latitudes. State which latitudes you would prefer to interpret the magnetic data, giving reasons. Give a brief example of a case history of a magnetic survey being used to solve an exploration or engineering problem.
6. Electrical and electromagnetic data are both primarily sensitive to the same physical property. However, they use different physical principles to excite the ground, and measure the geophysical response. Describe the similarities and differences of the physics, instruments, arrays and procedures used for these two methods. Give a brief example of a case history of an electrical or electromagnetic method being used to solve an exploration or engineering problem.
7. What is the physical property of a rock to which the gamma-ray spectrometry geophysical methods is sensitive to. Describe the limitations of the gamma-ray spectrometry method, the most appropriate times and places to collect this type of data, and the procedures for collecting the data. Describe some of the procedures that are necessary to correct and calibrate the data and instruments?

8. Describe the geological circumstances and survey specifications that would be required to get strong seismic refraction arrivals. Describe a case history where refraction seismic data is useful and discuss how the data is plotted and interpreted. Discuss some sources of noise in refraction and how these could be dealt with.
9. Define the acoustic impedance and describe why it is important in the reflection seismic method. Explain what a sonic log is and how the data is collected and interpreted. Describe how sonic logs can be used to help in the processing and interpretation of reflection seismic data.
10. Describe a case history when the reflection seismic method has been used either in an exploration project (for coal, oil, natural gas, minerals, groundwater) or for geotechnical studies or engineering problems. Describe the survey objective, the expected physical property contrasts, the survey design, the data processing, the interpretation methodology and the conclusions. Describe ways that the survey could be improved if more money was available.