

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

SPH 4220 GEOPHYSICS II

BSc HONOURS PART IV : MAY 2002

DURATION: 3 HOURS

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

SECTION A

1. (a) Describe in brief the magneto – telluric methods of prospecting. Discuss the targets considered suitable for this type of prospecting. [4]
- (b) (i) Using the principle of equivalence calculate the thickness of a horizontal layer of resistivity  $120\Omega\text{m}$ , which gives rise to an identical Schlumberger resistivity curve with a layer of thickness 15m and resistivity  $30\Omega\text{m}$ . [3]
- (ii) When will a bed be suppressed in resistivity sounding? Explain in terms of its thickness and resistivity parameters. [3]
- (c) Name two cases of geophysical exploration in which the method of induced polarization (IP) is preferred over the resistivity method giving reasons of your choice. [5]
- (d) What is the phase difference between the primary and the secondary fields over a good conductor in an electromagnetic (EM) prospecting? Include a diagram in your answer. [6]
- (e) Distinguish, with the aid of a diagram, between the terms *cross-over distance* and *critical distance* in the case of a single horizontal interface at a depth  $h$  between two media with velocities  $v_1$  and  $v_2$  when  $v_1 > v_2$ . [7]
- (f) State Snell's Law of reflection and refraction of seismic waves at an interface where conversions occur. Define all the terms of the equation. [6]
- (g) Explain the terms *Nyquist frequency* and *aliasing*. What are the consequences of these phenomena in the analysis of data, collected as a time sequence? [6]

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**SECTION B**

2. (a) What are the principal mechanisms of producing “spontaneous ground potentials”? Discuss in detail the phenomenon of spontaneous polarization in mineralized zones. [7]
- (b) The values in table 1 (below) represent a detailed self potential (SP) profile. The stations are 5m apart and the SP readings are given with reference to station 0.
- (i) Draw the SP curve along the profile; [6]
- (ii) Make a crude interpretation of the sketched anomaly in terms of the shape; dip; and depth of the polarized body. [7]

Table 1.

Station	SP/ (mV)	Station	SP (mV)
0	0	9	-335
1	-37	10	-258
2	-100	11	-170
3	-108	12	-120
4	-158	13	-73
5	-236	14	-40
6	138	15	-21
7	-210	16	-17
8	-290	17	-7

3. (a) Compare the advantages and the disadvantages of the Schlumberger and the Wenner arrays in resistivity prospecting. [6]
- (b) From first principles, derive an expression for the potential due to a point current source on a homogeneous earth. Hence show that for the Wenner array the geometric factor is given by  $k = 2\pi a$ , where  $a$  is the spacing between the adjacent electrodes. [9]
- (c) List the basic assumptions made in interpreting resistivity sounding data. [5]
4. (a) Explain the origin of the phenomenon of induced polarization (IP) in metallic ore bodies. [5]
- (b) Define the quantities required to measure the IP effect in the time and frequency domains giving reasons for their requirements. [7]

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- (c) Explain, how the following factors affect the magnitude of the IP effect:
- (i) percentage of sulphide grains in the rock;
  - (ii) size of the sulphide grains;
  - (iii) porosity of the rock; and
  - (iv) the degree to which the pore structure is filled with fluid. [8]
5. (a) Discuss the factors governing the response of a horizontal two coil EM system traversing over a conducting ore body. In your essay include some account of the effects of the ore body geometry, depth, position, and especially the magnetic susceptibility. [14]
- (b) How do *time domain* EM measuring systems normally discriminate between poor and good conductors? [6]
6. (a) Explain the terms *seismic body wave* and *surface wave*, giving two examples of each. State clearly the polarization of each wave. [6]
- (b) In a seismic experiment, a basement reflection at the critical distance and its time are clearly observed. Given that the basement velocity can be assumed, show that these data can be used to derive the average velocity down to the basement and its depth (assumed constant). [9]
- (c) Write explanatory notes on the Common Depth Point (CDP) techniques for acquisition of multiple fold seismic data. Discuss its advantages and disadvantages as compared to other techniques. [5]

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