2901/203
ROCKS, FLUID AND
RESERVOIR GEOPHYSICS
Oct. / Nov. 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN PETROLEUM GEOSCIENCE
MODULE II

ROCKS, FLUIDS AND RESERVOIR GEOPHYSICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
mathematical tables/ non-programmable scientific calculator (fx - 82);
answer booklet.
*This paper consists of **EIGHT** questions.*
*Answer question **ONE** and **FOUR** other questions in the answer booklet provided.*
Maximum marks for each part of a question are indicated.
Candidates should answer the questions in English.

This paper consists of 8 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. (a) Figure **1** shows an incident and a reflected seismic ray through layers of rocks A and B. Study the figure and use it to answer the questions that follow.

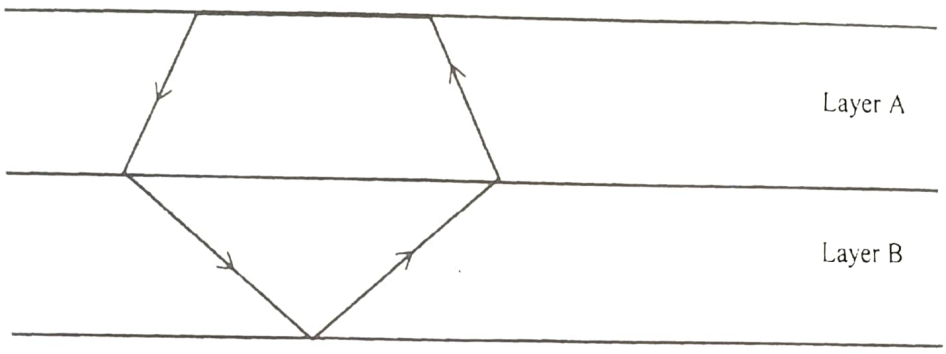

Fig. 1

(i) Given that the **two** way travel time of the ray is 20 seconds and the root mean square velocity of the two layers is 100 m/s, determine the total thickness of the layers. (3 marks)

(ii) Illustrate the path of the seismic ray if the two rock layers A and B are of equal seismic velocities. (4 marks)

(b) Table **I** shows the seismic velocities and the densities of two rock layers X and Y. Study and use it to answer the questions that follow.

Table I

	Layer X	Layer Y
Seismic velocity m/s	1500	2000
Density g/cm^3	25	30

(i) Determine the acoustic impedance of layers X and Y. (7 marks)

(ii) Identify which of the **two** layers is the underlying layer giving **two** reasons. (3 marks)

(iii) Comment on the porosity condition of the two layers. (3 marks)

2. (a) (i) Distinguish between editing and common mid point (CMP) seismic data processing methods. (2 marks)

(ii) Outline **one** instance when each of the processing methods in (i) is used. (2 marks)

(iii) State **one** objective of each of the seismic data processing methods in (i). (2 marks)

(b) Figure **2** shows a set up of seismic sources and receivers/ geophones during an onshore survey. Study and use it to answer the questions that follow.

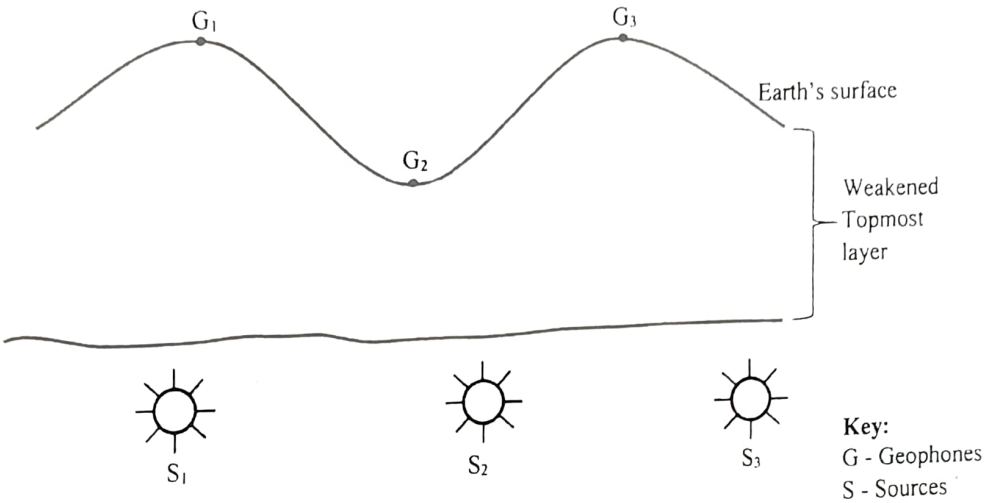

Fig. 2

(i) Identify the most inevitable data correction that should be performed on the collected seismic data. (1 mark)

(ii) By citing **two** examples, explain **two** reasons for the answer in(i) by giving examples from the figure. (6 marks)

(c) Explain **three** benefits of seismic data quality control during petroleum exploration. (6 marks)

(d) Name **one** Krigging method used in seismic data analysis. (1 mark)

3. (a) Table **II** shows some marine depositional environments and their characteristics.

Table II

Depostional Environments	Characteristics
A	- Wind is the depositing agent - Well sorted sediments
B	- Occur in rivers - Water is the depositing agent - Classified as continental environment
C	- Occur on continental shelves - Made of organic structures that are composed of calcium carbonate secreting organisms.
D	- Classified as marine environment - Occur at abbysal plains of ocean morphology
E	- Classified as continental depositional environment - It is a low energy depositional environment

(i) Identify the types of marine and continental depositional environment represented by letters A, B, C, D and E. (5 marks)

(ii) Name **two** dominant rock types found in each of the environment stated in (i). (10 marks)

(b) (i) Explain the term interpolation as used in exploration data analysis. (3 marks)

(ii) Give **two** instances when interpolation can be applied in geophysical data analysis. (2 marks)

4. (a) Explain the following terms used in metamorphic rocks:

(i) protolith; (2 marks)
(ii) relict minerals; (2 marks)
(iii) retrograde metamorphism. (2 marks)

(b) **Figure 3** shows a metamorphic rock. Study and use it to answer the questions that follow.

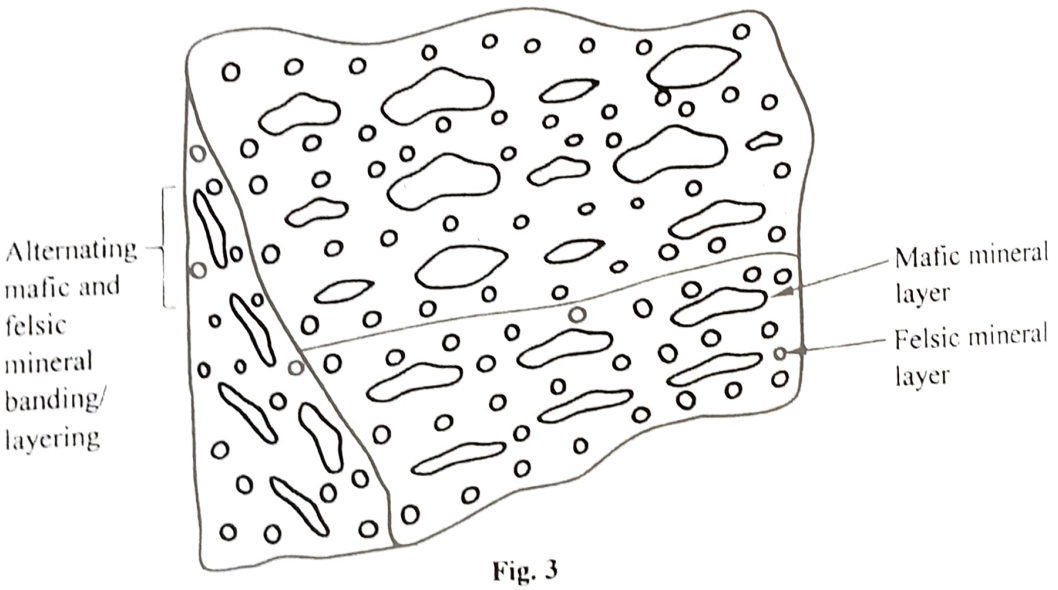

Fig. 3

(i) Describe the texture that results to the mineral layering illustrated on the figure. (4 marks)

(ii) Explain the formation of the texture described in (i). (7 marks)

(iii) Give the likely name of the metamorphic rock. (1 mark)

(iv) Give **two** reasons for the answer in (iii). (2 marks)

5. (a) Table III shows a list of sedimentary rocks. Study and use it to answer the questions that follow.

Table III

Sedimentary rocks
Sandstone
Opal
Shale
Limestone
Breccia
Dolostone

(i) Place each rock in its appropriate class and subclass. (6 marks)

(ii) Name **one** major mineral contained in each of the sedimentary rock. (6 marks)

(b) **Figure 4** shows descriptions of four processes A, B, C and D involved in formation of sedimentary rocks. Study and use it to answer the questions that follow.

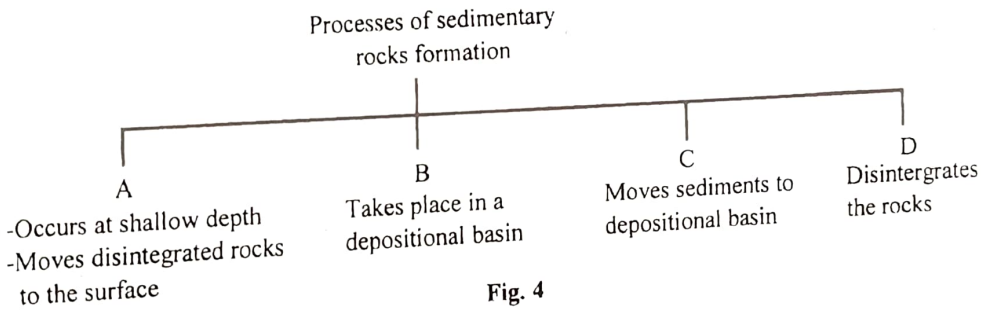

Fig. 4

(i) Identify processes A, B, C, and D. (4 marks)

(ii) Name **one** agent of processes A, B, C and D. (4 marks)

6. (a) **Figure 5** shows sketches of hand specimens a, b and c of igneous rocks. Study and use it to answer the questions that follow.

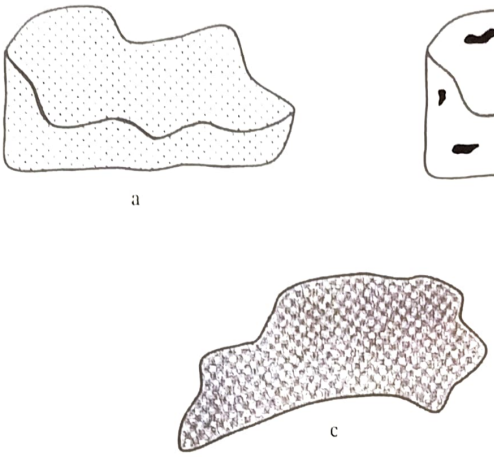

Fig. 5

(i) Identify the texture of each of the hand specimens labelled a, b and c. (3 marks)

(ii) Describe the formation of each of the hand specimens in (i). (9 marks)

(iii) Suggest the likely rock name for each of the hand specimens a, b, and c. (3 marks)

(b) (i) State *7As* in full as used in classification of igneous rocks. (1 mark)

(ii) List the **four** classes of igneous rocks based on chemical composition. (4 marks)

7. (a) **Figure 6** shows a flow chart for the rocks and their classification factors.

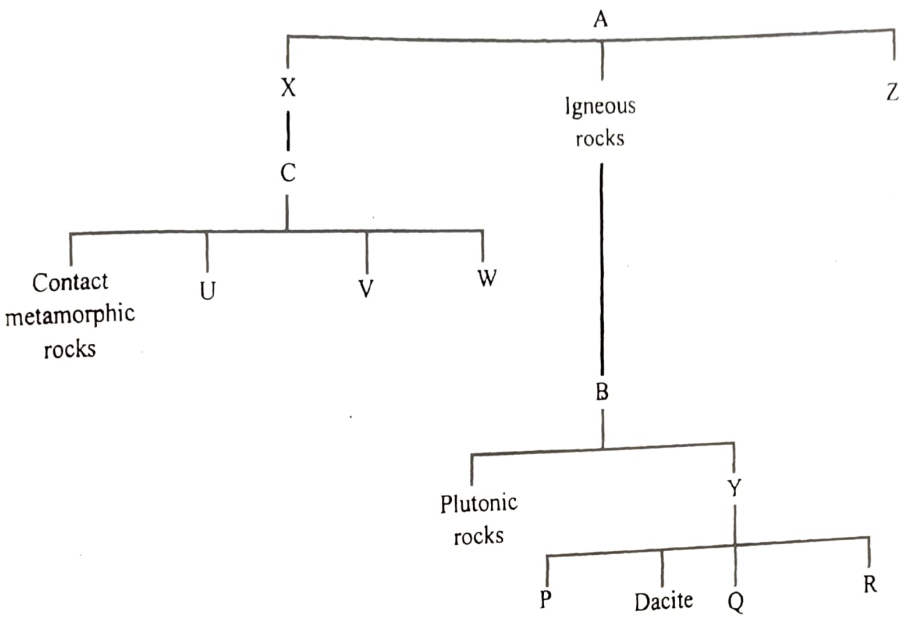

Fig. 6

(i) Identify the rocks classification factors represented by letters A, B and C. (3 marks)

(ii) Name the classes of rocks represented by letters:

(I) X and Z; (2 marks)
(II) U, V and W; (3 marks)
(III) Y. (1 mark)

(iii) Identify rocks P, Q and R. (3 marks)

(b) Explain **four** applications of knowledge of rocks and their classification in petroleum exploration. (8 marks)

8. (a) **Figure 7** shows an amplified seismic wave of a petroleum field with major reflection points labelled U, V and W. The field is composed of porous sandstone, shale and granite rocks. Study and use it to answer the questions that follow.

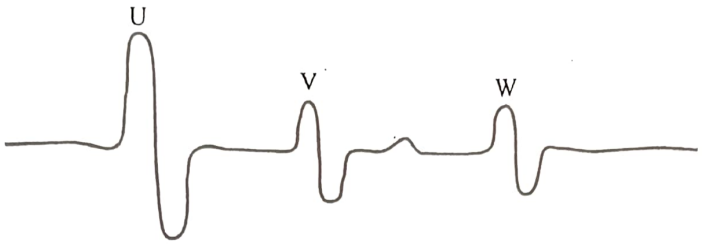

Fig. 7

Identify the reflection points U, V and W as either representing porous sandstone, shale or granite; giving reasons for your answer. (6 marks)

(b) (i) Name the attribute data used in modelling results from each of the following petroleum exploratory data.

(I) seismic survey; (1 mark)
(II) acoustic well log; (1 mark)
(III) natural gamma log. (1 mark)

(ii) Explain the **two** properties of hydrocarbon field that is interpreted from each of the attribute data model in b(i). (6 marks)

(c) With the aid of a labelled diagram, illustrate a spherical model variogram. (5 marks)

THIS IS THE LAST PRINTED PAGE.