BOARD OF STUDIES
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

1996

GEOLOGY

2 UNIT

Time allowed—Three hours
(Plus 5 minutes reading time)

DIRECTIONS TO CANDIDATES

- Board-approved calculators may be used.

Section I—Core

- Attempt ALL questions.
- **Part A** 15 multiple-choice questions, each worth 1 mark.
  Mark your answers in pencil on the Answer Sheet provided.
- **Part B** 10 questions, each worth 3 marks.
  Answer this Part in the Part B Answer Book.
- **Part C** 6 questions, each worth 5 marks.
  Answer this Part in the Part C Answer Book.
- Write your Student Number and Centre Number on each Answer Book.
- You may keep this Question Book. Anything written in the Question Book will NOT be marked.

Section II—Electives

- Attempt ONE question.
- Each question is worth 25 marks.
- Answer the question in a *separate* Elective Answer Book.
- Write your Student Number and Centre Number on the cover of the Elective Answer Book.
- Write the Course, Elective Name, and Question Number on the cover of the Elective Answer Book.
- You may ask for extra Elective Answer Books if you need them.

SECTION I—CORE

(75 Marks)

Attempt ALL questions.

PART A

Questions 1–15 are worth 1 mark each.

Mark your answers in pencil on the Answer Sheet provided.

Select the alternative A, B, C, or D that best answers the question.

1 . All of the following volcanic regions are related to a plate boundary, except the

(A) Japanese Islands.

(B) Andes Mountains.

(C) Indonesian Archipelago.

(D) Hawaiian Islands.

2 . Fossil evidence suggests that South America was once joined to Africa. The most convincing evidence is the distribution on both continents of the same species of

(A) Jurassic ammonites.

(B) Permian reptiles.

(C) Tertiary pollens.

(D) Cretaceous fish.

3 . Compared with continental crust, oceanic crust is relatively young. No oceanic crust is older than 200 million years. This is because

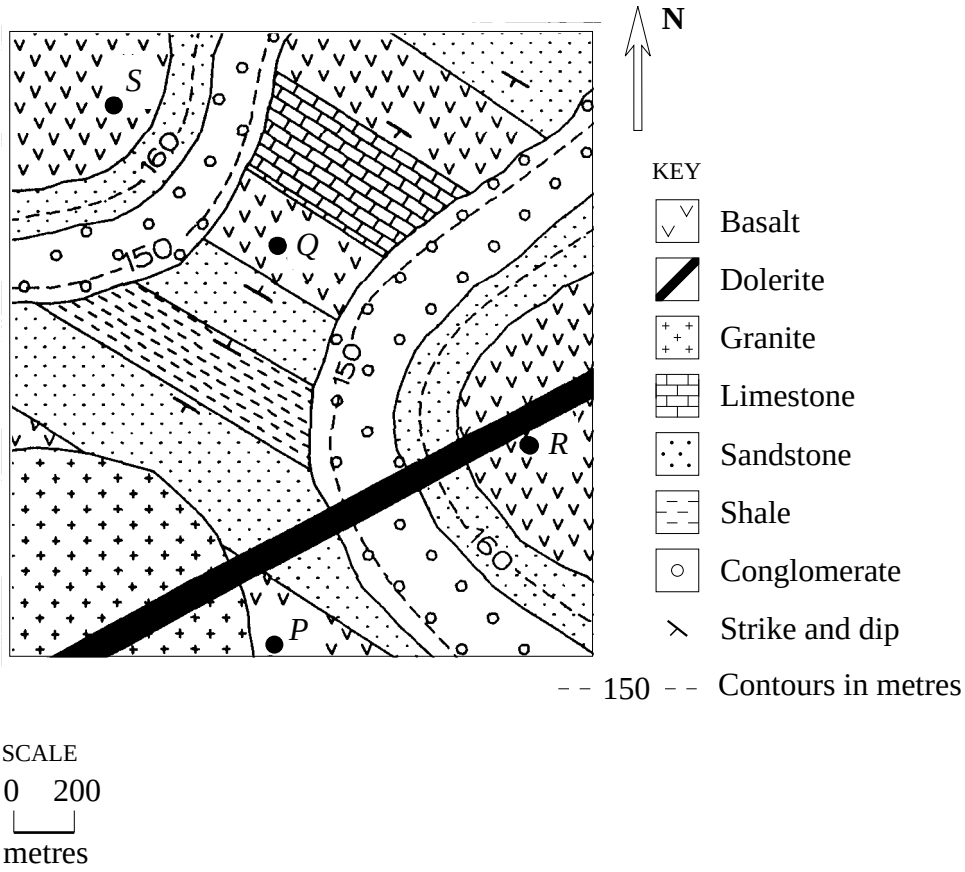
(A) plate tectonics did not commence until the early Jurassic.

(B) oceanic crust is constantly being created at mid-ocean ridges.

(C) older oceanic crust has been subducted beneath oceanic trenches.

(D) older oceanic crust has been uplifted into mountain ranges.

4 . A geologist needs to sample basalt flows for palaeomagnetic measurements. Sampling in localities where the rocks have been deformed or reheated has to be avoided.



The best location for sampling is at

(A) *P*

(B) *Q*

(C) *R*

(D) *S*

5 . Earth scientists have determined that a zone of partially molten rock exists between 100 km and about 300 km below the surface of the Earth. This layer has been called the asthenosphere. The asthenosphere can be identified because the partially molten rock causes

(A) a large negative gravity anomaly.

(B) a decrease in the velocity of seismic waves.

(C) an increase in the velocity of P-waves.

(D) a reversal of the Earth’s magnetic field.

6 . The margins of some tectonic plates are destroyed by the process called subduction. The major evidence indicating that plates actually sink back into Earth's interior as rigid slabs is the occurrence of

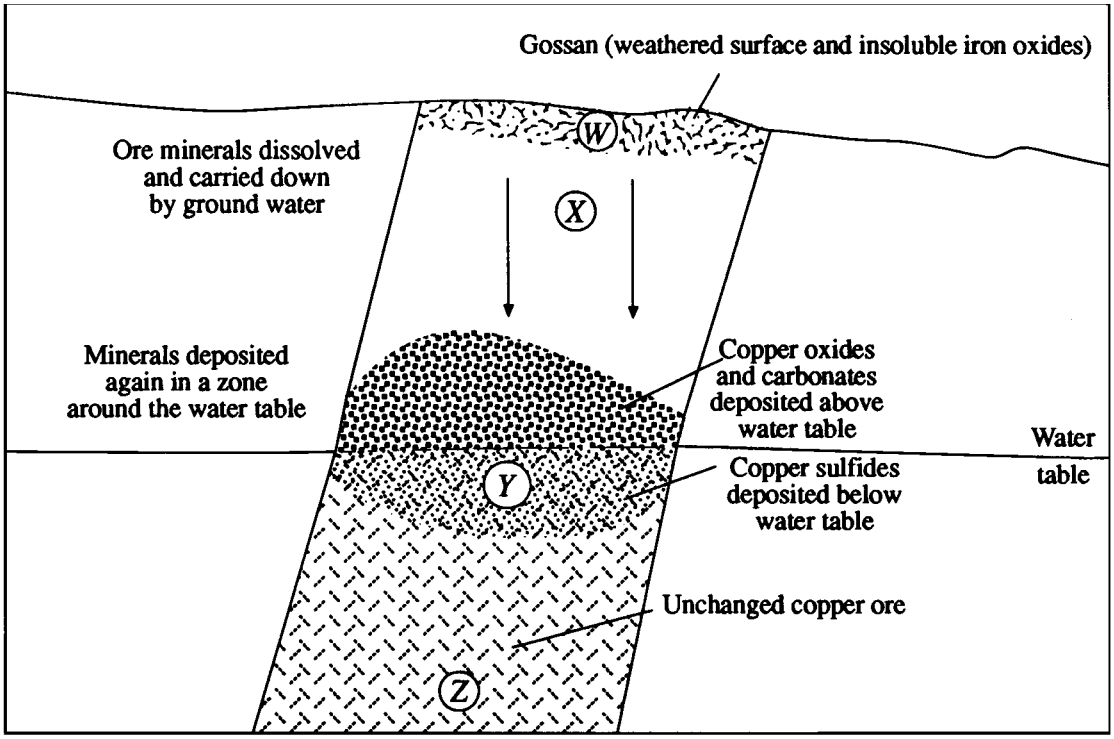
(A) deep focus earthquakes.

(B) transform faults.

(C) rifting at mid-ocean ridges.

(D) hot-spot volcanoes.

7 . The diagram below illustrates a process known as secondary enrichment that changes the concentration of copper in a copper-bearing ore deposit.



The location of highest copper grade would be

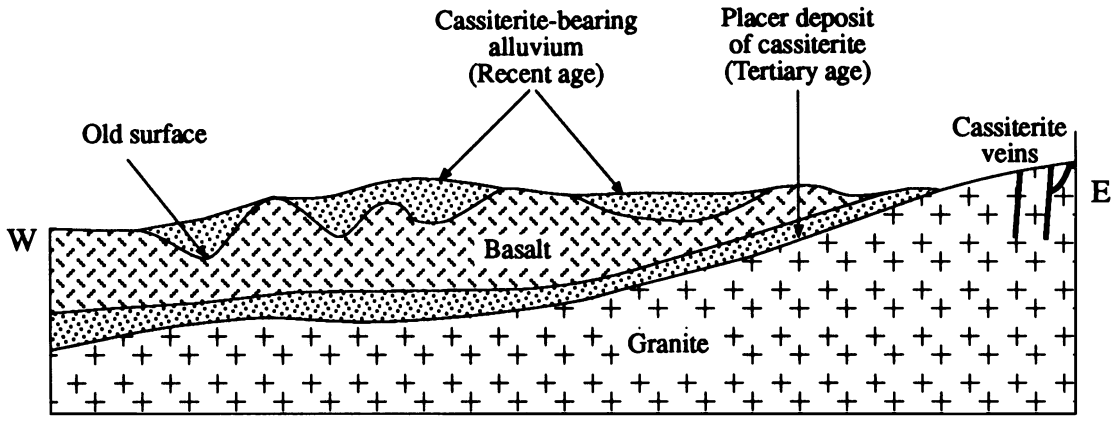
(A) *W*

(B) *X*

(C) *Y*

(D) *Z*

8 . The diagram below shows a cross-section through a mineralised area containing deposits of the tin-bearing mineral cassiterite.



The cassiterite would have formed from

(A) chemical weathering of the basalt layer.

(B) density settling within the basalt flow.

(C) contact metamorphism of the granite by the basalt.

(D) hydrothermal solutions associated with the granite.

9 . The table below shows the analyses of coal samples from four sites in the Northern Perth Basin.

Perth Basin—Northern	*Moisture* (%)	*Ash* (%)	*Volatile matter* (%)	*Fixed carbon* (%)	*Specific energy* (mJ/kg)
Eradu	30·0	17·7	20·7	31·6	14·1
Irwin River	22·1	24·8	35·6	17·4	17·3
Eneabba	3·7	14·6	34·9	46·8	27·9
Gairdner and Brazier	23·0	19·0	30·0	27·0	17·5

The highest ranking coals would be from

(A) Eradu.

(B) Irwin River.

(C) Eneabba.

(D) Gairdner and Brazier.

10. Investigation of a newly discovered ore body indicates it has an estimated volume of 4 million cubic metres. Ore samples assay at 30 parts per million (ppm) of useful mineral. 1 cubic metre of ore weighs 4·5 tonnes.

The amount of useful mineral in the ore body is closest to

(A) 27 tonnes.

(B) 120 tonnes.

(C) 540 tonnes.

(D) 2700 tonnes.

11. A developer has made a study of four possible sites for a high-rise residential building.

Site 1. A level area, once a quarry, but now filled with clean fill and covered with topsoil.

Site 2. A gentle slope on thickly-bedded quartz sandstone, with a thin layer of sandy soil.

Site 3. Well-vegetated sand-dunes between a lake and the ocean, with magnificent water views.

Site 4. A gentle slope on deeply weathered shale, overlooking a golf course and river mouth.

The most suitable site, geologically, for this development is

(A) Site 1.

(B) Site 2.

(C) Site 3.

(D) Site 4.

12. Concern has been expressed regarding the safety of tailings dams at uranium mines in the Northern Territory. A major reason for this concern is that

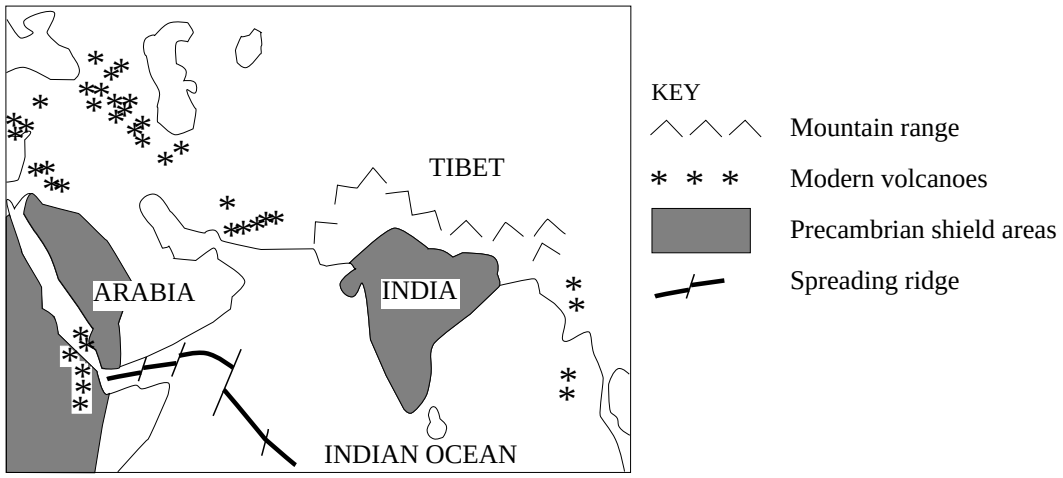
(A) floods during the wet season may wash radioactive minerals into rivers downstream.

(B) exposure of tailings to oxygen may lead to the formation of unstable radioactive minerals.

(C) radioactive barramundi may find their way to restaurants, thus harming the tourist trade.

(D) tailings minerals are too porous to be used in dam walls.

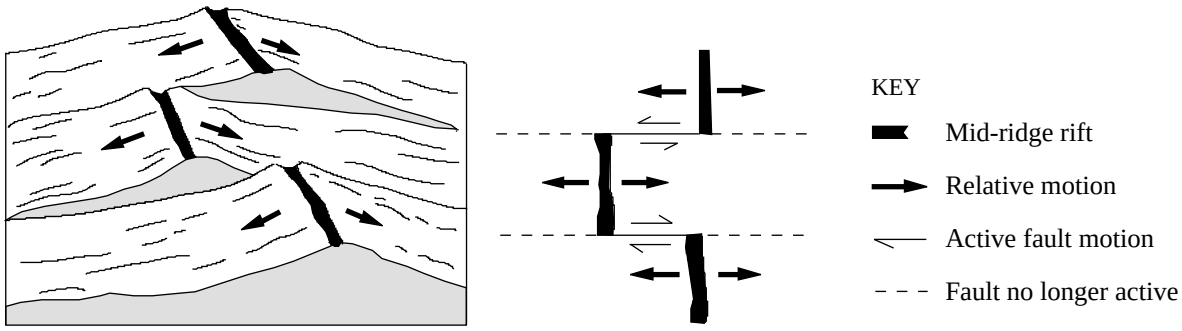
13. This question refers to the diagram below.



The mountain range shown is most likely to have formed from

(A) continent–continent collision.
(B) isostatic rebound after glacial retreat.
(C) volcanic activity.
(D) uplift prior to continental rifting.

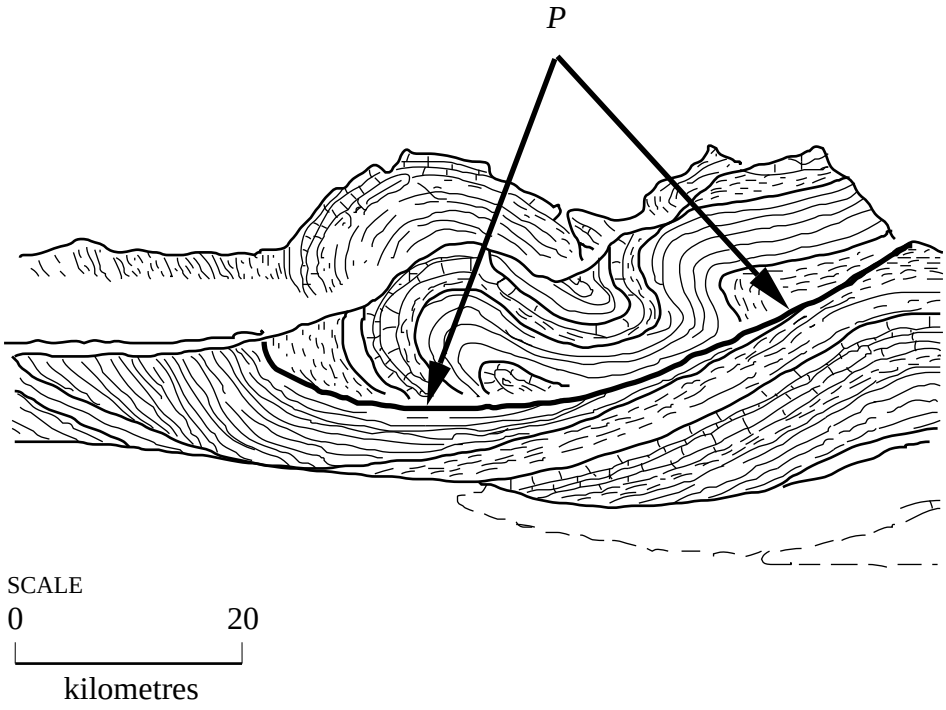
14. The diagram below shows a segment of a mid-ocean ridge that is offset by faults.



The active faults are termed

(A) transform.
(B) normal.
(C) reverse.
(D) dip-slip.

15. The diagram below shows a geological section through the European Alps.



The feature labelled *P* is

(A) a bedding plane.

(B) a normal fault.

(C) an unconformity.

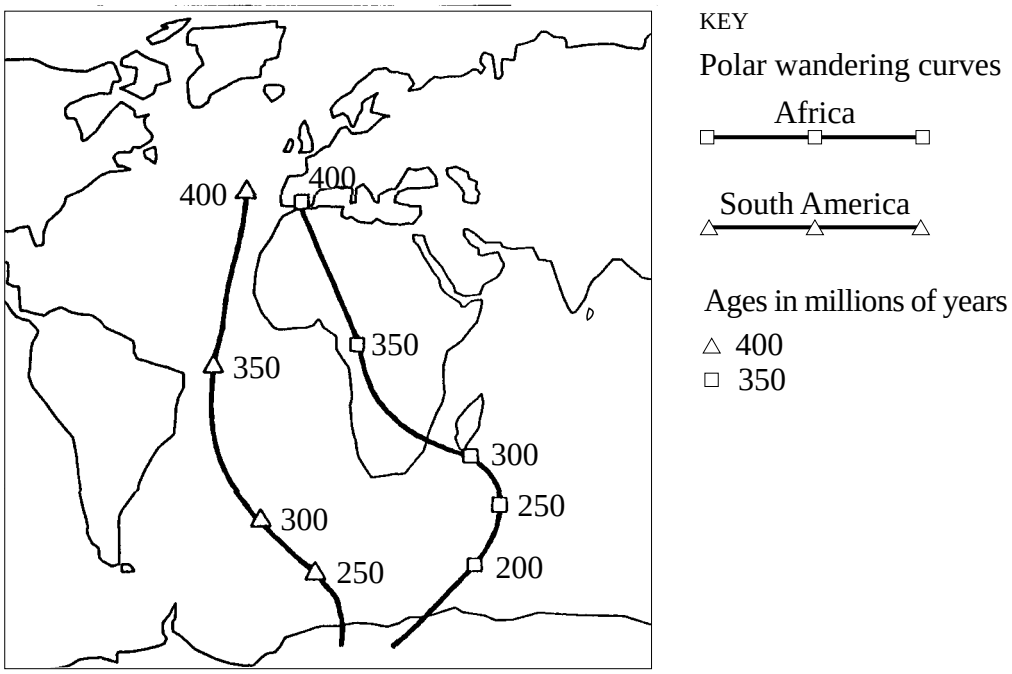
(D) a thrust fault.

PART B

Questions 16–25 are worth 3 marks each.

Answer this Part in the Part B Answer Book.

16. The diagram below shows the apparent polar wandering curves for Africa and South America. These were determined from the direction of the magnetic field imprinted in rocks at the time of their formation. The rocks were dated by radiometric methods.



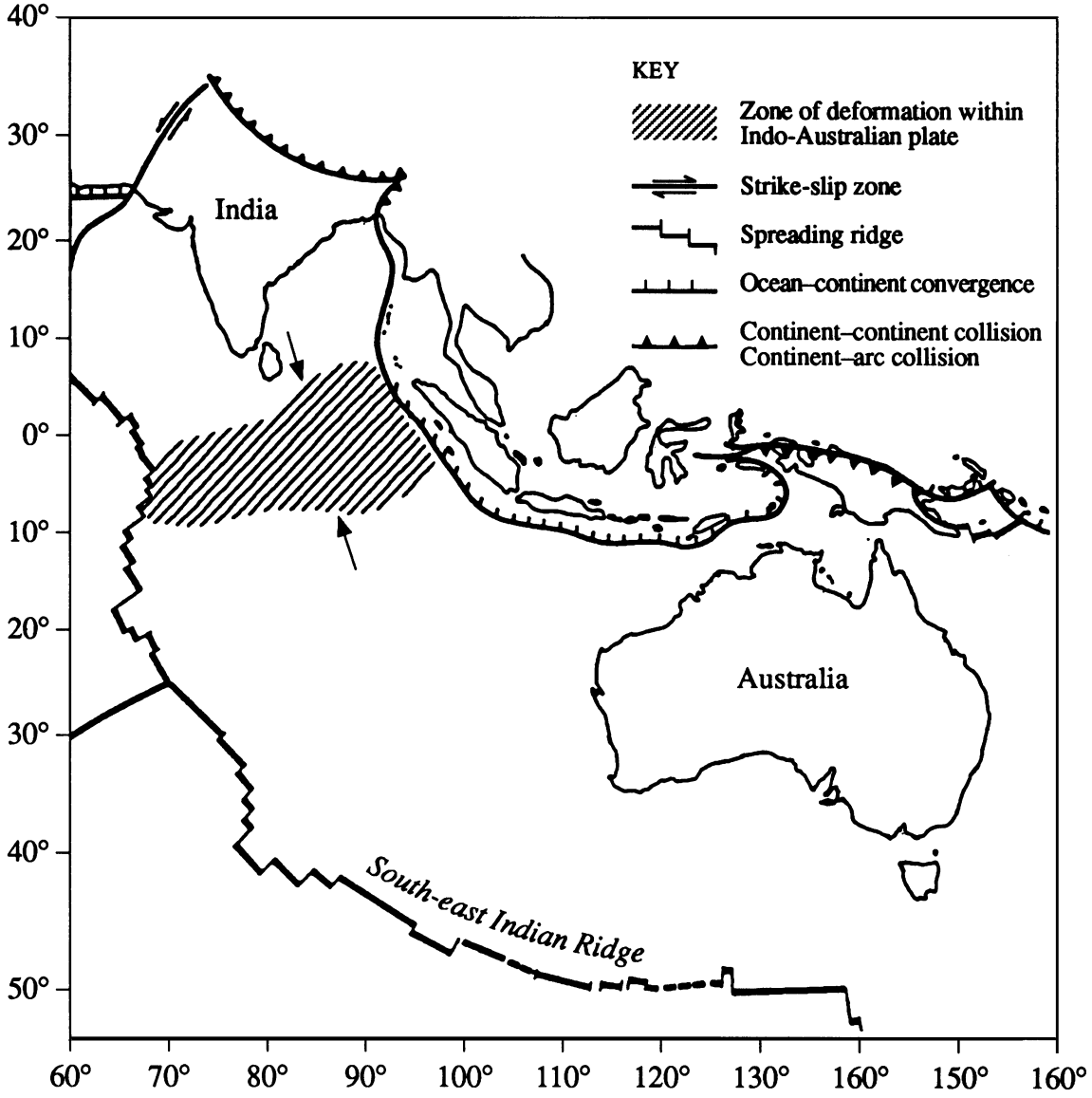
(a) Give ONE reason why carbon-14 could NOT be used for determining the ages of these rocks.

(b) Polar wandering curves provide evidence for continental mobility.

(i) Explain why the pole positions appear to have moved south during the period 400–200 million years ago.

(ii) Explain how scientists account for the presence of more than one curve.

17. Recent ocean exploration has revealed the presence of a broad zone of deformation in the Indian Ocean as shown on the map below. The presence of this zone has led geoscientists to suggest that a new plate boundary is developing between India and Australia.



The arrows on the map indicate the directions of stress.

(a) Name the type of plate boundary likely to form at the zone of deformation.

(b) Describe the geological and topographical features characteristic of the type of plate boundary named in part (a).

18. The table below shows the characteristics of some common placer minerals which are concentrated by sedimentary processes.

MINERAL CHARACTERISTICS

Mineral	*Hardness*	*Cleavage*	*Density* (g/cm^3)	*Composition*
Rutile	6–6·5	1 (poor)	4·2–5·2	TiO_2
Zircon	7	2 (poor)	4·2–4·8	$ZrSiO_4$
Cassiterite	6–7	2 (poor)	6·8–7·1	SnO_2
Platinum	4–4·5	None	14–19	Pt (+Pd etc.)
Gold	2·5–3	None	15–19·3	Au (+Ag etc.)
Sapphire	9	None	3·9–4·1	Al_2O_3
Diamond	10	1 (perfect)	3·5	C

(a) Most minerals formed in placer deposits are hard, and have poor or no cleavage. Explain why these characteristics are important for placer minerals.

(b) Select *EITHER* density *OR* mineral composition and explain why it is significant in the formation of placer deposits.

19. In the space provided in the Answer Book, draw a cross-section through a tectonic plate.

Clearly indicate on your cross-section the positions of the asthenosphere, crust, lithosphere, and mantle.

20. (a) Describe the conditions that give rise to magma formation at subduction zones.

(b) Explain why magmas formed in subduction zones are of andesitic (intermediate) composition.

21. Coal is an organically-produced sedimentary rock that commonly forms in swamp-type environments.

(a) Describe the organisms from which coal is formed.

(b) Give TWO reasons why swamps provide a suitable environment for coal formation.

22. In 1972, a group of seventy renowned public figures known as the 'Club of Rome' published a book called *The Limits to Growth.* The book predicted when key resources would run out. Some of these predictions are shown below.

Resource	*Run-out date*
Gold	1981
Silver and mercury	1985
Tin	1987
Petroleum	1992
Copper and lead	1993
Natural gas	1994

Briefly outline THREE possible reasons why these predictions have proved to be wrong.

23. The structures produced during the formation of block mountains are very different from those produced during the formation of fold mountains.

In the designated space in the Answer Book, for *each* type of mountain range:

(a) draw a labelled diagram of ONE characteristic structure;

(b) indicate the directions of forces that would form *each* structure;

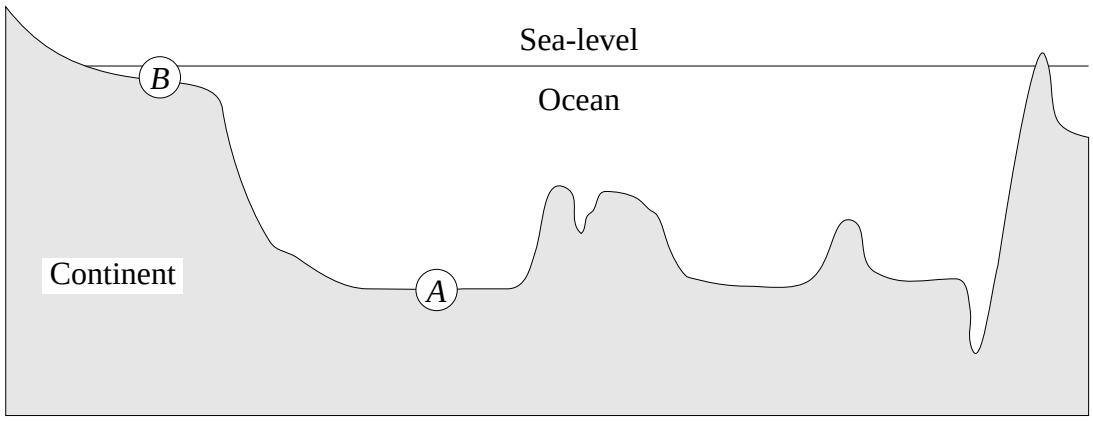
(c) name an example of *each* type of mountain range.

24. During the Cambrian, widespread tectonism produced mountain ranges in central Australia. Sediment shed from these mountain ranges formed the conglomerate of Katatjuta (The Olgas) and the sandstone of Uluru (Ayers Rock) shown below. Today Katatjuta and Uluru stand as isolated hills in an otherwise flat desert region.

Photograph: Dept of Foreign Affairs and Trade.

Briefly describe the processes that may have occurred in this region between the Cambrian and present to produce these landforms.

25. The diagram below is a schematic section of the topography of the ocean floor.



(a) In the boxes on the diagram in your Answer Book, label the topographic features indicated by the arrows.

(b) Describe the type of sediment deposited at *A* and *B* above.

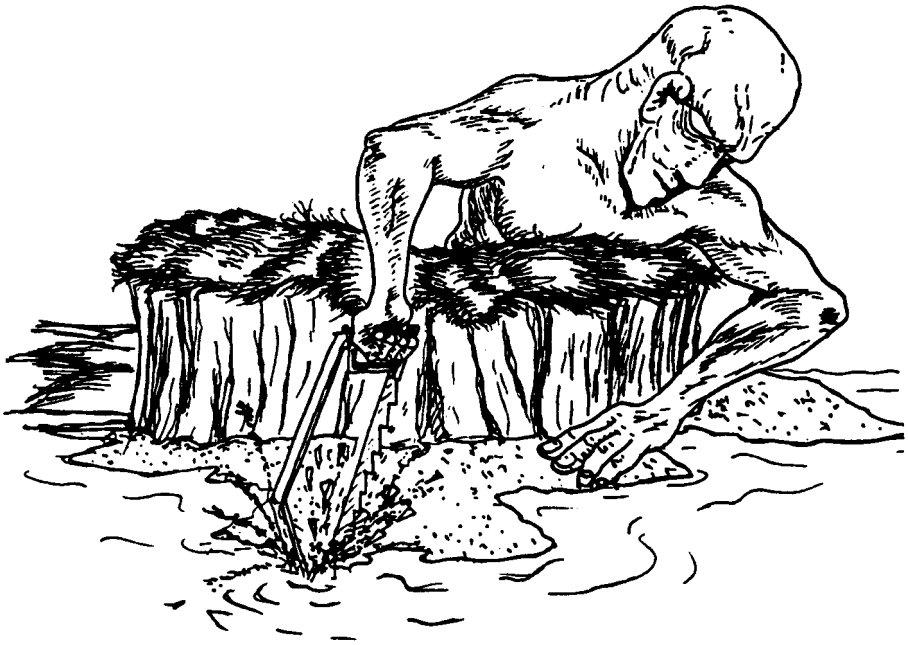
PART C

Questions 26–31 are worth 5 marks each.

Answer this Part in the Part C Answer Book.

26. Describe in detail the stages involved in the formation and accumulation of petroleum resources. At least one diagram should be used to illustrate your answer.

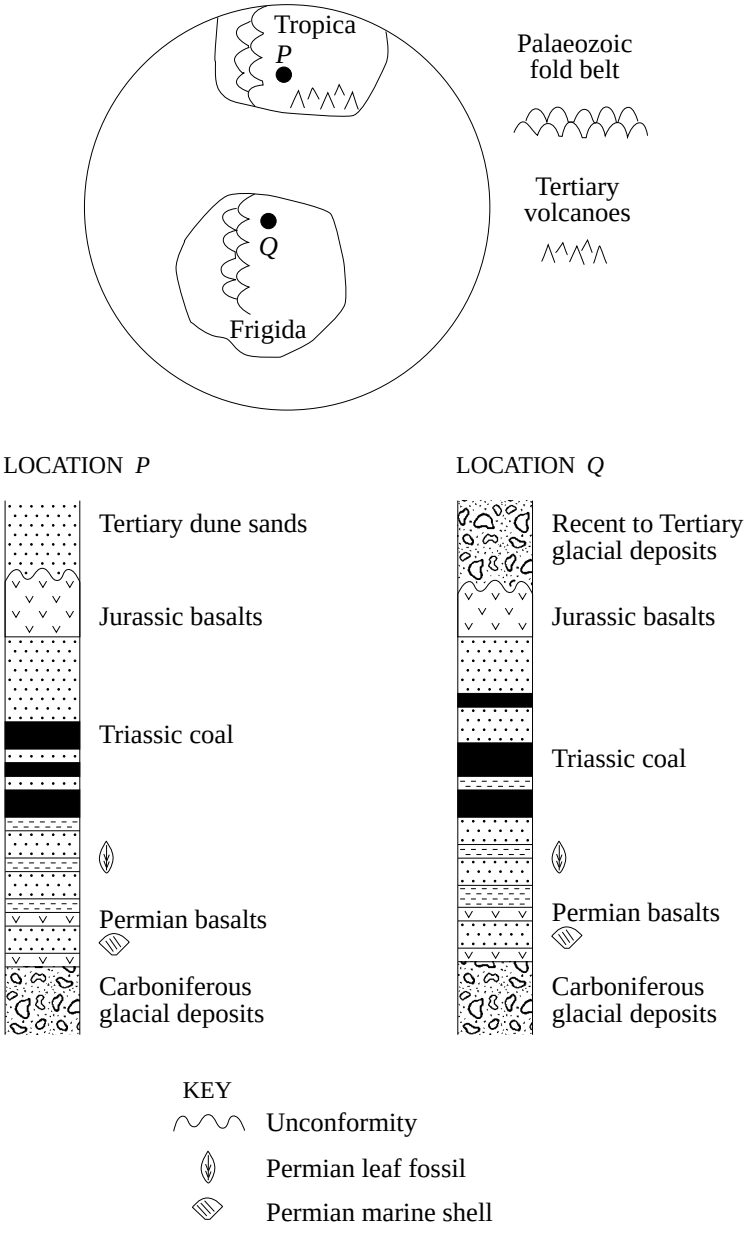
27. The cartoon below shows one way of breaking up a continental block (i.e. using a giant hack-saw).



Using a sequence of diagrams to illustrate your answer, describe in detail the break-up of a continental block and the creation of new ocean between separating continental blocks, by plate tectonic processes. Highlight in your diagrams and descriptions the following:

- the mid-ocean ridge;
- continental crust and oceanic crust;
- relative ages of the ocean floor and ocean sediments;
- sea-floor magnetic anomaly pattern;
- source of new crust.

28. The map below shows the present positions of two continents known as Tropica and Frigida. Stratigraphic columns for location *P* on Tropica and location *Q* on Frigida are also shown. Palaeomagnetic studies of the Permian basalts from location *P* on Tropica indicated that the Earth's magnetic field was vertical in this locality at that time.

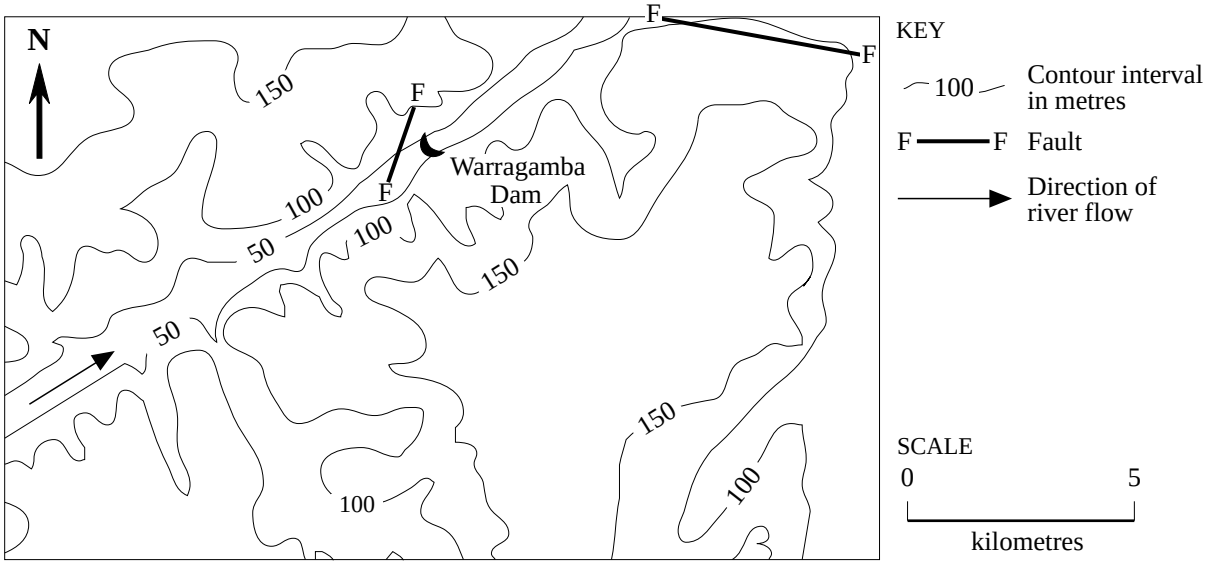


(a) Describe TWO pieces of land-based evidence which suggest that Tropica and Frigida were once joined.

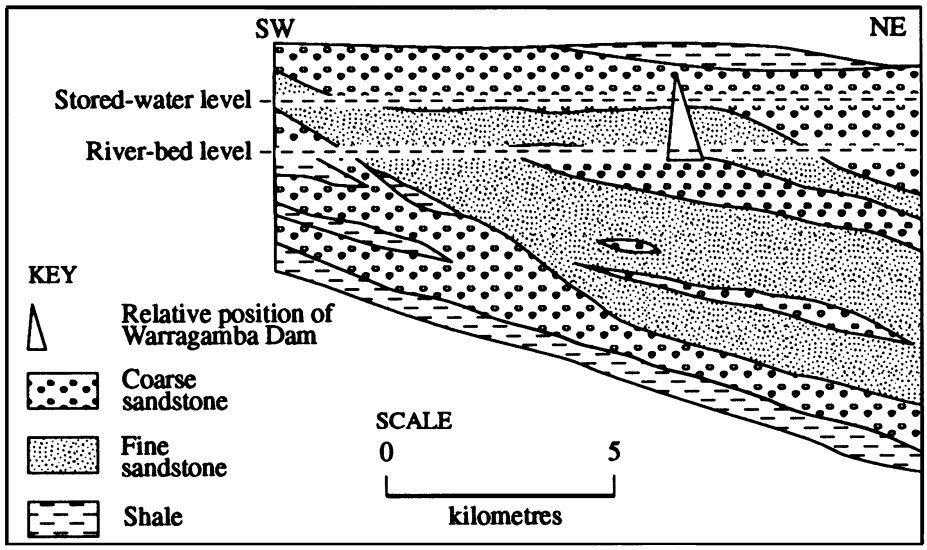
(b) From the data supplied, estimate when the separation of Tropica and Frigida occurred. Give a reason for your answer.

(c) State what the palaeomagnetic data suggest about the location of Tropica in the Permian, and give a reason for your answer.

29. In the 1950s it was decided to build a major dam to increase Sydney's water supply. That dam was built at Warragamba, on the eastern edge of the Blue Mountains, west of Sydney. The geological map, section, and description below are of the area in which Warragamba was sited.



TOPOGRAPHIC MAP



GEOLOGICAL SECTION ALONG RIVER

DESCRIPTION

Warragamba Dam, near the city of Penrith in NSW, is a concrete gravity dam that captures water from the Wollondilly, Cox and Warragamba Rivers. The surrounding rock is sandstone of the Lower Hawkesbury Sandstone and Upper Narrabeen Group. The sandstones are quartz-rich with a silica cement. One kilometre downstream of the dam, the Warragamba River joins the Nepean River. Approximately 5 km downstream from the junction, the Nepean River flows across its extensive flood-plain made up of alluvial sand and gravel. The flood-plain is heavily populated and extensively farmed.

Outline THREE reasons for, and TWO reasons against, building the dam at this site.

30. This question refers to the volcano in the photograph below.

(a) What is this type of volcano called?

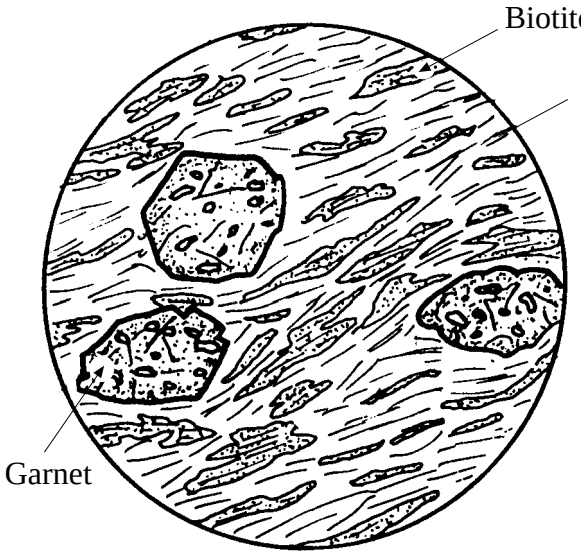
(b) Describe the eruptive style of this type of volcano.

(c) Name TWO types of rocks formed by this type of volcano.

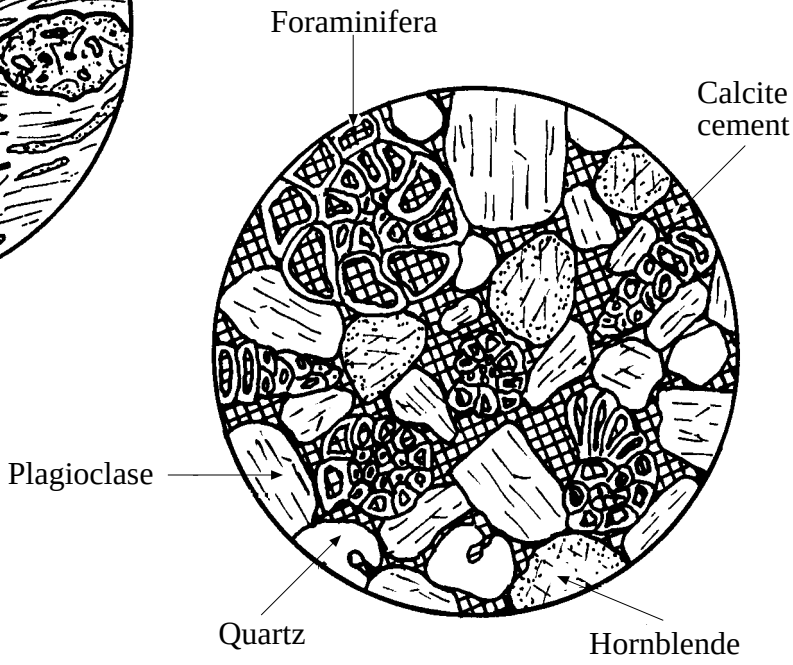
(d) On the world map in your Answer Book, place a cross (×) at two different locations where volcanoes like this would occur.

(e) Briefly describe a plate tectonic setting in which this type of volcano occurs.

31. The photomicrographs below are of two rocks, schist and calcareous sandstone, which formed in association with a mountain range.



SCHIST



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millimetres

CALCAREOUS SANDSTONE

(a) Describe the texture and origin of the schist.

(b) Describe the texture and origin of the calcareous sandstone.

(c) On the diagram in the Answer Book, indicate with letters *A* (for schist) and *B* (for calcareous sandstone) the locations at which each of these rocks could have been formed.

SECTION II—ELECTIVES

(25 Marks)

Attempt ONE question.

Answer the question in a *separate* Elective Answer Book.

Page

Contemporary Sedimentary Processes 21
Igneous Rocks 24
Economic Geology 28
Regional Geology 30
Palaeontology 32

QUESTION 32. Contemporary Sedimentary Processes **Marks**

In this elective you have studied ONE of the following depositional environments:

- a river or stream
- a beach
- a lagoon or lake
- a bay, estuary, or delta
- a desert.

(a) (i) From the above list, name the environment you have studied. **6**

(ii) Describe THREE field or laboratory methods used in your study, and explain why each method was appropriate.

(b) (i) Draw a map of the area and indicate the locations where samples were collected. **5**

(ii) Make an enlarged copy of Table 1 in your Elective Answer Book. From TWO sample sites, choose ONE type of sediment. For each sediment, list its properties, including the size and sorting, shape, composition, and a description of the source of the sediments.

TABLE 1

Particle characteristics	*Site 1*	*Site 2*
Size and sorting		
Shape		
Composition		
Source		

(c) (i) Sketch THREE sedimentary structures that allow you to determine the direction of sediment transport in your area. Include a scale, and an arrow showing the sediment transport direction. **6**

(ii) For ONE of these sedimentary structures, discuss how it could be used to aid interpretation of an ancient sedimentary environment.

(d) Discuss FOUR ways in which people have affected the sedimentary processes and products in the area you have studied. **4**

Question 32 continues on page 22

QUESTION 32. (Continued) **Marks**

(e) The photograph below shows a sediment deposited by a glacier. **4**

(i) Describe this sediment.

(ii) Explain why this glacial sediment is similar to, or different from, the sediment you have described at Site 1 in your study area. Include reference to:

- size
- sorting
- shape.

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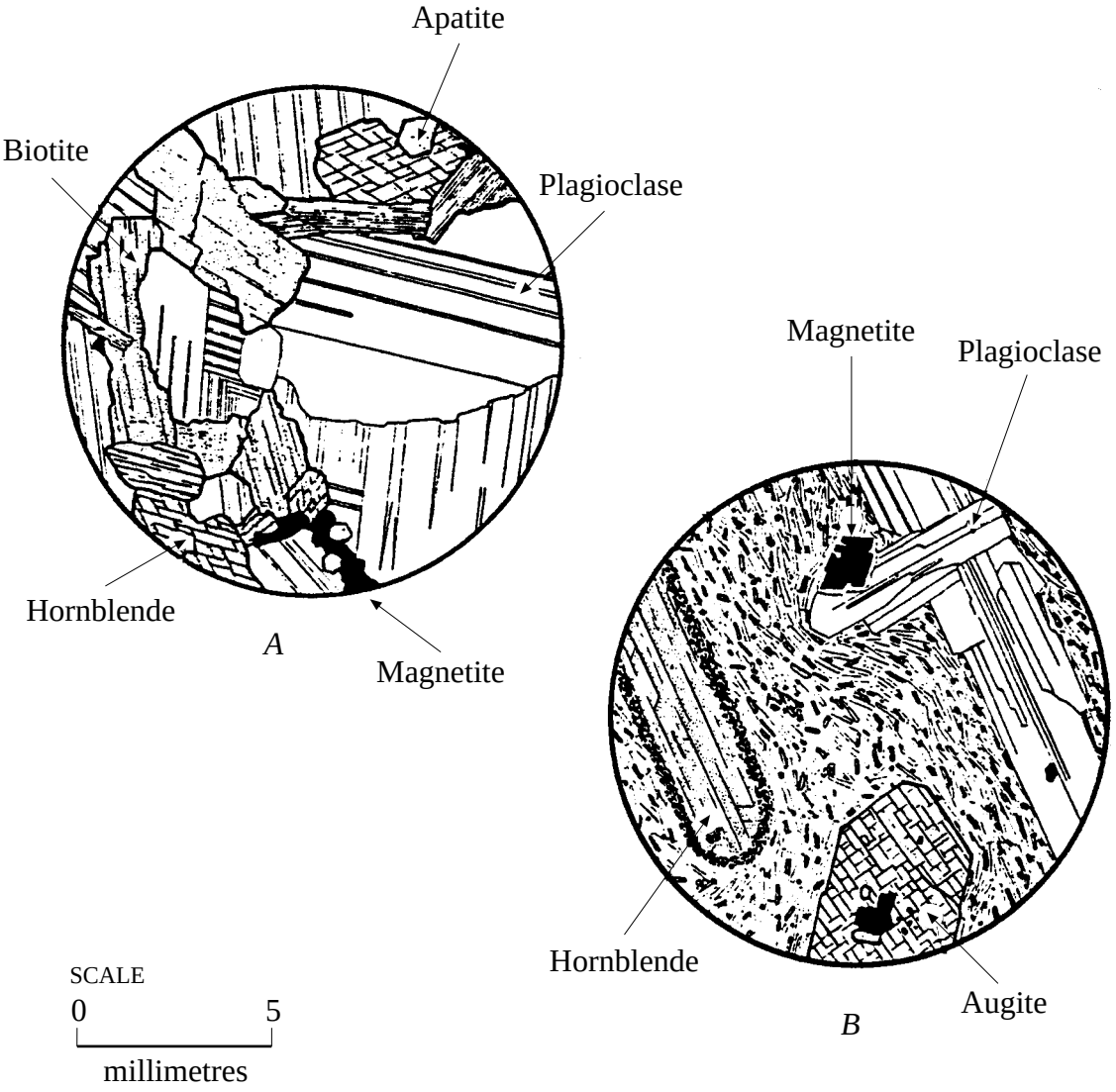
QUESTION 33. Igneous Rocks **Marks**

(a) The diagrams below are from thin sections of two different igneous rocks, *A* and *B*. **7**



(i) Briefly describe the cooling history of rocks *A* and *B*, giving reasons for your interpretations.

(ii) Giving reasons for your answers:

1. describe a tectonic setting in which rock *A* is formed;

2. describe a tectonic setting in which rock *B* is formed.

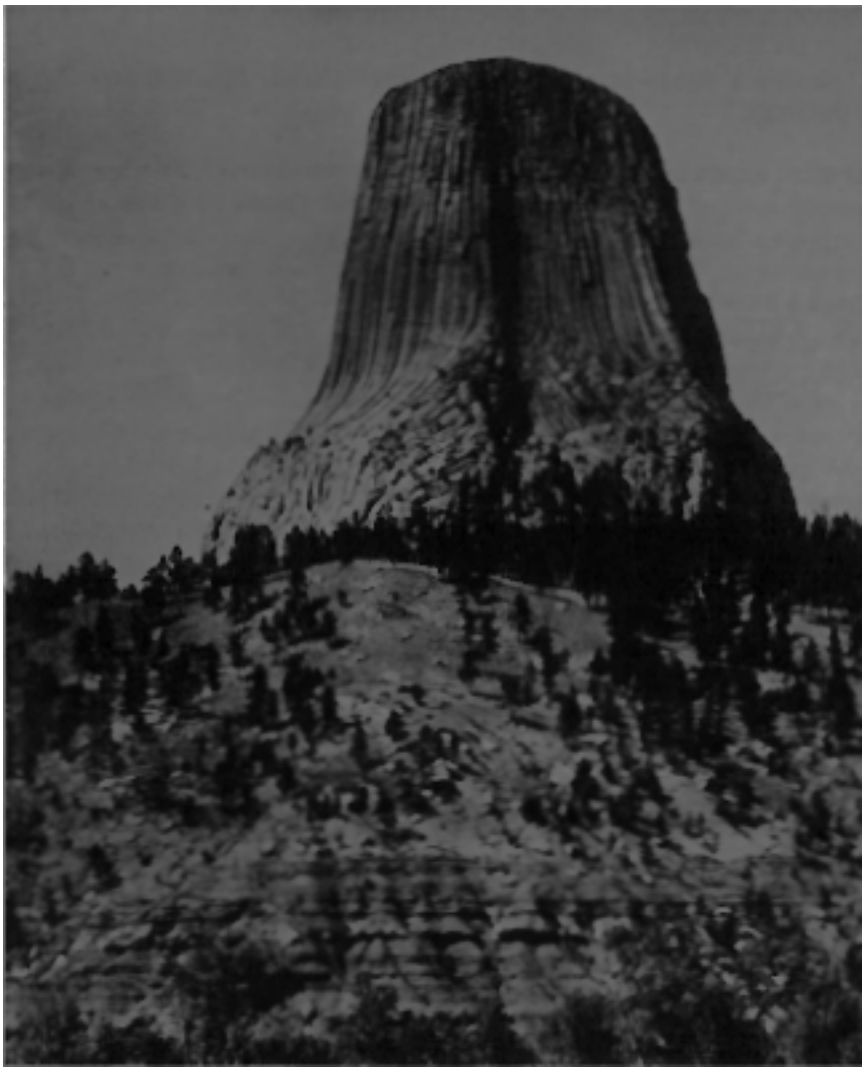
(iii) Describe the magmatic origin of rock *A*.

(iv) Name rock *A*.

QUESTION 33. (Continued) **Marks**

(b) This question refers to the igneous body shown in the photograph below. **5**

US Geological Survey. Photo: NH Darton.



(i) Describe how this igneous body formed.

(ii) Describe the texture that you would expect to find in the rock that makes up the igneous body.

(iii) Account for the formation of the prominent, elongated, sometimes curved, structures in the igneous body.

Question 33 continues on page 26

QUESTION 33. (Continued) **Marks**

(c) This question refers to the diagrams below. **6**

Diagram *P* shows a generalised map of an island which has been built by the coalescence of volcanic material from several volcanoes.

Diagram *R* shows a cross-section through the island, taken along *AB* as indicated on the map.

HT Stearns and GA Macdonald. 'Principles of Geology', Gilluly, Waters & Woodford, WH Freeman and Co, 1951 p412.

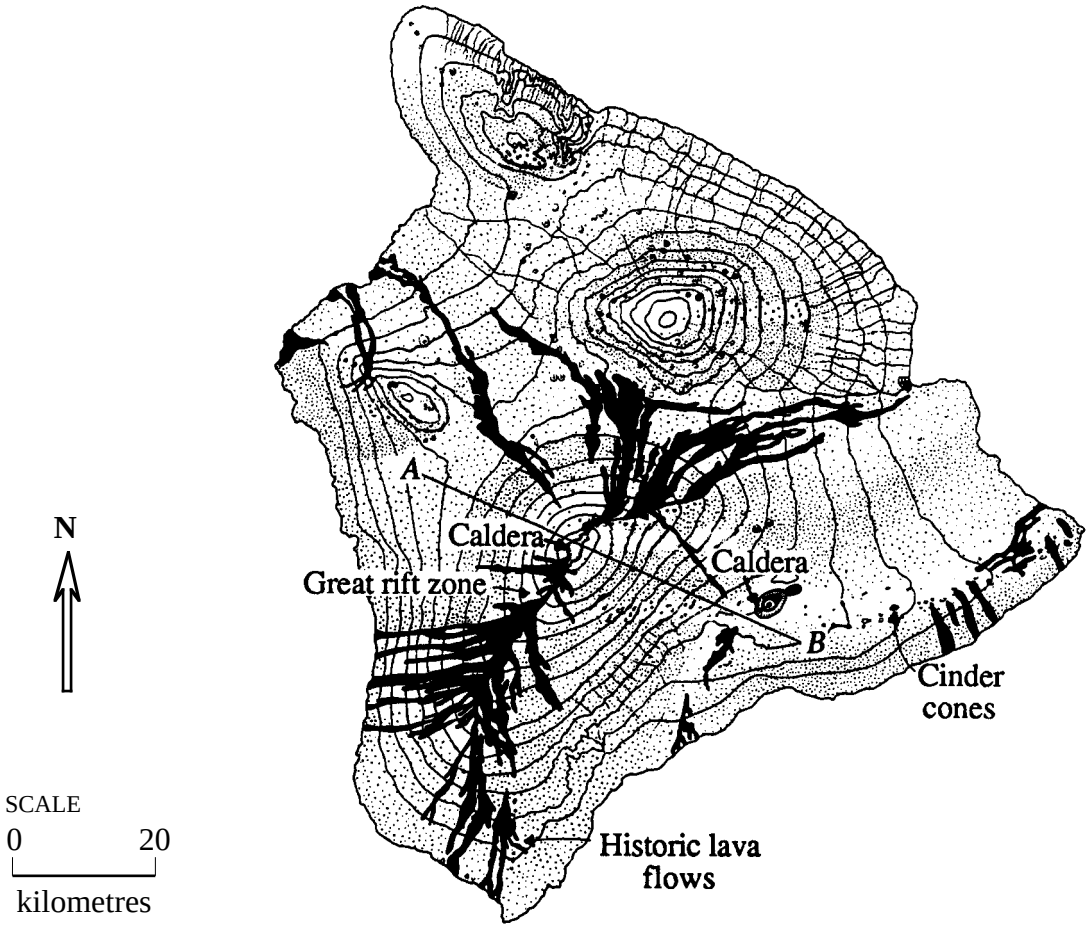


DIAGRAM *P*

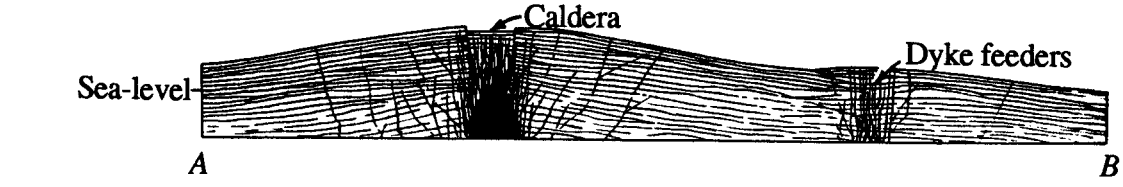


DIAGRAM *R*

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QUESTION 33. (Continued) **Marks**

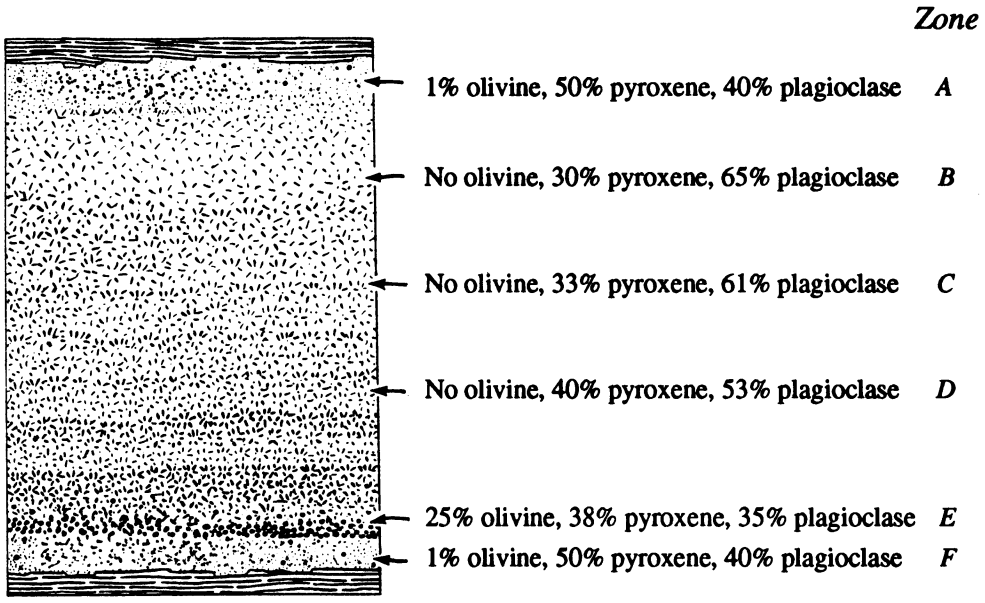
(i) Describe the eruptive characteristics of the type of volcano that has built the island.

(ii) Describe TWO possible tectonic settings for islands formed in this way.

(iii) 1. Name THREE minerals you could find in igneous rocks from this island.

2. Name ONE mineral that would *not* occur in rocks from this island, and give reasons for your choice.

(d) (i) This question refers to the diagram below, which shows a diagrammatic section of the 200 m thick Palisades sill, New Jersey, USA. Percentages of olivine, pyroxene, and plagioclase are shown. **5**



1. Describe the likely texture of rocks in zones *A* and *F*.

2. Account for the similarity of mineral composition in zones *A* and *F*.

3. Which zone would have the coarsest grains? Give reasons for your answer.

4. Explain why olivine is more abundant in the lower portion of the sill.

5. Name the rock that occurs in Zone *F*.

(ii) Describe the manner of formation of a hydrothermal ore deposit, including information about its relationship to an associated igneous source. **2**

QUESTION 34. Economic Geology **Marks**

In this elective you will have studied TWO of the following:

- an economic deposit formed by igneous and/or metamorphic processes;
- an economic deposit formed or concentrated by weathering or sedimentary processes;
- an engineering project.

Answer all parts of this elective.

(a) Using *EITHER* an economic deposit formed by igneous and/or metamorphic processes *OR* an economic deposit formed or concentrated by weathering or sedimentary processes. **13**

(i) Name the deposit chosen.

(ii) Draw a labelled cross-section of the deposit to show the relationship between wanted material and waste material. Indicate on your diagram any variations in the nature of the wanted material.

(iii) Describe the geological processes that were responsible for concentrating the wanted materials in the deposit.

(iv) In point form, outline the stages involved in the mining of the deposit.

(v) Draw a diagram or flowchart to show the stages involved in the processing of your deposit.

(b) Using *EITHER* an engineering project *OR* a deposit you have NOT used in (a), answer the following questions. **7**

(i) Name the project or deposit chosen.

(ii) Choose ONE exploration or testing method, and

1. name the method chosen and describe at what stage in the development of the project it was used;

2. explain why management chose to use this method;

3. explain the procedures involved in carrying out this method;

4. describe (preferably by the use of a diagram) how the results of the exploration or testing method are displayed for interpretation.

(iii) Discuss the role of TWO of the following factors in setting up the project.

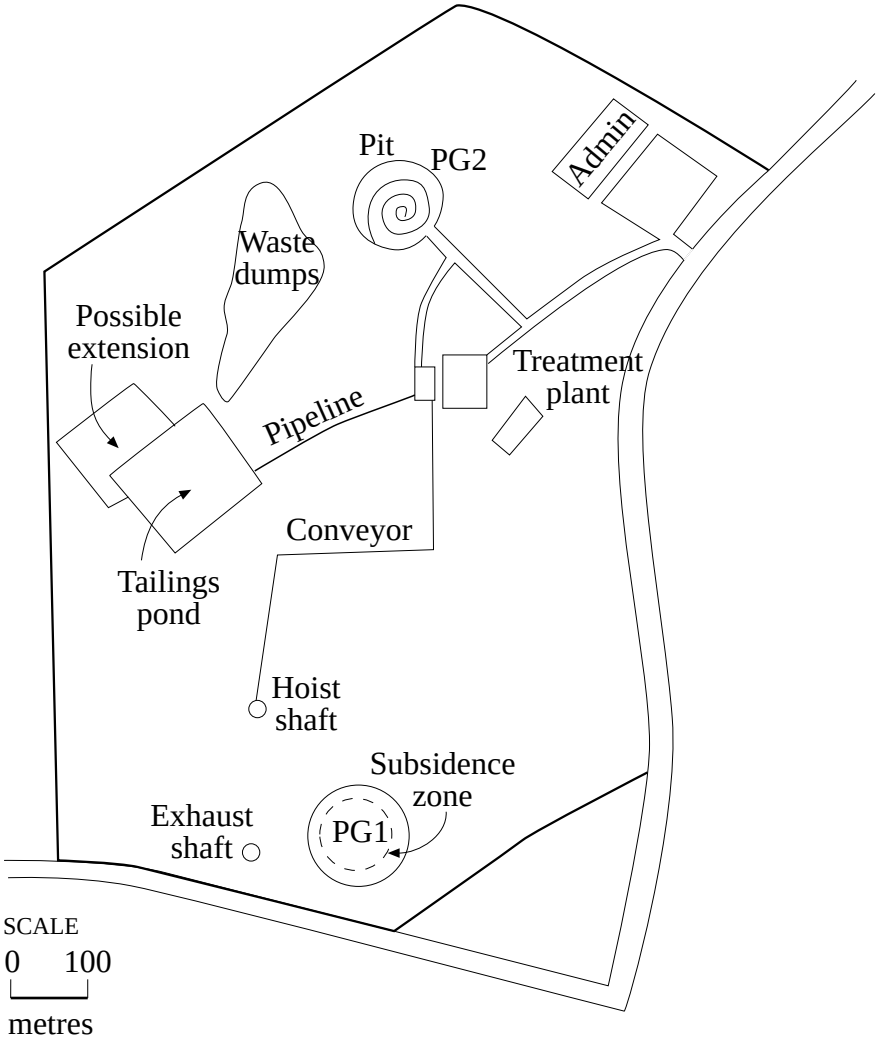
- government policy
- influence of nearby centres of population
- availability of capital
- proximity to markets
- availability of water

QUESTION 34. (Continued) **Marks**

(c) The information below relates to an imaginary mining project (NOT one you have studied). **5**

The CSH project involves the mining of an underground (PG1) and a near-surface (PG2) base-metal deposit, and the processing of the ore in an on-site treatment plant.

The diagram below shows the layout of the CSH mining lease.



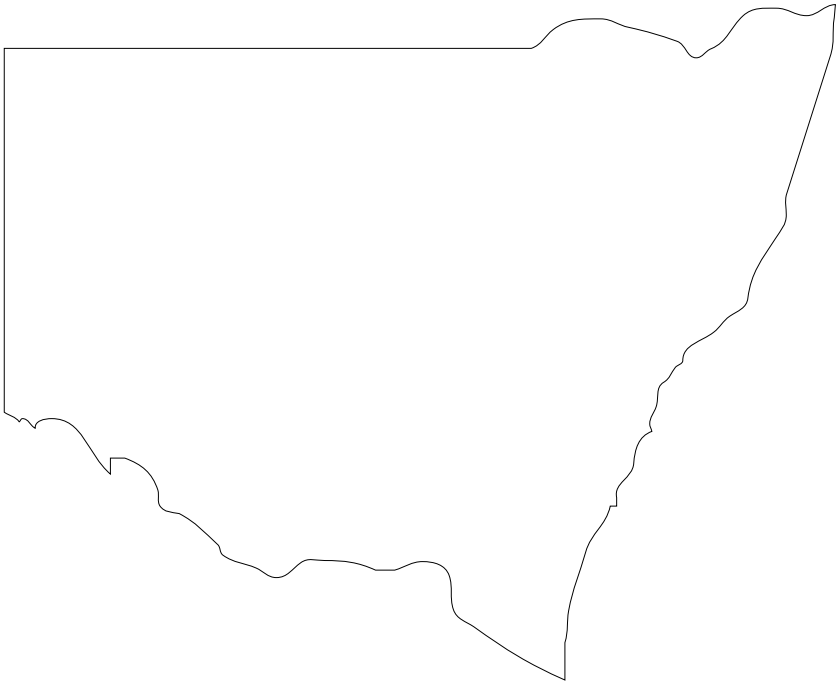
Using the information provided above, and the skills you have developed while studying this elective, answer the following.

Describe FIVE specific environmental problems that have resulted, or may result from the development of this project. For each one, indicate a method that could be used to overcome the problem.

QUESTION 35. Regional Geology **Marks**

In this elective, you will have studied ONE of the following regions.

- North-western Fold Belt
- Central and Southern Fold Belt (northern areas)
- Central and Southern Fold Belt (southern areas)
- New England Fold Belt
- Sydney Basin
- Clarence–Moreton Basin
- Great Artesian Basin
- Murray Basin



(a) Copy the map of NSW into your Elective Answer Book. Name, and sketch the location of the region you studied. **1**

(b) The region you have studied is bounded by other regions. Each of the boundaries is marked by a change in structure, or lithology, or both. **5**

(i) Select ONE boundary of your region, and name the adjoining region. Indicate on your map the geographical location of the boundary.

(ii) Describe fully the nature of the changes that mark the position of the boundary.

(c) Using a well-labelled geological column, summarise the geological history of your area. Include details of any major periods of sedimentation, igneous activity, metamorphism, and tectonic activity. **9**

QUESTION 35. (Continued) **Marks**

(d) Select ONE economic activity occurring in your region and describe how the geology of the area in which it occurs has influenced that activity. Include references to geological and geomorphological processes. **5**

(e) Your region will contain features of special geological interest. **5**

Select ONE such feature in your region and describe why it is of special geological interest. Outline the processes that have led to its formation or development.

QUESTION 36. Palaeontology **Marks**

(a) Name ONE of the key personalities involved in the development of palaeontology. Describe this person's contribution and explain its significance. **3**

(b) Although mammals first appeared during the Jurassic there are very few mammalian fossils older than the Miocene found in Australia. **3**

Give TWO possible reasons for this gap in the mammal record in Australia.

(c) Choose ONE of the major fossil groups that you have studied (ammonites, trilobites, OR graptolites) and answer the following questions. **10**

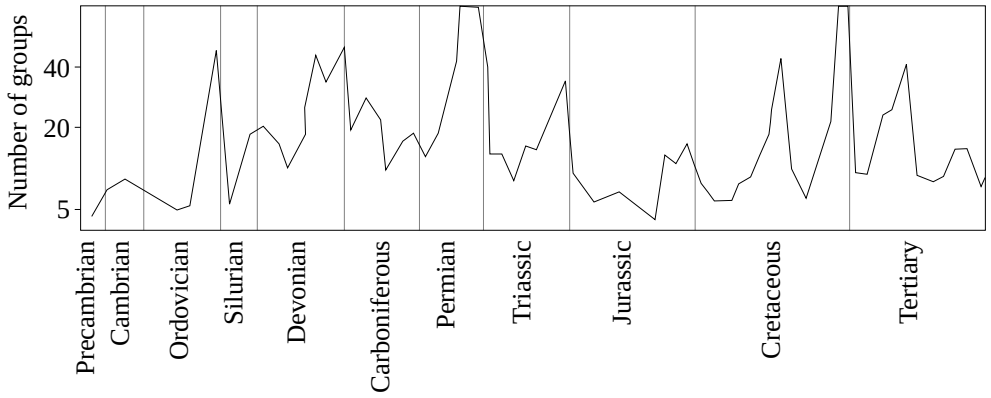
(i) Describe in detail the major morphological changes in this fossil group. Illustrate your answer with sketches.

(ii) Describe where this fossil group occurs in the fossil record in relation to geological time and the evolution of life.

(iii) Name the phylum to which this fossil group belongs.

(iv) Ammonites, trilobites, and graptolites are now extinct. Outline TWO difficulties that are encountered in classification of extinct groups.

(d) The graph below shows the number of fossil groups that became extinct at a particular geological time. **4**



(i) Name TWO geological periods in which mass extinctions occurred.

(ii) Outline TWO possible causes of crises that could lead to the extinction of major groups.

QUESTION 36. (Continued) **Marks**

(e) Answer *EITHER* (i) *OR* (ii) *OR* (iii). **5**

EITHER

(i) The following statement was made in a recent TV documentary series called 'Written in Stone'.

'Layers of rock are the pages of geological history, but it is the task of geologists to put the pages in the correct order.'

Describe how geologists would use fossils to determine the stratigraphy of an area. In your answer, refer to the principles involved and to the importance of index fossils.

OR

(ii) No organism exists in isolation, but lives in a close relationship with its environment and other organisms.

Describe how assemblages of fossils can be used in conjunction with other evidence in determining the palaeoecology of an area. Your answer should refer to at least TWO different palaeoenvironments.

OR

(iii) Aboriginal Australians are believed to have inhabited Australia for at least 50 000 years. Discuss the application of palaeontological principles in determining the pre-European history of humans in Australia. Your answer should include reference to the interaction of humans and their environment.

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