2009 Geology

Higher

Finalised Marking Instructions

Marks

Section A

All questions in this section should be attempted. Forty marks are allocated to the section.

1. (a) Complete the table below which shows the chemical groups and properties of some minerals in hand specimen. Choose the correct terms from the word bank below.

Element, biotite, fluorite, bright green colour, barites, haematite, sulphate, oxide, Mohs scale hardness of 6, Mohs scale hardness of 8

Name of mineral	*Chemical group*	*Distinctive property in hand specimen*
Barites	Sulphate	High relative density
Gypsum	**Sulphate**	Can be scratched with fingernail
Malachite	Carbonate	**Bright green colour**
Quartz	**Oxide**	Cannot be scratched with steel blade
Graphite	**Element**	Easily cleaved
Biotite	Silicate	Platy cleavage into flexible sheets
Plagioclase feldspar	Silicate	**Mohs scale hardness of 6**
Fluorite	Halide	Forms cubic crystals

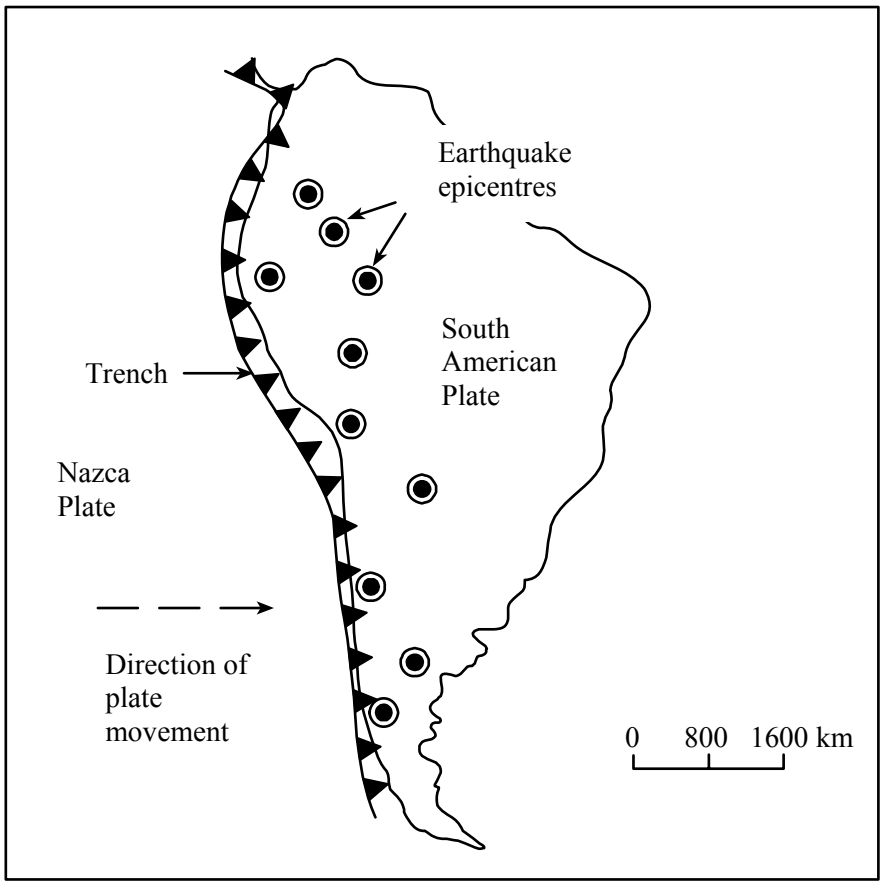
7 – 8 correct = 4 marks
5 – 6 correct = 3 marks
3 – 4 correct = 2 marks
1 – 2 correct = 1 mark **4**

(b) Diamond and graphite are **polymorphs** of carbon. What is a polymorph?

- **Same chemistry but different form/structure.** **1**

Marks

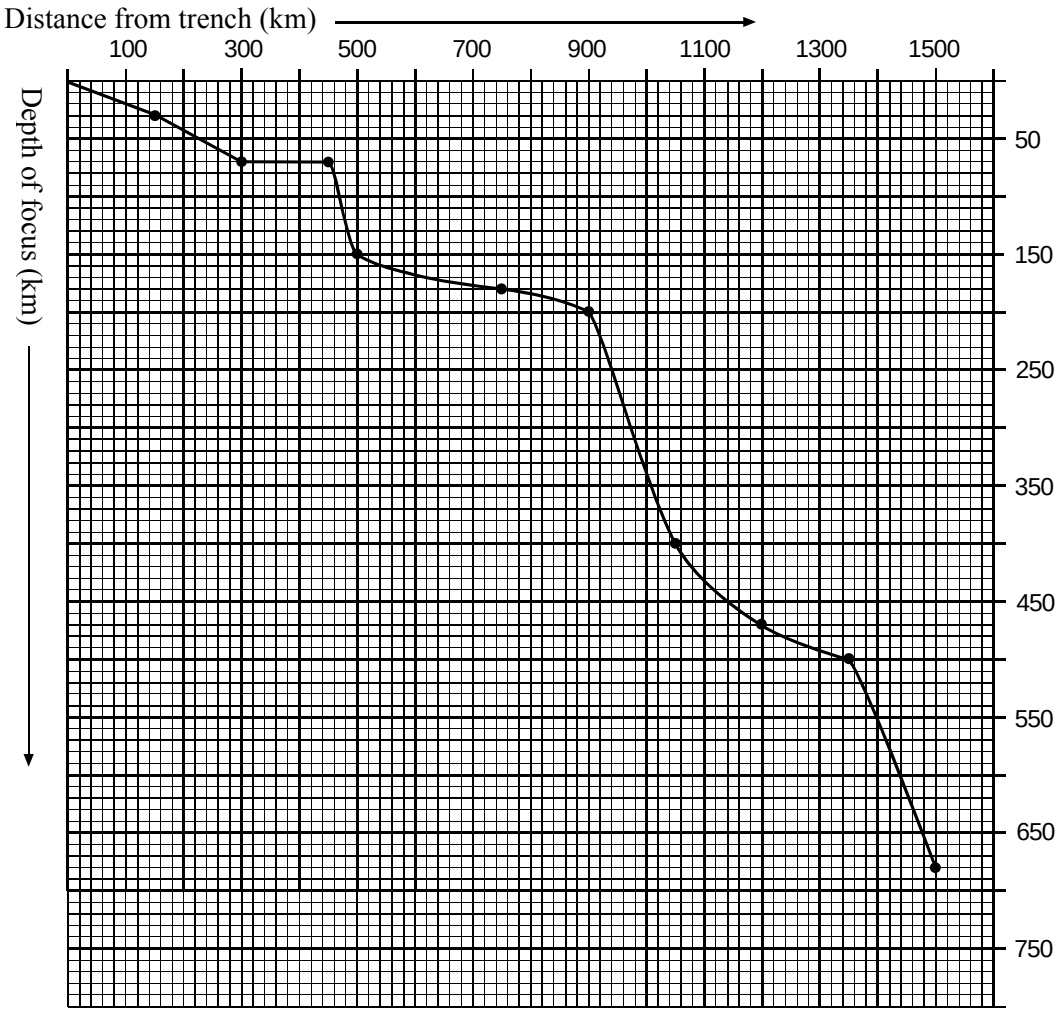
2. Study the map below of the seismically active area around South America.



The distance and depth of the earthquakes recorded east of the oceanic trench are shown in the table below.

Distance from trench (km)	*Depth of focus of earthquake* (km)
150	30
300	70
450	70
500	150
750	180
900	200
1050	400
1200	470
1350	500
1500	680

	Marks
(a) On the graph paper below draw a graph of distance from trench against depth of focus (km).	



2

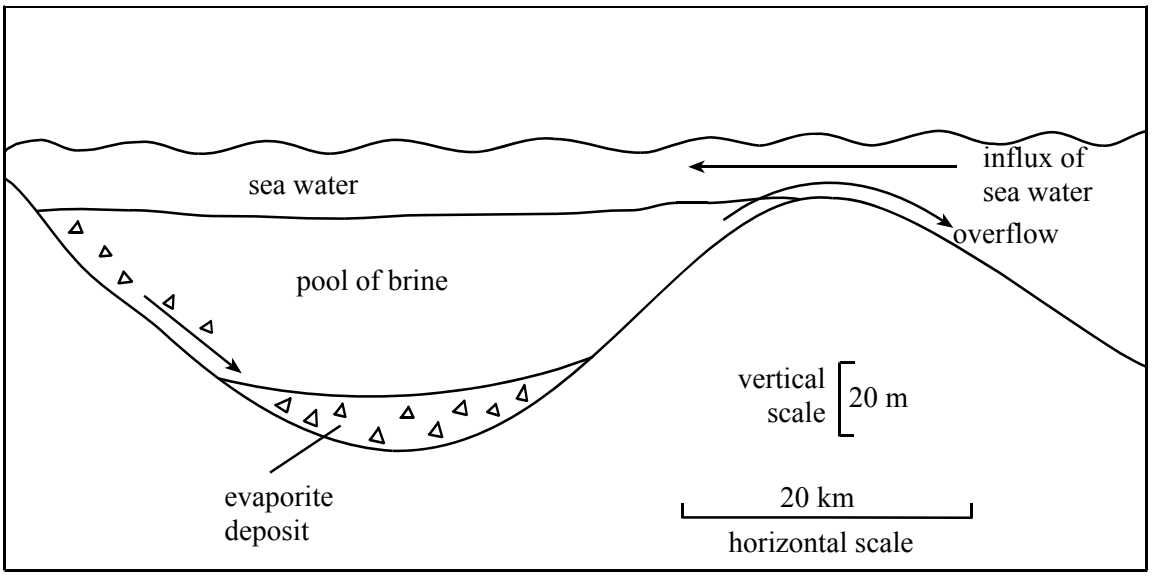
(b) **Describe** the general relationship shown by the graph.

- **Positive. As distance from trench increases, so does depth.** **1**

		Marks
(c)	**Explain** why such a relationship between depth and distance from trench exists. (You may wish to use diagrams.)	
	• **Nazca plate is descending at an angle below the South American plate. Earthquakes occur along this zone as the plate fractures. Further from the trench the deeper the focus. Diagram may be awarded a maximum of two marks. Candidates not using a diagram will require a more detailed explanation.**	**2**
(d)	Which **three** of the following statements are correct?	
	A The Mercalli scale of earthquake intensity is based on direct observation of the effects of earthquakes.	
	B The Wadati Benioff zone of inclined earthquake foci is associated with constructive plate boundaries.	
	C Every year there are many large magnitude earthquakes and only a few of small magnitude.	
	D A major hazard associated with large magnitude earthquakes in mountainous areas is the activation of major landslides.	
	E S-waves produced by earthquakes travel approximately twice as fast as P-waves.	
	F A seismometer is an instrument which records seismic vibrations.	
	G Isoseismal maps show lines of equal earthquake magnitude away from the focus.	
	Give only the letters: **A** **D** and **F**	**3**
(e)	**Explain** why earthquakes do not occur at depths greater than 720 km in the earth.	
	• **Fracture cannot occur. Rock is too ductile at this depth.**	**1**

	Marks

3. Study the diagram below which shows a cross section through an evaporite basin.



(a) Which **four** of the following statements best describe the processes operating in the basin and the minerals and rocks produced in such environments?

A Evaporation concentrates ions in the water until first potassium and magnesium salts crystallise out.

B Anhydrite is an isomorph of gypsum.

C The continuous inflow of seawater can produce great thicknesses of evaporite minerals over time.

D The thick salt deposits in North East England accumulated during the Carboniferous Period.

E The overflow of dense brine over the lip of the basin ensures that there is more gypsum but less magnesium salts than would be expected from such an evaporating body of seawater.

F The chemical formula for halite is NaCl.

G Evaporites are sedimentary rocks.

H Evaporites form most commonly in humid conditions.

Give only the letters: **C E F G** **4**

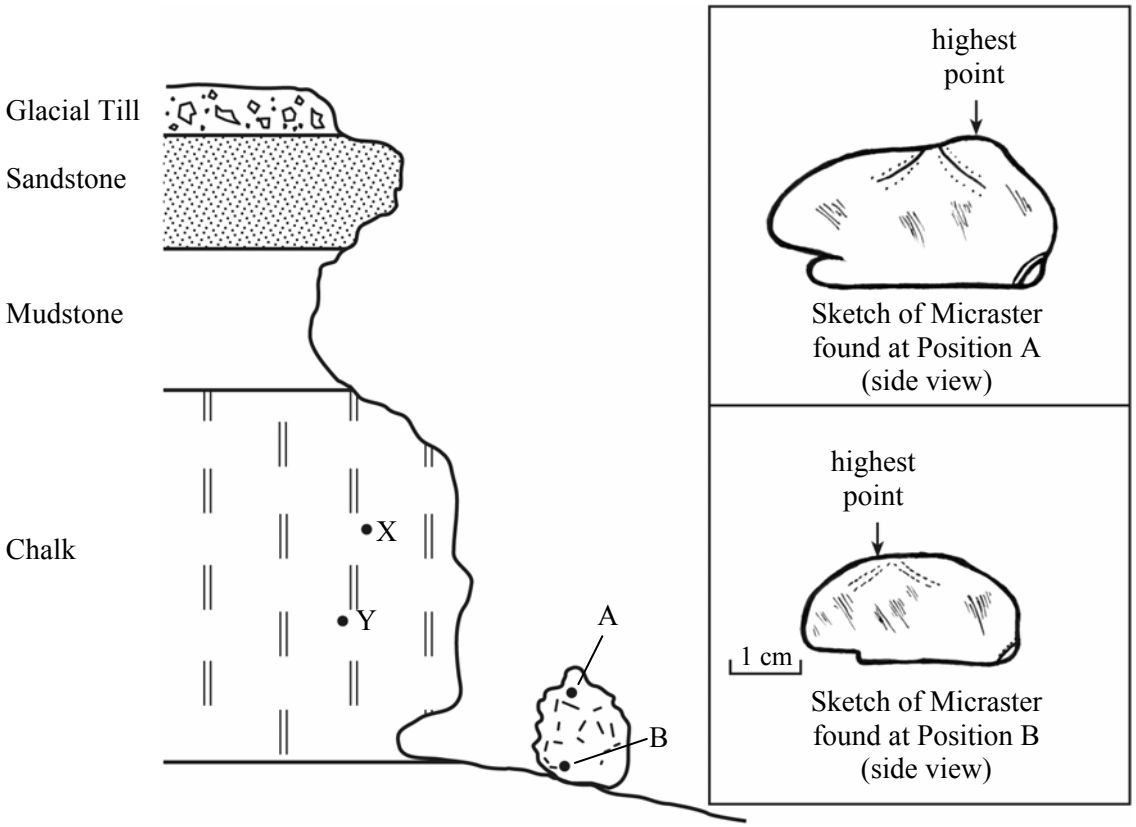
(b) **Explain** the difference between placer and residual deposits. (You may use diagrams.)

Placer **deposit concentrated by mechanical action. Credit example such as inside of meander.**

Residual **weathered material remaining in situ after soluble constituents removed.** **2**

	Marks

4. Examine the annotated field sketch below.



X: Micraster specimen found here with a deep anterior groove.

Y: Micraster specimen found here with a shallow anterior groove.

(a) Which **three** of the following statements are correct?

A Micraster is an Upper Cretaceous echinoid.

B As Micraster evolved, its test remained the same shape.

C The block fallen from the cliff face has come to rest with the oldest bed at the bottom.

D The sequence of rocks in the cliff face shows that over time the depositional environment changed from shallow to deep water.

E Chalk is formed from the calcareous skeletons of micro- organisms.

F The evolutionary changes in Micraster are related to its improved adaptation to swimming.

Give only the letters: **A C E** **3**

(b) Give **two** characteristics of good zone fossils.

- **Narrow range in time – ie undergone rapid evolution.**
- **Widespread distribution.**
- **Easily identifiable.**

Credit mention of egs like graptolites for silurian and ordovician or ammonites for jurassic **2**

Marks

5. Study the table below.

Type of meteorite	*Percentage of all meteorites falling to earth*
Stony	95·0
Iron	3·5
Stony – iron	1·5

How does the information in the table support the idea that meteorites are fragments of early formed planets?

- **The presence of iron meteorites suggests they came from the core of differentiated bodies, stony – iron meteorites suggest the core mantle boundary, stony suggest the mantle.** **2**

Marks

6. Heat flow is the rate at which heat transfers through the Earth's surface. Heat flow is measured in milliwatts per square metre.

The table below shows some information about heat flow of the ocean floor.

Age of ocean floor (Ma)	*Heat flow* (mW/m^2)
0-4	149
20-35	60
65-80	57
110-125	55
160+	50

Which **three** of the following statements are correct?

A There is a positive relationship between heat flow and the age of oceanic crust.

B At present most heat within the Earth is generated by the decay of long lived radioisotopes.

C Heat mainly travels through the crust by convection.

D There is no relationship between heat flow and age of oceanic crust.

E All the heat flowing through the ocean floor comes from the Earth's core.

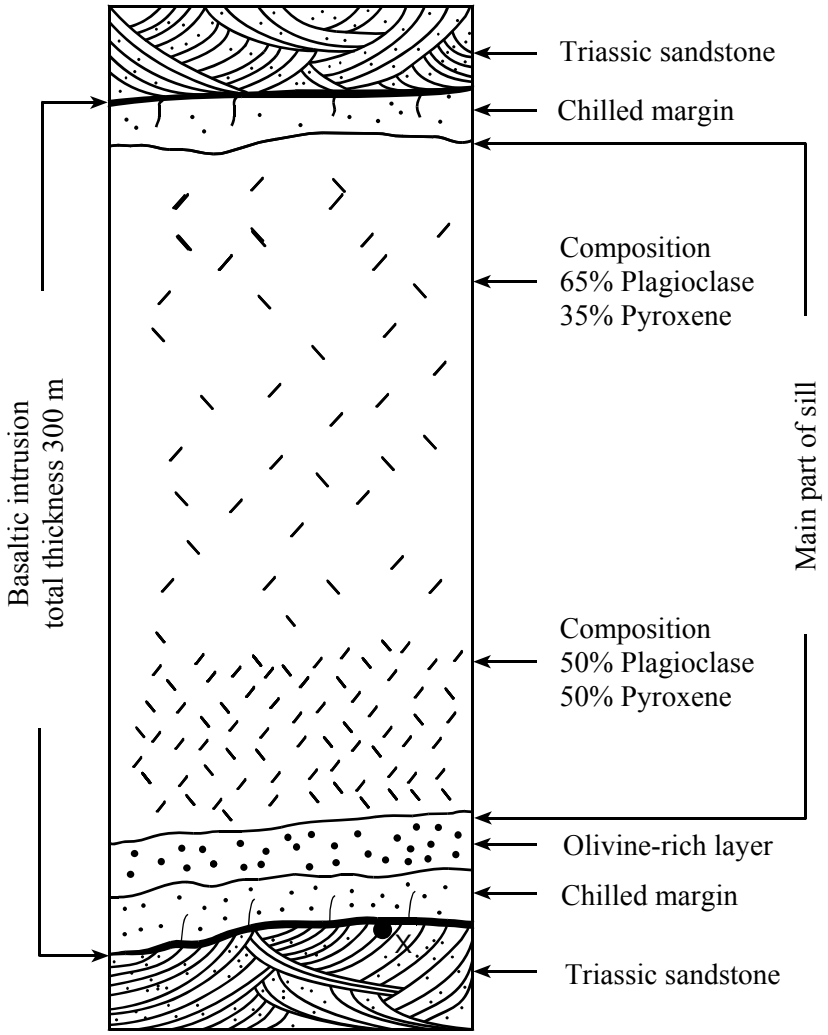
F At a heat flow of 56 mW/m^2, the age of the crust would be about 90 million years.

G Mid ocean ridges have steep geothermal gradients.

Give only the letters: **B F G** **3**

	Marks

7. Examine the cross section through the Palisades Sill, New York.



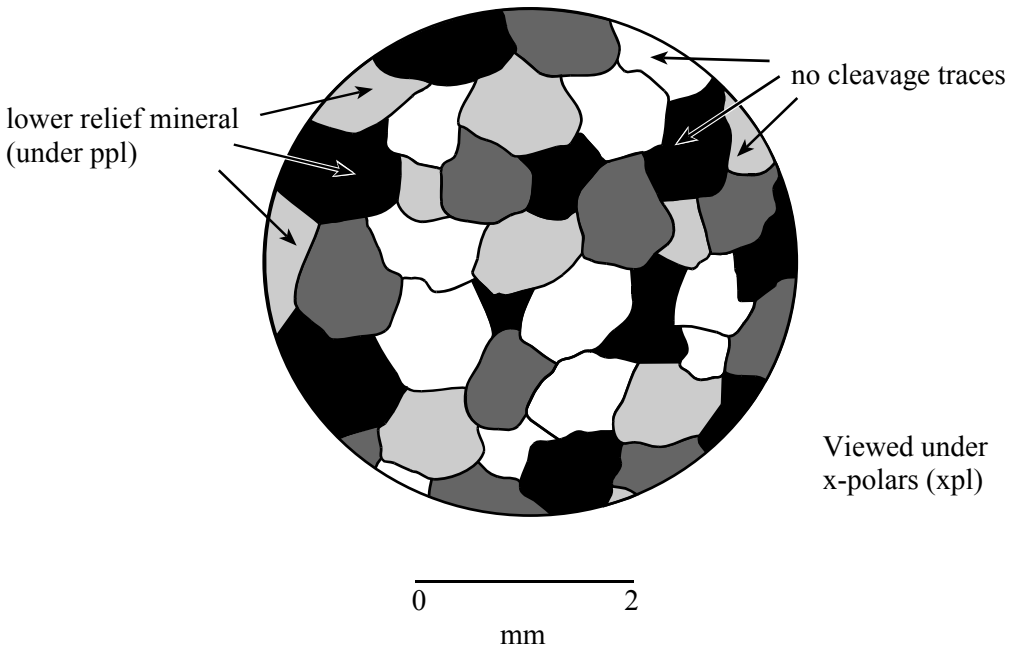
(a) Name the country rock.

- **Sandstone** **1**

(b) With the aid of a diagram **explain** why there are two chilled margins.

Credit diagram showing sill intruding between beds and contact with relatively cool country rocks leading to chilling on the upper and lower surfaces. **1**

	Marks
(c) Why is there an olivine-rich layer at the base of the sill?	
• **As cooling occurred olivine being the highest temperature mineral formed first. Its high relative density meant that it sank to the base of the cooling sill. Credit term cumulates.**	**1**
(d) **Explain** the variations in the mineral composition of the main part of the sill.	
• **Olivine crystalizing out first changed composition of magma favouring plagioclase feldspar and pyroxene. Plagioclase less dense so floated up, pyroxene more dense so relatively abundant in lower layers due to gravity settling.**	**2**
(e) Which labelled layer best represents the original composition of the intruded magma?	
• **Chilled margin**	**1**
(f) Examine the thin section below which was taken from a rock sample at point X.	

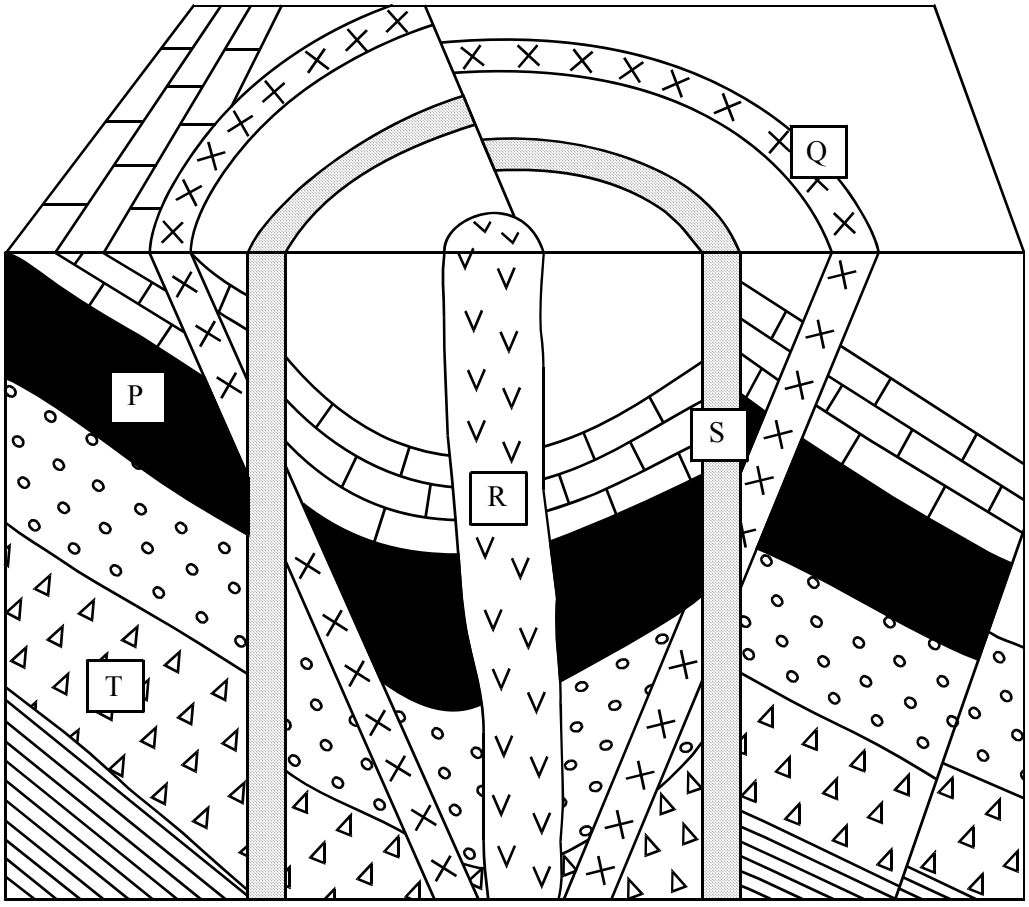


Name this metamorphic rock.

- **Metaquartzite or quartzite** — **1**

Marks

8. Examine the geological section below.



Which **three** of the following statements are correct?

A Rock P is a lava flow.

B Rock R is cut by a tear fault.

C Igneous intrusion Q is a cone sheet.

D Igneous intrusion S is a cone sheet.

E Three faults cut the rocks in this area.

F There are two unconformities shown.

G Rock Q is cut by a tear fault.

H Rock T is the oldest rock.

Give only the letters: **C** **E** **G** **3**

Section A: Total (40) marks

		Marks
	Section B	
	This section consists of three questions. Only ONE question should be attempted. Fifteen marks are allocated to this section.	
	Candidates should write their answer on pages 17, 18 and 19.	
	Additional space for answers may be found at the end of this book.	
9.	Write an essay on resources and reserves.	
	Credit will be given for the use of maps and diagrams	
	Give details as follows.	
(a)	Different types of resources — 4 marks up to a maximum of 5	**4**
	Credit correct explanation and examples of: • **physical and biological** • **renewable versus non renewable, mention of fossil fuels and sustainabilty.**	
(b)	Factors affecting the lifetime of reserves — 3 marks up to a maximum of 4	**3**
	Credit: • **changing rates of use and/or extraction** • **changes in price** • **improvements in technology leading to increased discovery and/or recovery.**	
(c)	Place value — 2 marks up to a maximum of 3	**2**
	Credit: • **explanation of the concept of how much transport costs add to the price of a mineral deposit. Diamonds have a low place value since transport costs add relatively little to their price whereas sand or gravel has a high place value and must be worked near the place of use.**	
(d)	Oil and coal formation — 6 marks up to a maximum of 7	**6**
	Credit: • **anaerobic decay of organic matter** • **burial, heating, migration from source rock into reservoir rock. Further migration halted by cap rock** • **structural and stratigraphic traps** • **coal burial and compaction of peat following anaerobic decay of tropical swamp vegetation** • **mention of carboniferous, palaeo-latitude, different types of coal, grade and rank – ratio of carbon to volatiles.**	
	total marks must not exceed 15	

		Marks
10.	Write an essay on stratigraphy.	
	Credit will be given for the use of maps and diagrams	
	Give details as follows.	
	(a) Stratigraphic relationships including unconformity, overlap and diachronism 5 marks up to a maximum of 6	**5**
	Credit: • **diagrams explaining how angular unconformity forms** • **how the filling of a basin leads to overlap** • **explanation that diachronous beds are deposited across time eg as a result of slow marine transgression or regression therefore same bed may contain different zone fossils because it was deposited at different times in different places.**	
	(b) The use of way-up criteria 5 marks up to a maximum of 6	**5**
	Credit: • **correct explanation with or without diagrams of graded bedding, cross bedding, filled voids, sole marks, flute casts etc.**	
	(c) Correlation: how sequences are matched up in different areas, the use of marker horizons and varves 5 marks up to a maximum of 6	**5**
	Credit: • **explanation of correlation based on either rock type or fossil content. Rock correlation allows us to establish they were once physically continuous (beware diachronism). Fossil correlation means that they can be equated in terms of time** • **marker horizons – thin bed of distinctive character – often widely distributed and capable of being recognised and traced over a wide geographical area. Result of either very short episodes of deposition (eg marine band) or almost instantaneous events such as fall of volcanic ash.** • **banded layer of silt and sand deposited annually in lakes, especially near to ice sheets. Pattern of thicknesses of different varves is often distinctive therefore correlations can be made between widely separated deposits.**	
	total marks must not exceed 15	

		Marks
11.	Write an essay on metamorphism.	
	Credit will be given for the use of maps and diagrams	
	Give details as follows.	
	(a) Regional metamorphism mentioning processes, tectonic setting, rock types, structures, metamorphic grades and metamorphic zones 8 marks up to a total of 10	**8**
	• **Colliding plates, crustal compression and thickening may be initially associated with subduction zones. Thickened crust causes heat build up. Pressure and heat combine to change the structure and mineral content of a vast crustal area.** • **Crustal compression will cause crustal shortening producing faults, nappes and thrust faults.** • **Grade describes intensity of metamorphism. As grade increases, rock types, minerals, grain size and rock texture change.** **low : medium : high grade** • **Index minerals chlorite : biotite : garnet** • **Type locality is Scottish southern Highlands (Barrovarian zones).** • **all rocks affected eg** **sandstone, quartzite (metaquartzite), quartz schist, limestone, marbles pelites, slate, phyllite, talc schist, mica schist, garnet mica schist, gneiss, migmatite, basalt, amphibolite, greenschist.**	
	(b) Contact metamorphism around large igneous intrusions 5 marks up to a total of 7	**5**
	• **Low pressure/high temperature causing mineral change. Granitic intrusions aided by volatiles and metasomatism.** • **Temperature declines rapidly away from intrusion.** • **Zone of metamorphosed rock is called an aureole. The larger the intrusion, the larger the aureole (normally).** • **Metamorphic grade increases towards the intrusion.** • **All igneous intrusions can be discussed ie stocks, sills, dykes along with baked and chilled margins.** • **Xenoliths of country rock may be present in the intruded rock showing various stages of metamorphism.** • **Expect mention of metamorphic change eg** **mudstone, spotted rock, hornfels, slate, spotted slate, hornfels, slaty cleavage, foliation disappears, splintery rock, fine grained, medium grained, course grained, minor recrystalisation, total recrystallisation.** • **Possibly reference to economic significance eg hydrothermal veins, skarns in dolomitic limestones etc.**	
	Credit example mentioned – eg Skiddaw Granite, Comrie Diorite	

		Marks
(c)	Dynamic metamorphism 2 marks up to a total of 3 • **Formation of slickensides, polished surface and grooves.** • **Fault breccia, angular fragments of unaltered rock.** • **Thrust fault, shear zone, extreme strain, mylonite, recrystallisation during stress.**	**2**
	Total marks must not exceed 15	

Marks

Section C

All questions in this section should be attempted. Forty marks are allocated to this section.

12. Look at the photograph below of a sedimentary rock.

Choose **two** correct statements from the list below about the structures shown.

A This is found in desert deposits.

B This is found in wind blown deposits.

C This is found in river deposits.

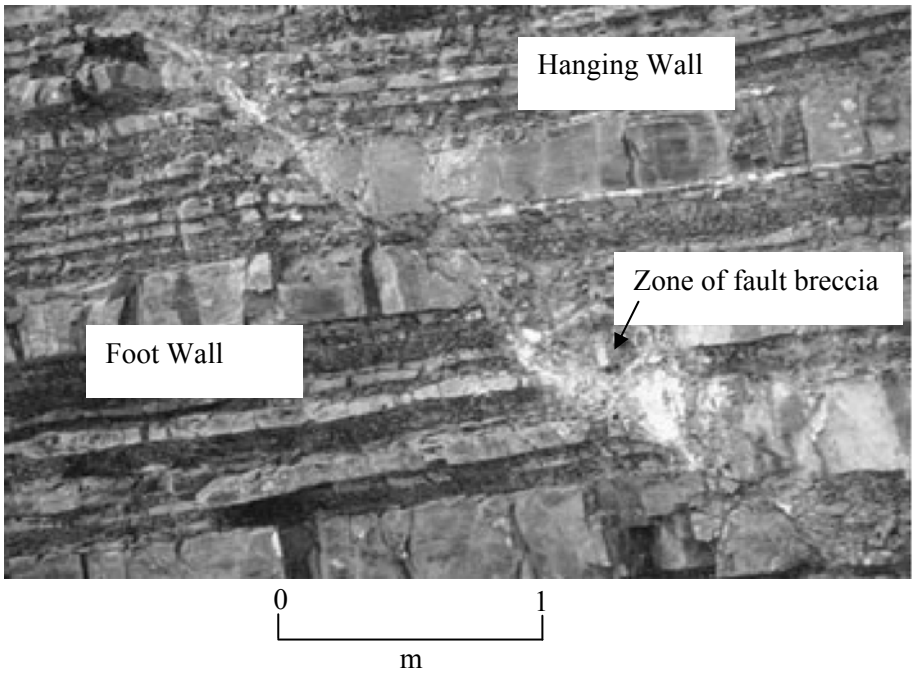
D This is called cross bedding.

E This is called graded bedding.

Give only the letters: **C and E** **2**

Marks

13 Look at the photograph below of a quarry face showing an exposed fault.



(a) Choose **three** correct statements from the list below.

A This type of fault is normally associated with crustal stretching.

B This type of fault is normally associated with crustal compression.

C This is an example of a low angle thrust fault.

D This is an example of a normal fault.

E This is an example of a reverse fault.

F There is a 1 metre displacement along the fault plane.

G There is a 50 cm displacement along the fault plane.

Give only the letters: **B E and G** **3**

(b) Annotate the photograph using the following labels.

- Hanging wall.
- Foot wall.
- Zone of fault breccia. **3**

Marks

14. Examine the photograph below of a volcanic eruption.

Choose **two** correct statements from the list below.

A This sort of eruption is typical of shield volcanoes.

B This sort of eruption is typical of basaltic eruptions.

C This sort of eruption might happen on an andesite volcano.

D This is an example of a nuees ardentes or hot avalanche.

E This is an example of a fissure eruption.

Give only the letters: **C and D** **2**

	Marks

15. Study the map (on the **separate worksheet**) and answer the questions based on it.

(a) How can you tell that the following statements are correct?

(i) Fault F2 is a tear fault.

- **Horizontal displacement of microgranite dykes.** **1**

(ii) Fault F2 is younger than fault F1.

- **Microgranite cuts F1** **1**

(b) There are two unconformities shown on the map. Write the letter "U" on each unconformity on the map.

- **Anywhere between gneiss and limestone and between sed breccia and any rocks below it.** **2**

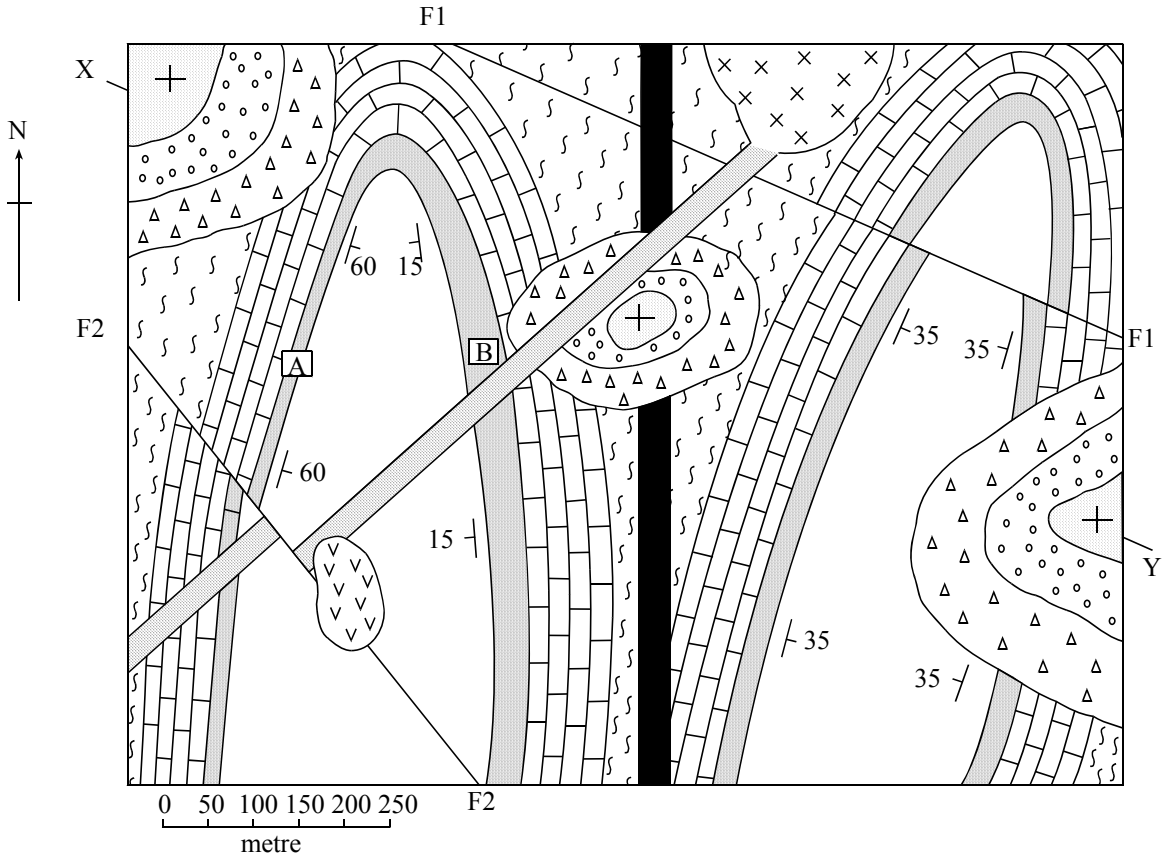
(c) (i) On which side of Fault F1 have the rocks been **upthrown**.

- **S.W.** **1**

(ii) Give a reason for your answer.

- **Reference to width/space between beds/amount of erosion.**
- **Older on upthrown/younger on downthrown.** **1**

(iii) The dolerite dyke continues north of fault F1. Draw the outcrop of the dolerite dyke north of fault F1 on the map on the separate worksheet. **1**



	Marks

(d) Why is the outcrop of the sandstone narrower at **A** than at **B**? Use diagrams in the space below to explain your answer.

Reference to angles of dip

1

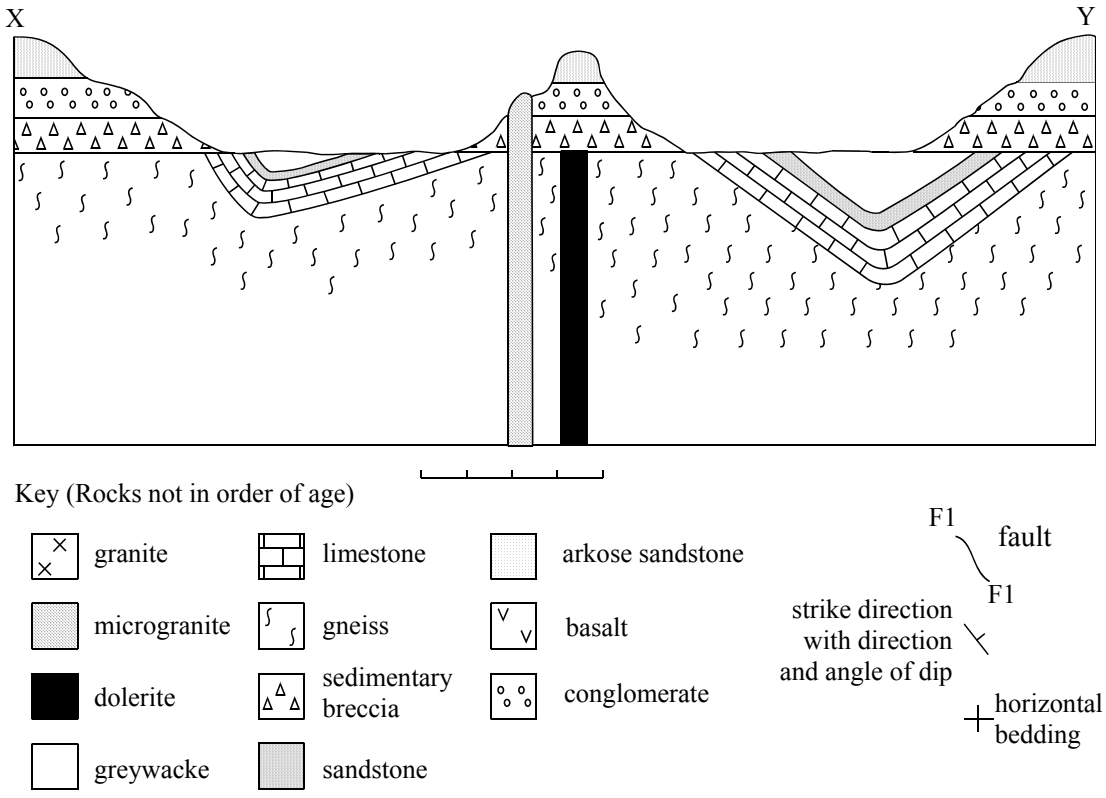
(e) In which direction do the two synclines plunge?

- **South** **1**

(f) By how many metres has fault F2 moved?

- **50 metres** **1**

(g) On the topographic profile, (on the **separate worksheet**), draw a geological section between points X and Y on the map. **3**



2

Marks

(h) Place the geological events of this map area in the correct order by inserting the correct letters from the list below.

The events in this table are not in the correct order.

A gneiss	E dolerite
B basalt	F granite and microgranite intrusion
C folding	G limestone, sandstone, greywacke
D breccia, conglomerate, arkose sandstone	H F2

(Give only the letters)

YOUNGEST

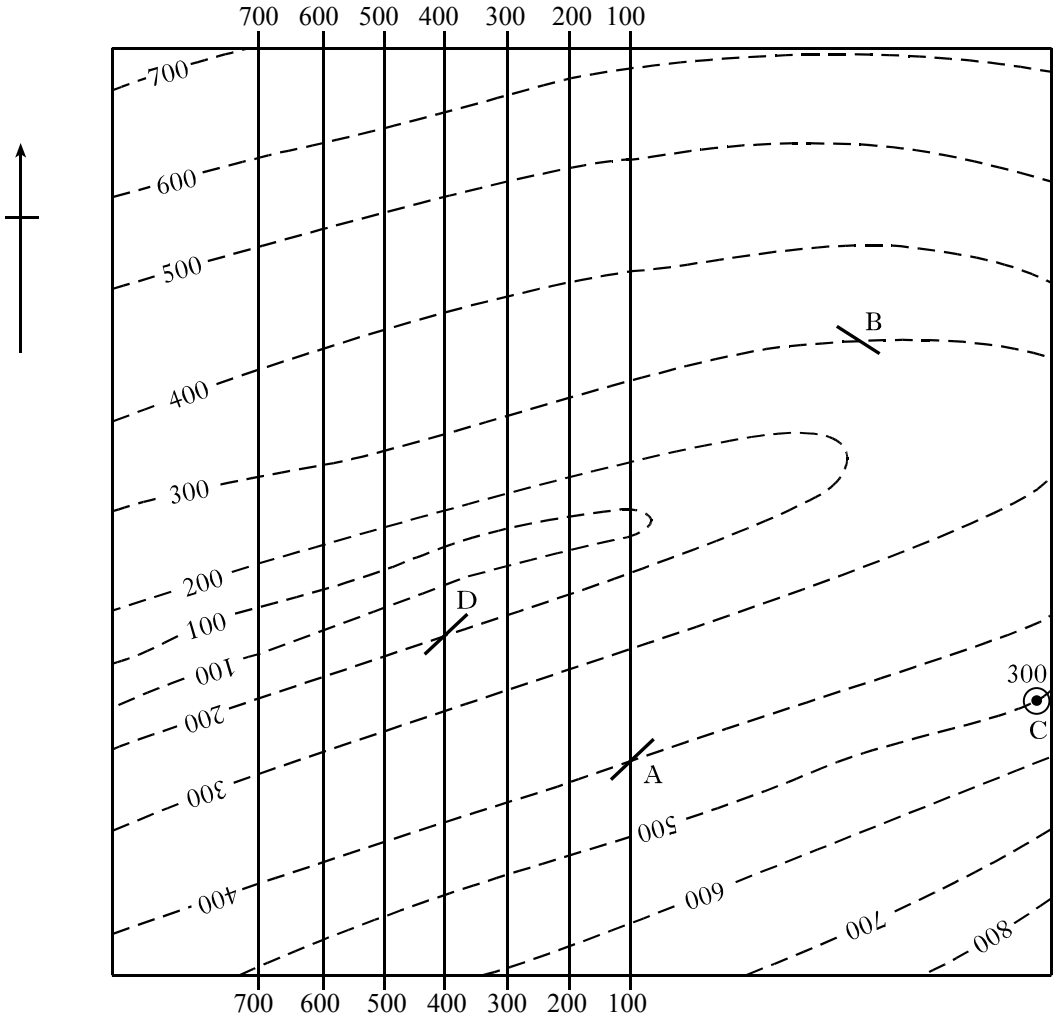
B
H
F
D
E
C
G
A

OLDEST

3

Marks

16. Study the map below then answer the questions on the next page.



Key

Scale
0 1
km

surface contour with height in metres

600

outcrop of coal seam

borehole with depth to coal seam from surface (depth in metres)

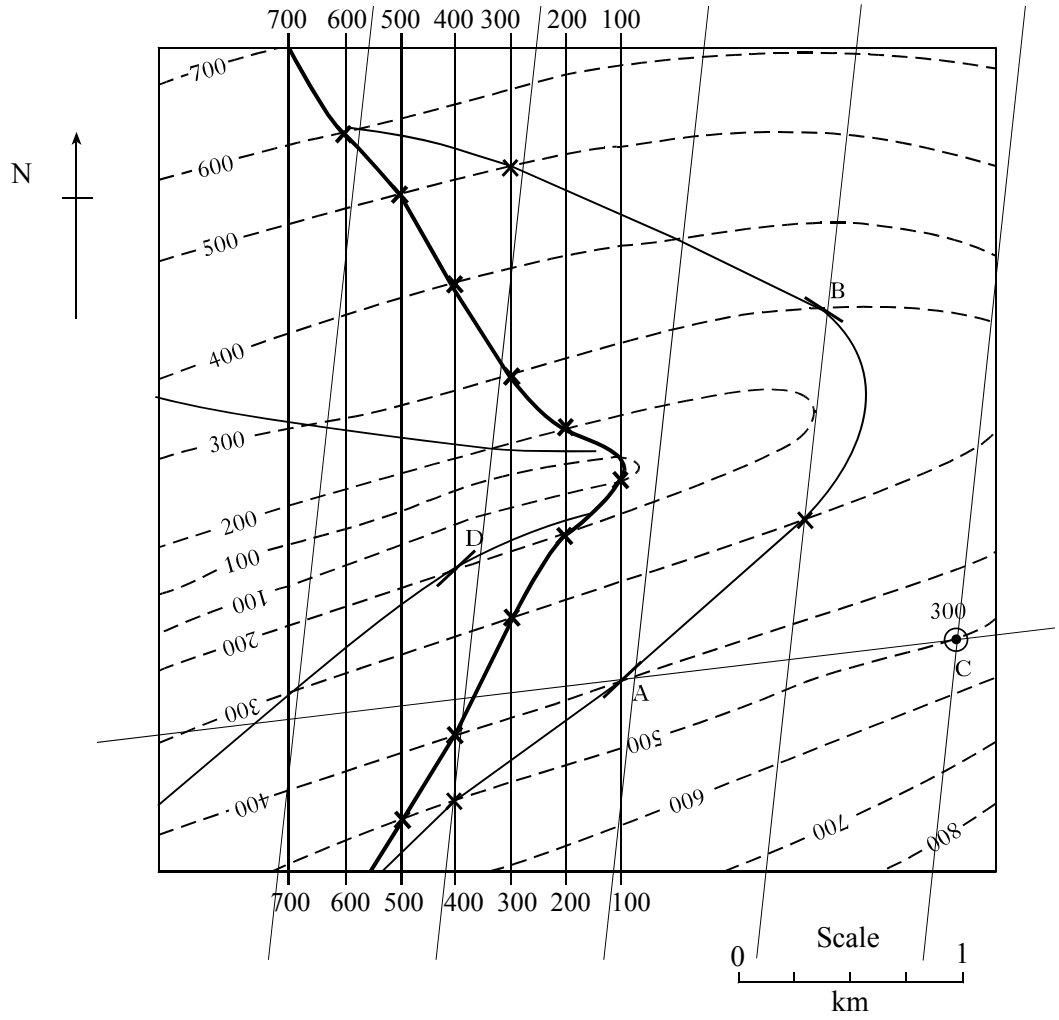
200

structure contour for fault plane with height in metres

200

Marks

(a) Structure contours have already been drawn for a fault plane which crosses this area. Draw in the outcrop of the fault plane, **remembering** that the fault will outcrop **where relief contours cross structure contours** of the same height.



			Marks
(b)	What is the angle and direction of dip of the fault?		
	• **East at 22˚**		
	Space for working		
	$\tan \theta = \frac{100}{250} = \frac{1}{25} = 0 \cdot 4$		**2**
(c)	A coal seam of uniform dip outcrops at A and B. The coal seam is also found in borehole C at a depth of 300 metres below the surface.		
	(i)	Draw and number the structure contours for the coal seam in the area east of the fault.	**3**
	(ii)	Draw the outcrop of the coal seam in the area east of the fault.	**3**
(d)	(i)	The coal seam outcrops at D. Renumber the structure contours west of the fault.	**2**
	(ii)	Draw the outcrop west of the fault.	**2**

[END OF MARKING INSTRUCTIONS]