2010 Geology

Higher

Finalised Marking Instructions

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Marks

Section A

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

1. Use the statement bank below to complete the table at the bottom.

Statement bank

A	Fragmental texture. Grains of quartz and feldspar in a dark red matrix.
B	Coarsely crystalline metamorphic rock with light and dark bands.
C	Glassy texture, dark colour, conchoidal fracture.
D	Contains shell fragments and fizzes in acid.
E	Fine grained, dark coloured, splits easily.
F	Coarsely crystalline, light coloured igneous rock.
G	Coarsely crystalline, dark coloured igneous rock, abundant plagioclase feldspar.
H	Coarsely crystalline, dark green igneous rock, abundant olivine.

Give only the letters.

Name of rock	*Letter*
Gneiss	**B**
Gabbro	**G**
Granite	**F**
Peridotite	**H**
Slate	**E**
Obsidian	**C**
Arkose	**A**
Limestone	**D**

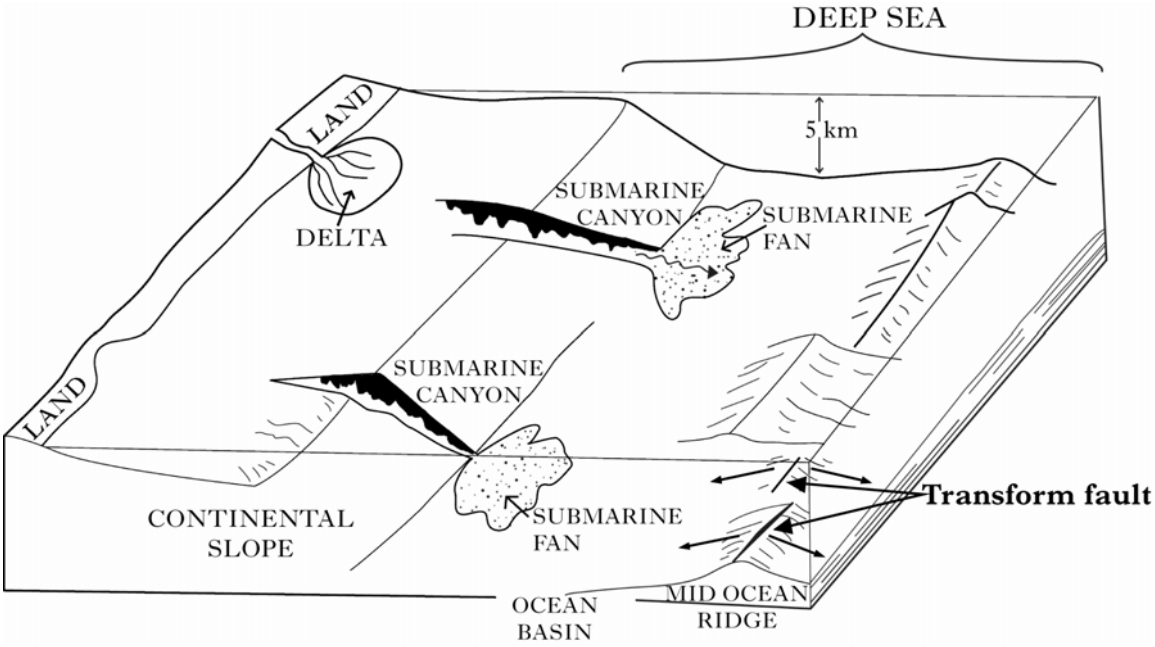
4

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

			Marks
2.	**(a)**	Choose the correct t**hree** statements from the list below.	
		A Most rock forming minerals are silicates.	
		B Feldspar is the most common mineral in the crust.	
		C Quartz has a rigid framework with strong silicon-aluminium bonds.	
		D In micas, the SiO_4 tetrahedra are arranged in sheets and the charges are balanced by calcium and sodium ions.	
		E Silicate minerals formed at low temperatures are stable at the Earth's surface and are most resistant to weathering.	
		F The atomic structures of silicates are unrelated to their crystallisation temperature.	
		Give only the letters **A, B and E**	**3**
	(b)	**Explain** how the ore mineral bauxite AlO(OH) can be formed by the weathering of feldspar $NaAlSi_3O_8$.	
		• **Chemical weathering removes soluble materials, leaving insoluble residual deposit in which aluminium may be concentrated.** • **In hot climates extreme weathering breaks down the silicate minerals completely and alters the alumina to insoluble aluminium oxides.** • **Credit use of term 'laterite'.**	**2**

	Marks

3. Study the diagram below.



(a) Label a transform fault and add arrows to show the direction of movement on each side of this fault. **2**

(b) The correct term given to the coal-bearing sequence of rocks which may form in **the delta** is:

A Cyclothem;

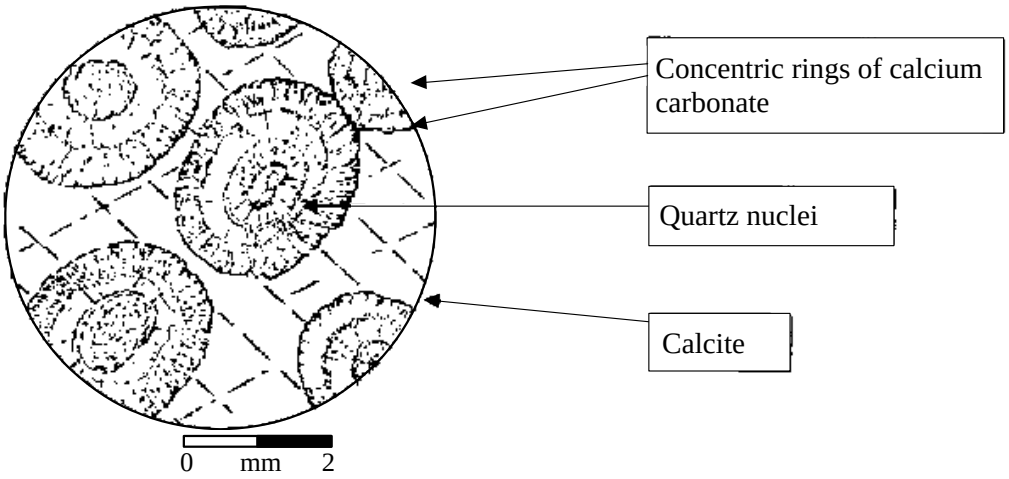
B Varve deposits;

C Banded ironstone;

D Evaporite.

Give only the letter: **A** **1**

			Marks
(c)	The thin section below is of limestone formed in the very shallow tropical water.		



(i) Name this type of limestone.

- **Oolitic Limestone** **1**

(ii) Explain how the rounded structures in this rock were formed.

- **Formed in warm strongly evaporating shallow sea water. Formed from ooids which are spheres of calcium carbonate around 1 mm in diameter. CaCo3 is precipitated as a series of concentric bands on the outside of grains causing them to grow. Wave actions roll them and smooth them.** **2**

(d) **(i)** Name the sedimentary rock which may form from the sediment deposited in the submarine fan.

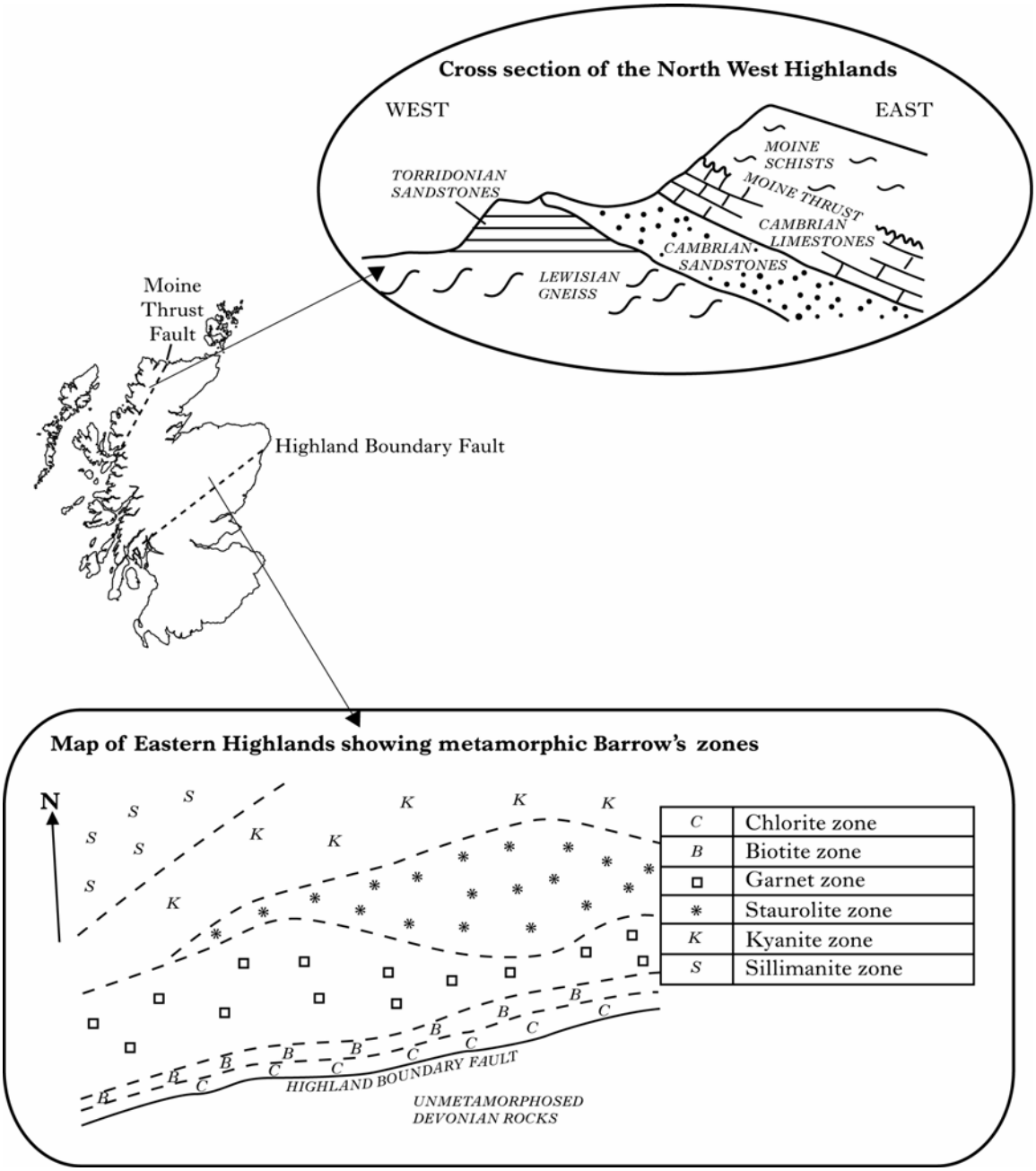
- **Accept greywacke or turbidite** **1**

(ii) List **four** sedimentary structures which are commonly found in such rocks. Choose from the word box below.

Rain prints; sole marks; flute casts; load structures; ripple bedding; graded bedding; mud cracks; varves.

1 **Sole marks**
2 **Flute casts**
3 **Load structures**
4 **Graded bedding** **2**

4. Study the cross section and maps below.



	Marks

4. (continued)

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

A The Moine schists are older than the Cambrian limestones.

B The law of superposition states that in an ascending sequence of strata the youngest rocks are at the bottom and the oldest at the top.

C The Moine Thrust was formed by tensional forces in the earths crust.

D Mylonite is a fine grained flinty rock formed by grinding along a fault plane.

E "Barrow's" metamorphic zones are based on the first appearance of a high grade index mineral.

F The zones indicate a progressively higher grade of metamorphism towards the north west.

G The presence of unmetamorphosed Devonian rocks indicates that contact metamorphism occurred during the Devonian.

H Both biotite and garnet are present in the Biotite Zone.

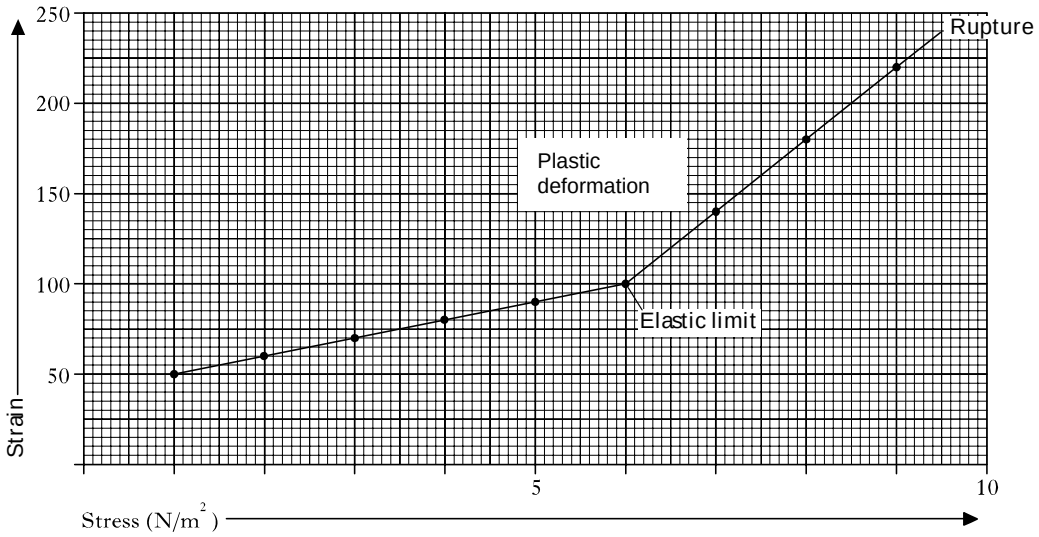
Give only the letters: **A, D, E and F** **4**

Marks

5. Stress and strain were measured for the progressive loading of a length of elastic. The data are recorded and shown in the table below.

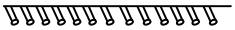
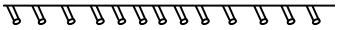
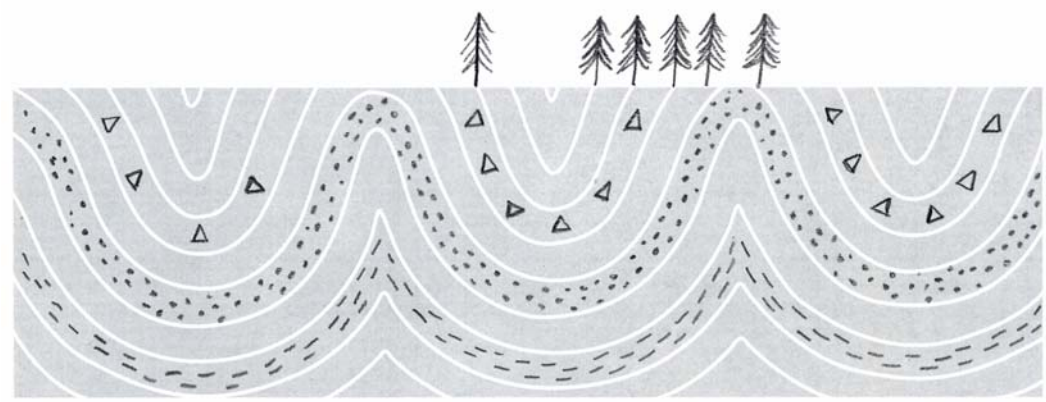
Stress (N/m^2)	*Strain*
1	50
2	60
3	70
4	80
5	90
6	100
7	140
8	180
9	220
10	Elastic snapped

(a) Plot the data on the graph below. **2**



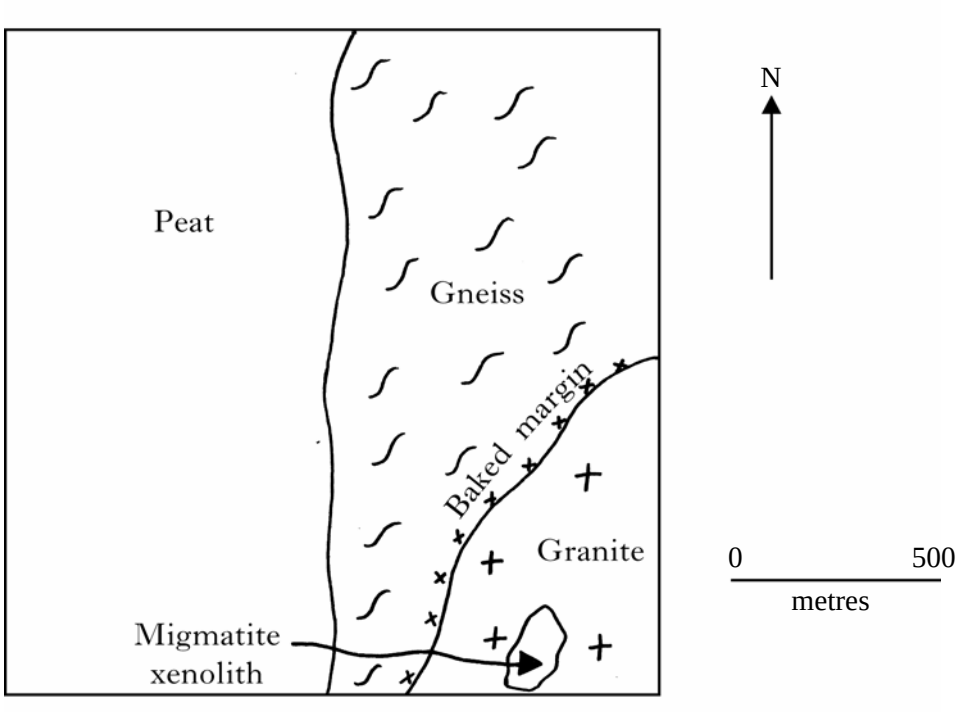
(b) Add labels to the graph to show: **2**

- Elastic limit
- Plastic deformation.

		Marks
(c)	Changes in the length of a linear feature in rocks during deformation are expressed by a measure called percentage extension. Percentage Extension = $\frac{(l - lo)}{lo} \times 100$ Where **lo** is the length of a linear feature before deformation and **l** is the length of the same line after deformation. Percentage extension is commonly expressed as a percentage change in length. Calculate the % extension of the graptolite below. Original length  (actual size) Graptolite after deformation  (actual size) Space for working **60 - 41 = 19** **19/41 × 100 = 46%** } **accept 42% - 50%** Answer **46%**	**2**
(d)	The field sketch below shows an exposed quarry face with parallel folding of the rocks.  Explain the term parallel folding. • **Thickness of layers (measured at right angles to the layers) does not change throughout the fold.**	**1**

Marks

6. The sketch map below shows a fieldwork area.



(a) Laboratory analysis of the gneiss revealed the following amounts of the parent Uranium isotope and the daughter Lead isotope.

Element	*Number of atoms*
Uranium	16
Lead	240

The half life for this decay scheme is 710 Ma.

Calculate the age of the gneiss assuming no lead was originally present.

Space for working

4 half lives have passed 4 x 710 = 2840

Answer **2840** million years **2**

		Marks
(b)	In the western area of the map peat covers the bedrock.	
	(i) How would you date plant or wood fragments in the peat?	
	• **Accept Radiocarbon dating or Carbon 14 dating (accept carbon dating).**	**1**
	(ii) Explain why this technique is suitable for dating wood fragments.	
	• **Short half life (about 5,500 years) makes it applicable to organic material from the last 70k years. When organism dies exchange of carbon with atmosphere ceases and the radiocarbon fixed in the organism decays at the known half-life rate.**	**1**
(c)	The granite was radiometrically dated at 430 Ma. The migmatite xenolith gave two different radiometric ages. **Explain** why.	
	• **Parts of the xenolith may yield different dates. Unaltered part may give same date as gneiss whereas melted part may have involved exchange with granite therefore clock reset to give age of granite.**	
	• **Also, melting would mean that existing radioactive minerals are destroyed and new ones form as xenolith cools ∴ clock restarts ∴ melted part likely to give similar age to granite.**	**1**

Marks

7. The table below gives information about the composition and calorific value of peat and coal.

Fuel	*Composition % weight*		*Calorific value* (kJg-1)
	Carbon	*Other elements*	
Peat	56	44	10
Lignite	73	27	20
Bituminous coal	84	16	30
Anthracite	94	6	34

(a) What relationship exists between rank (percentage carbon) and calorific value?

- **Positive; Calorific value increases from peat through to anthracite.** **1**

(b) Explain **two** processes which may lead to an increase in the rank of coal.

Process 1 **Depth of burial**

Explanation **Pressure and temperature increase which leads to the removal of volatiles**

Process 2 **Regional tectonic deformation**

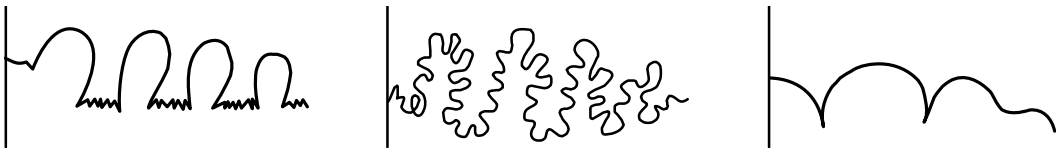
Explanation **Pressure and temperature increase which leads to the removal of volatiles**

Accept also length of burial/igneous activity can drive off volatiles **2**

	Marks

8. Look at the Ammonoid sutures below

(a) Place the sutures in their correct evolutionary order from **oldest** to **youngest**.



A B C

Give only the letters: **C** **A** **B**
oldest youngest **1**

(b) Explain why the Ammonoids are good zone fossils.

- **Widespread**
- **Evolved rapidly**
- **Easily identified**
- **Accept any other valid reason** **2**

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 15, 16, 17 and 18.	
	Additional space for answers may be found at the end of this book.	
9.	Write an essay on minerals.	
	Credit will be given for the use of diagrams and reference to specific minerals.	
	Give details as follows.	
	(a) The identification of minerals in hand specimen	
	Credit reference to: • **hardness** • **lustre** • **colour** • **cleavage** • **streak** • **flame test** • **fracture** • **density** • **any reference to crystallography should be credited.**	
	Award full marks only when specific examples are given of minerals eg Quartz, no cleavage, Micas have one perfect cleavage etc	**5 – 6**
	(b) Optical properties of rock forming minerals under a polarising microscope.	
	Credit reference to: • **pleochroism** • **cleavage** • **angle of cleavage** • **angle of extinction** • **relief, positive/negative/high/low** • **twinning** • **birefringence/double refraction/refraction indices** • **polarisation colours/Newtons scale/orders** • **isotropic/anistrophic** • **Becke line/test** • **opaque**	
	Award full marks only when specific examples are given of minerals eg olivine high relief pyroxene cleavage at 90° in thin section	**6 – 7**

		Marks
(c)	Polymorphism and isomorphism. **Credit reference to:** **Polymorphism – substance which exists in two or more distinct forms – having identical chemical compositions eg calcite and aragonite are polymorphs of calcium carbonate** **Diamond and graphite – carbon atoms arranged differently/strength of bonding** **Isomorphism – substitution of one ion by another in the case of different ions the same ionic radius and change eg** **Fe+2 replaced by Mg+2** **Same form but different** **Al+3 Fe+3** **chemical composition** **Na+3 Ca+2** **Substitution among similarly sized anions eg 0-2 OH-1 and F-1**	**4 – 5** **(15)**
10.	Write an essay on oil. **Credit will be given for the use of diagrams.** Give details as follows.	
(a)	The processes leading to the formation of oil. **Organic origin, partial decomposition in anaerobic conditions of planktonic marine organisms. The presence of plant pigments (porphyrins) suggests petroleum has formed from algae. Petroleum forms at relatively low temperatures (porphyrins) decompose at temperatures around 200 c. Planktonic remains accumulate in low energy environments to form an organic mud (sapropel).**	**2 – 3**
(b)	Stratigraphic and structural traps. **Anticlines Faults Unconformities Salt plugs/domes facies/lateral variation/wedge – edge reefs. Reference should be made to source rocks/reservoir rocks/cap rocks.**	**5 – 6**
(c)	Methods of finding and extracting oil. **Exploration - seismic reflection, aerial photography, magnetic and gravity surveys, drilling (radioactivity + resistivity). Extraction eg North Sea could include production platforms where oil is piped ashore or via tankers. Reference may be made to secondary recovery.**	**5 – 6**
(d)	Why oil reserves fluctuate but oil resources remain more constant. **Reserve figures are subject to frequent alteration eg as exploration and extraction techniques improve and prices change. The term 'reserves' does not represent a fixed quantity. Resources are natural materials and in this case a source of energy we find useful and in finite.**	**3 – 4** **(15)**

		Marks
11.	Write an essay on igneous rock.	
	Credit will be given for the use of diagrams.	
	Give details as follows.	
	(a) The classification of igneous rocks in terms of mineral content and grain size.	
	Silica content acid, intermediate etc related to mineral content. Accept any reference to colour eg melanocratic etc. Grain size course, medium etc. Rates of cooling	**5 – 6**
	(b) Ways in which different types of magma are formed, and their variety of composition.	
	Magmatic differentiation - crystal fractionation. Contamination Mixing of magmas Accept subduction and rising plume with detail about magma generation	**5 – 6**
	(c) Pegmatites and their economic value.	
	Anhydrous minerals from granitic magmas such as feldspar and quartz leave a watery pegmatitic magma rich in metals eg beryllium, caesium, lithium, tin and uranium. The magma crystallises to form a very coarse grained rock which may contain gemstones eg aquamarine and topaz.	**2 – 3**
	(d) The formation of the following characteristics of lavas, amygdales, flow banding, xenoliths.	
	Amygdales - gas holes/vesicles in lava flows in filled with minerals such as calcite after lava has solidified. **Flow banding - frequently found in rhyolites.** **Xenoliths - inclusion of rock fragments into vent and lava flow material.**	**3 – 4** **(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.

(a) Name the structure shown.

- **Ripple marks** **1**

(b) Choose **two** correct statements from the list below about the structure shown.

A Many igneous rocks display these structures.

B This feature is only found in rock formed from ancient desert deposits.

C This feature can be used to indicate the direction ancient rivers flowed.

D This feature is most likely to be found in conglomerate.

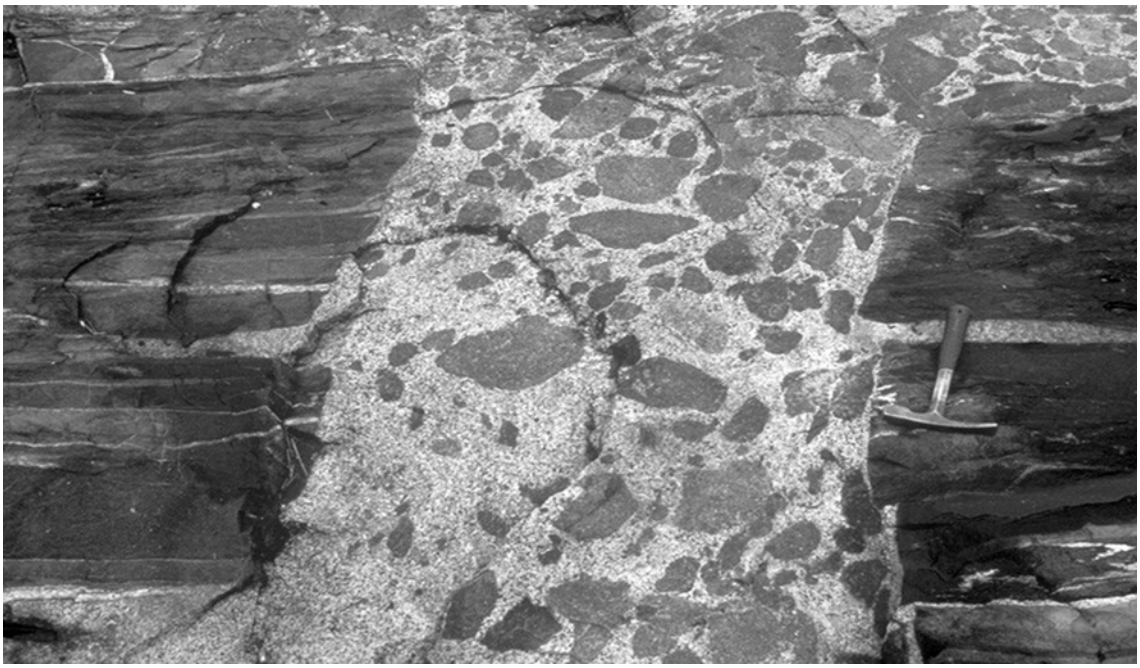
E This feature is most likely to be found in sandstones.

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

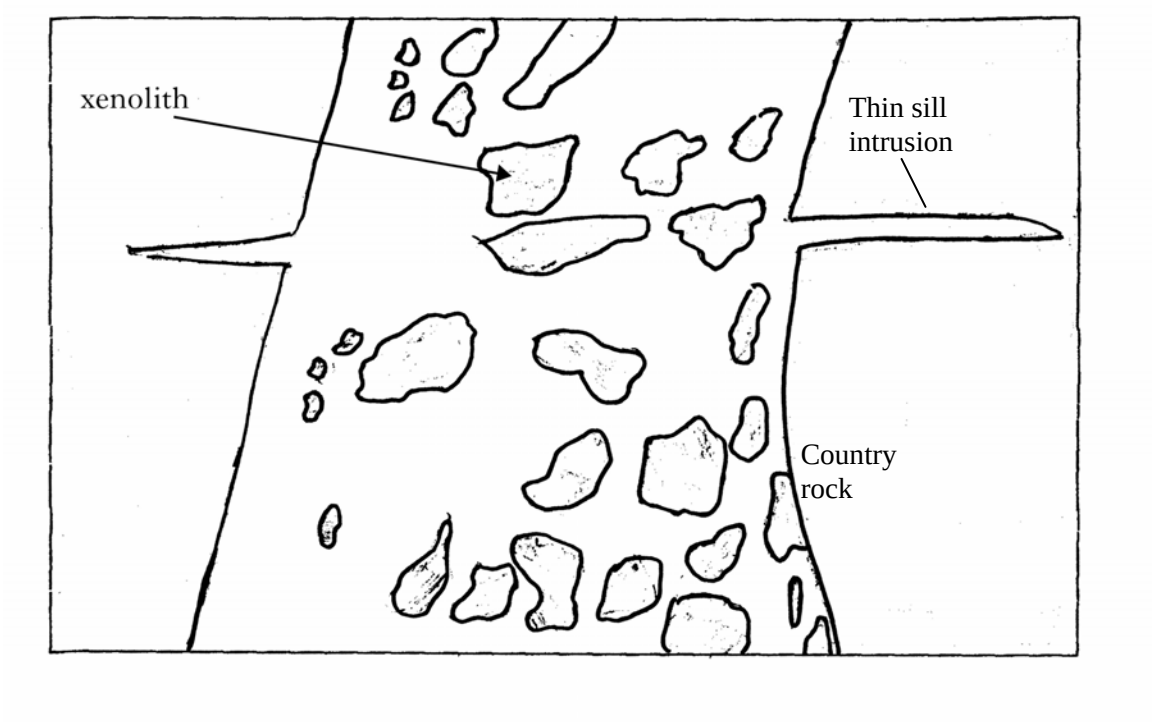
	Marks

13. Look at the photograph and student field sketch below.

Photograph of a dyke intrusion



Field sketch of the dyke intrusion



(a) Label the field sketch using the terms provided. **3**

xenolith country rock thin sill intrusion

		Marks
(b)	How can you tell that the dyke intrusion was formed from a granitic magma?	
	• **Light colour indicates few minerals containing magnesium and iron.**	**1**
(c)	This sketch shows what this area will look like after many years of weathering and erosion.	

Explain why the dyke will form higher ground than the surrounding rock.

- **Igneous rock is often harder/resists weathering better than other rocks.**
- **Country rock appears to have bedding suggesting sedimentary, this is normally less able to resist erosion than igneous rock.** **1**

			Marks
14.	Study the map (on the **separate worksheet**) and answer the questions based on it.		
(a)	**(i)**	Which **one** of the following statements correctly describes the movement of the rocks on the north west side of **fault F1**. A They have been moved vertically upwards. B They have been moved vertically downwards. C They have been moved to the south west. D They have been moved to the north west. Give only the letter: **A**	**1**
	(ii)	Explain your choice. • **Anticline outcrop pattern is wider indicating it has suffered more erosion.**	**1**
(b)	**(i)**	What type of fault is F2? • **Tear fault/shear fault.**	**1**
	(ii)	Give a reason for your answer. • **Vertical dyke displacement horizontal. Sedimentary beds unchanged.**	**1**
(c)		Place an "S" on the map where slickensides would be found. **Accept anywhere along F1 or F2.** **"The surface of a fault plane may be polished to form slickensides"**	**1**
(d)		Which **three** of the following statements are correct? A Two unconformities are shown B Three unconformities are shown. C Fault F2 cuts through the granite. D The dip of the breccia and conglomerate has been altered by the intrusion of the granite. E The dolerite dyke is younger than the breccia. F The dolerite dyke is older than the breccia. G The breccia has been deposited on a sloping hillside of the granite. H The granite is older than the dolerite dyke. I Fault F2 has moved in different directions, at different times. J Fault F1 is a tear fault. Give only the letters: **A, D and F**	**3**

Marks

(e) On the topographic profile (on the **separate worksheet**), complete the geological section between points X and Y on the map. **7**

(f) 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	Deposition of greywacke and shale unconformibly on schist
B	Intrusion of dolerite dyke
C	Intrusion of granite
D	Deposition of breccia and conflomerate
E	Faulting on F2
F	Formation of schist
G	Folding of greywacke and shale

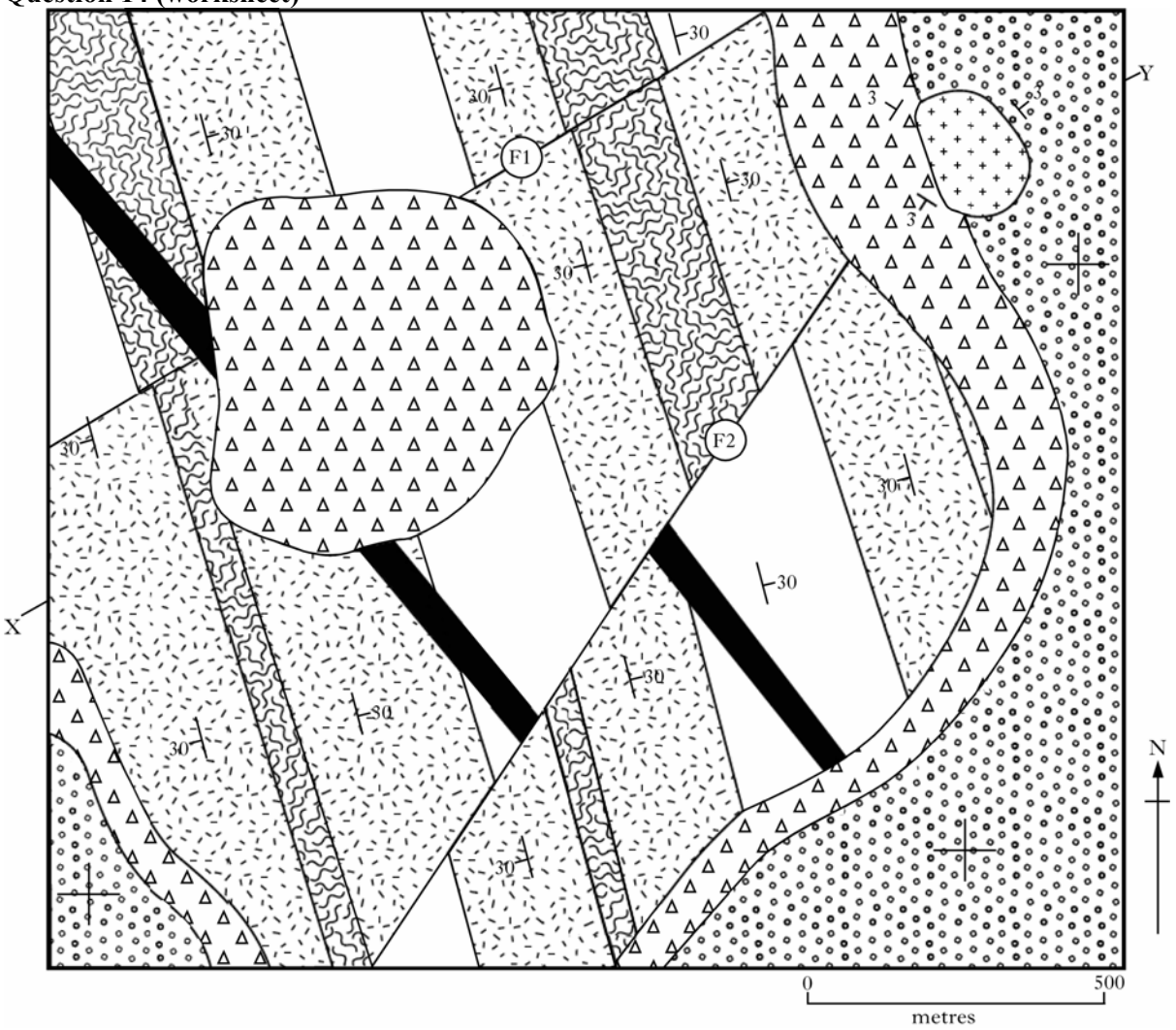
(Give only the letters)

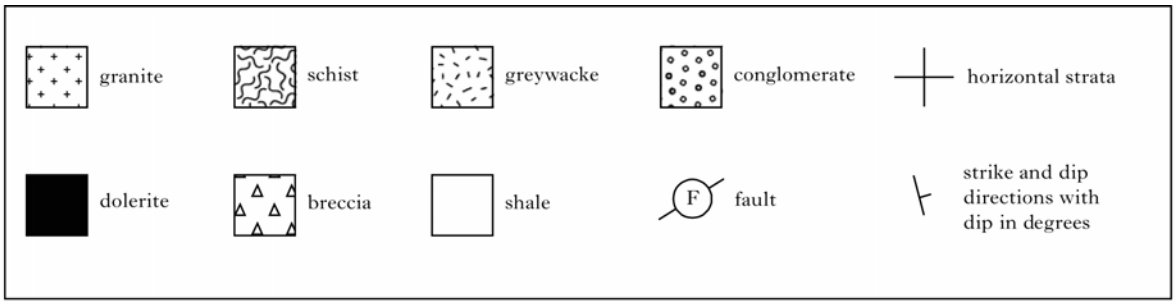
YOUNGEST

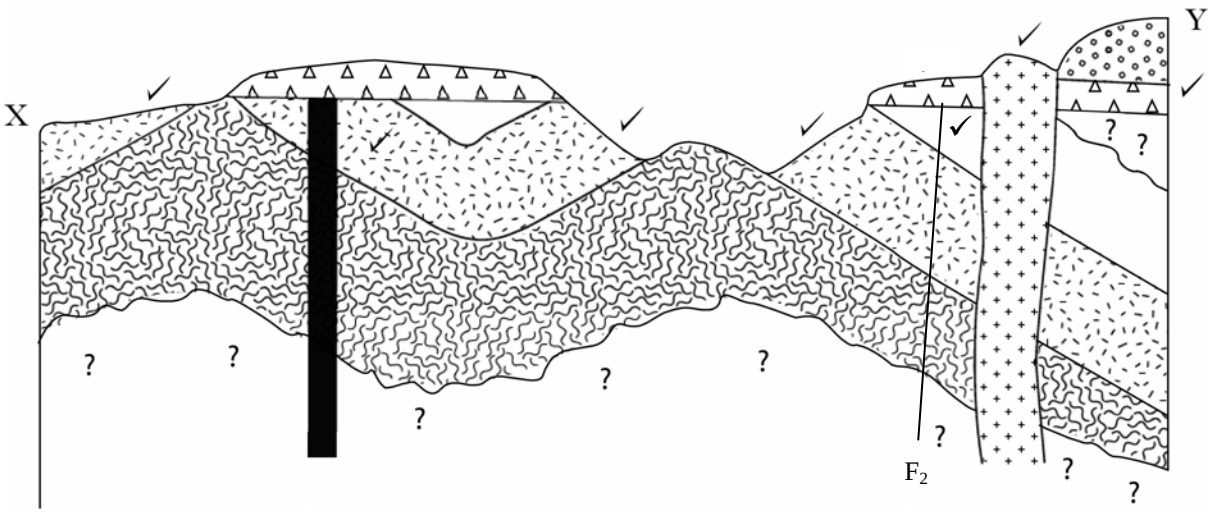
C
D
E
B
G
A
F

OLDEST **3**

Question 14 (worksheet)

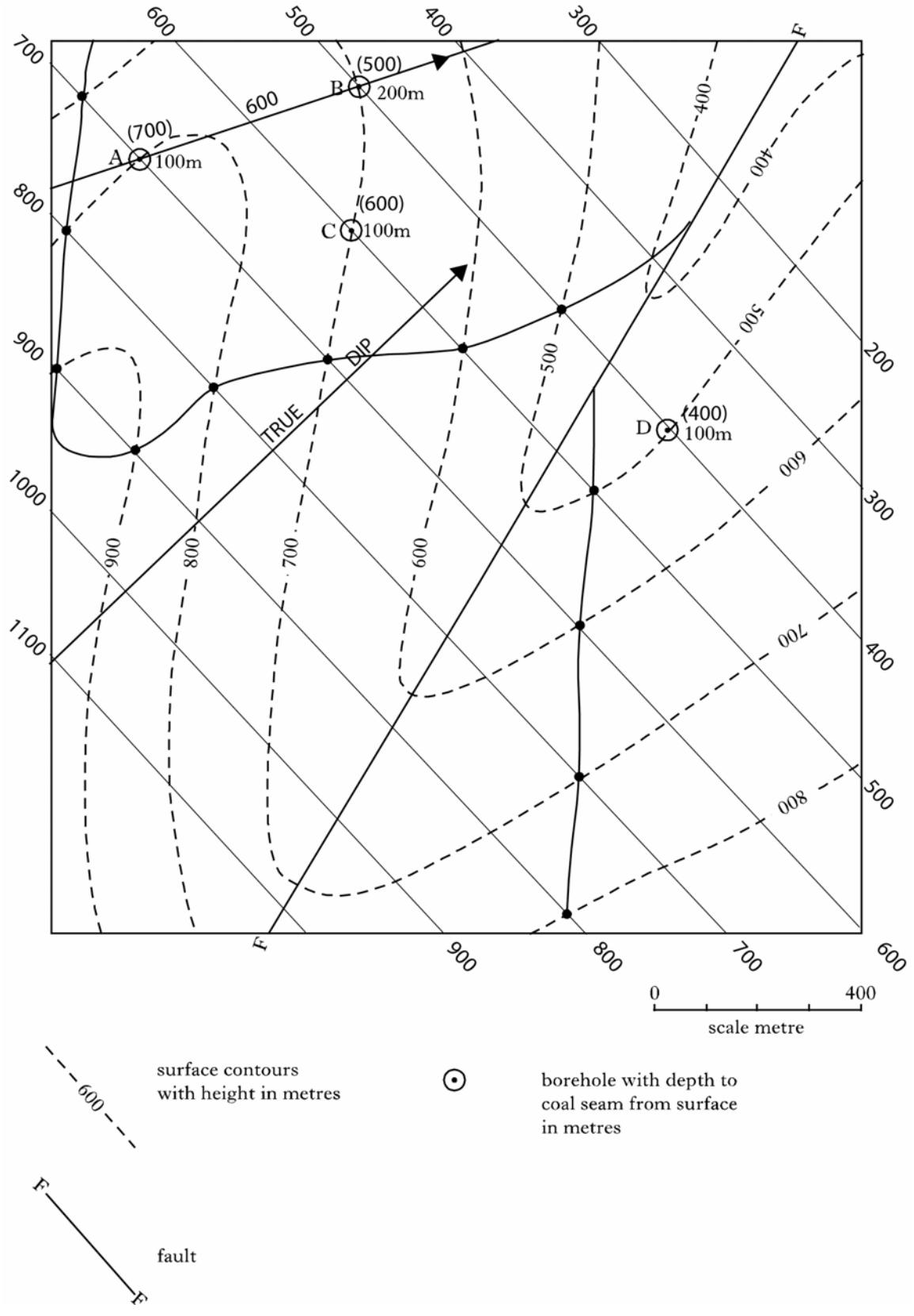






15. Study the map below then answer the questions on the next page.

A constantly dipping coal seam occurs in boreholes A, B C and D at the **depths** shown.



			Marks
(a)	Calculate the heights of the coal seam in boreholes A, B and C. Use these to draw structure contours for the coal seam **across the whole map**. Label the heights of the structure contours **north west** of the fault.		**4**
(b)	Draw the outcrop of the coal seam **north west** of the fault.		**2**
(c)	**(i)**	In which direction does the coal seam dip?	
		• **North east**	**1**
	(ii)	At what angle does the coal seam dip?	
		Space for working	
		tan θ = $\frac{100}{200} = 0 \cdot 5$	
		25° ⟶ **27°**	**1**
(d)	Use borehole D to number the structure contours to the **south east** of the fault.		**2**
(e)	Draw the outcrop of the coal seam to the **south east** of the fault.		**2**
(f)	**(i)**	On which side of the fault have the rocks been downthrown?	
		• **South east**	**1**
	(ii)	By how many metres have the rocks been downthrown?	
		• **100 metres**	**1**

[END OF MARKING INSTRUCTIONS]