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Total

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X043/301

NATIONAL
QUALIFICATIONS
2010

THURSDAY, 20 MAY
1.00 PM – 3.30 PM

GEOLOGY
HIGHER

Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Date of birth

Day Month Year

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Scottish candidate number

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Number of seat

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1. This paper consists of three sections A, B and C. You are advised to spend about 1 hour on Section A, half an hour on Section B and 1 hour on Section C.
2. You should attempt **all** of the questions in Sections A and C and only **one** question in Section B.
3. All answers should be written in the spaces provided in this answer book and should be written clearly and legibly in ink.
4. The marks allocated to each question or part of a question are shown at the end of each question or part of a question.
5. Additional space for answers or rough work will be found at the end of this book. If further space is required, supplementary sheets may be obtained from the Invigilator and should be inserted inside the **front** cover of this booklet. You should draw a line through anything which you do not wish the examiner to mark.
6. Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.



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.

<i>Name of rock</i>	<i>Letter</i>
Gneiss	
Gabbro	
Granite	
Peridotite	
Slate	
Obsidian	
Arkose	
Limestone	

Marks

2. (a) Choose the correct **three** 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.
- G All rock forming minerals are silicates.
- H Silicate minerals formed at high temperatures are not stable at the Earth's surface but are very resistant to weathering.

Give only the letters:, and

3

(b) **Explain** how the ore mineral bauxite $\text{AlO}(\text{OH})$ can be formed by the weathering of feldspar $\text{NaAlSi}_3\text{O}_8$.

.....

.....

.....

.....

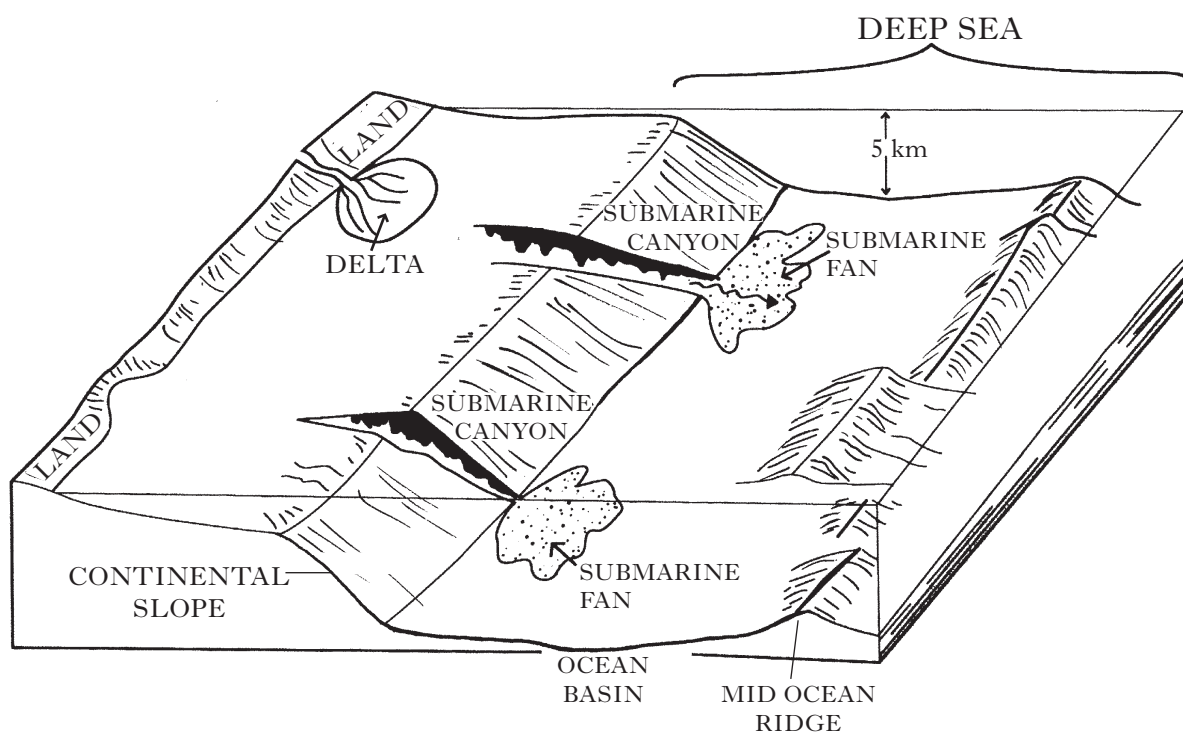
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2

[Turn over

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.

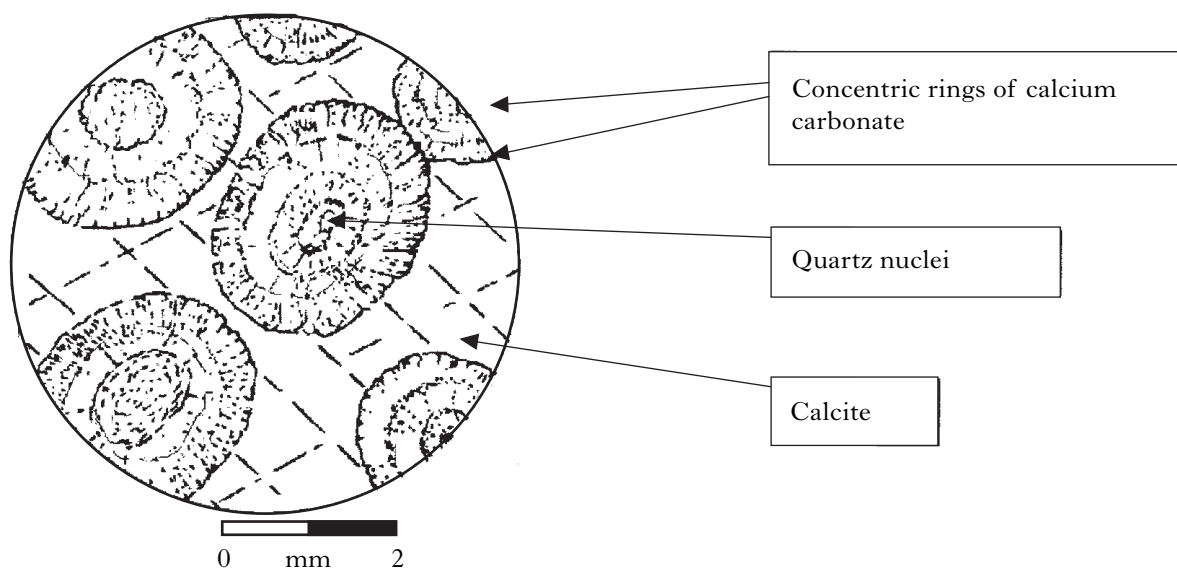
Give only the letter:

1

Marks

3. (continued)

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



(i) Name this type of limestone.

.....

1

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

.....

2

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

.....

1

(ii) List **two** sedimentary structures which are commonly found in such rocks.

Choose from the word box below.

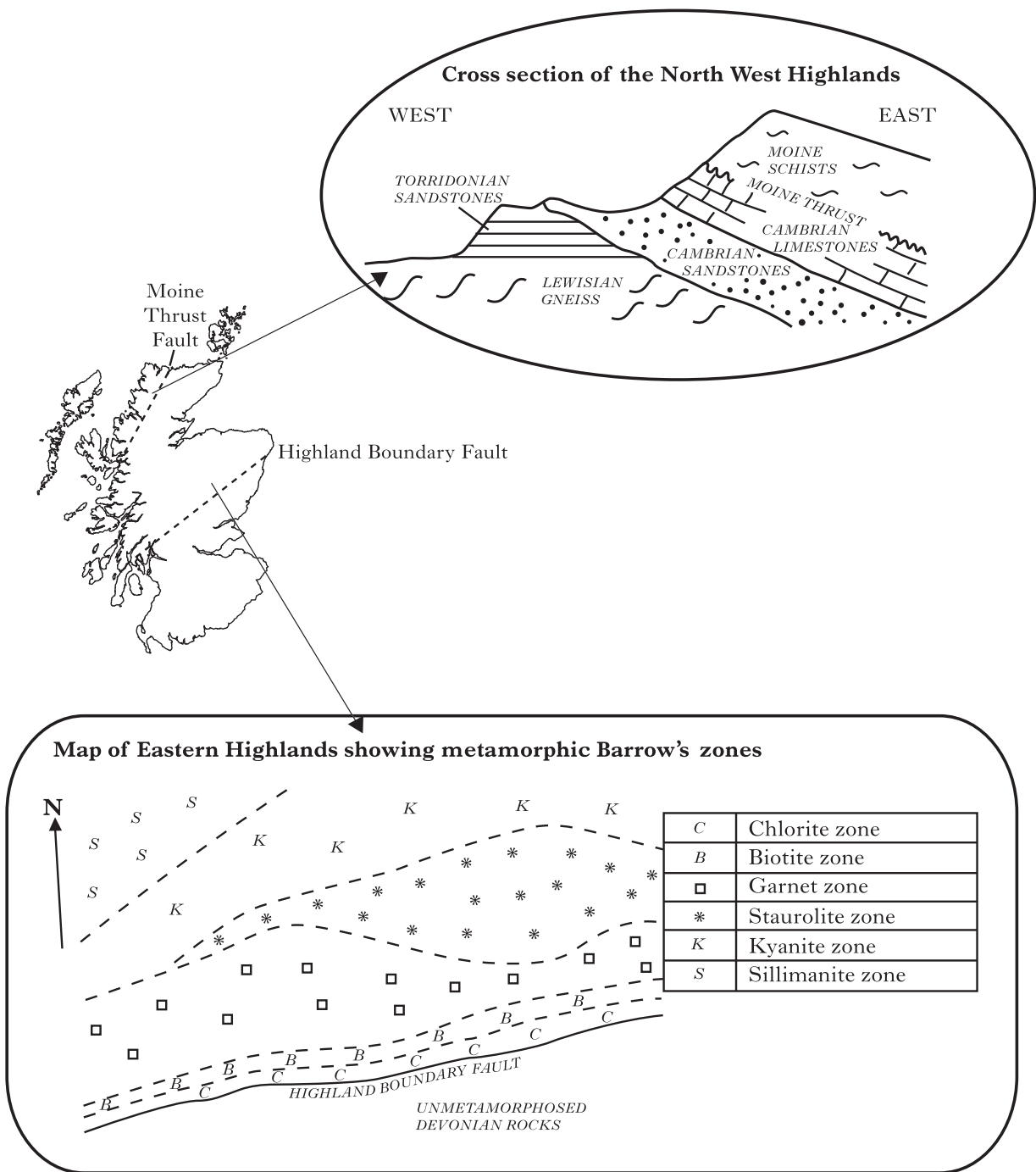
Rain prints; sole marks; flute casts; load structures; ripple bedding; graded bedding; mud cracks; varves.

1

2

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 Earth's 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.
- I Mylonite is more likely to be associated with the Highland Boundary Fault rather than the Moine Thrust Fault.
- J The index minerals found in Barrow's zones are always the most commonly found minerals in these rocks.

Give only the letters:,, and

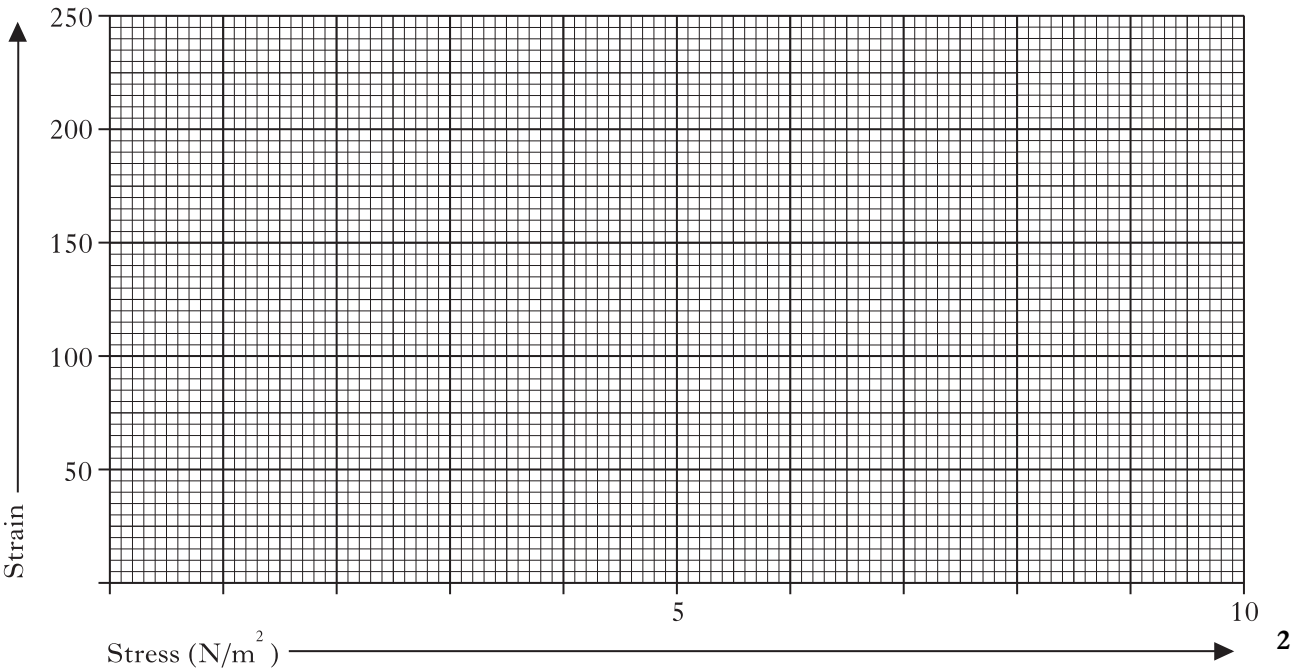
4**[Turn over**

Marks

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

<i>Stress</i> (N/m ²)	<i>Strain</i>
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.



- (b) Add labels to the graph to show:
- elastic limit
 - plastic deformation.

2

Marks

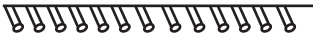
5. (continued)

- (c) Changes in the length of a linear feature in rocks during deformation are expressed by a measure called percentage extension.

$$\text{Percentage extension} = \frac{(l - l_o)}{l_o} \times 100$$

Where l_o is the length of a linear feature before deformation and l is the length of the same line after deformation.

Calculate the % extension of the graptolite below.

Original length  (actual size)

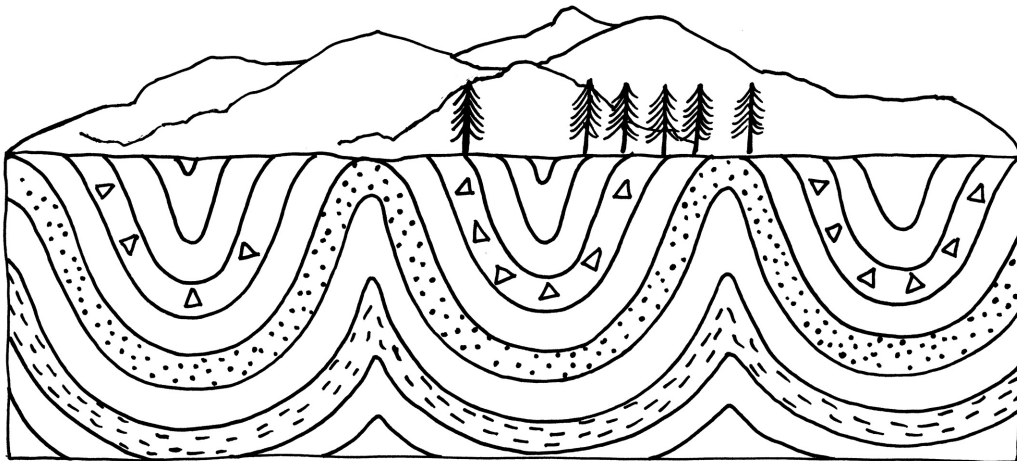
Graptolite after deformation  (actual size)

Space for working

Answer %

2

- (d) The field sketch below shows an exposed quarry face with parallel folding of the rocks.



Explain the term parallel folding.

.....

.....

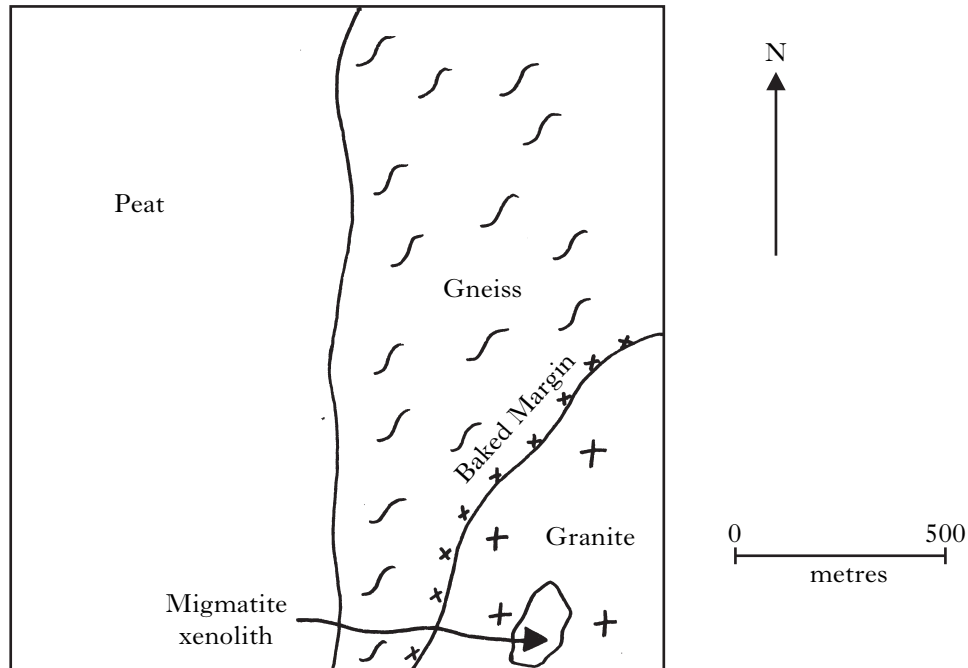
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1

[Turn over

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.

<i>Element</i>	<i>Number of atoms</i>
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

Answer million years

2

Marks

6. (continued)

(b) In the western area of the map, peat covers the bedrock.

(i) How would you date plant or wood fragments in the peat?

.....

1

(ii) **Explain** why this technique is suitable for dating wood fragments.

.....

.....

.....

1

(c) The granite was radiometrically dated at 430 Ma. The migmatite xenolith gave two different radiometric ages. **Explain** why.

.....

.....

.....

1

[Turn over

Marks

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

<i>Fuel</i>	<i>Composition % weight</i>		<i>Calorific value</i> (kJ g ⁻¹)
	<i>Carbon</i>	<i>Other elements</i>	
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?

.....
 1

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

Process 1

Explanation

Process 2

Explanation

 2

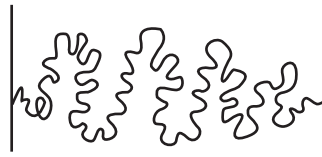
Marks

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:,,
oldest youngest

1

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

.....

.....

.....

.....

2

Section A: Total (40) marks

[Turn over

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 | 5 |
| (b) Optical properties of rock forming minerals under a polarising microscope | 6 |
| (c) Polymorphism and isomorphism | 4 |
| | (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 | 2 |
| (b) Stratigraphic and structural traps | 5 |
| (c) Methods of finding and extracting oil | 5 |
| (d) Why oil reserves fluctuate but oil resources remain more constant | 3 |
| | (15) |

- 11.** Write an essay on igneous rocks.

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 | 5 |
| (b) Ways in which different types of magma are formed, and their variety of composition | 5 |
| (c) Pegmatites and their economic value | 2 |
| (d) The formation of the following characteristics of lavas: amygdales, flow banding, xenoliths | 3 |
| | (15) |

Section B: Total (15) marks

NOW GO TO SECTION C ON PAGE NINETEEN

SPACE FOR ANSWERS

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SPACE FOR ANSWERS

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SPACE FOR ANSWERS

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SPACE FOR ANSWERS

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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.

.....

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: and

2

[Turn over

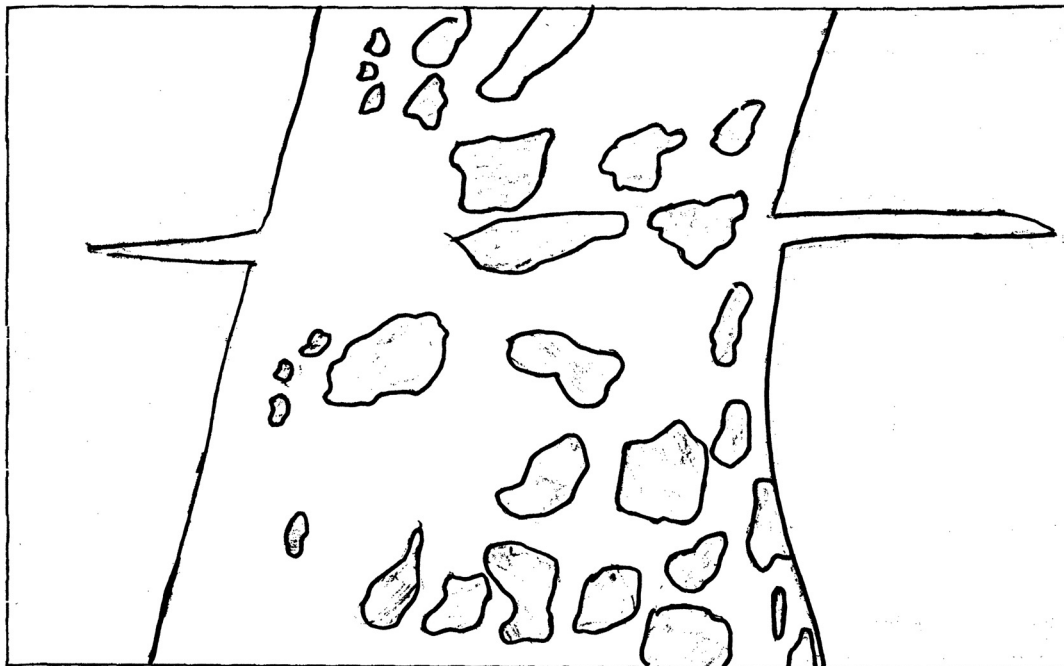
Marks

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

Photograph of a dyke intrusion



Field sketch of the dyke intrusion



Marks

13. (continued)

- (a) Label the field sketch using the terms provided.

xenolith

country rock

thin sill intrusion

3

- (b) How can you tell that the dyke intrusion was formed from a granitic magma?

.....

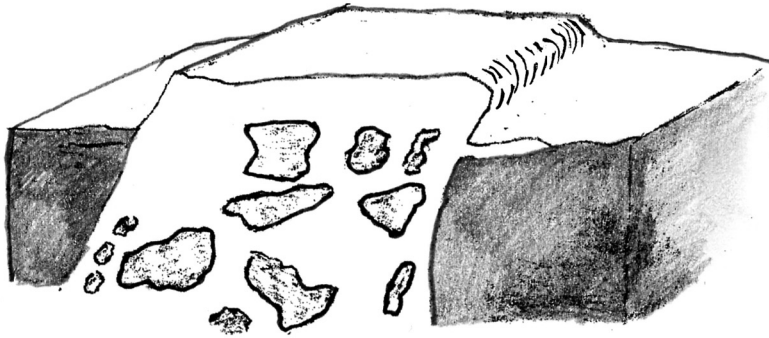
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.....

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.

.....

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1

[Turn over

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:

1

- (ii) **Explain** your choice.

.....
.....
.....

1

- (b) (i) What type of fault is F2?

.....

1

- (ii) Give a reason for your answer.

.....
.....
.....

1

- (c) Place an “S” on the map where slickensides would be found.

1

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

- A Two unconformable relationships are present.
- 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:, and

3

Marks

14. (continued)

- (e) On the topographic profile, (on the **separate worksheet**), complete the geological section between points X and Y on the map.
- (f) Place the geological events of this map area in the correct order by inserting the correct letters from the list below.

7

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

A	Deposition of greywacke and shale unconformably on schist
B	Intrusion of dolerite dyke
C	Intrusion of granite
D	Deposition of breccia and conglomerate
E	Faulting on F2
F	Formation of schist
G	Folding of greywacke and shale

Give only the letters

YOUNGEST

B

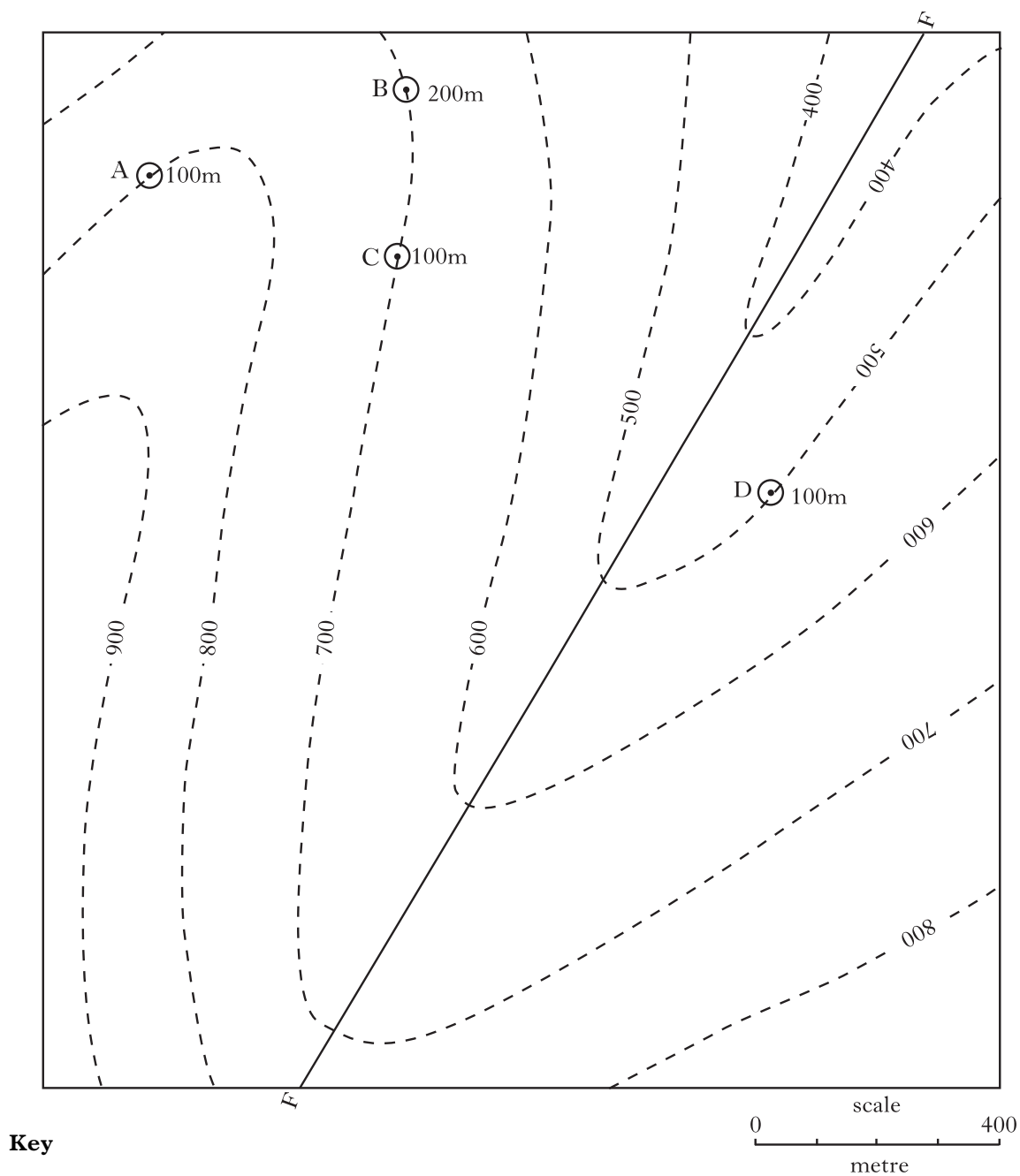
OLDEST

3

[Turn over

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.



Key

0 scale 400
metre

--- 600 ---
surface contours
with height in metres

⊙ borehole with depth to
coal seam from surface
in metres

F
fault
N
North

Marks

15. (continued)

- (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?

.....

1

- (ii) At what angle does the coal seam dip?

Space for working

.....

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?

.....

1

- (ii) By how many metres have the rocks been downthrown?

.....

1

Section C: Total (40) marks

[END OF QUESTION PAPER]

SPACE FOR ANSWERS OR FOR ROUGH WORK

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SPACE FOR ANSWERS OR FOR ROUGH WORK

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2010

THURSDAY, 20 MAY
1.00 PM – 3.30 PM

**GEOLOGY
HIGHER**
Worksheet for Question 14

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

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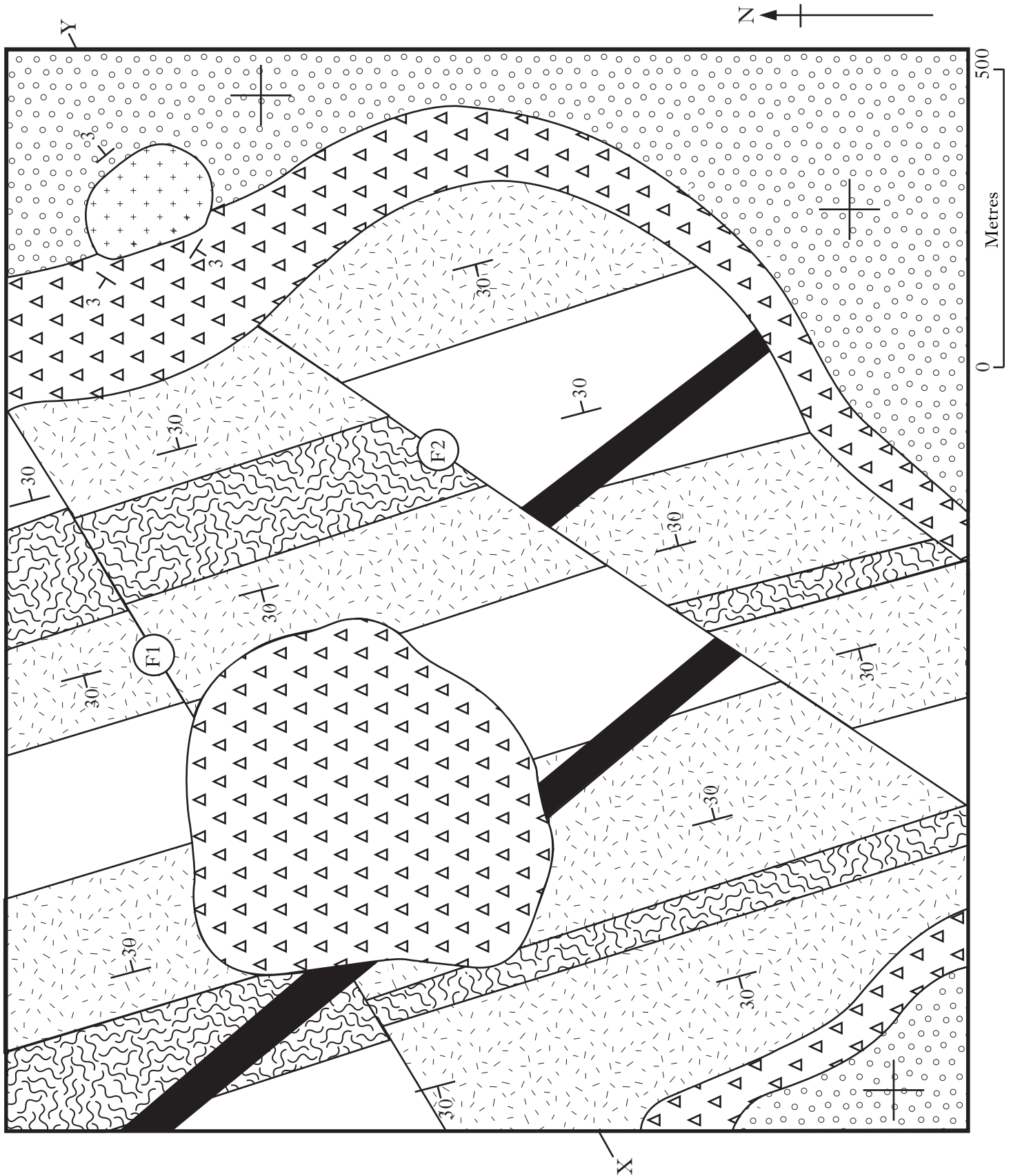
Scottish candidate number

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Number of seat

To be inserted inside the front cover of the candidate's answer book and returned with it.

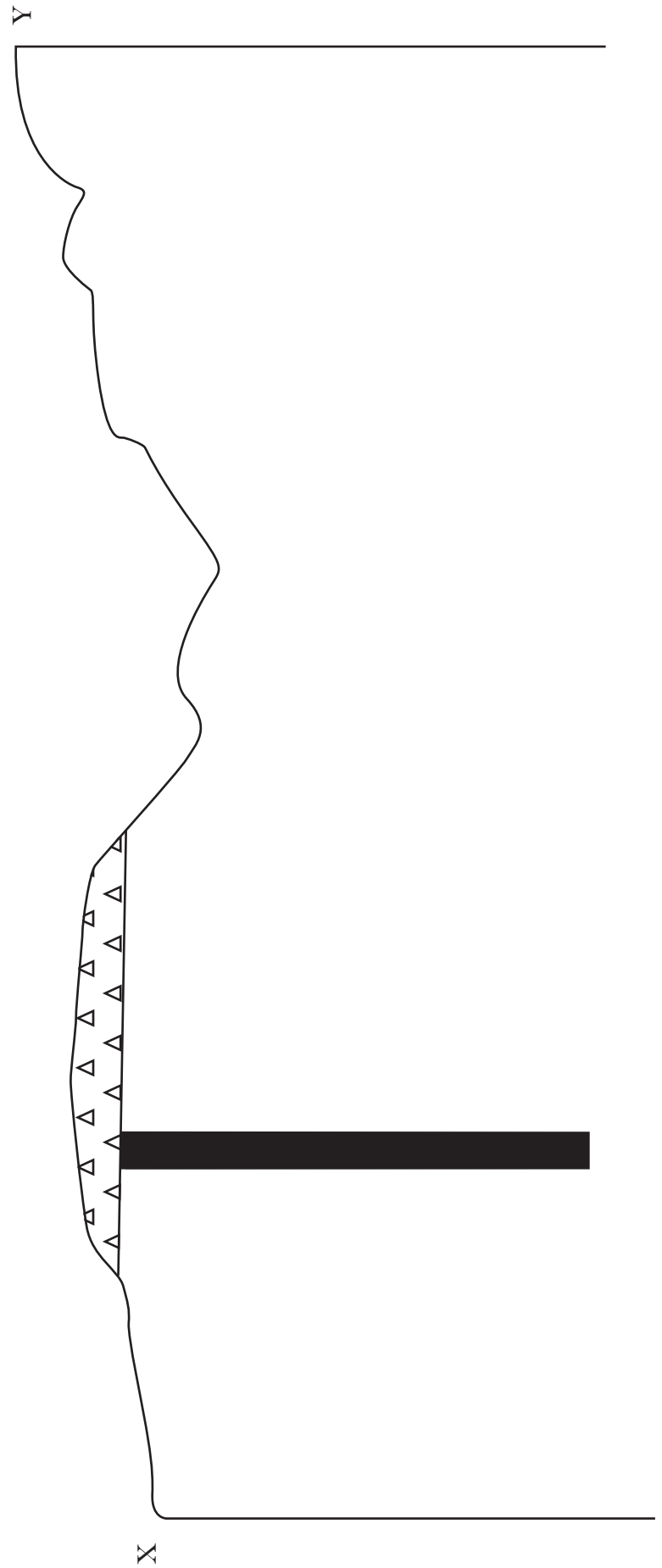




Key (Rocks not in order of age)

	granite		schist		greywacke		conglomerate		horizontal strata
	dolerite		breccia		shale		fault		strike and dip directions with dip in degrees

Figure Q14(e)



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