GCE A level

1214/01

GEOLOGY – GL4

Interpreting The Geological Record

A.M. MONDAY, 8 June 2015

2 hours plus your additional time allowance

Surname ______________________________

Other Names ______________________________

Centre Number ______________________________

Candidate Number 2 ______________________________

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	1.	14	
	2.	16	
	3.	15	
	4.	15	
Section B	5.	9	
	6.	9	
	7.	9	
	8.	13	
	Total	100	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- the Geological Map Extract (Malmesbury);
- a hand-lens or magnifier to study the map (optional);
- a calculator;
- a protractor.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

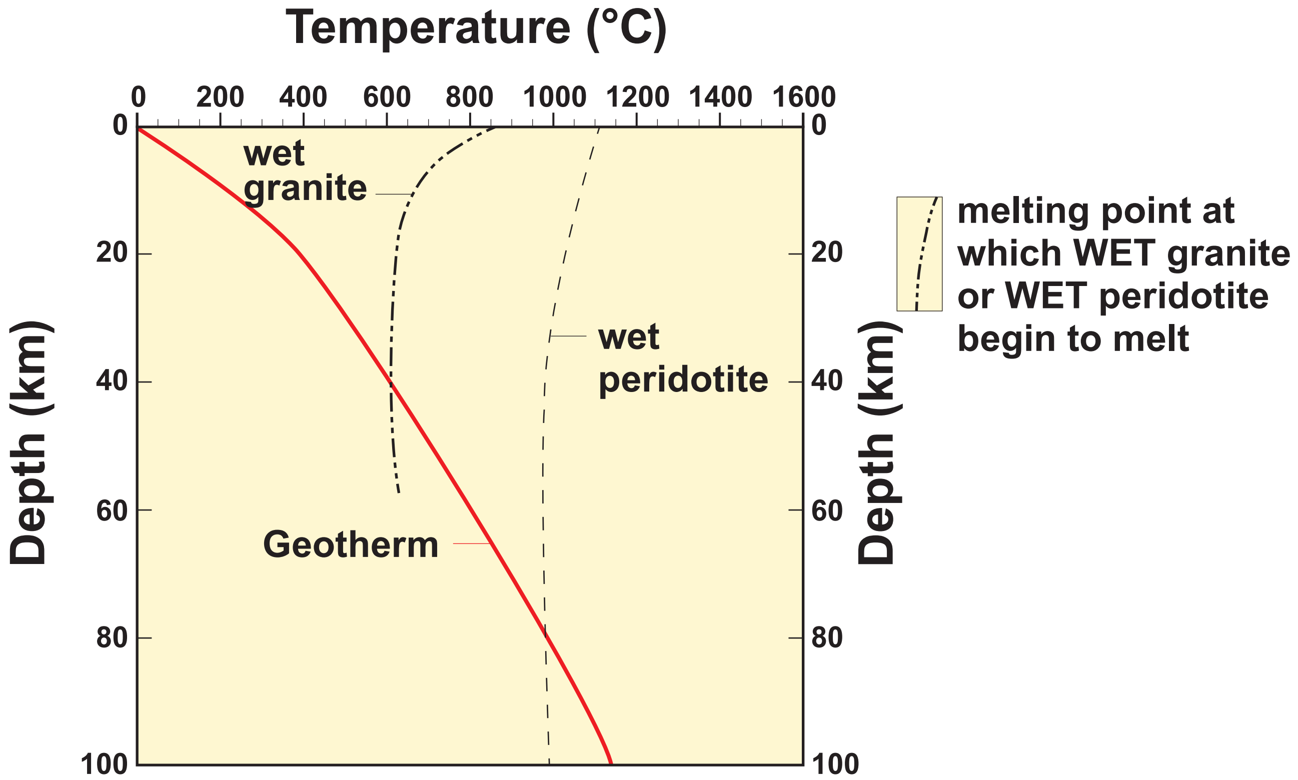
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Candidates are reminded that marking will take into account the quality of communication used in their answers.

FIGURE 1a


Temperature (°C)
0
200
400
600
800
1000
1200
1400
1600
0
20
40
60
80
100
Depth (km)
wet
granite
wet
peridotite
Geotherm
melting point at
which WET granite
or WET peridotite
begin to melt

SECTION A

Answer ALL questions in the spaces provided.

This section should take approximately 1 hour to complete.

1. **FIGURE 1a opposite is a temperature/depth diagram showing the geothermal gradient associated with a continent, together with the melting point curves for WET granite and WET peridotite, obtained from laboratory experiments.**

Refer to FIGURE 1a.

(a) (i) Complete the table below by stating the following predicted temperatures and depths in the crust and mantle. [3]

Temperature/depth	Temp (°C)	Depth (km)
Temperature of the continental crust at 30 km depth	•	30
Predicted depth at which WET granite would begin to melt	600	•
Predicted temperature at which WET peridotite would begin to melt	•	80

1(a) (ii) Calculate the average geothermal gradient for the top 20 km of the continental crust (°C km^{-1}). Show your working. [2]

Geothermal gradient = ___________ °C km^{-1}

(b) FIGURE 1b opposite is a section across a convergent plate boundary showing the variation in temperature (isotherms) with depth.

(i) Explain why granite and peridotite might be WET at depths > 50 km on FIGURE 1b. [2]

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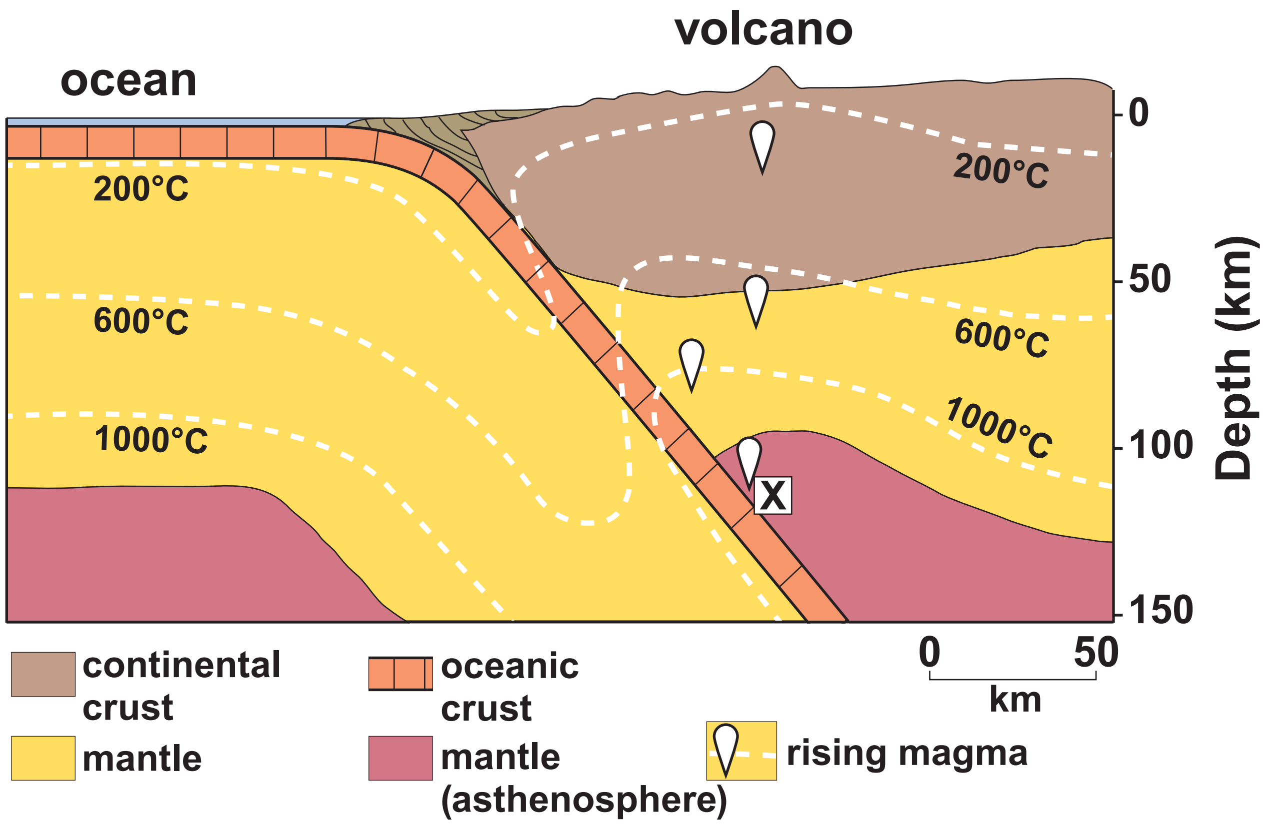
1(b) (ii) Using FIGURE 1a, shade in an area on FIGURE 1b in which CRUST composed of wet granite is predicted to be partially molten. [2]

(iii) Using FIGURE 1a, explain why a partial melt generated in the continental crust is unlikely to be erupted at the surface. [2]

FIGURE 1b



volcano
ocean
0
50
100
150
Depth (km)
200°C
600°C
1000°C
200°C
600°C
1000°C
X
0
50
km
continental crust
oceanic crust
mantle
mantle (asthenosphere)
rising magma

1(c) **The magma generated at X in FIGURE 1b produces lava at the surface with a range of composition from mafic to silicic. Suggest reasons for this variation in composition. [3]**

14

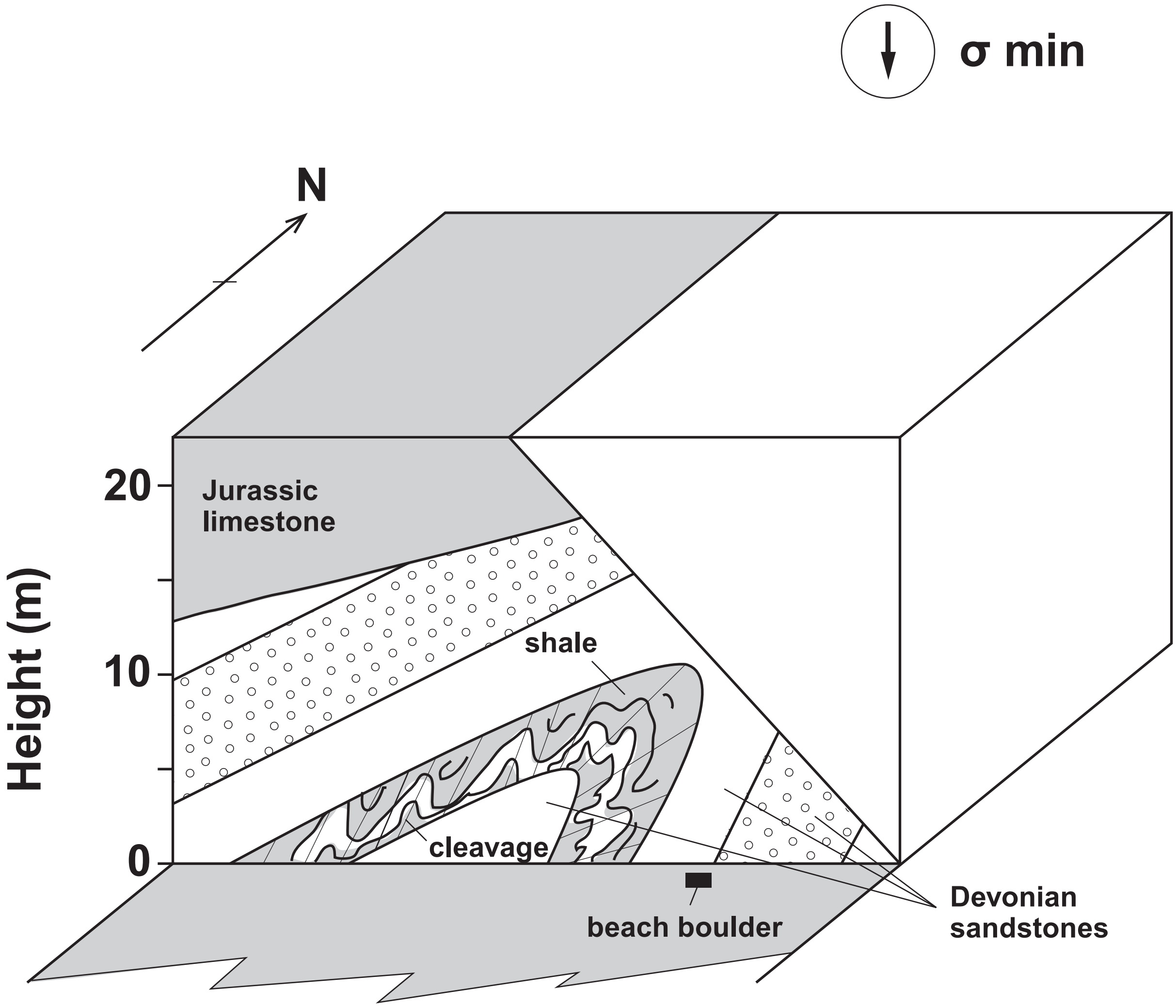
2. FIGURE 2a opposite is a partly completed block diagram of folded strata cut by a dip slip fault.

TABLE 2

- The Devonian fold is overturned but does not plunge.
- The orientations of the principal stresses (σ min is vertical) have produced a dip slip fault with a 5 METRE THROW of the beds.
- The sequence was intruded by a thin vertical, E–W trending dyke of Permian age which cuts the centre of the east-facing surface.

(a) With reference to TABLE 2, complete FIGURE 2a opposite by sketching in the geology as it would be seen on the top and side surfaces of the block diagram. [6]

FIGURE 2a



σ min
N
Height (m)
20
10
0
Jurassic
limestone
shale
cleavage
beach boulder
Devonian
sandstones

1(b) FIGURE 2b opposite is a photograph of a loose boulder from the Devonian sandstone that has fallen from the cliff onto the beach as indicated in FIGURE 2a.

(i) In the boxes on FIGURE 2b name the TWO sedimentary structures that show the boulder is the correct ‘way up’. [2]

(ii) Explain the formation and use of ONE of these sedimentary structures in determining the correct ‘way up’ of the boulder. [2]

Chosen sedimentary structure (1 or 2) ☐

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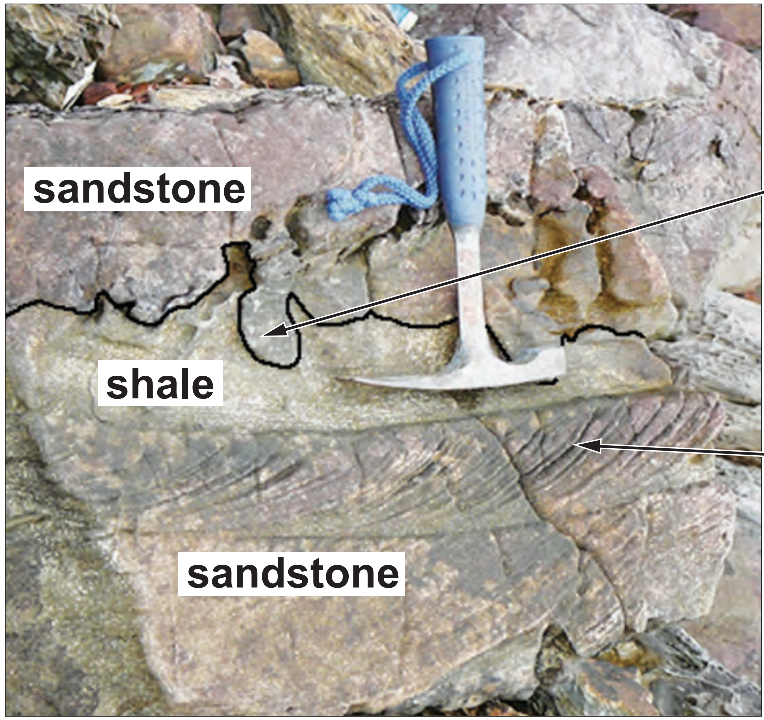
1(b) (iii) Evaluate the use of THIS boulder in establishing which one of the Devonian fold limbs is overturned. [2]

(c) (i) Using FIGURE 2a, describe how the Devonian shale and sandstone have responded so differently to stress during folding. [2]

1(c) (ii) Explain why the Devonian shale and sandstone in FIGURE 2a have responded so differently to stress during folding. [2]

16

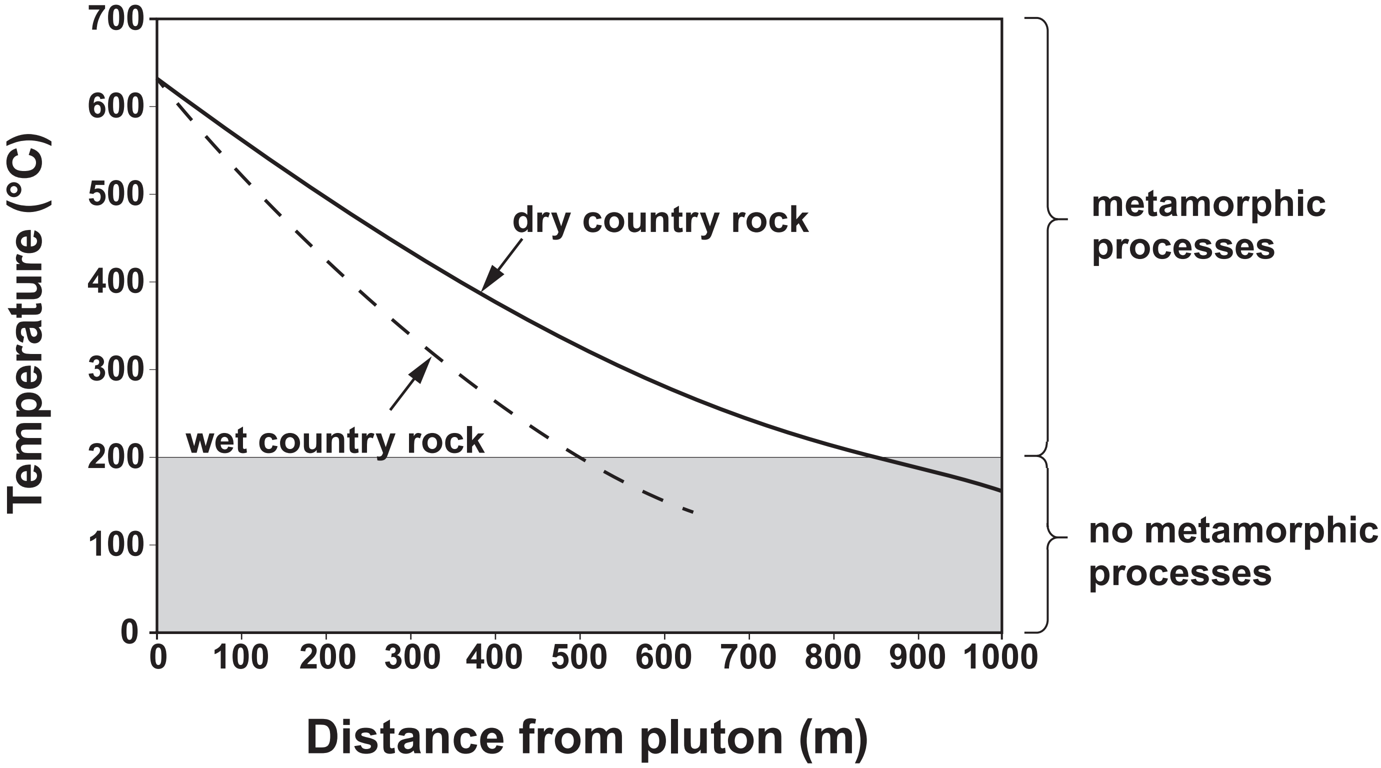
FIGURE 2b



1.

2.

FIGURE 3a



700
600
500
400
300
200
100
0
Temperature (°C)
dry country rock
wet country rock
0
100
200
300
400
500
600
700
800
900
1000
Distance from pluton (m)
metamorphic processes
no metamorphic processes

3. **FIGURE 3a opposite represents a model showing the predicted temperature of wet and dry country rock after the intrusion of a pluton.**

Refer to FIGURE 3a.

(a) **State the temperature at which the model predicts metamorphic processes will start to operate. Explain why metamorphic processes only start operating at this temperature. [2]**

Temperature ____________________ **°C**

Explanation ____________________________________

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____

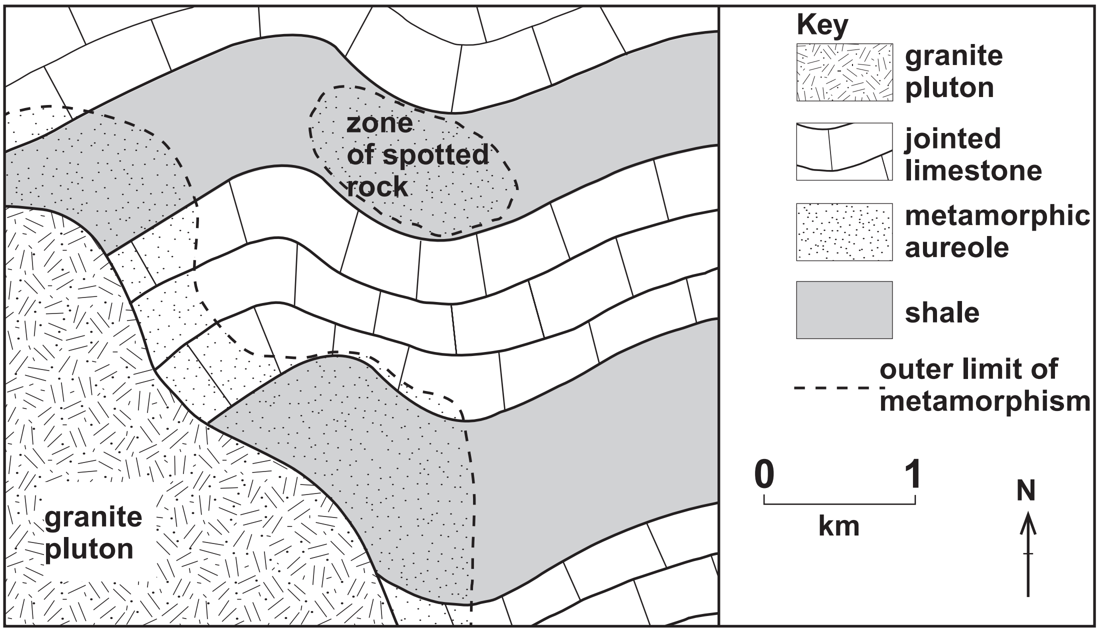
3(b) Complete TABLE 3 below to show for both WET and DRY country rock:

- the temperature at 600 m from the pluton
- the width of the metamorphic aureole (the distance from the pluton over which metamorphic processes operate). [3]

TABLE 3

	Country rock temperature at 600 m from pluton contact (°C)	Width of the metamorphic aureole (m)
Dry country rock	280	•
Wet country rock	•	•

FIGURE 3b


zone of spotted rock
granite pluton
Key
granite pluton
jointed limestone
metamorphic aureole
shale
outer limit of metamorphism
0
1
km
N

3(c) The effect of contact metamorphism on the surrounding country rock varies with the transfer of heat by conduction and convection.
FIGURE 3b opposite is a MAP showing the metamorphic aureole surrounding a pluton intruded into different sedimentary rocks.

(i) Mark with a labelled arrow (← H) a probable location on FIGURE 3b of the metamorphic rock HORNFELS. Explain your answer. [2]

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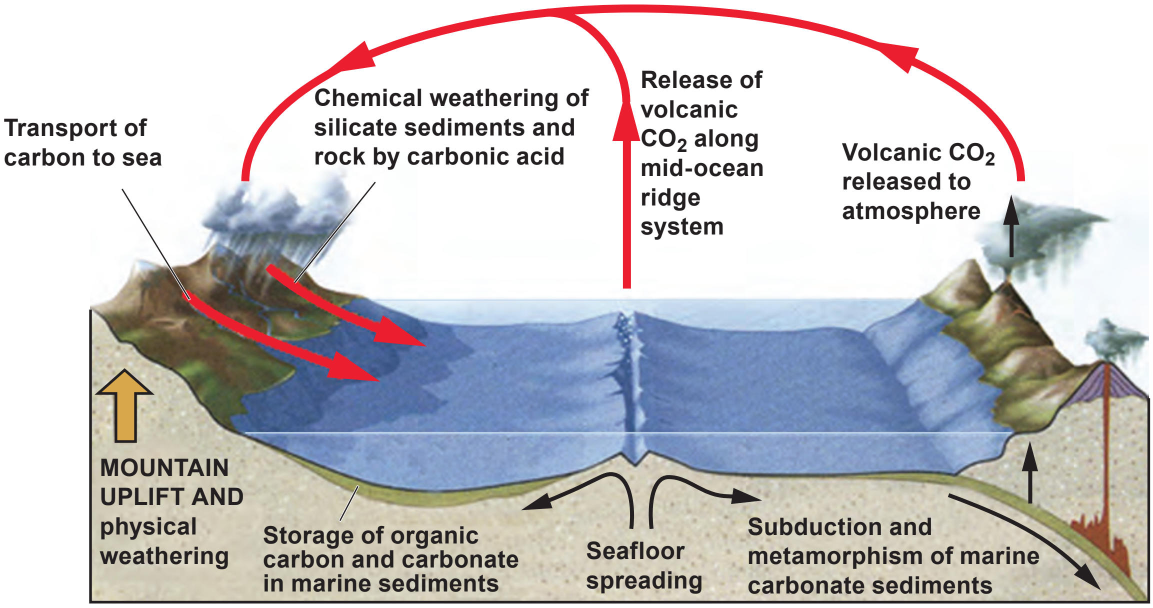
3(c) (ii) **Using FIGURE 3a, describe and explain how water and rock type might have affected the width of the metamorphic aureole in FIGURE 3b. [4]**

3(d) (i) **Suggest ONE reason for the zone of spotted rock to the NE of the granite pluton.** **[2]**

(ii) **Suggest TWO features of PLUTONS that may influence the width of their metamorphic aureoles.** **[2]**

15

FIGURE 4a



Transport of carbon to sea
Chemical weathering of silicate sediments and rock by carbonic acid
Release of volcanic CO_2 along mid-ocean ridge system
Volcanic CO_2 released to atmosphere
MOUNTAIN UPLIFT AND physical weathering
Storage of organic carbon and carbonate in marine sediments
Seafloor spreading
Subduction and metamorphism of marine carbonate sediments

4. FIGURE 4a opposite is a model of the long-term carbon cycle in which plate tectonics and chemical weathering are the main controls of atmospheric carbon dioxide (CO_2).

(a) Refer to FIGURE 4a.

(i) Describe how carbon is transferred from marine sediments to the atmosphere at plate boundaries. [2]

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4(a) (ii) Describe how carbon is removed from the atmosphere and returned to marine sediments. [2]

(iii) From your knowledge, briefly describe the relationship between CO_2 in the atmosphere and global temperatures. [1]

FIGURE 4b

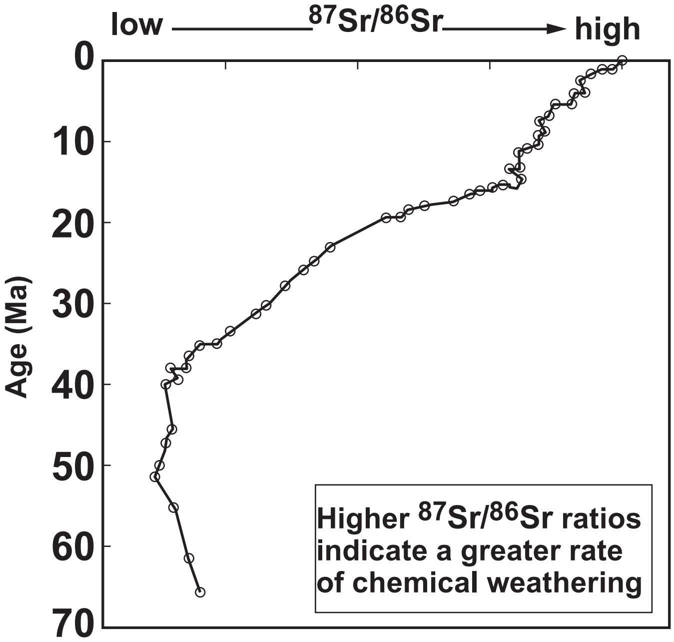
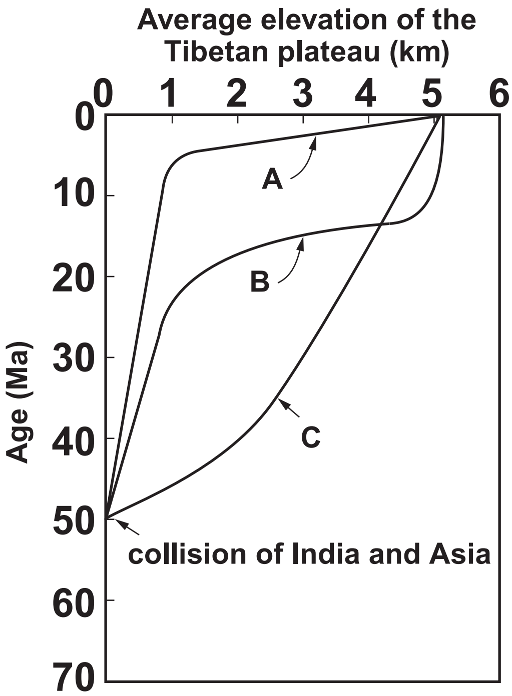


FIGURE 4c



4(b) **Global cooling in the last 40 Ma has been linked to uplift of the Himalayas/Tibetan plateau.**
FIGURE 4b opposite shows the change in $^{87}Sr/^{86}Sr$ isotope ratio for marine carbonates in the Indian Ocean.
FIGURE 4c opposite shows three contrasting models for the rate of uplift of the Tibetan Plateau formed by the collision of India with Asia.

Refer to FIGURES 4b and 4c.

(i) **Describe the relative change in $^{87}Sr/^{86}Sr$ ratios in FIGURE 4b over the last 40 Ma.**

[2]

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4(b) (ii) **State which uplift model in FIGURE 4c (A, B or C) most closely correlates with the $^{87}Sr/^{86}Sr$ ratio data (FIGURE 4b). Describe the degree of correlation between the two data sets. [3]**

Model (A, B or C) ☐

Correlation ____________________

____

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____

(c) Refer to FIGURES 4a, 4b and 4c.

(i) **Explain how an increase in the height of the Himalayas/Tibetan plateau might have caused global cooling in the last 40 Ma. [3]**

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4(c) (ii) With reference to FIGURE 4a or your knowledge, suggest ONE other possible mechanism for global cooling in the last 40 Ma. [2]

15

SECTION B

Questions 5–8 relate to the BRITISH GEOLOGICAL SURVEY 1:63 360 GEOLOGICAL MAP extract from MALMESBURY (SHEET 251)

Answer ALL questions in the spaces provided.

This section should take approximately 1 hour to complete.

5(a) (i) State the area covered by BOX Z on the GEOLOGICAL MAP (in square kilometres). **[1]**

______________________________ **square kilometres.**

(ii) Describe and explain the shape of the Triassic strata that crop out in BOX Z. **[2]**

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5(b) MAP P (an extract of the GEOLOGICAL MAP at a larger scale) shows GRID SQUARE 6688 in which a near vertical dip-slip fault is seen to crop out.

(i) Describe the FIELD OBSERVATIONS that might have been made to enable the fault to be drawn on the GEOLOGICAL MAP at this location. [3]

5(b) (ii) **Draw a geological SKETCH section across the fault along the line X–Y. With reference to the GENERALISED VERTICAL SECTION, clearly label the INDIVIDUAL UNITS of the Clifton Down Group (d^2). [3]**

X ———————————————— Y

9

FIGURE 6a

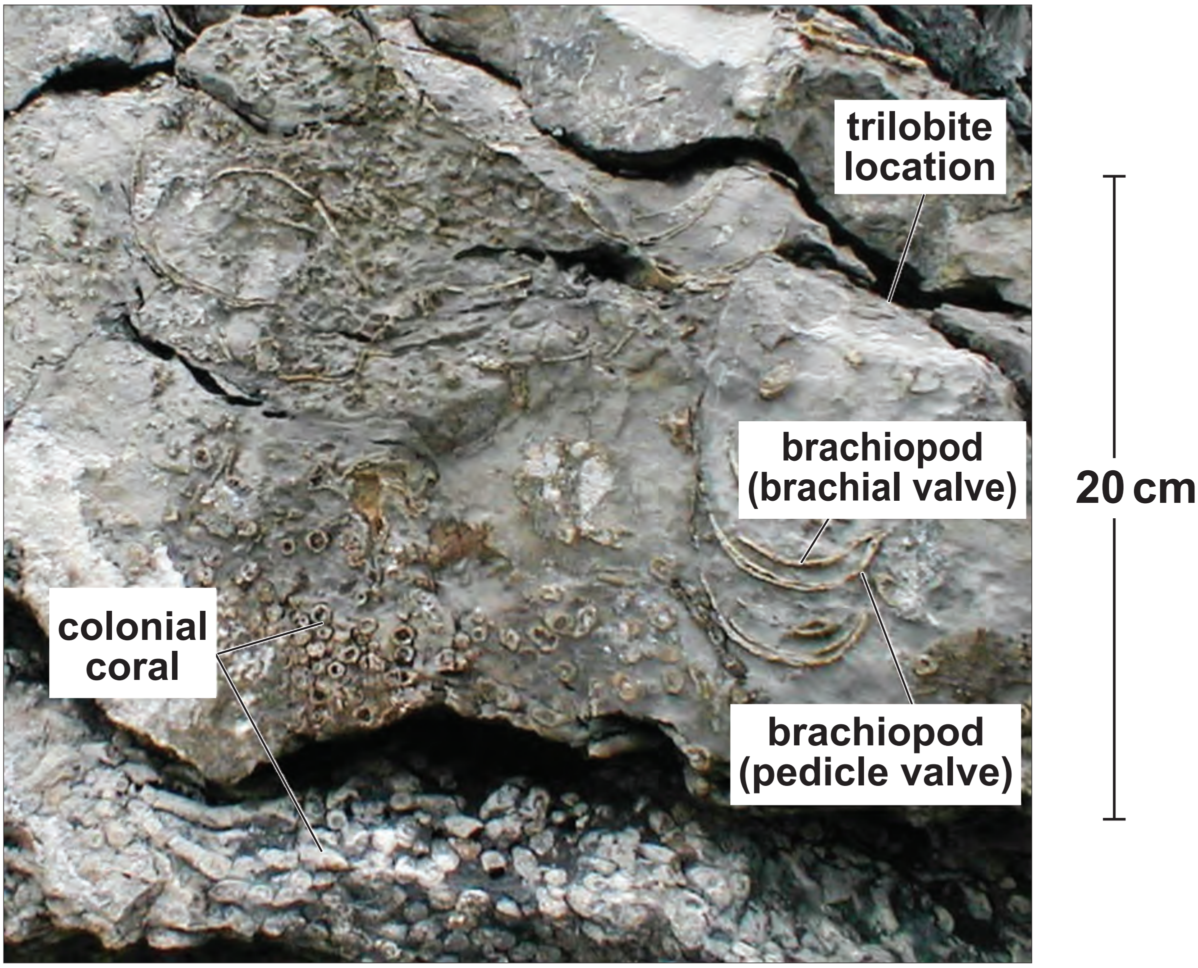

FIGURE 6b

6. FIGURE 6a opposite is a photograph of a vertical section of Clifton Down Limestone (d^2), showing a typical fossil assemblage. FIGURE 6b opposite is a photograph of part of a trilobite, also identified in the limestone.

(a) (i) State the function of morphological feature T in FIGURE 6b. [1]

Function ______________________________

(ii) Explain how the morphological features of this specimen provide evidence for the trilobite's mode of life. [3]

Mode of life ______________________________

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6(b) (i) With reference to FIGURE 6a, explain the evidence to support the hypothesis that the Clifton Down Limestone (d^2) was formed in a warm tropical sea. [2]

6(b) (ii) A student suggested that

"the fossils in this section of the Clifton Down Limestone indicate a decrease in the energy of the environment with time."

Critically evaluate this statement with reference to FIGURE 6a and FIGURE 6b. [3]

9

FIGURE 7a

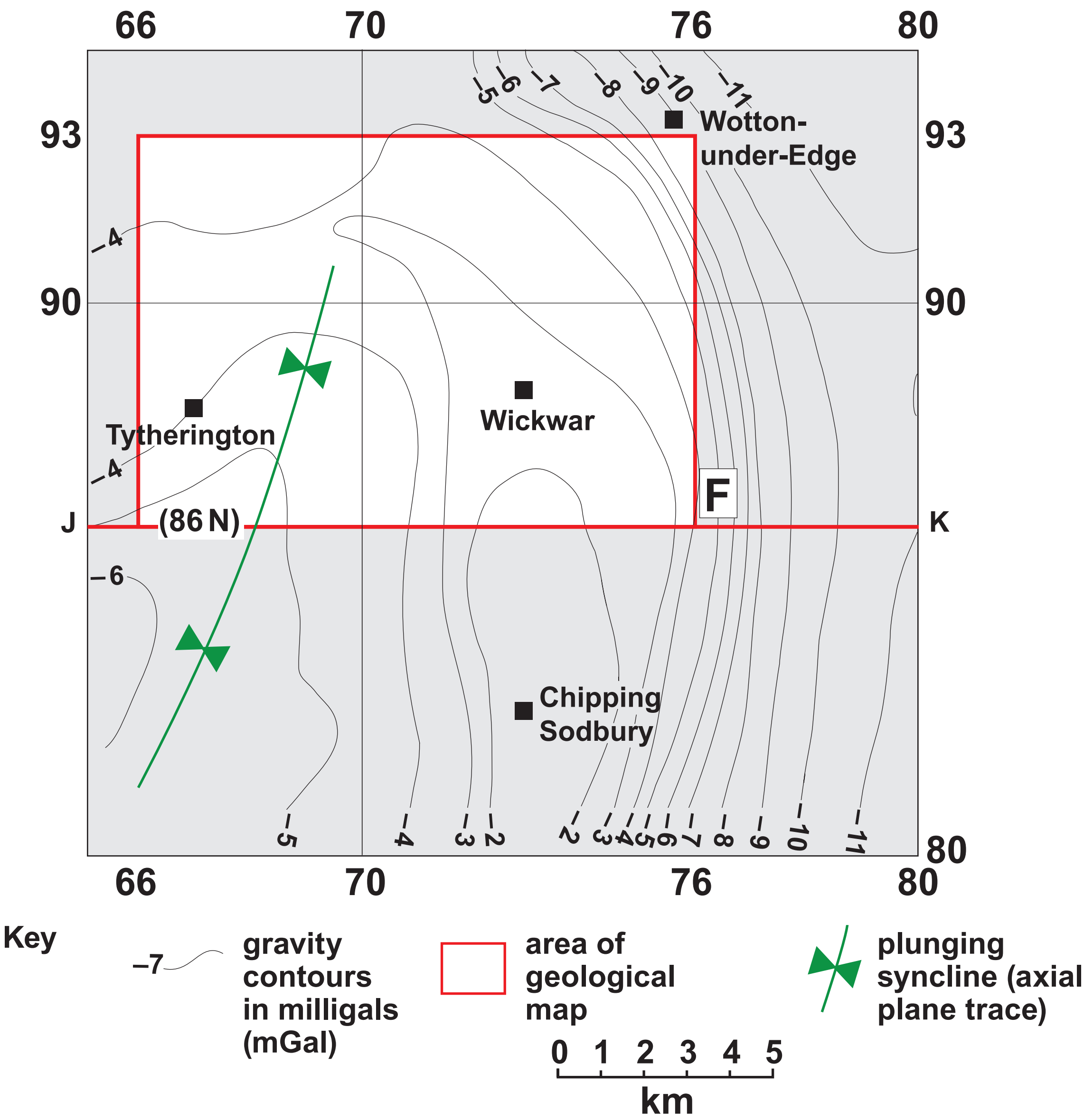


FIGURE 7b

7. FIGURE 7a opposite shows a Bouguer gravity anomaly map of the region which includes the area of the GEOLOGICAL MAP. FIGURE 7b is a partly completed gravity anomaly profile along the GRID LINE 86 (N) from J to K on FIGURE 7a.

Refer to FIGURES 7a and 7b, the GEOLOGICAL MAP and GEOLOGICAL CROSS SECTION.

(a) Complete TABLE 7 below by stating the evidence from the GEOLOGICAL MAP ALONE that the plunging syncline, indicated on FIGURE 7a, shows the following fold characteristics:

1. a synform
2. a syncline
3. a plunge to the SSW [3]

TABLE 7

FOLD CHARACTERISTICS	EVIDENCE
1. a synform	•
2. a syncline	•
3. a plunge to the SSW	•

7(b) Complete the profile on FIGURE 7b to show the variation in the gravity anomaly profile along the GRID LINE 86 (N) from J to K on FIGURE 7a. [2]

(c) **"The Bouguer gravity anomalies along GRID LINE 86 can be explained by:**

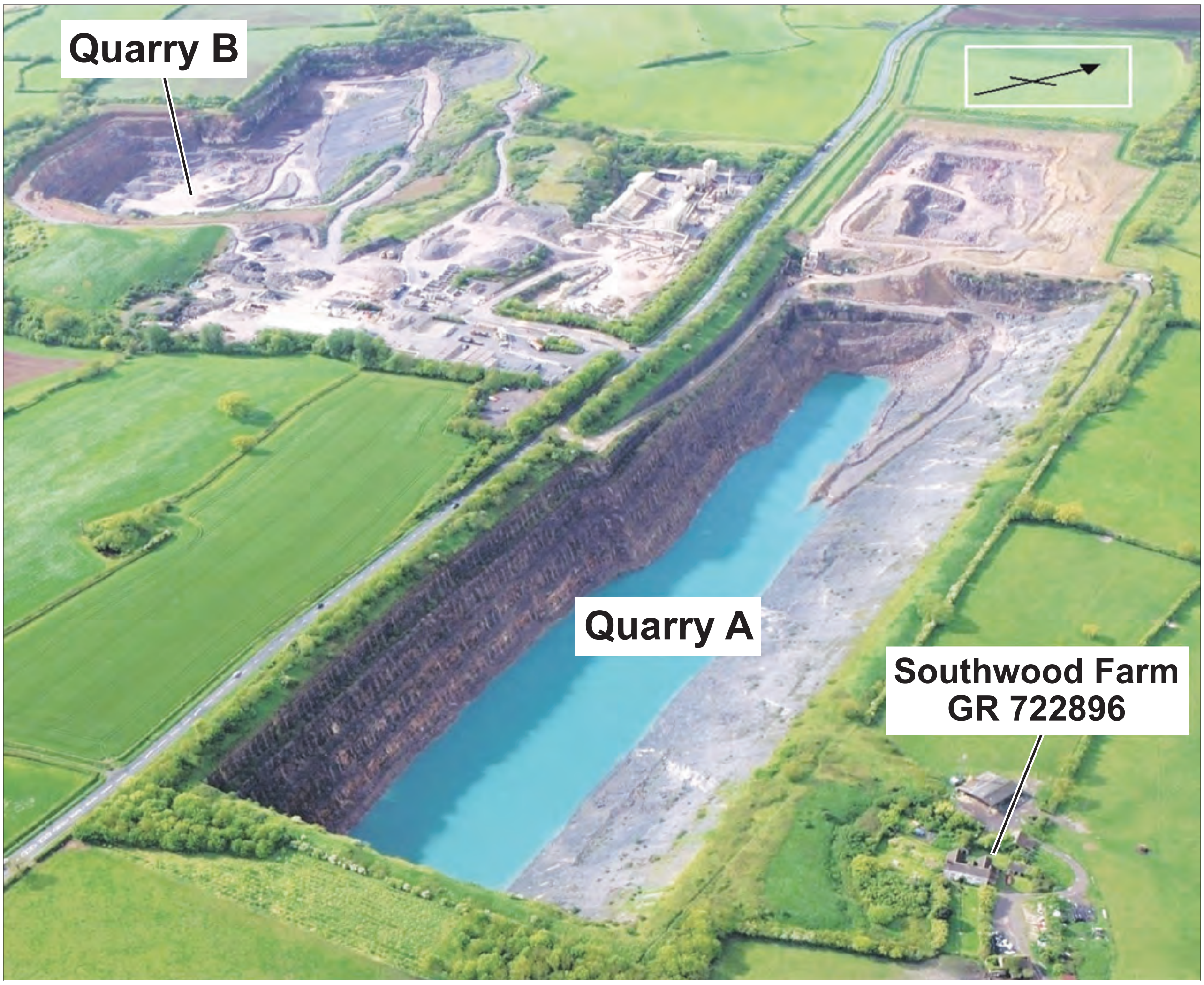
1. **differences in the mean rock density**
2. **the geological structure."**

(i) Suggest what conclusions might be made about the relative densities of Carboniferous strata that crop out in the core of the syncline compared with those which crop out on its limbs. Explain your answer. [2]

7(c) (ii) The Bouguer gravity anomaly data provides evidence for an UNMAPPED fault below location F on FIGURE 7a. Explain the gravity data evidence to support this conclusion. [2]

9

FIGURE 8a



8. FIGURE 8a opposite is a photograph of Wickwar Quarry (GRID SQUARE 7189) looking NW. The quarry workings are split into two areas labelled QUARRY A and B.

Refer to the GEOLOGICAL MAP, MAP Q, GEOLOGICAL SECTION and FIGURE 8a.

TABLE 8

Quarry	Rock type being quarried	Maximum thickness (m)	Dip (degrees)	Approximate dip direction
A	Black Rock Limestone (BRL), Dolomite (BRD) and Gulley Oolite (& Limestone)	see part (iii)	•	•
B	•	115	20	SW

8(a) (i) **Complete TABLE 8 opposite to describe the following characteristics of QUARRY A and QUARRY B:**

- **angle of dip of the limestone in QUARRY A**
- **general direction of the dip of the limestone in QUARRY A**
- **name of the limestone being quarried in QUARRY B [3]**

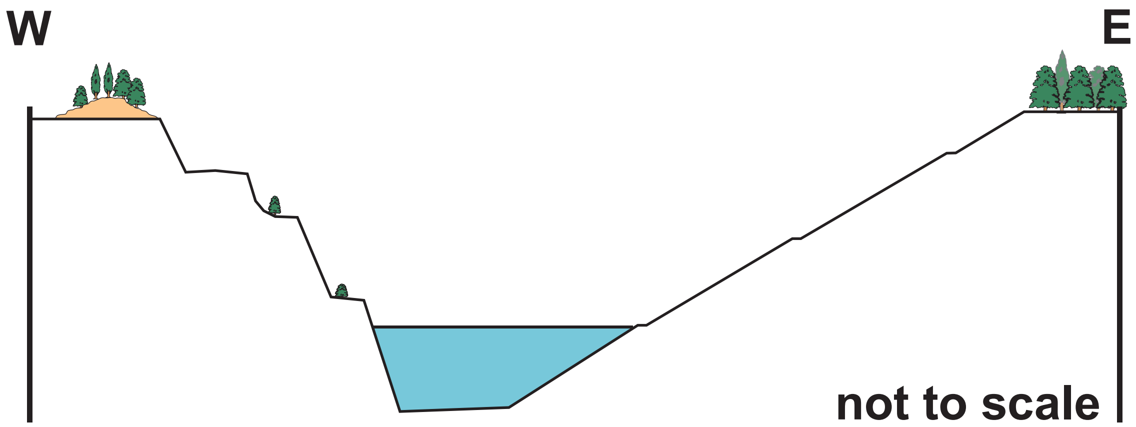
(ii) **Explain why the limestone beds seen on the western face of QUARRY A appear to be horizontal although the GEOLOGICAL MAP shows the limestone to be dipping. [1]**

8(a) (iii) **Using the GENERALISED VERTICAL SECTION, calculate the MAXIMUM thickness of the limestone beds in QUARRY A identified in TABLE 8. Show your working. [2]**

Maximum thickness = ________________ m

(b) (i) **FIGURE 8b OPPOSITE is a section showing the land surface across QUARRY A. Use FIGURE 8b to explain how the stability/ steepness of the quarry faces are controlled by the dip of the beds. You are required to use annotations. [3]**

FIGURE 8b



8(b) (ii) **Explain the GEOLOGICAL factors that may have contributed to limit the growth and development of limestone quarrying along the eastern and western margins of either QUARRY A or QUARRY B. [4]**

Chosen Quarry (A or B) ☐

13

END OF PAPER