| Surname | Centre Number | Candidate Number |
|---|---|---|
| Other Names | | 2 |

# GCE A level

1214/01

S15-1214-01

# GEOLOGY – GL4
## Interpreting the Geological Record

A.M. MONDAY, 8 June 2015

2 hours

| | 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** | |

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**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 or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

**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.

Examiner only

## SECTION A

*Answer* **all** *questions in the spaces provided.*

*This section should take approximately 1 hour to complete.*

**1.** **Figure 1a** 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.

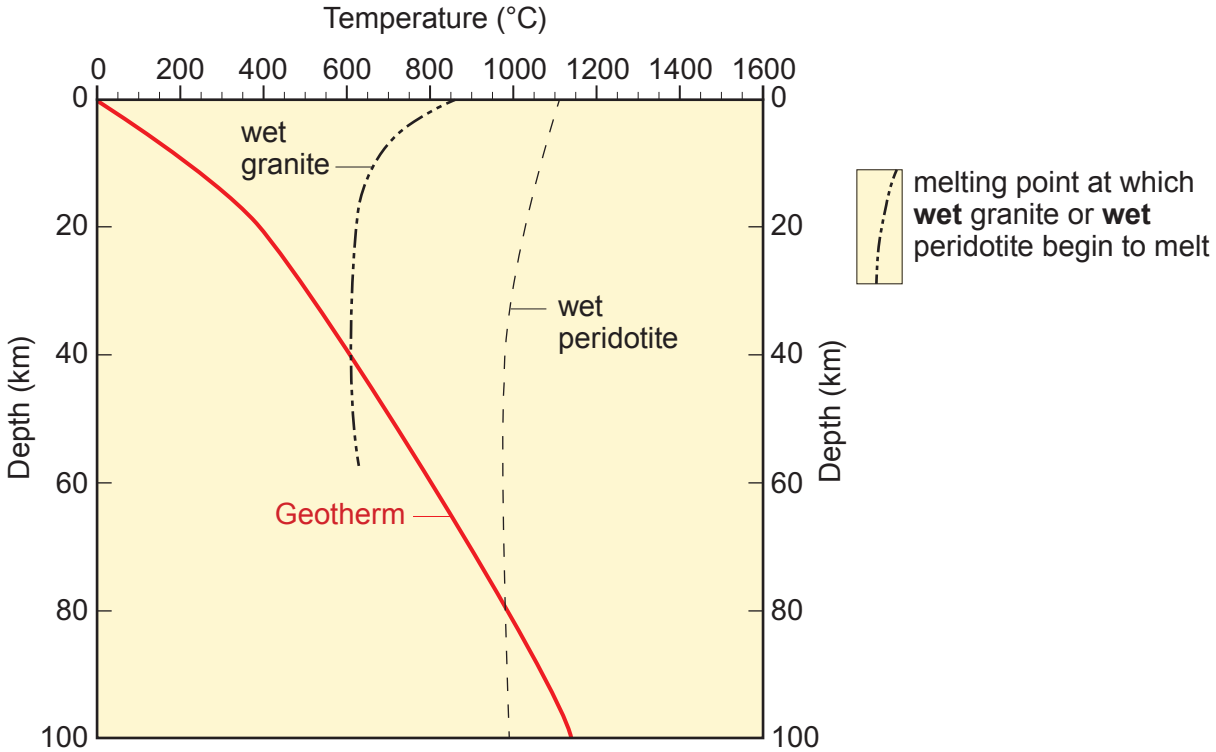


**Figure 1a**

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 |

(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 $km^{-1}$

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

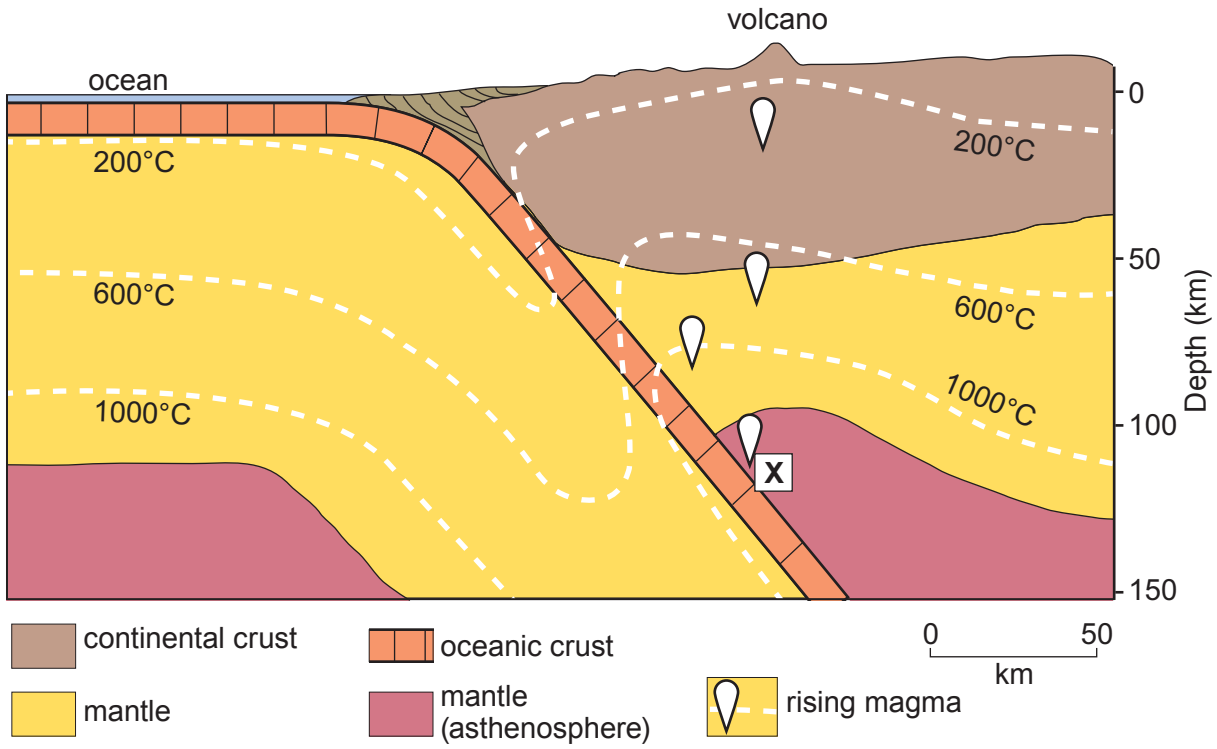


**Figure 1b**

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

.....

.....

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(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]

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Examiner only

*(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]

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

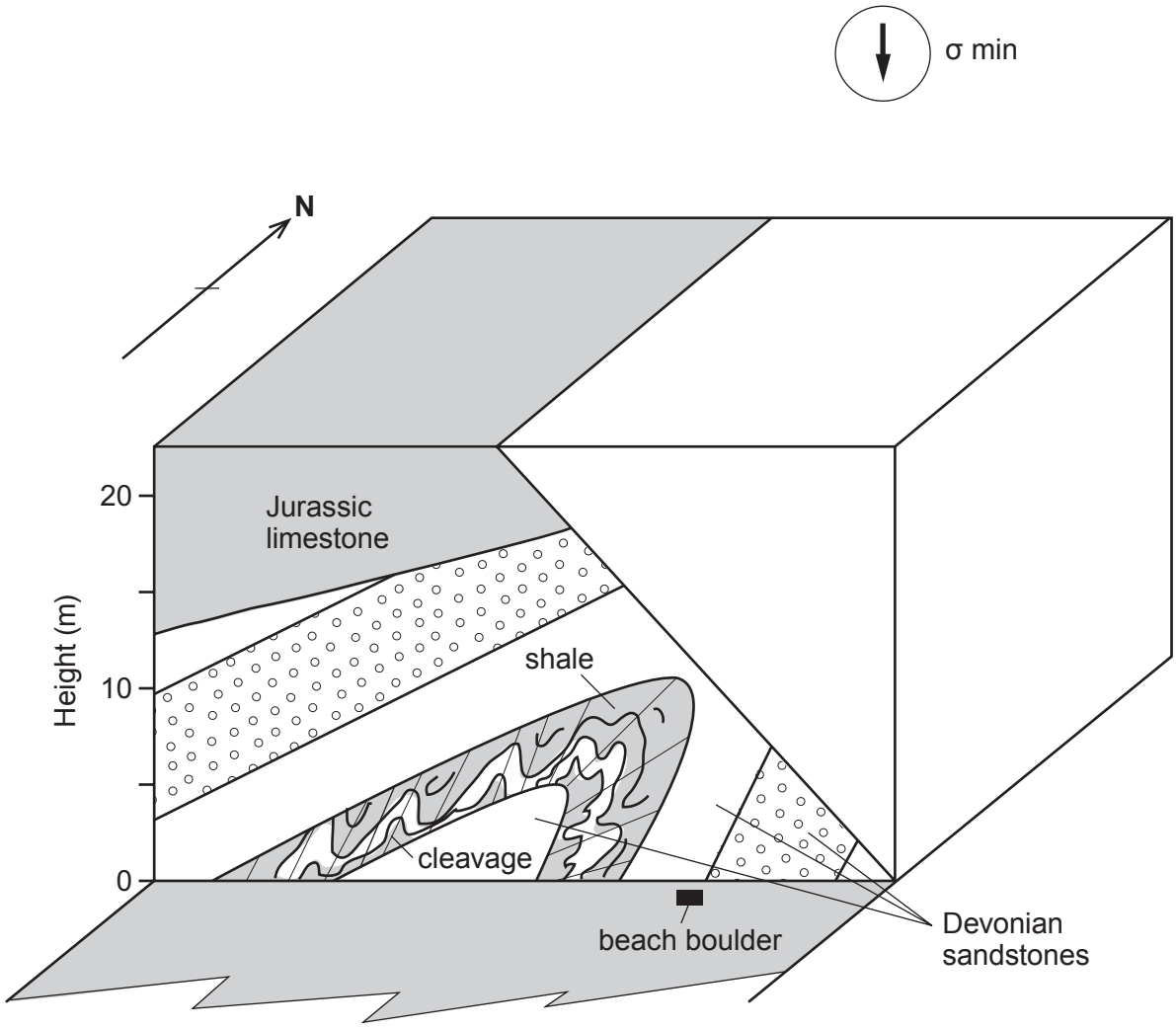


**Figure 2a**

| |
|---|
| • 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. |

**Table 2**

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

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*(b)* **Figure 2b** 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**.

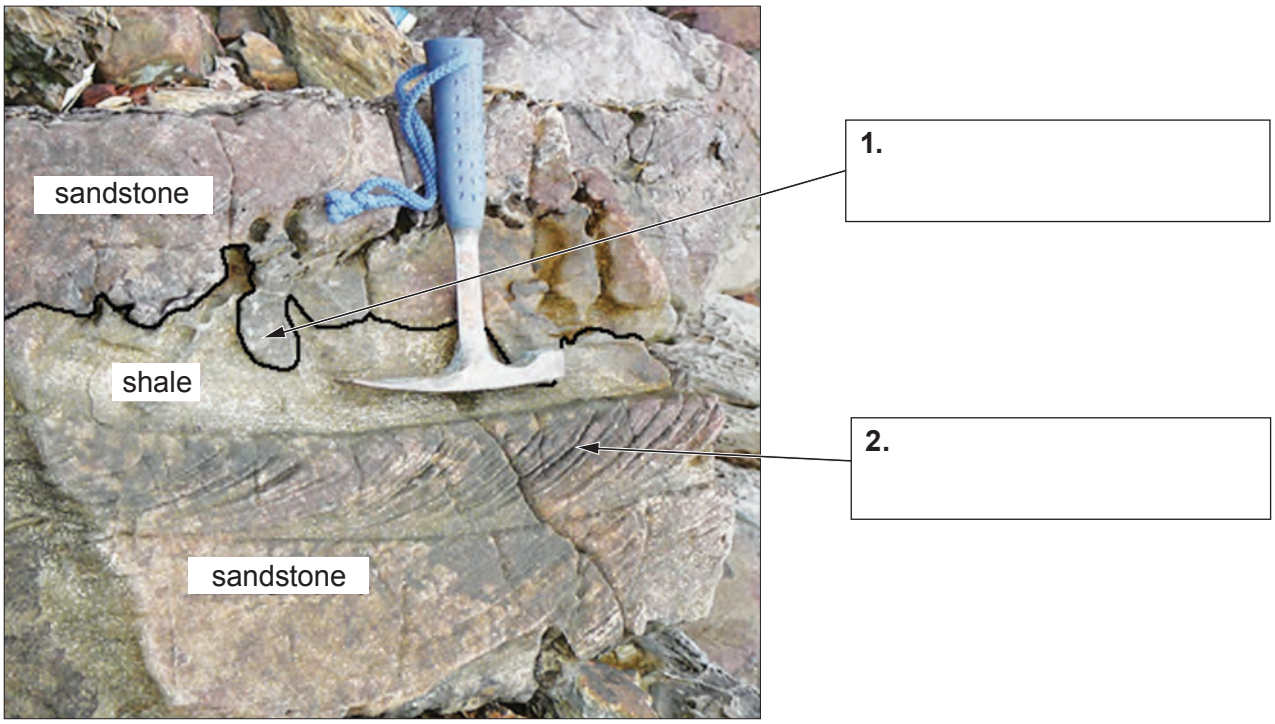


**Figure 2b**

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

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Examiner only

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

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

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**Turn over.**

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

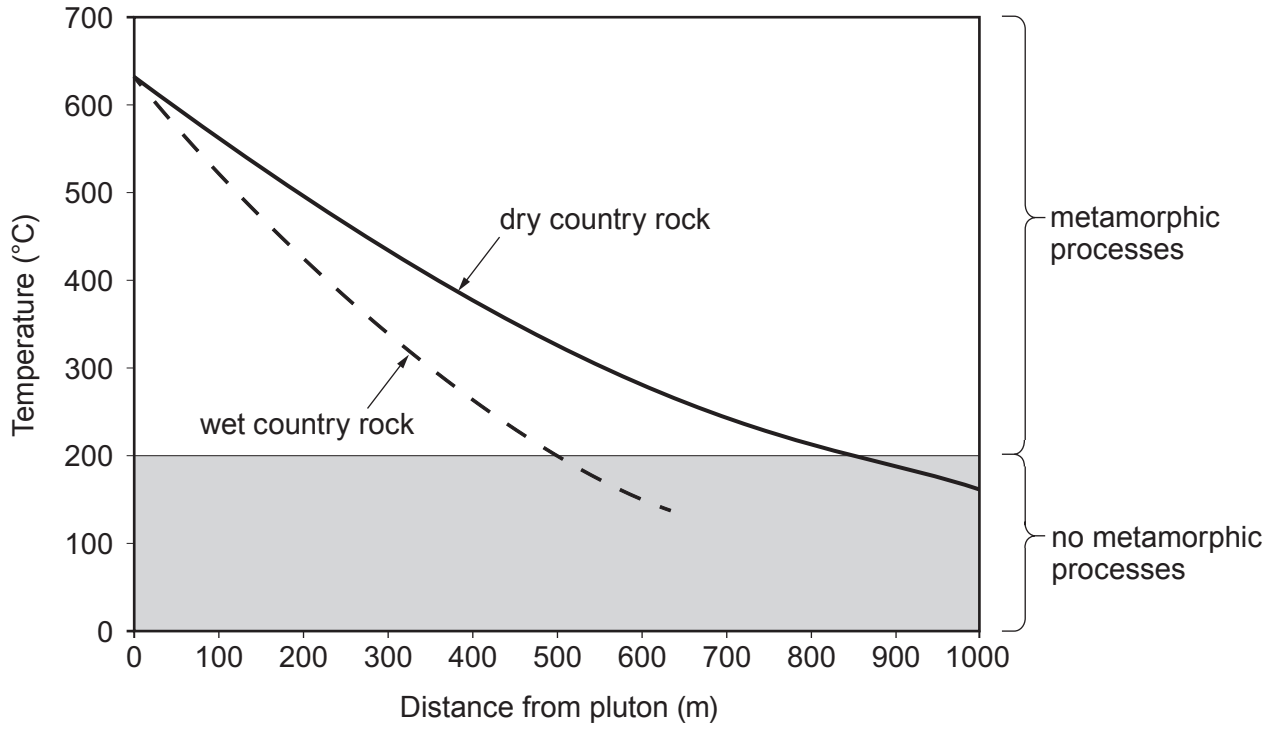


**Figure 3a**

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* .....

.....

*(b)* Complete **Table 3** 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]

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

**Table 3**

Examiner only

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

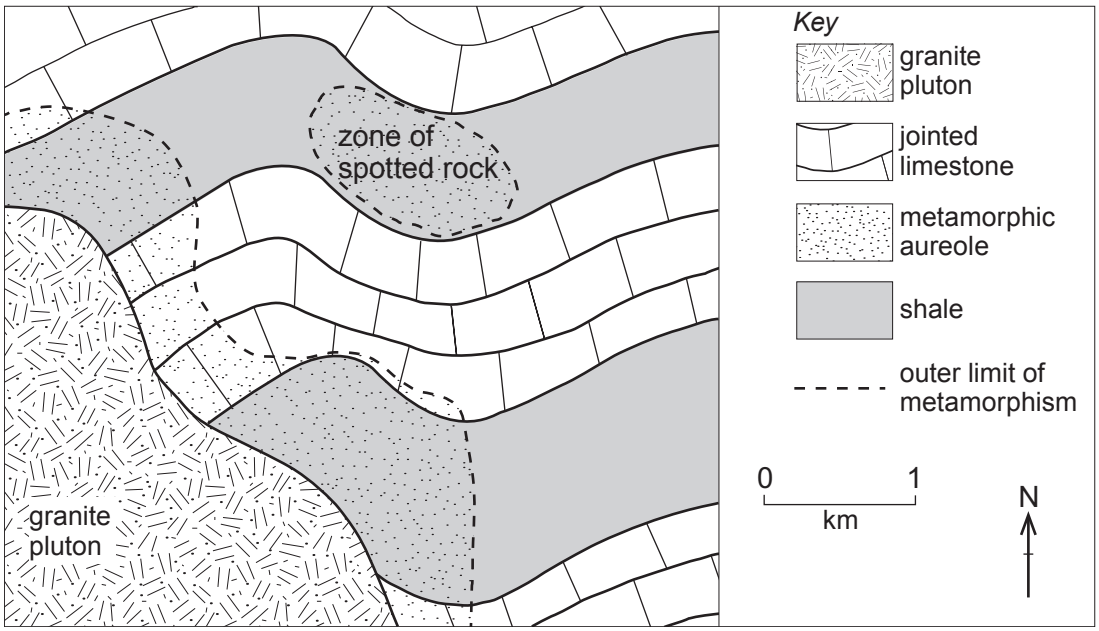


**Figure 3b**

(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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(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]

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**Turn over.**

Examiner only

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

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

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

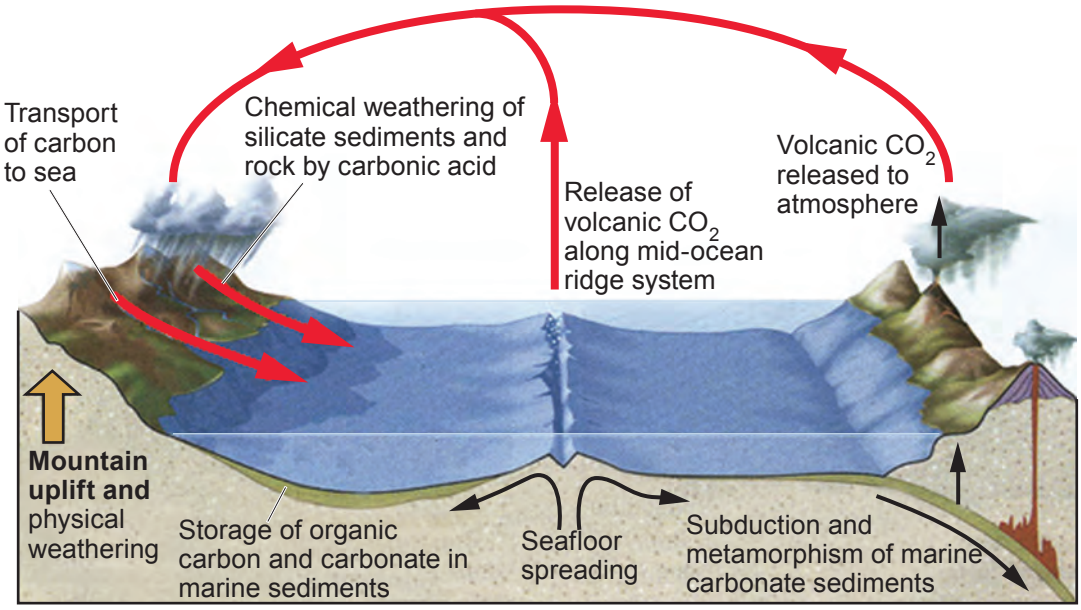


**Figure 4a**

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

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

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Examiner only

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

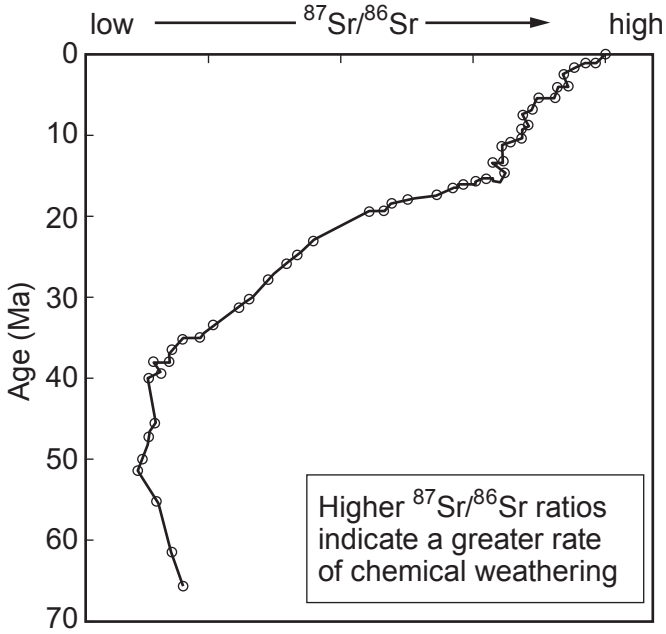


**Figure 4b**

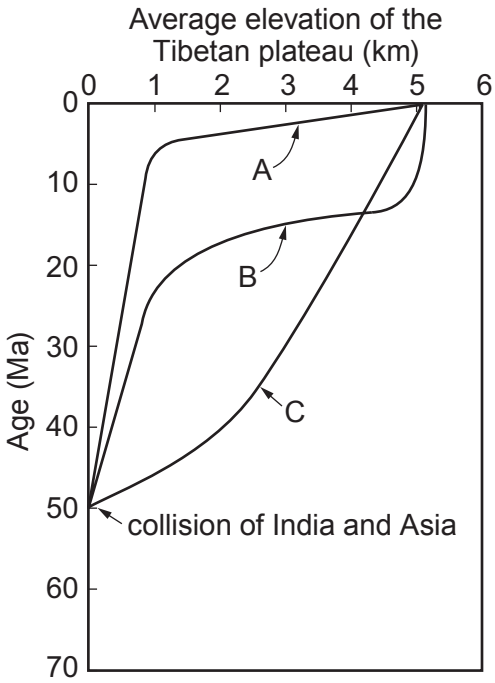


**Figure 4c**

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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(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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Examiner only

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

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**Turn over.**

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Examiner only

## 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).

..... square kilometres. [1]

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

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*(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]

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(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





**Turn over.**

Examiner only

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

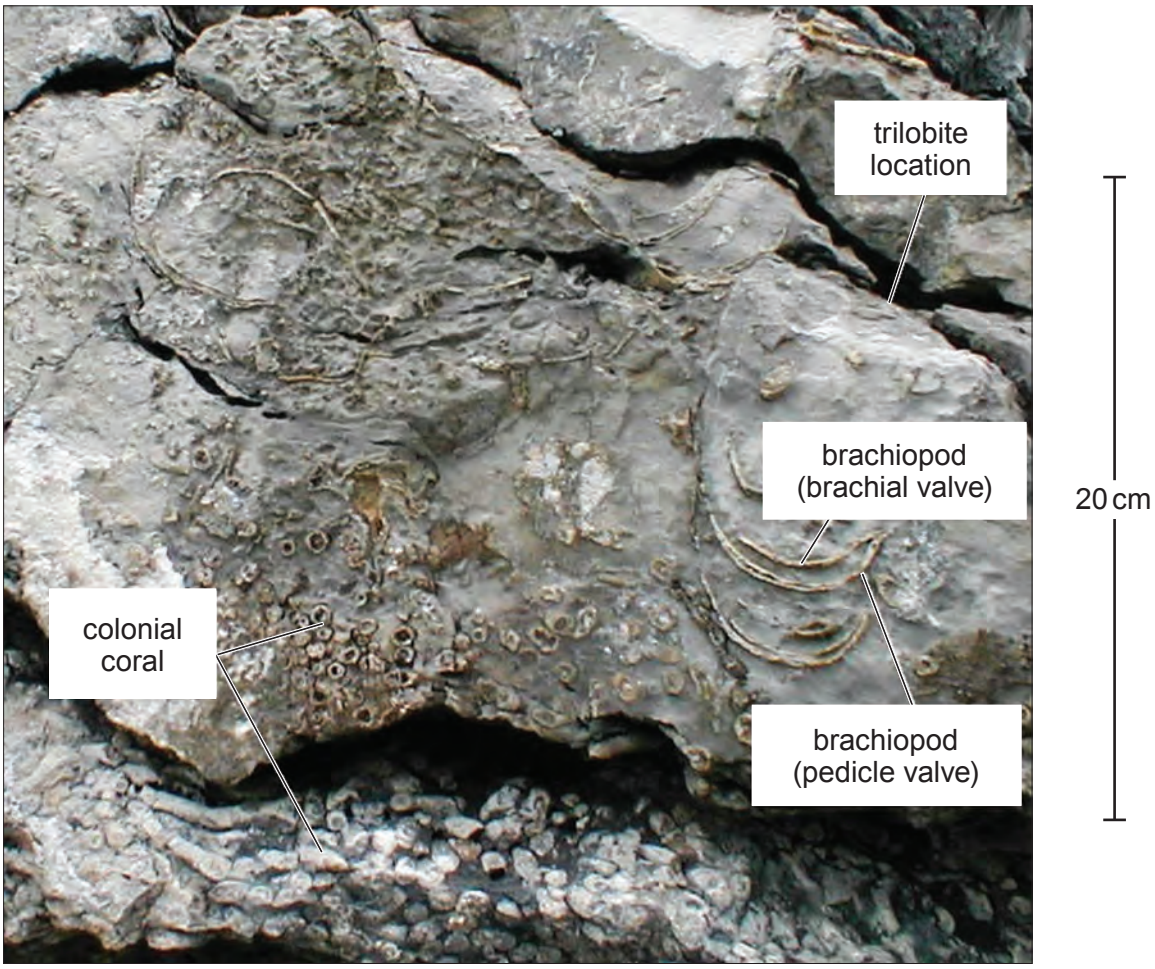


**Figure 6a**

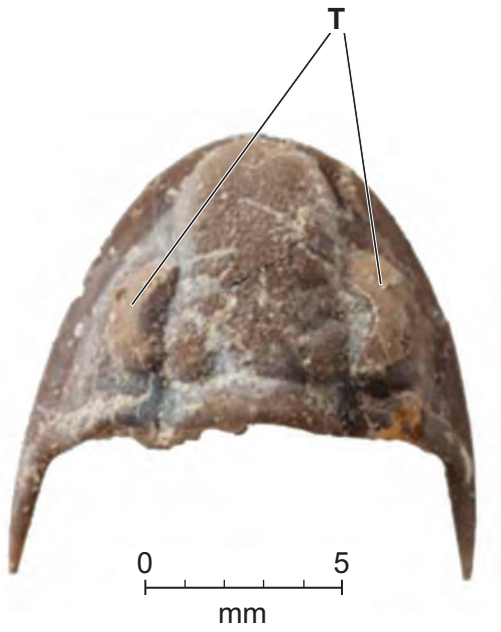


**Figure 6b**

Examiner only

*(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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*(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]

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(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]

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**Turn over.**

Examiner only

**7.** **Figure 7a** 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**.

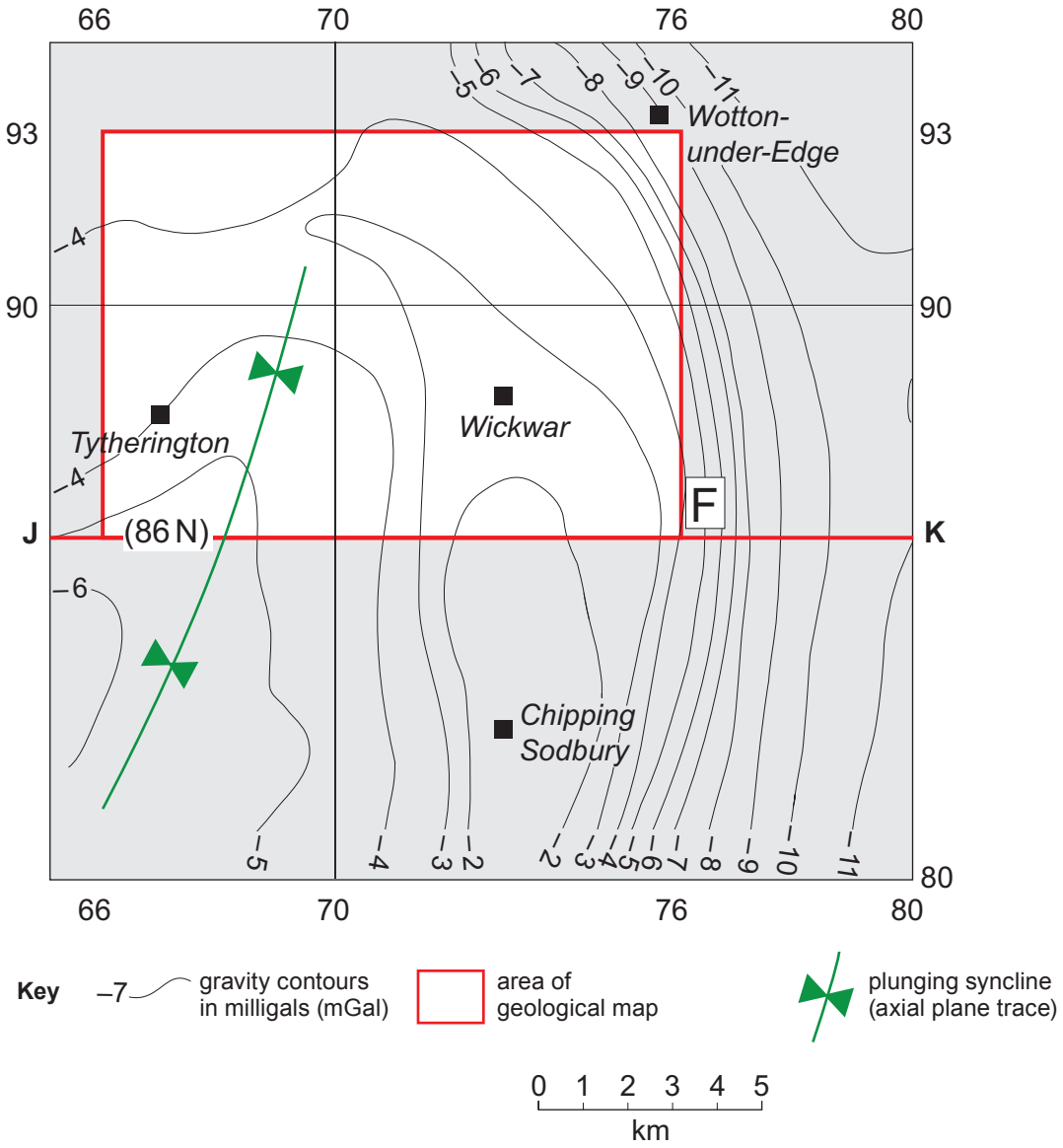


**Figure 7a**


**Figure 7b**

Examiner only

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]

| Fold Characteristics | Evidence |
|---|---|
| 1. a synform | . |
| 2. a syncline | . |
| 3. a plunge to the SSW | . |

**Table 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]

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(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]

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**Turn over.**

Examiner only

**8.** **Figure 8a** is a photograph of Wickwar Quarry **(grid square 7189)** looking NW. The quarry workings are split into two areas labelled **Quarry A** and **B**.

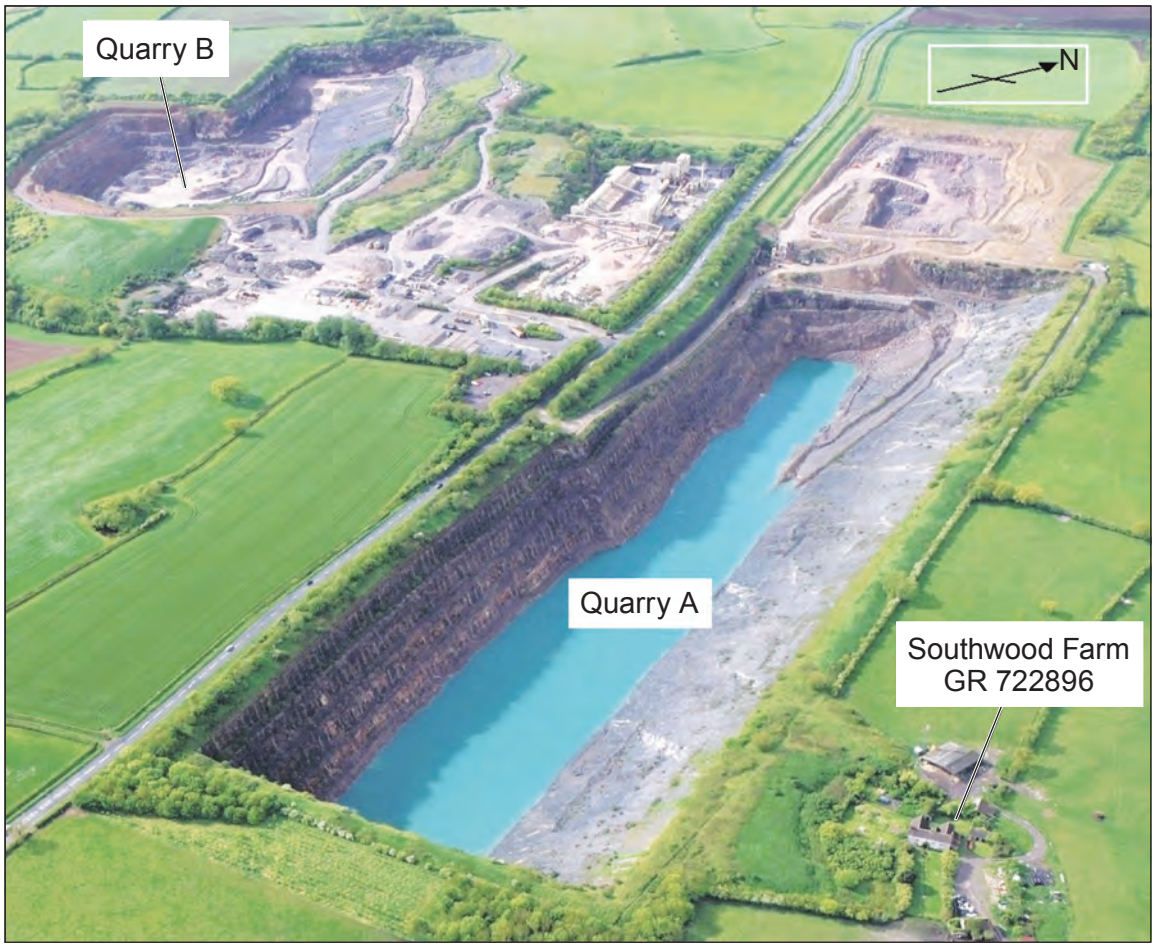


**Figure 8a**

Refer to the **geological map**, **Map Q**, **geological section** and **Figure 8a**.

*(a)* (i) Complete **Table 8** 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]

| 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 |

**Table 8**

Examiner only

(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]

.....

(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** 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]

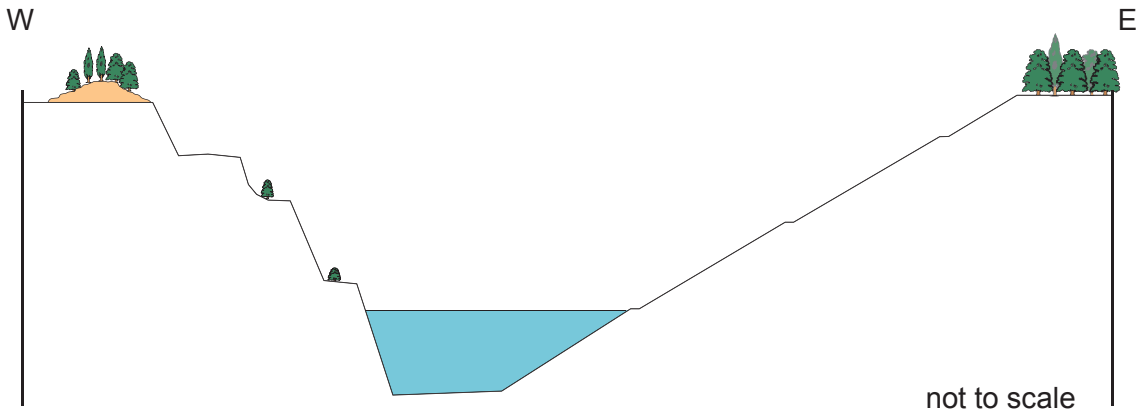


**Figure 8b**

(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**) ☐

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**END OF PAPER**

Acknowledgements

**Figure 4a** – http://stratus.astr.ucl.ac.be/textbook/chapter2_node14

**Figures 4b** and **4c** – Hancock & Skinner – Oxford companion to the Earth

**Figure 6b** – BGS http://www.3d-fossils.ac.uk/fossilType.cfm?typSampleId=25000745

**Figure 7a** – adapted from Figure 25 – Malmesbury district. Memoire for sheet E25: Cave R.

**Figure 8a** – http://www.cemexcommunities.co.uk/documents/WickwarPCExtension.pdf

 

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**For continuation only.**





**Turn over.**

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**GCE A level**

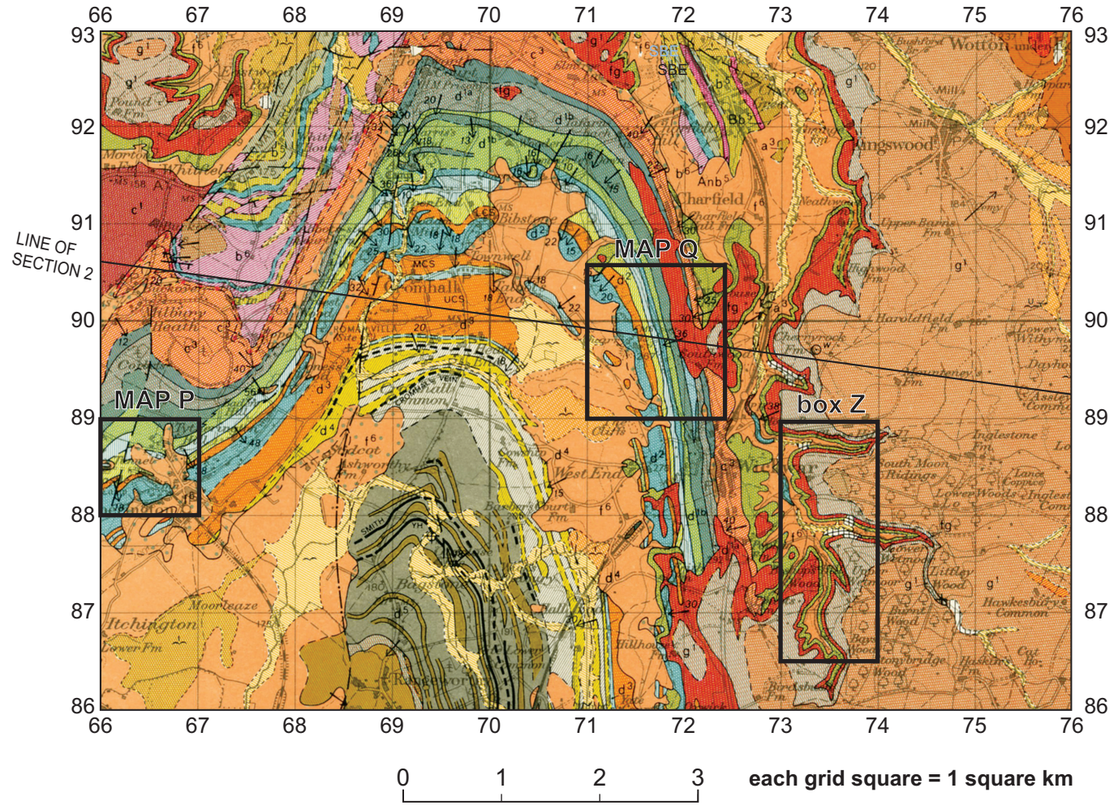
1214/01-A

S15-1214-01A

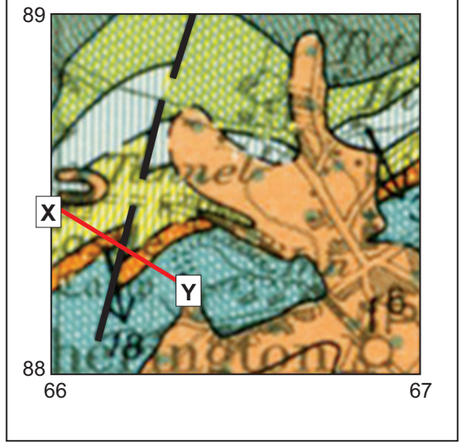
# GEOLOGY – GL4
## Interpreting the Geological Record

A.M. MONDAY, 8 June 2015

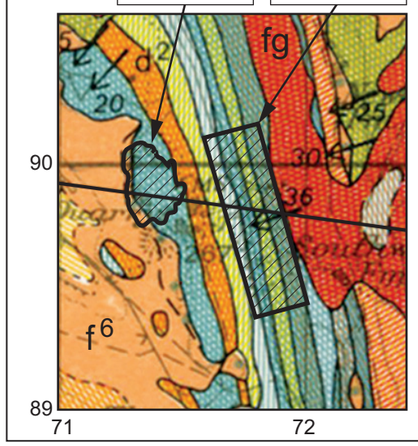
# WJEC 1214/01-A ADVANCED GEOLOGY GL4 JUNE 2015
## Extract from Malmesbury Sheet 251 (Solid and Drift) 1:63 360 (1 cm to 634 m)



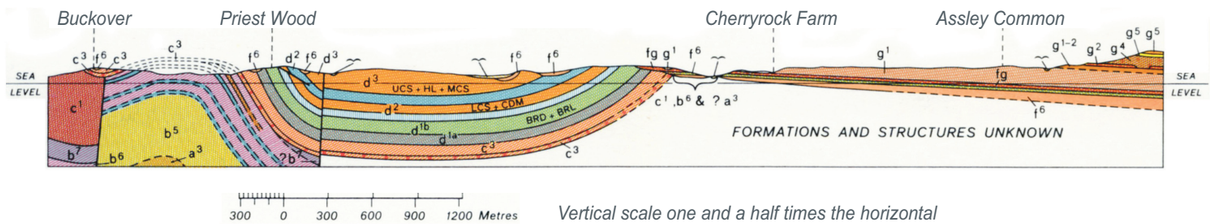

### MAP P




### MAP Q




### CROSS SECTION SHOWING THE GENERAL RELATIONS OF ROCKS ALONG LINE OF SECTION



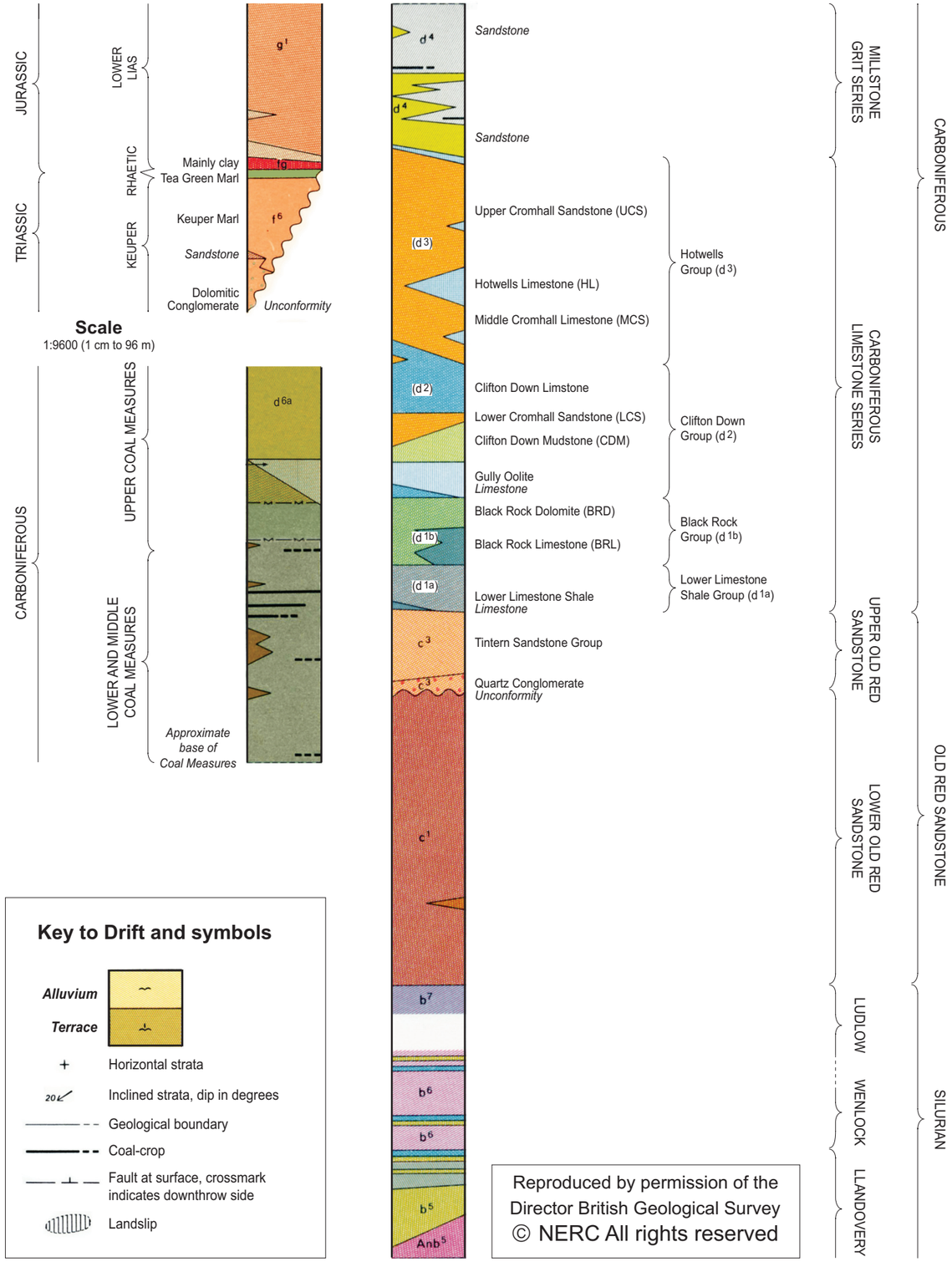

*Vertical scale one and a half times the horizontal*



(1214-01A)

## GENERALISED VERTICAL SECTION
Scale 1:9600 (1 cm to 96 m)

**Not drawn to scale**




### Key to Drift and symbols




- \+ Horizontal strata
- 20 Inclined strata, dip in degrees
- Geological boundary
- Coal-crop
- Fault at surface, crossmark indicates downthrow side
- Landslip