

Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced



CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch

454/01

GEOLOGY – GL4

INTERPRETING THE GEOLOGICAL RECORD

A.M. MONDAY, 11 June 2007

(2 Hours)

			Examiner only
Section A	1.	14	
	2.	15	
	3.	14	
	4.	17	
Section B	5.	10	
	6.	6	
	7.	10	
	8.	10	
Total		96	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

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

INSTRUCTIONS TO CANDIDATES

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

Answer **all** the 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 sub-question.

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

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

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

This section should take approximately 1 hour to complete.

1. Rocks **A**, **B** and **C** each have similar bulk chemical compositions but differ in their modes of formation. Only Rock **A** is sedimentary.

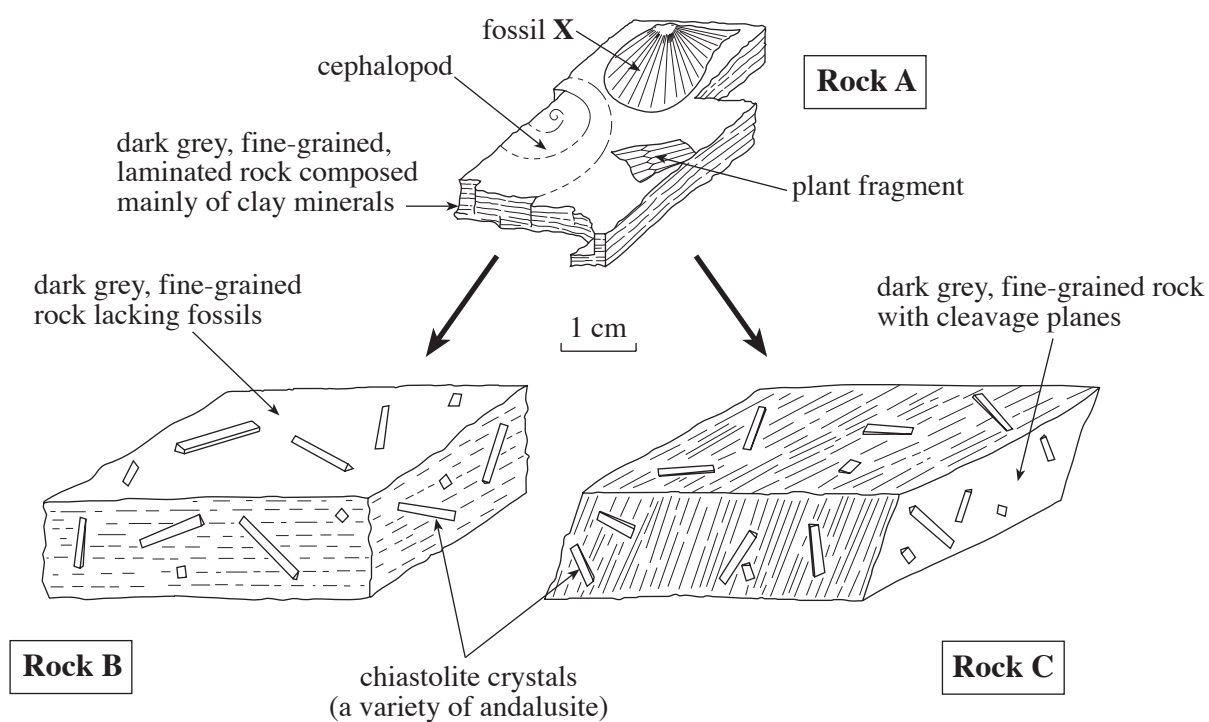


Figure 1

- (a) Refer to Rock **A** in **Figure 1**.

- (i) State the type of fossil labelled **X**. [1]

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- (ii) Giving **two** reasons, suggest a name for Rock **A**. [3]

Reason 1

Reason 2

Name

- (iii) State a possible environment of deposition for Rock **A**.
Explain the **two** pieces of evidence for this conclusion.

[3]

Environment

Evidence 1

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Evidence 2

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- (b) Refer to Rock **B** in **Figure 1**.

Describe the conditions under which Rock **B** could have been formed from Rock **A**. State the evidence for your conclusions.

[3]

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- (c) Describe the sequence of events that could have led to the formation of Rock **C** from Rock **A**. Explain the evidence for your conclusions.

[4]

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Total 14 marks

2. **Figure 2a** is a block diagram of faulted strata.

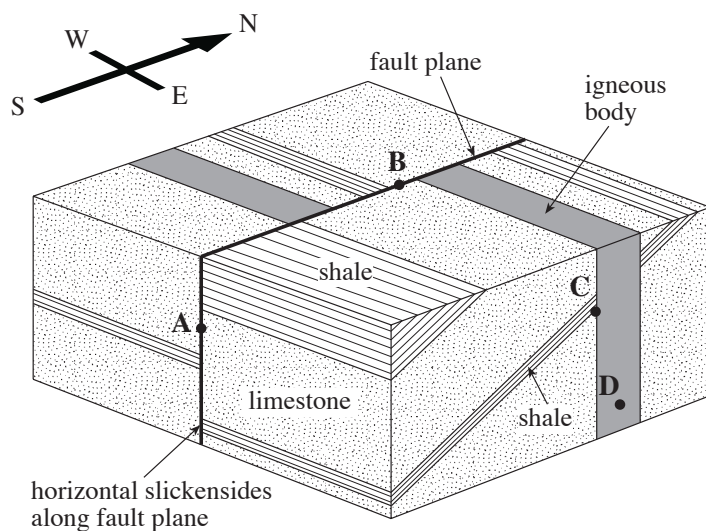


Figure 2a

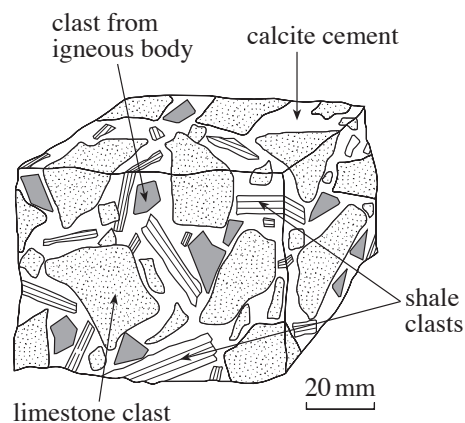


Figure 2b

(a) (i) Complete the table below to describe the characteristics of the fault.

[4]

Fault characteristics	Description
Strike directions	•
Dip (degrees)	•
Throw (vertical displacement)	0 (zero) metres
Principal stress directions of σ max	•
Type of fault	•

(ii) Explain how slickensides on a fault plane can be used to determine fault movement.

[2]

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(b) **Figure 2b** shows the texture of the rock at one of the locations **A**, **B**, **C** or **D** on **Figure 2a**. State in which location (**A-D**) the specimen is most likely to have been found. Explain the evidence from the specimen for your answer.

[3]

Location

Evidence

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(c) **Figure 2c** is a photograph of a typical exposure of the igneous body in **Figure 2a**.

structures composed
of dark, mafic,
medium-grained
igneous rock

poorly consolidated
aggregate of
crystals and clay
along joints with
red-brown staining



Figure 2c

A student incorrectly concluded that “*the structures are pillow structures formed during the submarine eruption of lava.*”

- (i) Evaluate the evidence from **Figure 2a** and **Figure 2c** which suggests the student’s conclusion was **incorrect**. [3]

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- (ii) Explain how these structures may have been produced by chemical weathering processes. [3]

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Total 15 marks

3. Mechanisms of magma emplacement and extrusion depend upon the viscosity of magma.

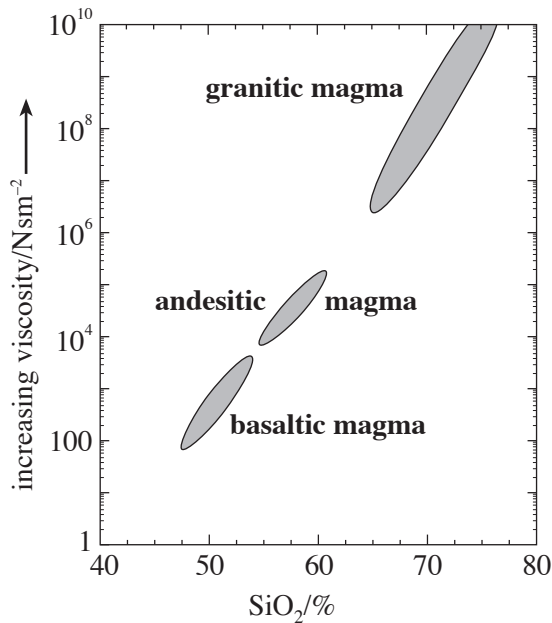


Figure 3a

(after Murase & McBinnay - 1973)

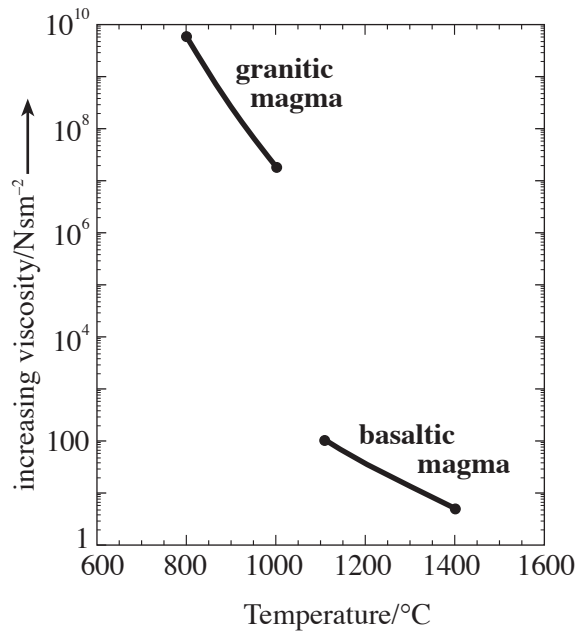


Figure 3b

- (a) **Figure 3a** shows the viscosity range of three types of magma related to their composition (SiO_2 content). Describe the relationship between viscosity and SiO_2 content. [2]

- (b) Refer to **Figure 3b**

- (i) Describe **one** similarity and **one** difference in the relationship between viscosity and temperature for granitic magma compared with basaltic magmas. [2]

Similarity

Difference

- (ii) Using **Figure 3b**, state the temperature below which basaltic magma becomes solid.

[1]

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- (iii) Draw a line on **Figure 3b** to show the probable relationship between viscosity and temperature for an **andesitic** magma.

[2]

- (c) Using evidence from **Figures 3a** and **3b**, explain why basalt lava flows commonly form low-angle “shield” cones extending many kilometres from the volcanic vent.

[3]

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- (d) Chemical analysis of the volcanic gases collected from **andesitic** volcanoes at destructive (convergent) plate margins indicates the presence of ions usually found in seawater.

- (i) Account for the presence of seawater ions in volcanic gases collected at destructive plate margins.

[2]

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- (ii) From your knowledge, explain the likely effect of seawater on the generation and eruption of magma at destructive plate margins.

[2]

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Total 14 marks

4. **Figure 4a** illustrates three fossil trilobites (**A-C**) interpreted as having different modes of life based on their external skeleton. Two reconstructions of possible modes of life are shown for trilobites **B** and **C**.

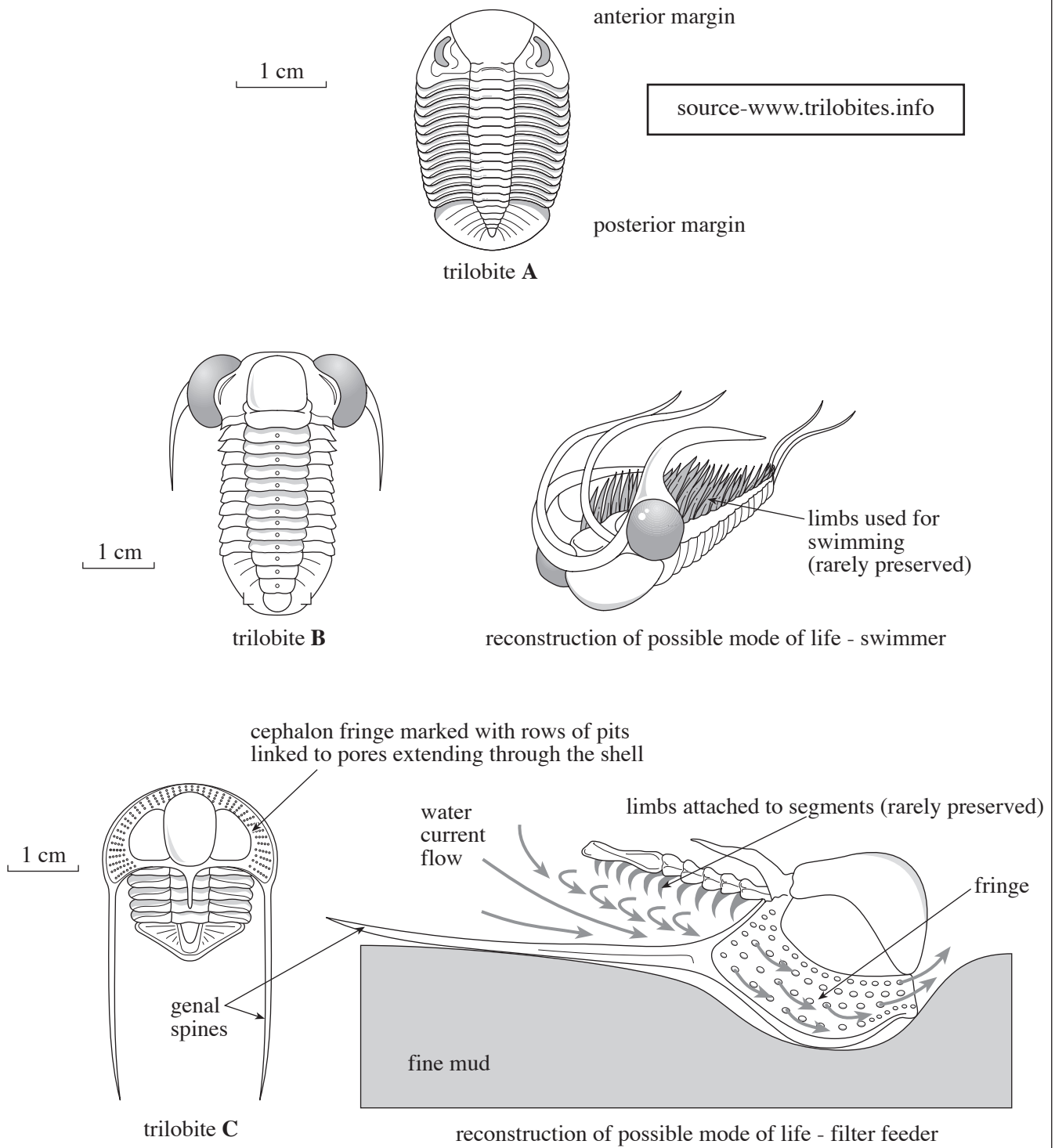


Figure 4a

Refer to **Figure 4a**

- (a) Evaluate the following student's description of trilobite **A**.

".....the semi-circular cephalon shows a glabella which is wider at the anterior margin, kidney-shaped eyes and no genal spines. The thorax contains 14 segments and the pygidium is larger than the cephalon." [2]

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- (b) (i) **Explain** how the morphological features of trilobite **B** suggest that it was an active swimmer. [2]

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- (ii) With reference to trilobite **C**, suggest a possible function of the morphological features shown in **this** proposed reconstruction of the animal in filter-feeding mode. [3]

Morphological feature	Possible function
Genal spines	•
Limbs	•
Fringe on the cephalon	•

- (c) Explain the problems of relating morphology to function and mode of life in extinct groups like the trilobites and why these problems may be minimised in areas of exceptional preservation. [3]

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- (d) **Figure 4b** illustrates selected data from a sample of Welsh trilobites showing how the average number of segments on the pygidia of one trilobite group changes with time.

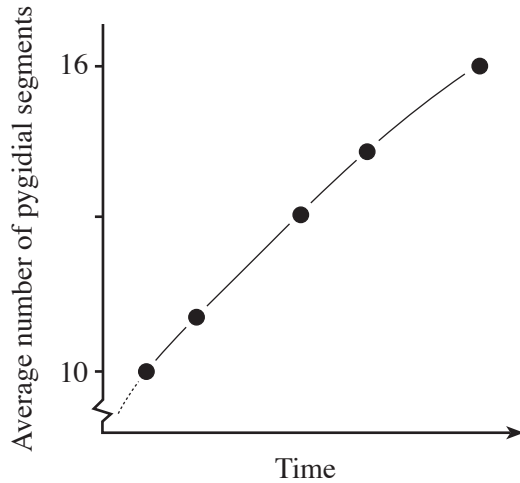


Figure 4b

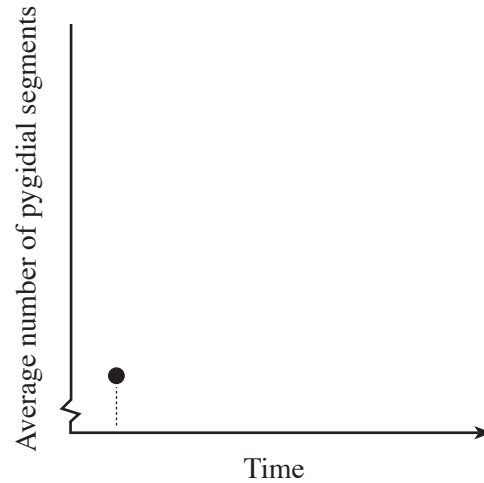


Figure 4c

Trilobites have been shown to demonstrate a gradual pattern of evolutionary change in the fossil record (*gradualism*) rather than an alternative pattern with periods of stability (*stasis*) interrupted by sudden change (*punctuated equilibrium*).

- (i) Explain why the evolutionary pattern in **Figure 4b** is interpreted as showing *gradualism* rather than *punctuated equilibrium*. [2]

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- (ii) Complete **Figure 4c** by sketching a graph that might be expected if the pattern of pygidial segments in trilobites showed *punctuated equilibrium*. Clearly label (with an **S →**) a period of 'stasis'. [2]

- (e) Using your knowledge, evaluate how reliable the fossil record is in interpreting evolutionary patterns. [3]

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Total 17 marks

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SECTION B

Questions 5–8 relate to the **British Geological Survey geological map extract of Worcester at 1:50,000 and 1:25,000 scales.**

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

This section should take approximately 1 hour to complete.

5. (a) Refer to the outcrop of the Precambrian Malverns Complex (**MvC**) on the **geological map (Map 1)**.

- (i) State the most common superficial deposit (drift) found to the east and west of the Malverns Complex (**MvC**). [1]

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- (ii) Describe the outcrop pattern of the Malverns Complex (**MvC**). [2]

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- (b) **Figure 5** is a field sketch of the boundary between the Malverns Complex (**MvC**) and the Wyche Formation (**Wy**) at **GR 766452**.

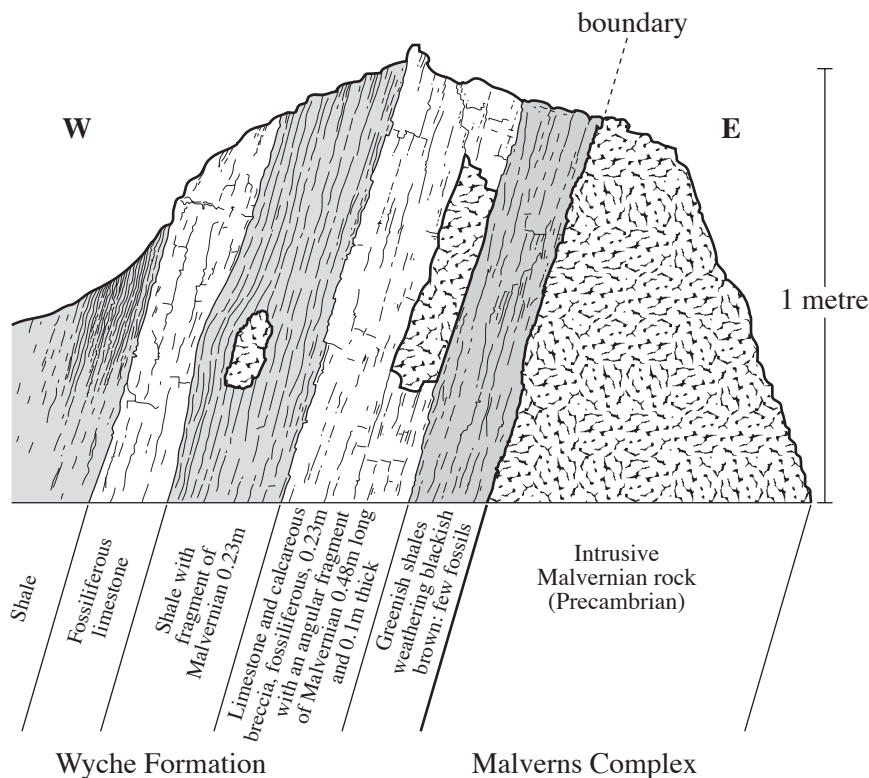


Figure 5

Source: Geology of country around Worcester (BGS-1997)

With reference to **Figure 5** and the **generalized geological column**,

- (i) complete the table below to identify the characteristics of the Wyche Formation (**Wy**), [4]

Formation	Wyche Formation (Wy)	Malverns Complex (MvC)
Dip direction	•	Not applicable
Apparent dip angle (degrees)	•	Not applicable
Rock type (igneous, sedimentary or metamorphic)	•	Intrusive igneous
Age	•	Precambrian

- (ii) outline the evidence from **Figure 5** that the Malverns Complex (**MvC**) did **not** intrude the Wyche Formation (**Wy**), [2]

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- (iii) name the type of boundary between the Wyche Formation (**Wy**) and Malverns Complex (**MvC**) present at this locality. [1]

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Total 10 marks

6. **Figure 6a** shows a Bouguer gravity anomaly map across the East Malvern Fault which includes the area of **Map 1**. **Figure 6b** is a partly completed gravity anomaly profile along the line of section on **Map 1** (A – B) extended to **C** on **Figure 6a**.

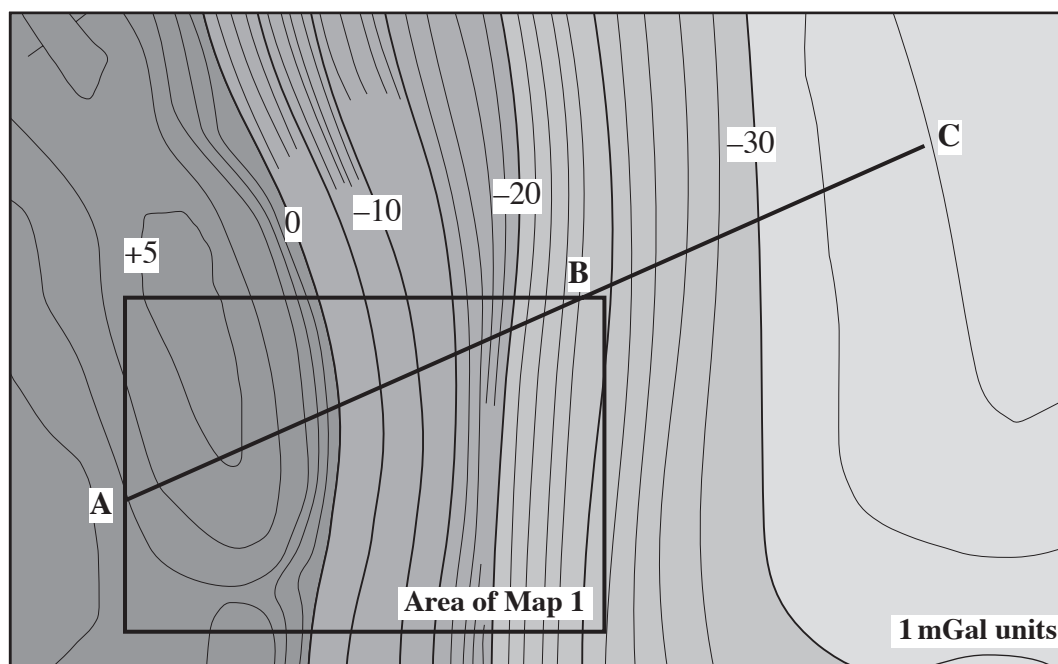


Figure 6a

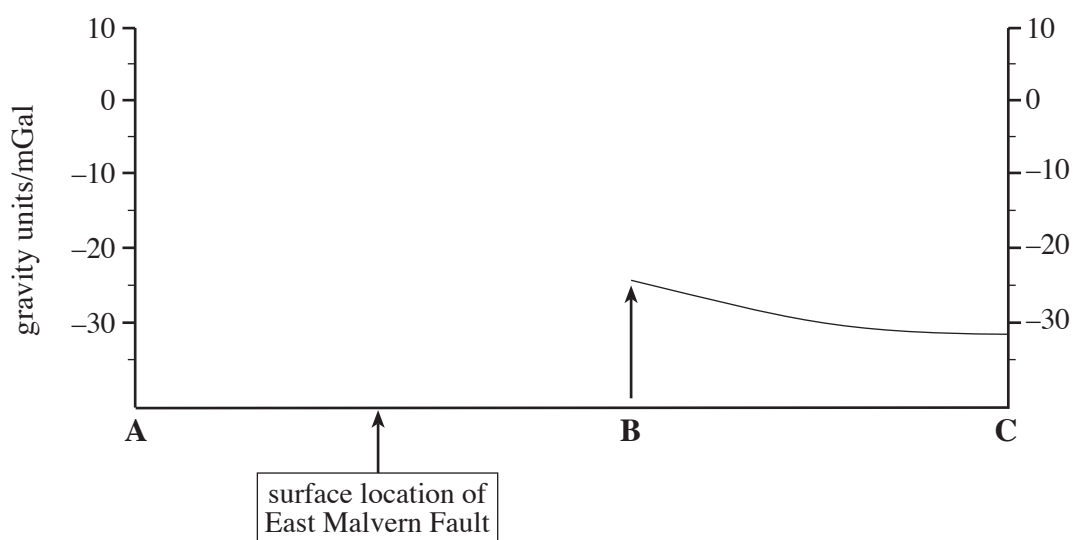


Figure 6b

Refer to **Figure 6a**, **geological Map 1** and the **cross section** as appropriate.

- (i) Complete the profile on **Figure 6b** to show the variation in gravity profile along the line of section **A** to **B**. [3]
- (ii) Explain the Bouguer gravity anomaly data in terms of :
- the probable density contrasts between rocks of the Permo-Trias and the older formations;
 - geological structure. [3]

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Total 6 marks

7. Refer to **geological Map 1**, the **cross section** and **generalised geological column** as appropriate.

- (a) Complete the table below to describe the **fold** structure responsible for the outcrop pattern of the Aymestry Limestone (**AL**) in **Map 1**, to the north east of the Colwall Fault, (**GR 752444**). [4]

Fold characteristic	Description
Fold type	•
Fold symmetry	•
Trend of axial plane trace	•
Plunge direction	•

- (b) (i) The **cross section** shows the base of Aymestry Limestone (**AL**) aligned with the base of the Woolhope Limestone (**WoL**) across the Colwall Fault.

Using the **generalised geological column**, calculate the throw (vertical displacement) of the Colwall Fault. Show your working. [2]

Throw (vertical displacement)m

- (ii) Using evidence from the **cross section only**, critically evaluate the following statement.

*The Colwall Fault and the East Malvern Fault **both***

- have similar **dips to the East**,*
- result from crustal **shortening** (compression) and*
- formed during the **same** period of deformation.*

[4]

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8. Refer to **geological Map 2** (an enlargement of the area shown on **Map 1**) and your knowledge.

- (a) *“Despite the crystalline nature of the igneous rocks, the Malverns Complex (MvC) is highly permeable and the margin of the outcrop is dominated by numerous freshwater springs.”*

Give a geological explanation for the high permeability associated with the Malverns Complex (MvC) and the presence of springs. [2]

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- (b) (i) Describe the variation in geology (rock type and structure) along the line of the Colwall tunnel (between **GR 761429** and **GR 773436**). [4]

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- (ii) Assess the possible effects the geology may have had on tunnel construction. [4]

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Total 10 marks

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