Candidate Name	Centre Number	Candidate Number
		2

GCE A level

454/01

GEOLOGY - GL4
INTERPRETING THE GEOLOGICAL RECORD

A.M. MONDAY, 9 June 2008

2 hours

			Examiner only
Section A	**1.**	**15**	
	2.	**14**	
	3.	**15**	
	4.	**16**	
Section B	**5.**	**12**	
	6.	**13**	
	7.	**11**	
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 their answers.

SECTION A

Answer **all** *questions in the space provided.*
This section should take approximately 1 hour to complete.

1. **Figure 1a** is a diagram showing the crystallisation temperature ranges of some common silicate minerals found in Bowen's Reaction Series.

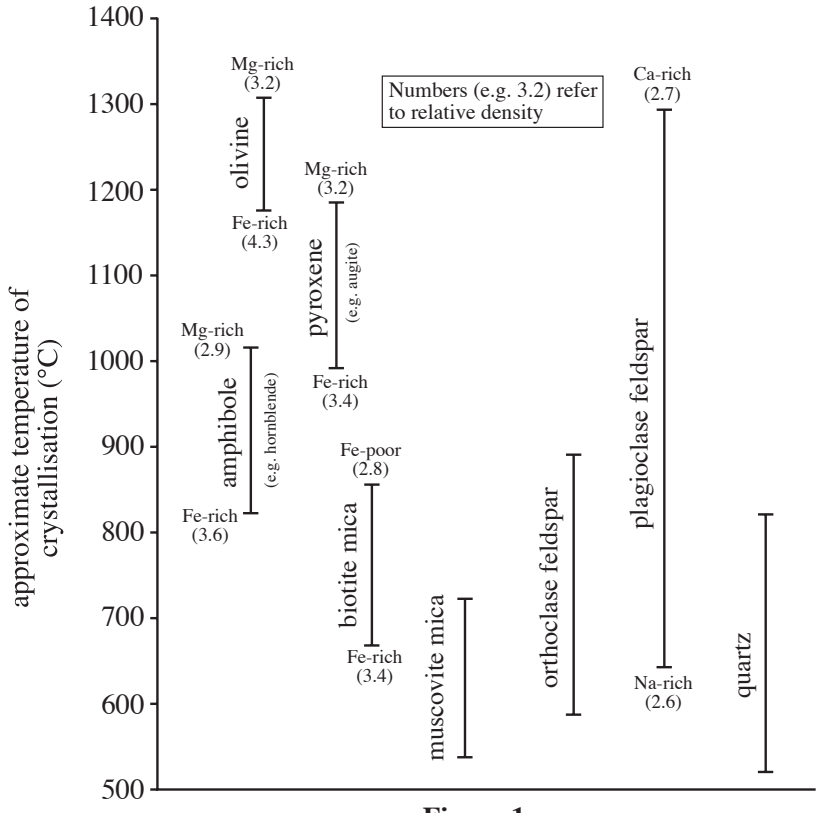

Figure 1a

(a) Refer to **Figure 1a**.

(i) State the temperature range over which olivine commonly crystallises from a magma. [1]

Range from ..... °C to ..... °C

(ii) State the difference in **composition** between the high temperature and low temperature forms of olivine. [1]

High temperature ..... Low temperature .....

(iii) Explain how the data in **Figure 1a** can be used to account for the occurrence of olivine rich layers near the base of some intrusions. [3]

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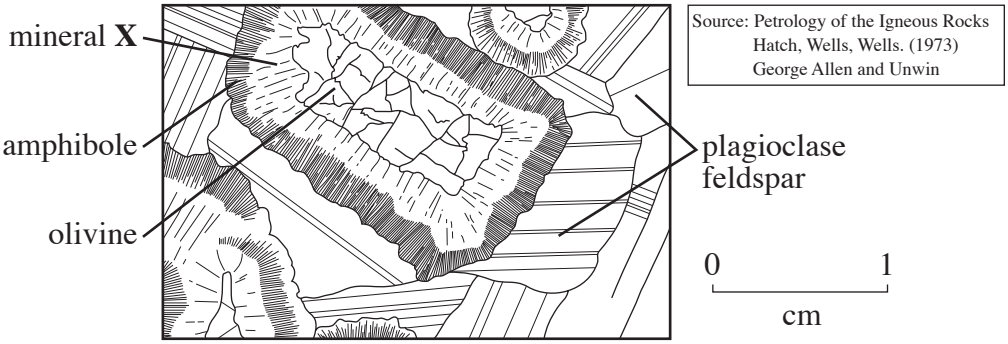
Examiner only

(b) **Figure 1b** is a photomicrograph of an igneous rock **P**.



Source: Petrology of the Igneous Rocks
Hatch, Wells, Wells. (1973)
George Allen and Unwin

Figure 1b

(i) With reference to **Figures 1a** and **1b**, suggest a name for the mineral labelled **X** in **Figure 1b**. Explain the evidence for your choice. [3]

Name .....

Explanation .....

.....

.....

(ii) Complete **Table 1** below to show the likely order of crystallisation of the minerals in **Figure 1b**; oldest (1) at the bottom. Explain the evidence for your choice. [4]

Order of crystallisation	Mineral
4 - youngest	• **Plagioclase**
3	•
2	•
1 - oldest	•

Table 1

Explanation .....

.....

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(c) A student concluded that igneous rock **P** had crystallised very slowly. Critically evaluate this statement with reference to the evidence in **Figure 1b**. [3]

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Total 15 marks

2. **Figure 2a** shows the effect of deep chemical weathering on the rock-forming minerals of a coarse-grained igneous rock in the tropics.

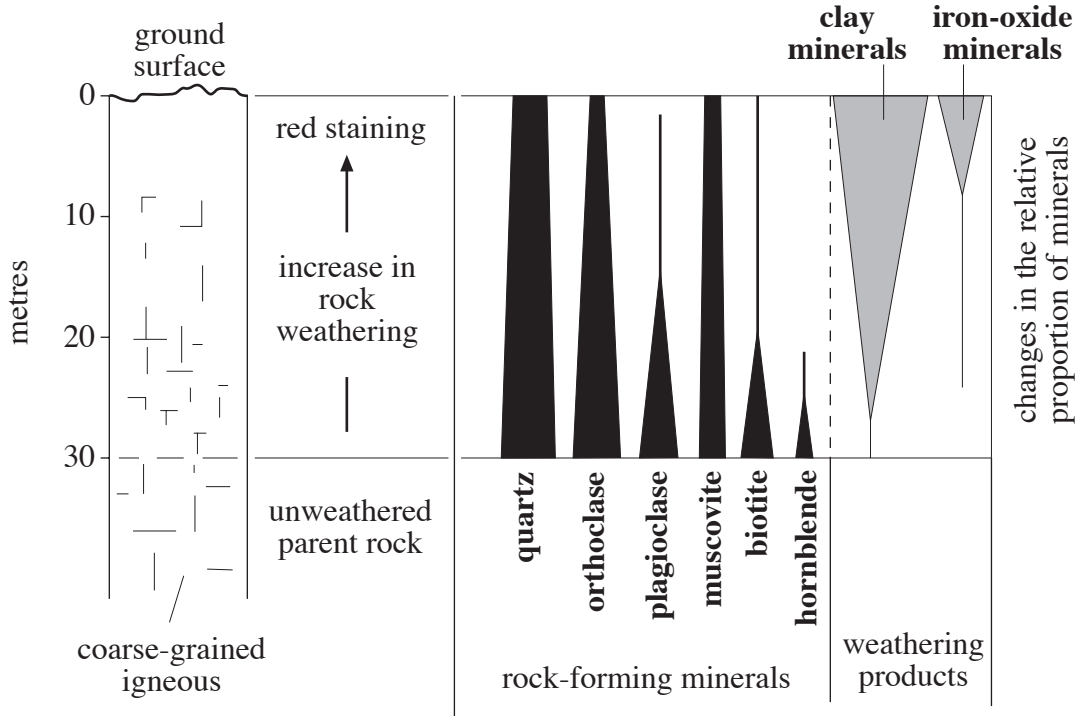

Figure 2a

(a) Refer to **Figure 2a**.

(i) Give a name for the type of parent igneous rock represented. [1]

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(ii) Name the rock-forming mineral that is
- least resistant
- most resistant

to chemical weathering. [2]

Least resistant .....

Most resistant .....

(iii) Describe the processes involved in the chemical weathering of the feldspar minerals (orthoclase, plagioclase). [3]

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(iv) Account for the *red staining* in the upper part of the weathered profile. [2]

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(b) **Figure 2b** shows the effect of increasing salinity on the proportion of clay particles in the sediment being transported by a river as it enters an estuary.

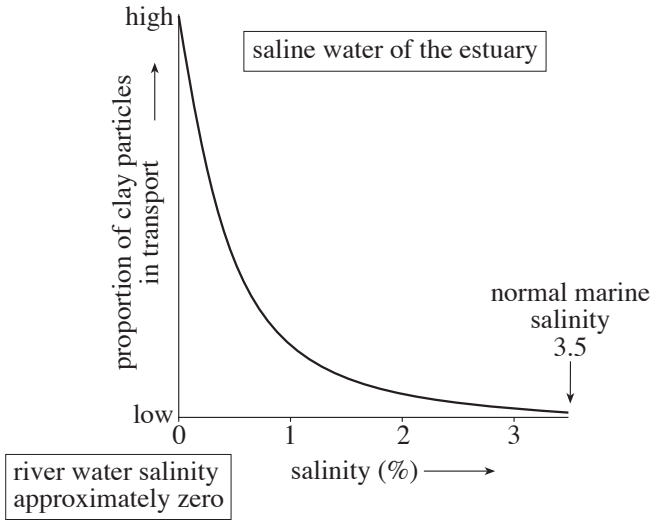

Figure 2b

Refer to **Figure 2b**.

(i) State how clay particles are transported in water. [1]

.....

(ii) Describe the relationship between the proportion of transported clay particles and water salinity. [2]

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(iii) Explain the difference in the proportion of clay in river water compared with water of normal marine salinity. [3]

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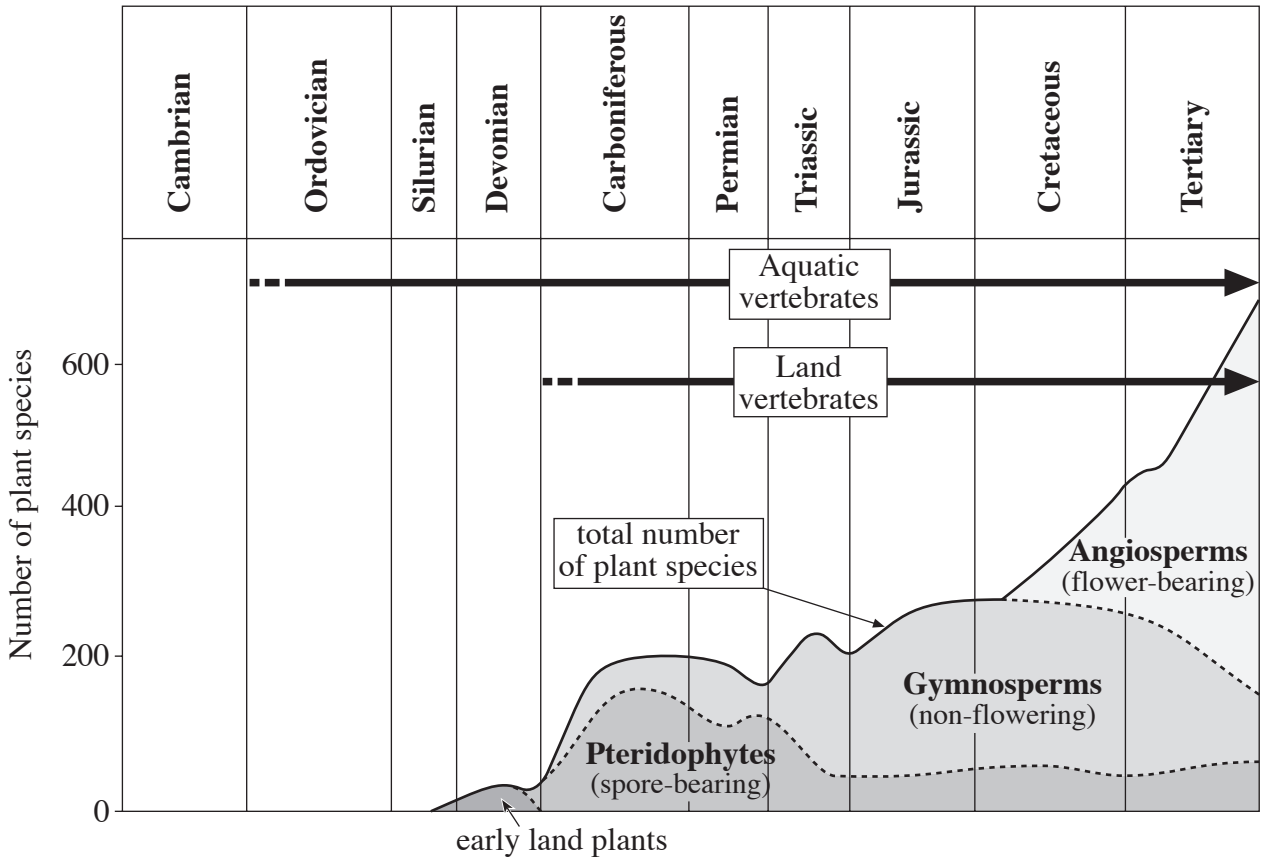
Total 14 Marks

3. **Figure 3a** shows changes in the diversity of fossil land plants and vertebrate development through time.



Source: Adapted from *The Elements Of Palaeontology* - Black. (second edition - 1990)

Figure 3a

(a) With reference to **Figure 3a**, state the geological period during which

(i) plants first began to colonise the land, ... [1]

(ii) land vertebrates first appeared. ..... [1]

(b) Describe the changes in the total number of plant species in **Figure 3a** and account for the anomalies at the end of the Permian and Triassic periods. [4]

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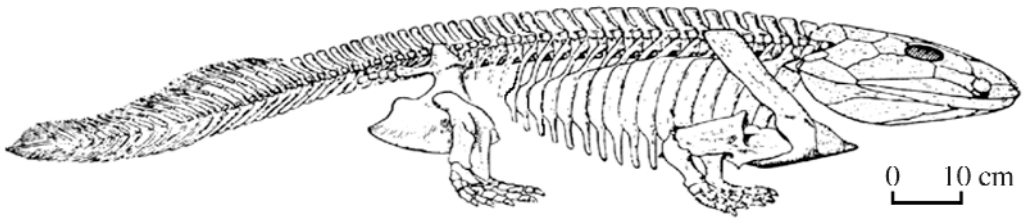
(c) **Figure 3b** shows the skeleton of a late Devonian amphibian *(Ichthyostega)*, thought to represent a transitional form between fish and land vertebrates.



Source: *www.mathsaharry.com/dino/oscar/rommy.htm*

Figure 3b

State **one** morphological adaptation that would suggest that *Ichthyostega* was

1. partly adapted to life in water,
2. partly adapted to life on land.

Explain your reasoning in each case. [4]

1. *Adaptation to life in water* .....

Explanation .....

.....

2. *Adaptation to life on land* .....

Explanation .....

.....

(d) There is little evidence in the fossil record of the gradual evolution of fish into land vertebrates. Explain how such evidence may be distorted or destroyed in the fossil record. [3]

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(e) With reference to **Figure 3a**, explain a possible link between the development of land plants and the evolution of land vertebrates. [2]

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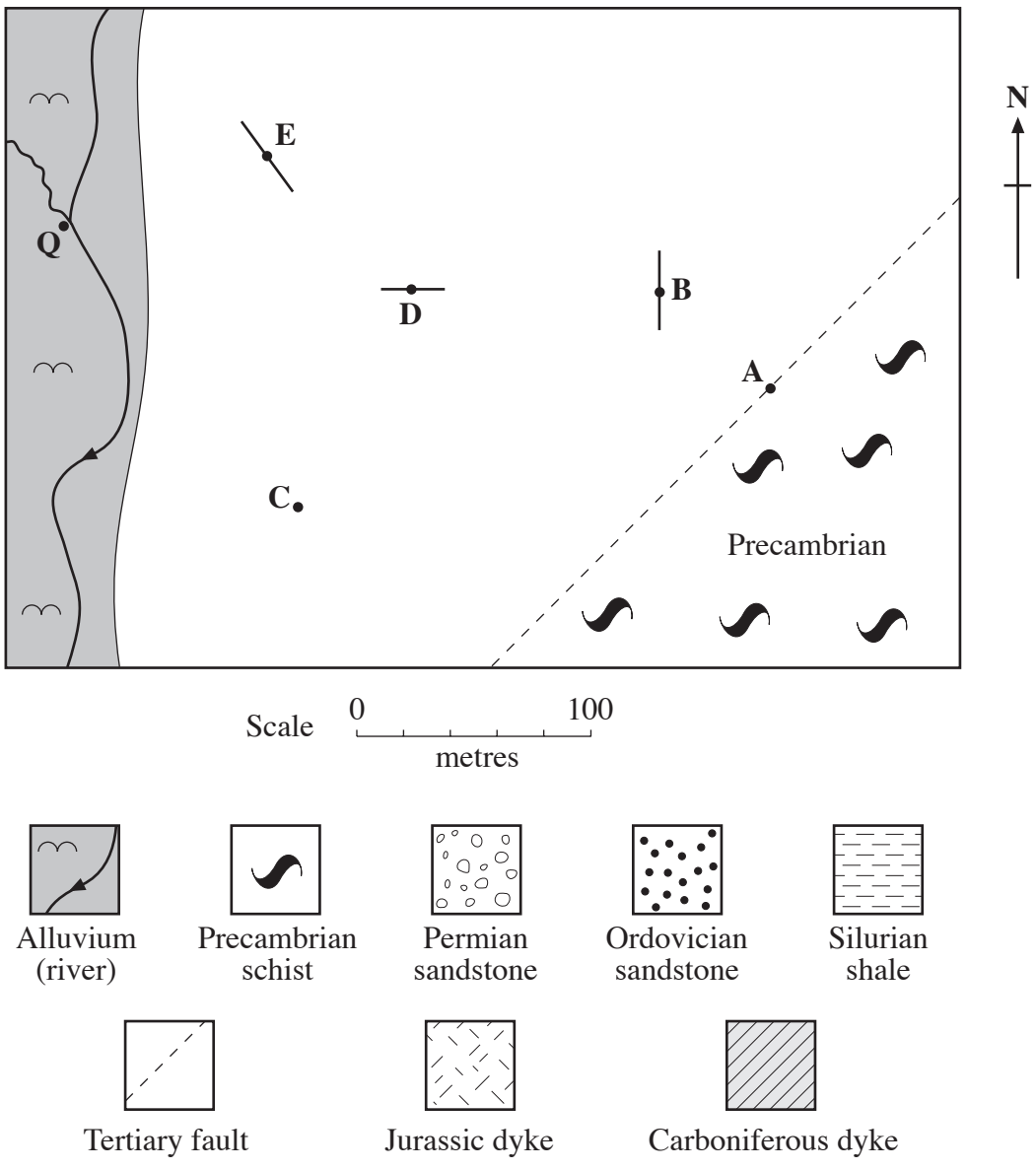
Total 15 marks

4. **Figure 4** is a partly completed geological map of an area of near **horizontal** ground, cut by a north-south trending river valley, overlain by superficial (alluvial) deposits.



(Strata not in order of age)

Figure 4

(a) Using the information from the five exposures **(A–E)** detailed below, complete the geological map **(Figure 4)**. Use the appropriate shading provided in the key.
The data from **Exposure A** has been completed on the map.

Exposure A: (Already mapped). A **Tertiary** fault, with a NE-SW strike
The fault dips at 15 degrees towards the SE. South east of the fault the area is composed of Precambrian schist.

Exposure B: The eastern contact of a vertical, 20 metre wide dyke of **Jurassic** age, with a N-S trend.

Exposure C: The unconformable base of **Permian** sandstone, with a NE-SW strike which dips SE at 5 degrees.

Exposure D: The conformable boundary between **Ordovician** sandstones and **Silurian** shales, striking E-W and dipping at 40° N.

Exposure E: The northern contact of a dolerite dyke of **Carboniferous** age, trending NW-SE and dipping at 75° to NE. The dyke has a **true thickness** of 20 metres.
[10]

(b) Using **two** pieces of evidence from the data provided, state the type of fault represented at **Exposure A**. [3]

Fault type .....

Evidence .....

.....

Evidence .....

.....

(c) A small outcrop of dolerite was identified on the western side of the valley at **Location Q**. A student concluded that this was a continuation of the Carboniferous dolerite dyke that crops out at **Exposure E** which had been offset by faulting. Critically evaluate the evidence for this conclusion. [3]

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Total 16 marks

SECTION B

*Questions 5 – 7 relate to the **British Geological Survey 1:25 000 geological map** extract of **Matlock***

*Answer **all** questions in the spaces provided.*
This section should take approximately 1 hour to complete.

5. *(a)* (i) State the **main** superficial deposit (drift) on the **Geological Map**. [1]

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(ii) Describe the major features of the outcrop pattern of the **Carboniferous Limestone Series** on the **Geological Map** by completing the table below. [3]

Outcrop pattern	Measurement or description
Maximum NW - SE length	• km
Maximum NE - SW width	• km
General shape	•

(b) Describe the characteristics of the major fold structure on the **Geological Map** and **cross section**. [4]

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(c) Refer to the line of section **A-B** in **grid square 3364** on the **Geological Map** and the cross sections (**X**, **Y** and **Z**) in **Figure 5** below.

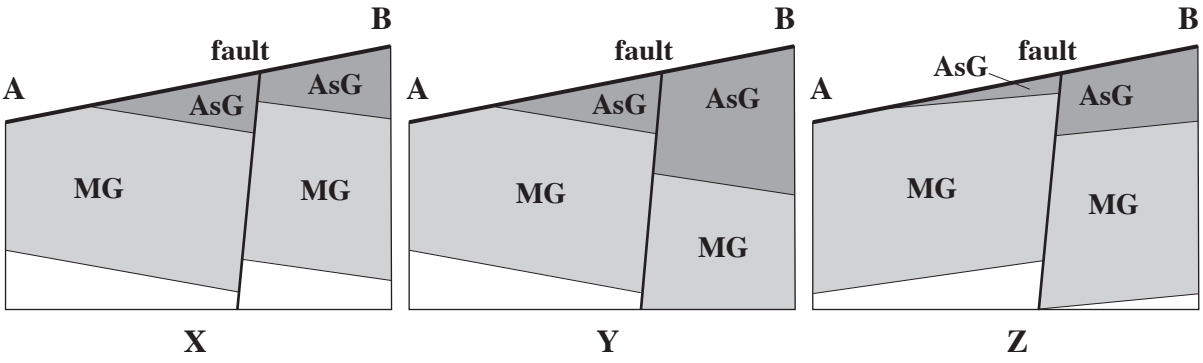

Figure 5

(i) State which of the cross sections (**X**, **Y** or **Z**) is most likely to represent the geology below the line of section **A-B**. [1]

Choice of section (**X**, **Y** or **Z**) ☐

(ii) Describe the map evidence in **grid square 3364** that supports this choice for the displacement of the Ashover Grits **(AsG)** across the fault. [1]

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(iii) Explain how the outcrop pattern around Hardwick Wood **(GR 335644)** might confirm the direction of dip of the Ashover Grits **(AsG)** in this area. [2]

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Total 12 marks

6. **Table 6** is a partly completed tally of orientations of the main mineral veins on the **Geological Map**. **Figure 6** is a partly completed rose diagram of vein orientations.

N-S		NE-SW		E-W		NW-SE	
/		𝍸 𝍸 𝍸 𝍸 //		𝍸 𝍸 𝍸 𝍸		𝍸 𝍸 𝍸 /	
Total	**1**	Total	•	Total	**20**	Total	•

Key

/ = 1 mineral vein 𝍸 = 5 mineral veins

Table 6

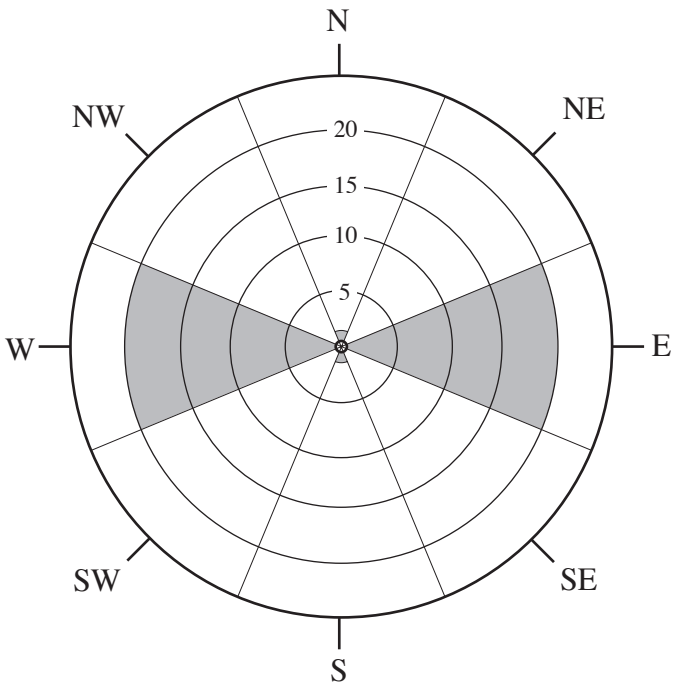

Figure 6

(a) Name **one** metal ore that has been mined in this region. [1]

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(b) (i) The tally in **Table 6** does not include the 4 mineral veins within **Box C** on the **Geological Map**. An enlargement of **Box C** is found on the map extract. Add these to the tally and complete the totals for the data set. [2]

(ii) Complete the rose diagram **(Figure 6)** to show the orientations of the veins for the completed data set in **Table 6**. [3]

(iii) Describe and account for the orientation and distribution of mineral veins on the **Geological Map**. [3]

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(c) Some mineral veins have formed along vertical fault planes.

(i) Critically assess the map evidence that the Gregory vein **(GR 340618)** has formed **"along a vertical fault plane"**. [2]

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(ii) Explain **one** piece of **field** evidence (other than displacement) that might indicate that the Gregory vein formed along a fault. [2]

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Total 13 marks

7. *(a)* **Figure 7** is a partially complete survey of radon gas concentrations in soil samples along the line of section drawn across the **Geological Map**. Further survey data are given in the information box **(Table 7)**. The Key to the superficial (drift) deposits is on the map extract.

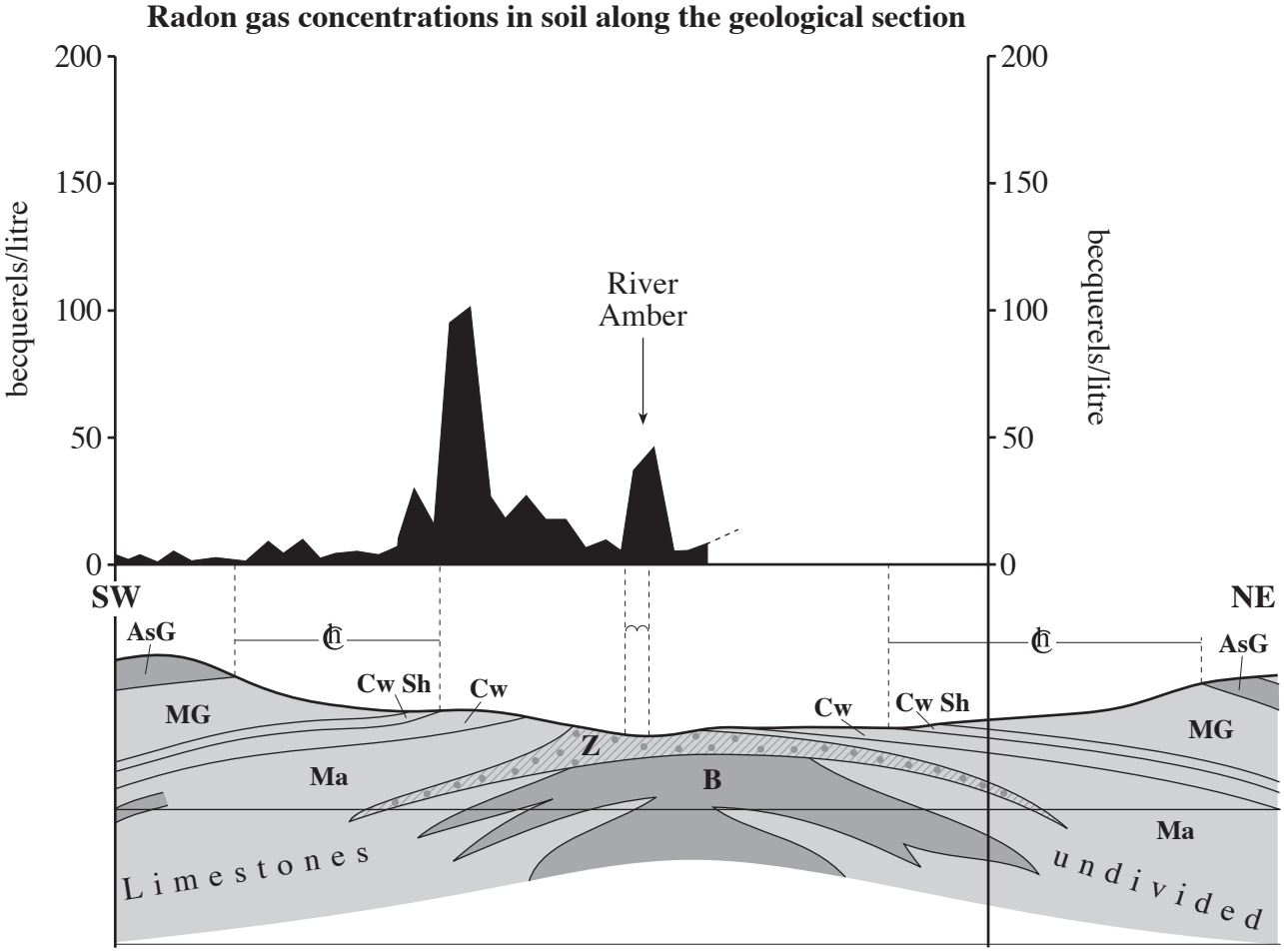

Figure 7

Radon gas concentrations in soil

Radon gas concentrations reach a maximum of 150 becquerels/litre on the NE side of the Amber Valley. The release of radon gas into the soil partly depends on the permeability of the underlying rock and the presence of any overlying superficial (drift) deposits.

Source: Quarterly Journal of Engineering Geology 24 1991
The Geological Society.

Table 7

(i) Using the data given, complete the survey on **Figure 7** by estimating the size and probable extent of radon gas concentrations in soils to the **NE** of the River Amber. [2]

(ii) Describe and account for the change in radon gas concentrations in soil samples above the outcrops of **either**:

1. the Millstone Grit Series - Shale **(MG)**.

or

2. the Carboniferous limestones - **Cw** and **Ma** [4]

Chosen unit 1 or 2 ☐

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(b) The area of the Amber Valley between **GR 343632** and **GR 355622**, where it is underlain by **Tuff (Z)**, could be developed as a reservoir.

Using evidence from the **Geological Map**, **cross section** and other data, assess the geological factors **that would need to be investigated** prior to such a development.

In particular you should discuss

- the geological suitability of the valley as a reservoir site and
- any potential pollution hazards. [5]

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Total 11 marks

Examiner only