Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1214/01

S16-1214-01

GEOLOGY – GL4
Interpreting the Geological Record

P.M. MONDAY, 6 June 2016

2 hours

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**15**	
	2.	**15**	
	3.	**15**	
	4.	**15**	
Section B	**5.**	**11**	
	6.	**17**	
	7.	**12**	
	Total	**100**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need:
- the Geological Map Extract (Kirkcaldy);
- 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.

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SECTION A

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

This section should take approximately 1 hour to complete.

1. **Figure 1a** is a geological section showing two igneous bodies (**A** and **B**) which occur within a sedimentary rock sequence. **Figure 1b** shows a vertical section of structures within igneous body **A**. **Figure 1c** shows details of the composition and texture at four selected depths between **P-Q** across igneous body **B** in **Figure 1a**.

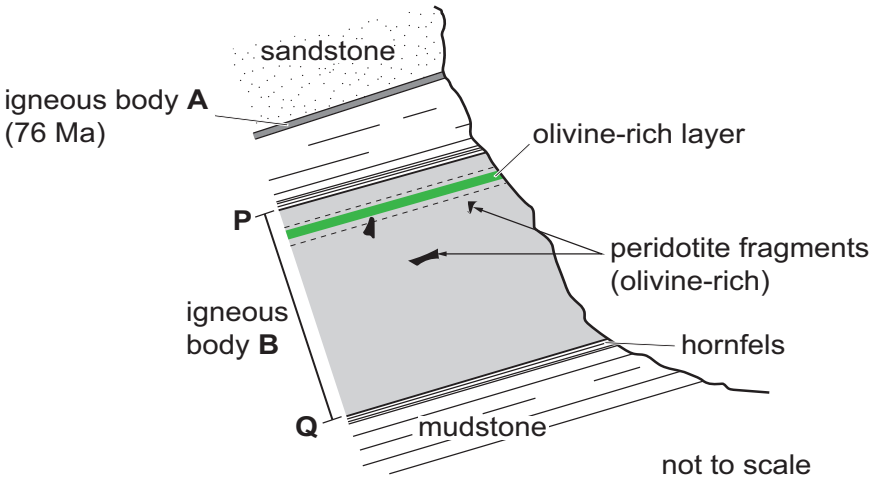

Figure 1a

Figure 1b

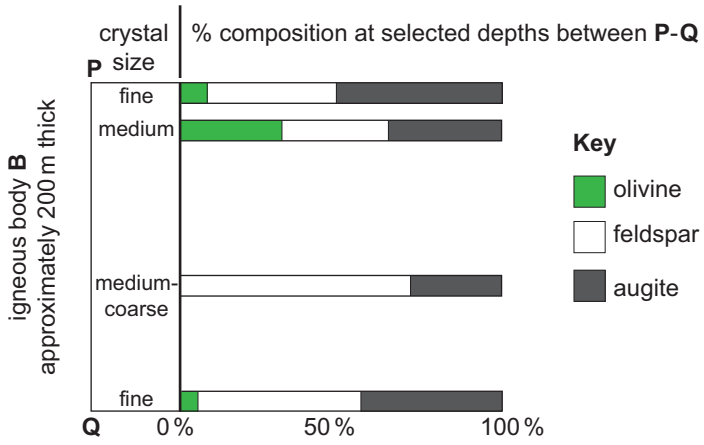

Figure 1c

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

(i) Identify the structures within igneous body **A** (**Figure 1b**) and explain their origin. [2]

Structures .....

Origin .....

.....

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(ii) Using evidence from **Figure 1b** *alone*, draw an arrow labelled **Y** (←**Y**) on **Figure 1a** to show the **youngest sedimentary** rock unit in the sequence. Explain your answer. [3]

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(b) (i) With reference to **Figure 1a** and **Figure 1c**, describe the distribution of olivine within igneous body **B**. [3]

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(ii) Explain the presence and location of the **olivine-rich layer** within the upper part of igneous body **B**. [4]

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(c) Igneous body **A** has a radiometric age of 76 Ma.
Draw an arrow labelled **X** (←**X**) on **Figure 1a** where a specimen of **igneous** rock might be **OLDER** than 76 Ma. Explain your answer. [3]

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Turn over.

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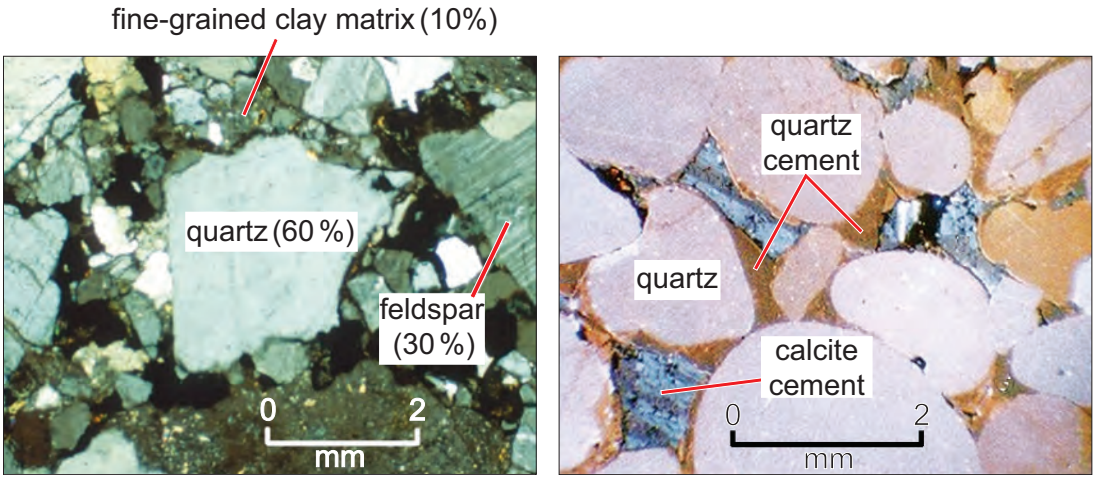
2. **Figure 2a** shows photomicrographs of two sedimentary rocks (rocks **A** and **B**).
Figure 2b is a triangular graph on which the composition of rock **A** has been plotted.



Rock **A** (rocks at different scales) Rock **B**

Figure 2a

Rock **A** Composition (%)	
Quartz	60
Feldspar	30
Clay	10

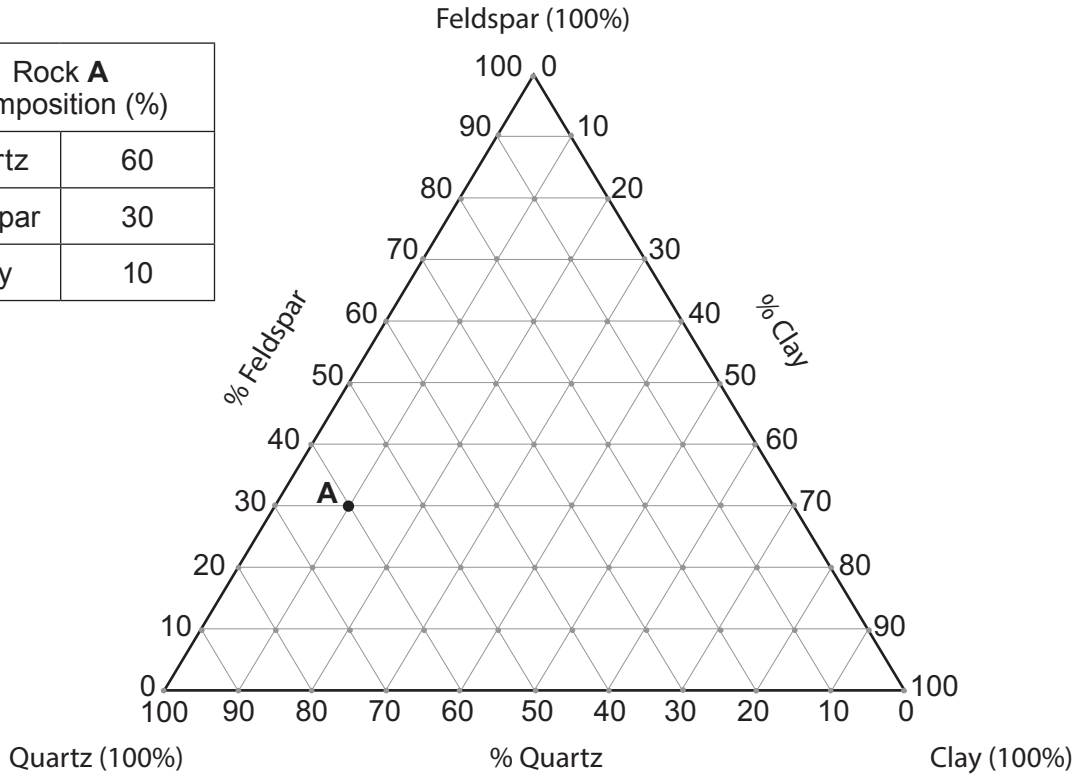


Figure 2b

Examiner only

(a) State **two** differences in **texture** between rocks **A** and **B** in **Figure 2a**. Explain why the textures differ. [4]

Difference .....

Difference .....

Explanation .....

.....

(b) (i) The composition of rock **B** before lithification was 95% quartz, 5% feldspar. Plot this composition on **Figure 2b** and label with the letter **B**. [1]

(ii) Draw an arrow from point **A** on **Figure 2b** to show how the **composition** of rock **A** might change over time if it were subjected to intense chemical weathering in a tropical climate. [2]

(iii) Explain the changes in composition you have identified in *(b)* (ii). [3]

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(c) State in which of the following environments of deposition you would most likely find sediments similar to those of rocks **A** and **B** being deposited today.

Choose **one** environment **only** from the list below for rock **A** and **one** for rock **B**, indicating with the appropriate rock letter (**A** or **B**). [2]

Environment of deposition	Rock **A** or **B** (Choose **one** environment for each rock)
beach (marine)	
coral lagoon	
semi-arid river (alluvial fan)	
tidal mudflats	

(d) Describe the likely **post-depositional** history of rock **B** stating the evidence for your conclusions. [3]

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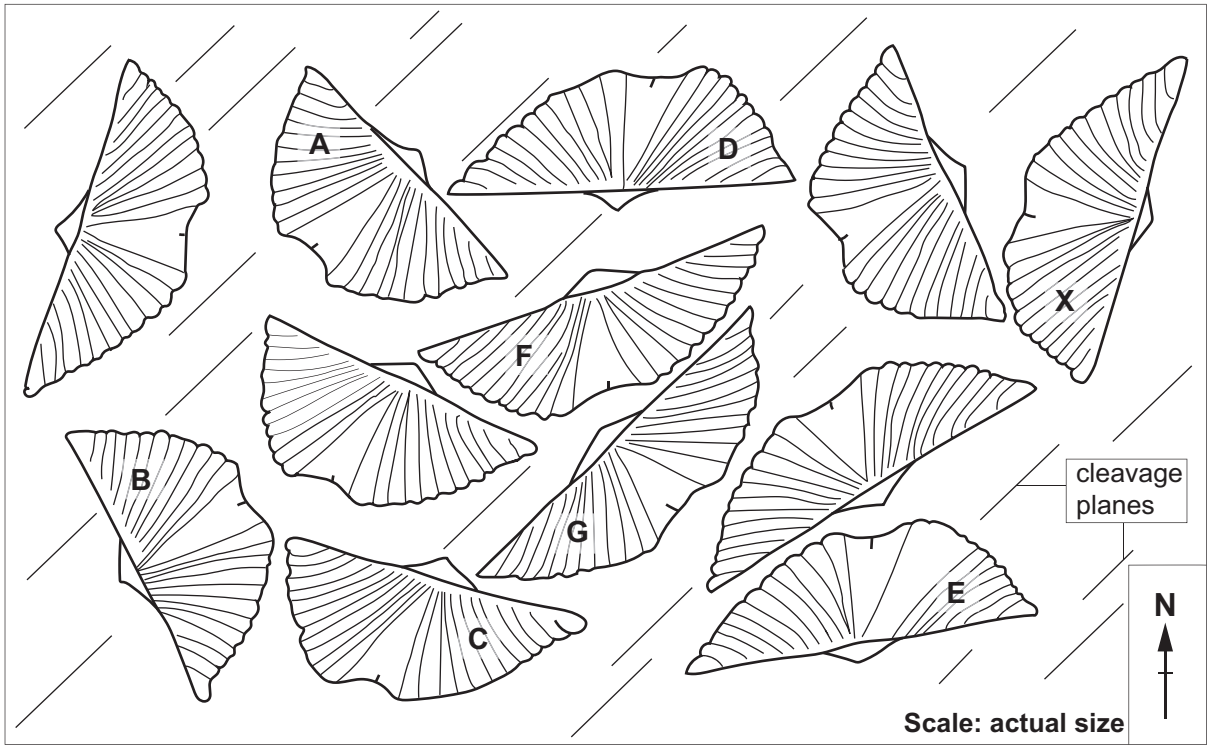
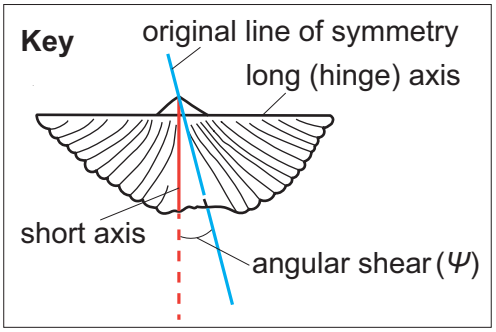
3. **Figure 3** shows deformed fossil brachiopods of the **same** species preserved on a bedding surface within cleaved shale. **Table 3** shows data collected from the specimens.





Angular shear (ψ) = the change in angle between the short axis (a line at 90° to the long, hinge axis) and the original line of symmetry

Figure 3

Brachiopod letter	Long (hinge) axis (mm)	Short axis (mm) (at 90° to long axis)	Long : short axis ratio	Angular shear (ψ)
A	38	19	2.0	0°
B	40	19	2.1	6°
C	41	19	2.2	15°
D	46	18	2.6	17°
E	47	16	2.9	17°
F	48	16	3.0	12°
G	51	15	3.3	0°
X		17		

Table 3

Refer to **Figure 3**.

(a) (i) Describe, with reasons, the possible environment in which the shale was deposited. [2]

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(ii) The evidence suggesting that the fossil brachiopods on this bedding plane represent a *life* or *death* assemblage is conflicting.

Critically evaluate the statement that suggests *"the brachiopods represent a **life** assemblage".* [3]

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(b) Complete **Table 3**.

(i) Measure the long (hinge) axis of brachiopod **X** and express this as a ratio with the short axis. [2]

(ii) Measure the angular shear (ψ) of brachiopod **X**. [1]

(c) Refer to **Figure 3** and **Table 3**.

(i) State the letter of **one** fossil brachiopod that shows bilateral symmetry. [1]

Brachiopod .....

(ii) Describe the differences in the way in which brachiopods **A** and **G** have been deformed. [2]

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(iii) A student concluded that the deformation of this bed was:

"consistent with an east-west crustal shortening with a minimum principal stress direction from the north-south".

Critically evaluate the evidence for this statement. [4]

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4. **Figure 4** shows the changes in diversity of marine fauna (Sepkoski's curves) during the Phanerozoic along with the arrangement of continents over the same time.

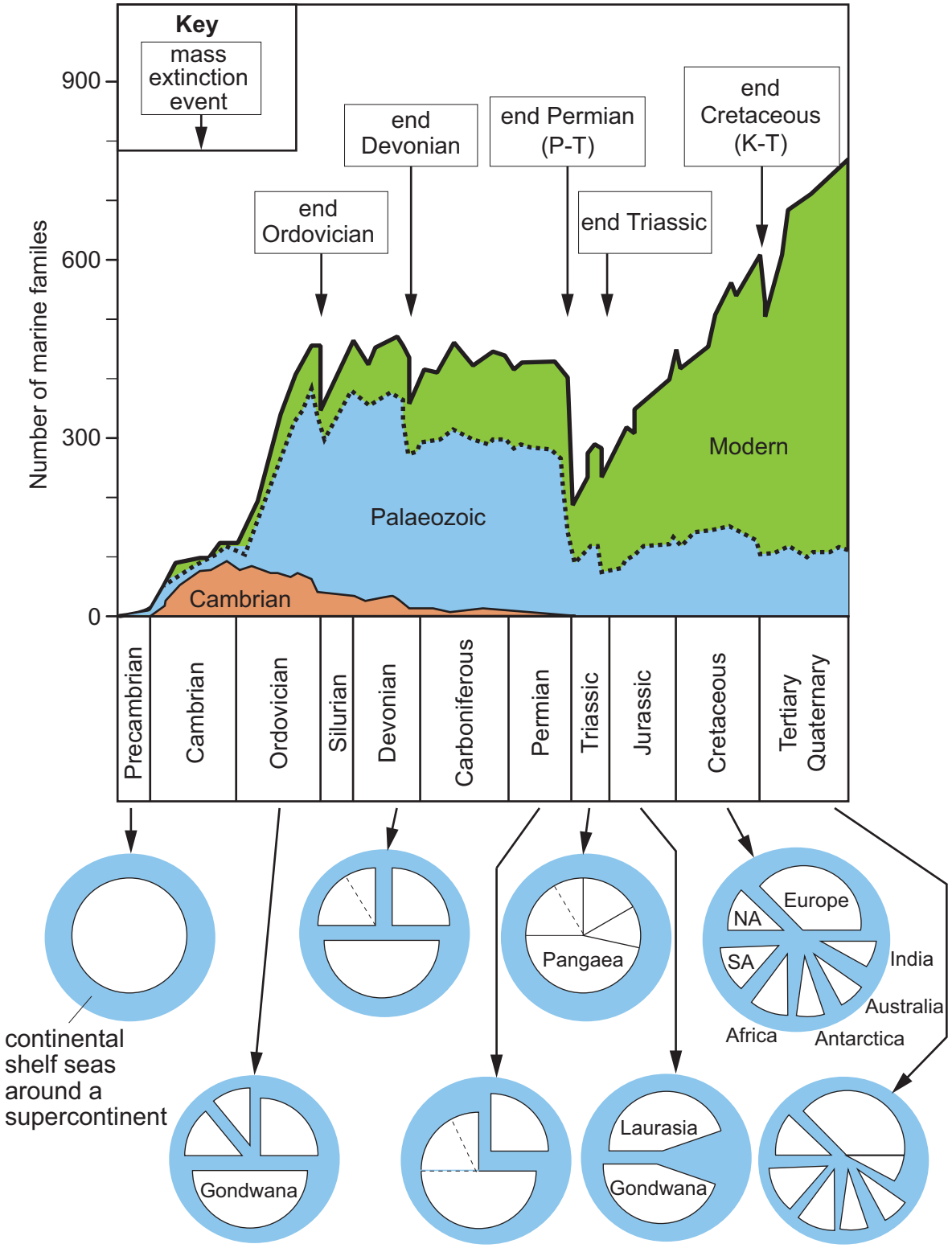

Figure 4

Refer to **Figure 4**.

(a) (i) Name the most abundant Phanerozoic fauna (*Cambrian, Palaeozoic* **or** *Modern*) that existed during the Mesozoic era. [1]

.....

(ii) Complete **Table 4** below with the following.

1. The percentage of marine families that became extinct during the end Cretaceous (K-T) extinction. Show your working in the space provided.

2. The name of the mass extinction at which approximately 51 % of marine families became extinct. [3]

Extinction events	Percentage of marine families extinct
end Cretaceous (K-T)	Working • *Answer* = ... %
•	51 %

Table 4

(b) Explain why the small number of families recorded in the late Precambrian may not necessarily reflect the abundance of life at that time. [3]

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(c) (i) Describe the relative change in the area of continental shelf seas in **Figure 4** between the Precambrian and the end of the Carboniferous. [2]

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(ii) **Describe** the correlation between changes in the diversity of marine organisms and the breakup of the continents following the end Permian (P-T) mass extinction. [2]

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(iii) *"Changes in the proportion of continental shelf seas were responsible for the diversity of marine fauna through geological time."*

Critically evaluate this statement. [4]

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SECTION B

*Questions **5 - 7** relate to the **British Geological Survey 1:50 000 geological map** extract of **Kirkcaldy (Sheet 40E)***

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

This section should take approximately 1 hour to complete.

5. *(a)* With reference to the **cross-section**, state the

- maximum thickness
- maximum depth

of the quartz dolerite (***qD***) beneath sea-level (OD) on the axis of the Leven Syncline.

Maximum thickness on the Leven Syncline	• m
Maximum depth on the Leven Syncline	• m

[2]

(b) The quartz dolerite (***qD***) that crops out in **Box A** on the **geological map** is interpreted as the surface outcrop of a sill.

(i) Complete **Figure 5** by stating the **two** rock types you might predict to find **in the field** at the upper boundary of the sill in **Box A**. [2]

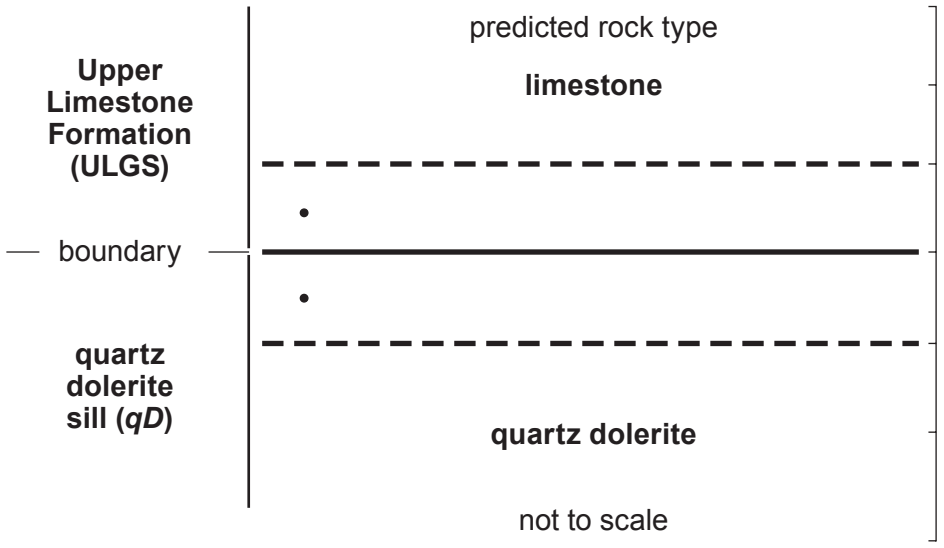

Figure 5

Examiner only

(ii) From your **knowledge**, explain why an igneous body made of quartz dolerite (***qD***) is more likely to be associated with an intrusion than a lava flow. [2]

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(iii) Critically evaluate the evidence from the **geological map** and **cross-section** that suggests the quartz dolerite (***qD***) forms a sill rather than a dyke. [3]

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(c) *"The quartz dolerite (**qD**) sill was partly intruded along faults."*

Critically evaluate the **evidence** from the **cross-section** for this statement. [2]

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Turn over.

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6. **Figure 6** is a copy of the **geological map**.

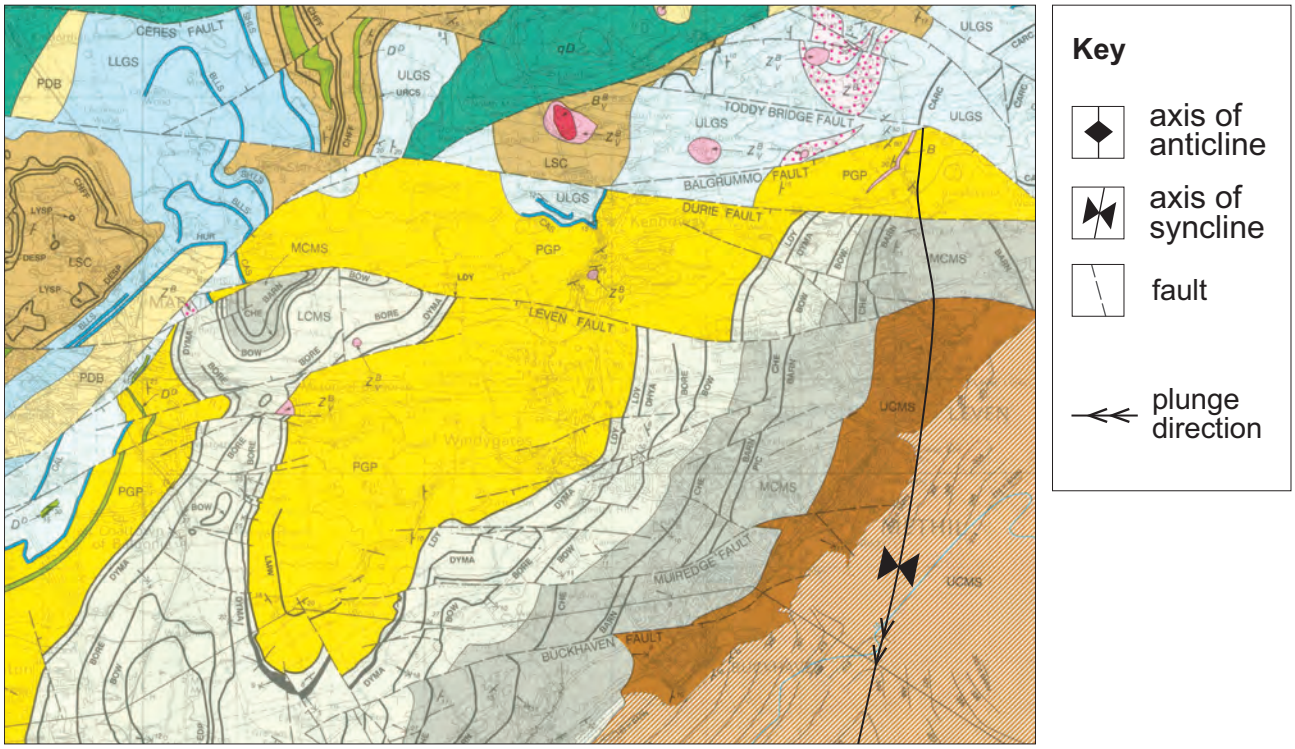

Figure 6

Refer to the **geological map**, **generalised geological column** and **Figure 6**.

(a) (i) On **Figure 6**, draw in the axial plane trace of a *plunging anticline*. Use the symbol in the key to indicate the direction of plunge of this fold. [2]

(ii) Describe the **evidence** that enables identification of the following fold characteristics. [2]

1. Anticline .....

2. Direction of plunge .....

.....

(b) A student incorrectly concluded that the Durie Fault (**GS 3602**) showed strike slip movement to the right (dextral). Give **two** pieces of map evidence that show this interpretation to be **incorrect**. [2]

1. .....

2. .....

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(c) Using the **geological map** and **cross-section**, describe the general characteristics of the Buckhaven Fault that crops out in **grid square 3698** by completing **Table 6** below. [4]

Buckhaven Fault characteristics	
Dip angle	varies with depth
Strike direction	•
Downthrow side	•
Hanging wall	•
Fault type	•

Table 6

(d) The **cross-section** shows the base of the Upper Coal Measures (**UCMS**) to the east of the Buckhaven Fault is approximately aligned with the Chemiss coal (**CHE**) of the Middle Coal Measures (**MCMS**) to the west.

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

Throw = ... m

(ii) Describe how displacement on the Buckhaven Fault varies with depth. [2]

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(e) Coal mining of the Middle and Lower Coal Measures (**MCMS** and **LCMS**) occurred within the Leven Syncline on land and beneath the Firth of Forth Estuary. Using the **cross-section** and **generalised geological column** suggest the **geological** problems that might have been encountered during mining. [3]

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Turn over.

Examiner only

7. **Figure 7a** is a model showing coal-bearing strata on the limb of a plunging fold. **Table 7** gives details of the conditions needed to dispose of carbon dioxide (sequestration) in coal-bearing strata.

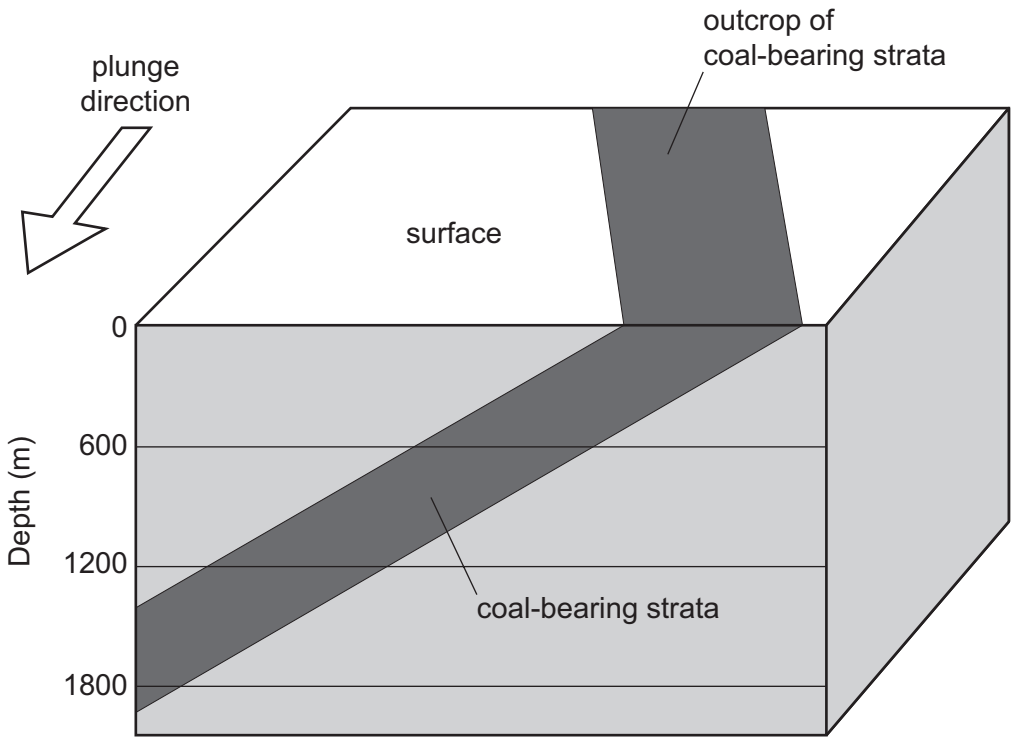

Figure 7a

CO_2 sequestration

The long-term disposal of carbon dioxide (CO_2) by pumping liquefied gas into deeply buried coal seams (over 1200 m deep) is an option for reducing atmospheric CO_2 levels. CO_2 binds strongly to the surfaces within coal where it is stored.

Table 7

Examiner only

(a) Shade and label the **top surface** of **Figure 7a** to show the area below which there is potential for CO_2 sequestration. [2]

(b) **Figure 7b** is a photo of a typical specimen of Carboniferous coal.

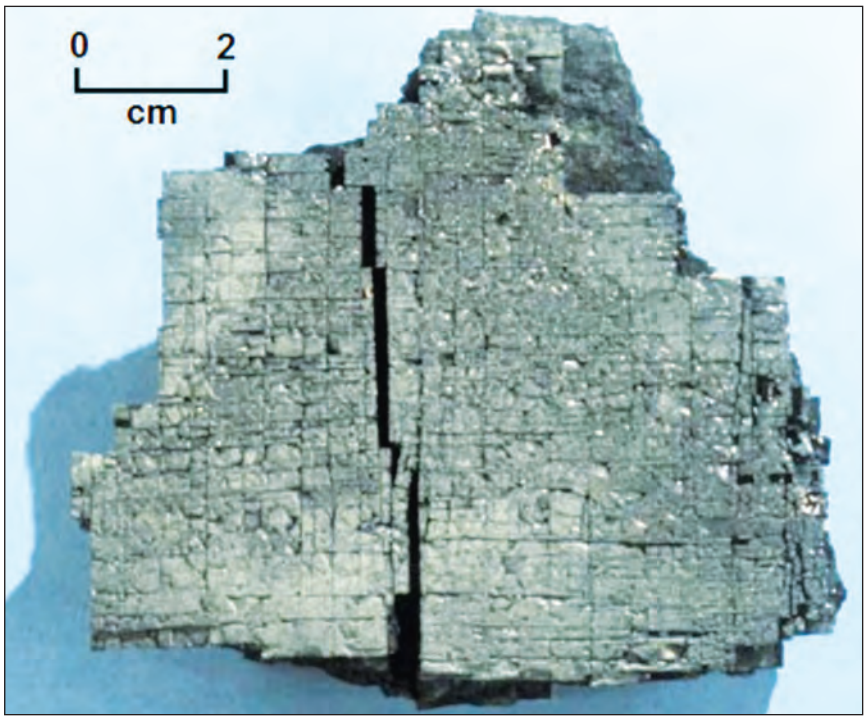

Figure 7b

Refer to **Figure 7b**.

(i) Describe the structures within the specimen of coal. [2]

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(ii) Explain why the structure of coal might be suitable as a host rock for CO_2 sequestration. [2]

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Examiner only

(c) *"The Carboniferous strata of the Leven Syncline provide potential for CO_2 sequestration."*

Use the data in the **generalised geological column**, the **cross-section** and **Table 7** to evaluate this statement. [6]

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END OF PAPER

Acknowledgements

Figure 1b http://www.cneas.tohoku.ac.jp/labs/geo/ishiwata/SendaiSympo3.htm

Figure 2a Rock **A**: https://cdn-assets.answersingenesis.org/img/articles/arj/v3/uluru-fig5.jpg
Rock **B**: http://wserv3.esc.cam.ac.uk/1acollections/items/show/176

Figure 3 adapted from Structural Geology – Twiss & Moores – W.H. Freeman 1992

Figure 4 Benton & Harper; Introduction to Paleobiology and the Fossil Record

Figure 7b BGS: UK Coal Resource for New Exploitation Technologies, Final Report

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For continuation only.

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GCE A level

1214/01-A

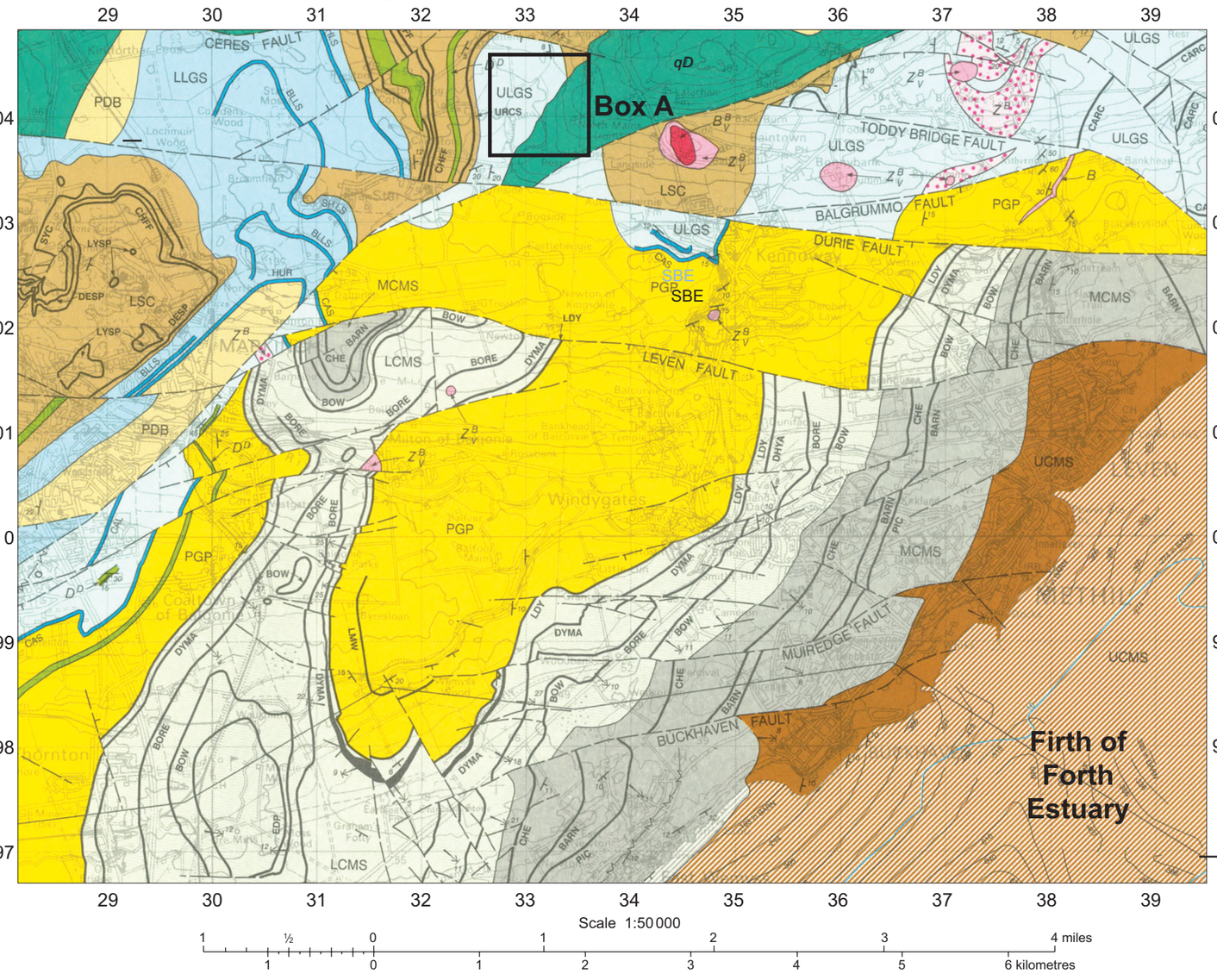
S16-1214-01A

GEOLOGY – GL4
Interpreting the Geological Record

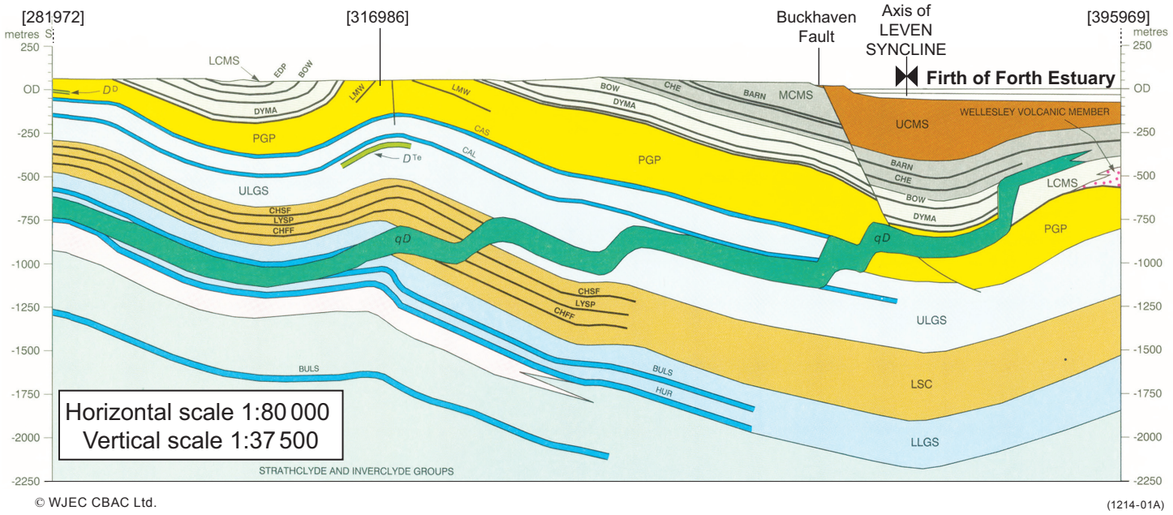
P.M. MONDAY, 6 June 2016

WJEC 1214/01-A ADVANCED GEOLOGY GL4 JUNE 2016

Extract from Kirkcaldy Sheet 40E (Solid) 1:50 000 (1 cm to 500 m)



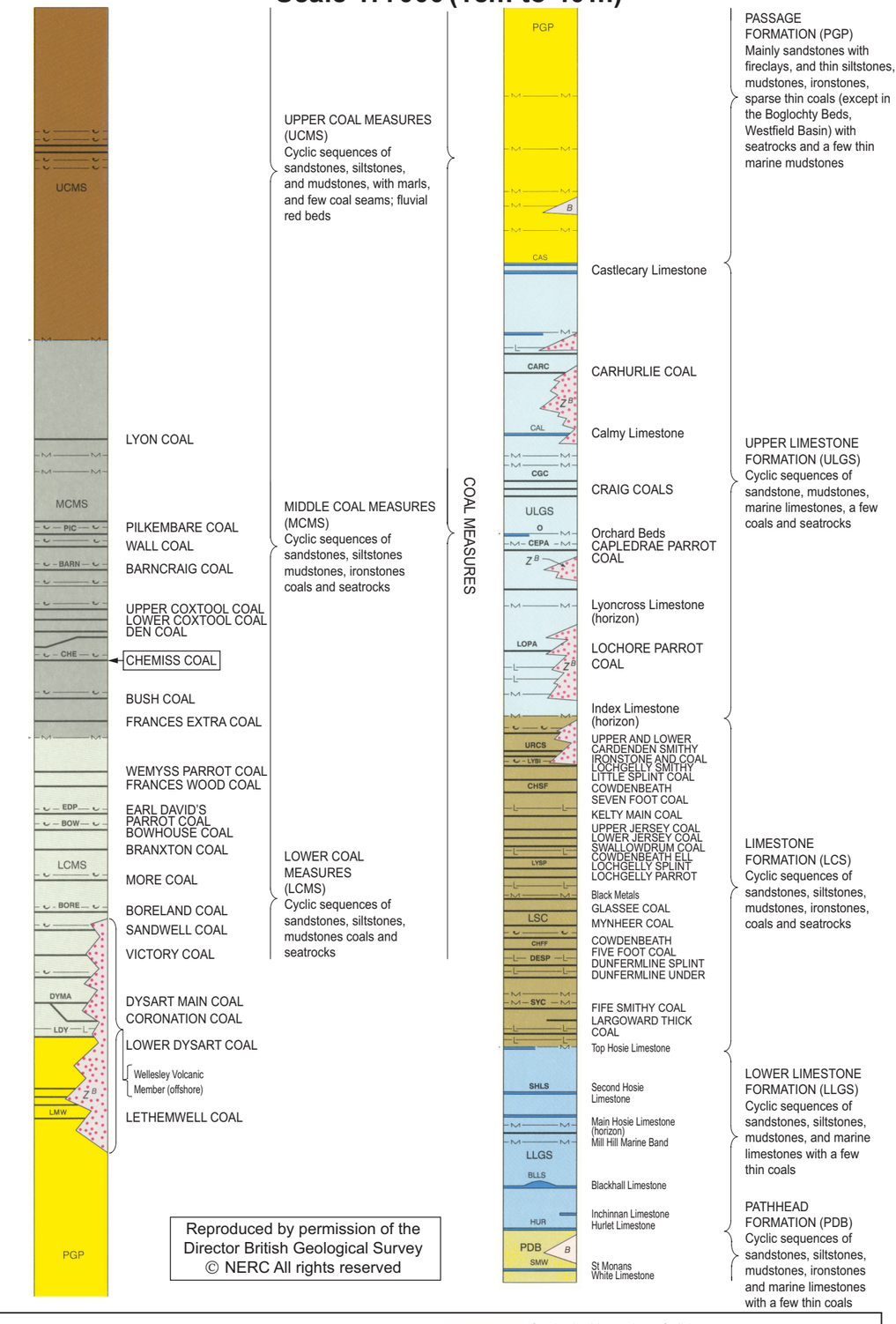
CROSS-SECTION SHOWING THE GENERAL RELATIONS OF ROCKS ALONG LINE OF SECTION



(1214-01A)

GENERALISED GEOLOGICAL COLUMN

Scale 1:4 000 (1cm to 40 m)



Key

EXTRUSIVE IGNEOUS ROCKS

CARBON-IFEROUS
- B — Basalt
- Z^B — Basalt tuff and lapilli tuff
- Z^Bha — Hyaloclastic rocks

INTRUSIVE IGNEOUS ROCKS

PERMO-CARBON-IFEROUS
- qD — Quartz-dolerite

- Geological boundary, Solid
- Fault, crossmark on downthrow side, where known
- 30 — Inclined strata, dip in degrees where known
- 20 — Bathymetric contour in metres below Ordnance Datum