Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

A480U30-1

S25-A480U30-1

THURSDAY, 19 JUNE 2025 – MORNING

GEOLOGY – A level component 3
Geological Applications

2 hours

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a calculator
- a ruler
- the Geological Map Extract

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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

Answer **all** questions in sections **A** and **B**.

Answer all questions in **one** option only in section **C**.

	For Examiner's use only			
	Question	Maximum Mark		Mark Awarded
Section A	1.	16		
	2.	14		
Section B	3.	15		
	4.	14		
	5.	16		
Section C option		10	12	
		14	12	
		6		
	Total	105		

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

This paper is in 3 sections, **A**, **B** and **C**.

Section A: 30 marks. Answer **both** questions. You are advised to spend about 35 minutes on this section.
Section B: 45 marks. Answer **all** questions. You are advised to spend about 50 minutes on this section.
Section C: 30 marks. Answer all the questions in **one** option only. You are advised to spend about 35 minutes on this section.

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

The assessment of the quality of extended response (QER) will take place in questions **8**, **11** and **14**.

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SECTION A

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

1. **Figure 1a** is a map showing the distribution of crystalline rocks (**A**) and sedimentary rocks (**B**) that may provide suitable sites for a geological disposal facility for high-level radioactive waste. **Figure 1b** has cross-sections showing the geology and hydrogeology of these two contrasting settings.

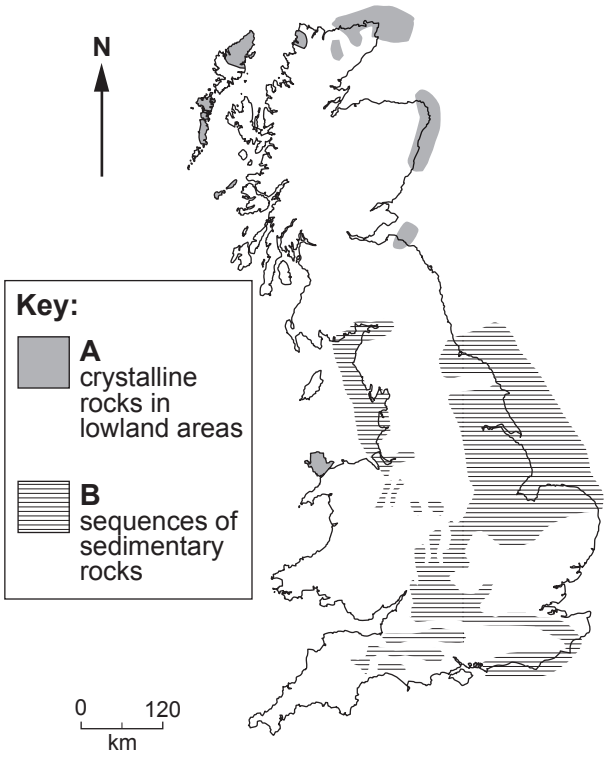


Figure 1a

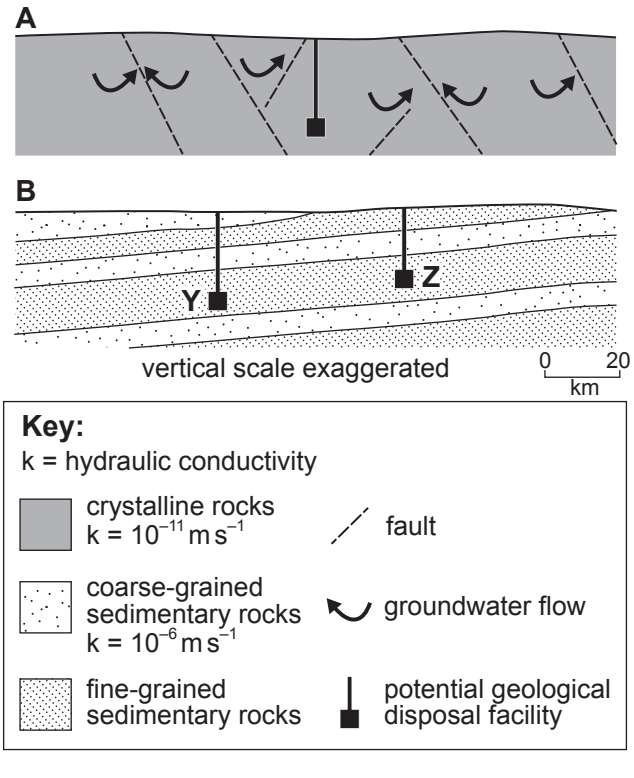


Figure 1b

Refer to **Figure 1a**.

(a) (i) Explain why high-level radioactive waste must not be disposed of in a landfill site for domestic waste. [2]

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(ii) Describe the distribution of the lowland areas in Britain with crystalline rocks (**A**) that may be a potential site for a geological disposal facility. [1]

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

(i) Mark on cross-section **B** in **Figure 1b** a labelled arrow (F→) to show the direction of groundwater flow in the coarse-grained sedimentary rocks. [1]

(ii) Two potential geological disposal facilities are shown in cross-section **B**:
- **Y** at a depth of 600 m,
- **Z** at a depth of 500 m.

The groundwater flow rate (Q) between **Y** and **Z** has been measured as $2 \times 10^{-12}\,m^3\,s^{-1}$.

Calculate the hydraulic conductivity (k) of the fine-grained sedimentary rocks using Darcy's Law. [3]

$$Q = kA\left(\frac{h_2 - h_1}{L}\right)$$

where:
Q = $2 \times 10^{-12}\,m^3\,s^{-1}$ (groundwater flow rate)
A = $1.0\,m^2$ (cross-sectional area)
$h_2 - h_1$ = difference in depth between site **Y** and site **Z** (m)
L = horizontal distance between site **Y** and site **Z** (m)

Show your working.

k = ... $m\,s^{-1}$

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(c) (i) Give **two** geological reasons why cross-section **A** could be considered a suitable location for a geological disposal facility for high-level radioactive waste. [2]

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(ii) Give **two** geological reasons why cross-section **B** could be considered a suitable location for a geological disposal facility for high-level radioactive waste. [2]

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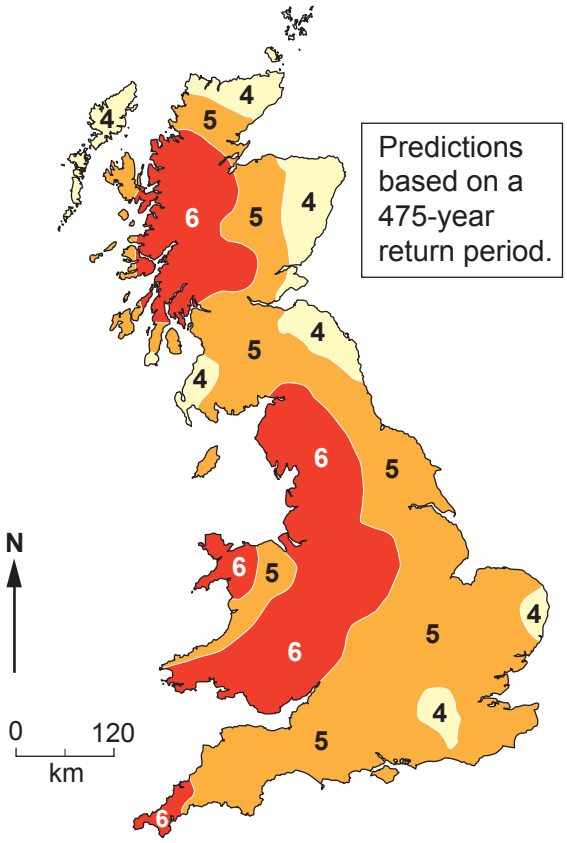
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(d) **Figure 1c** is a map of the predicted maximum earthquake intensity in Britain for a return period of 475 years.



Key: European Macroseismic Scale

4 Largely observed	The earthquake is felt indoors by many people, outdoors by very few. A few people are awakened. The level of vibration is not frightening. Windows, doors and dishes rattle. Hanging objects swing.
5 Strong	The earthquake is felt indoors by most, outdoors by few. Many sleeping people awake. A few run outdoors. Buildings tremble throughout. Hanging objects swing considerably. Cups and glasses clatter together. The vibration is strong. Top-heavy objects topple over. Doors and windows swing open or shut.
6 Slightly damaging	Felt by most indoors and by many outdoors. Many people in buildings are frightened and run outdoors. Small objects fall. Slight damage to many ordinary buildings; for example, fine cracks in plaster and small pieces of plaster fall.
7 Damaging	Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many ordinary buildings suffer moderate damage: small cracks in walls; partial collapse of chimneys.

Figure 1c

(i) Describe the level and distribution of risk from seismic hazards in Britain shown in **Figure 1c**. [2]

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(ii) "A geological disposal facility for high-level radioactive waste in Britain must be engineered to resist seismic hazards."
Evaluate this statement with reference to the data in **Figures 1a** and **1c**. [3]

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2. **Figure 2a** is a map of part of the North Atlantic Ocean showing the extent of the Storegga Slide, a Quaternary submarine mass movement deposit.

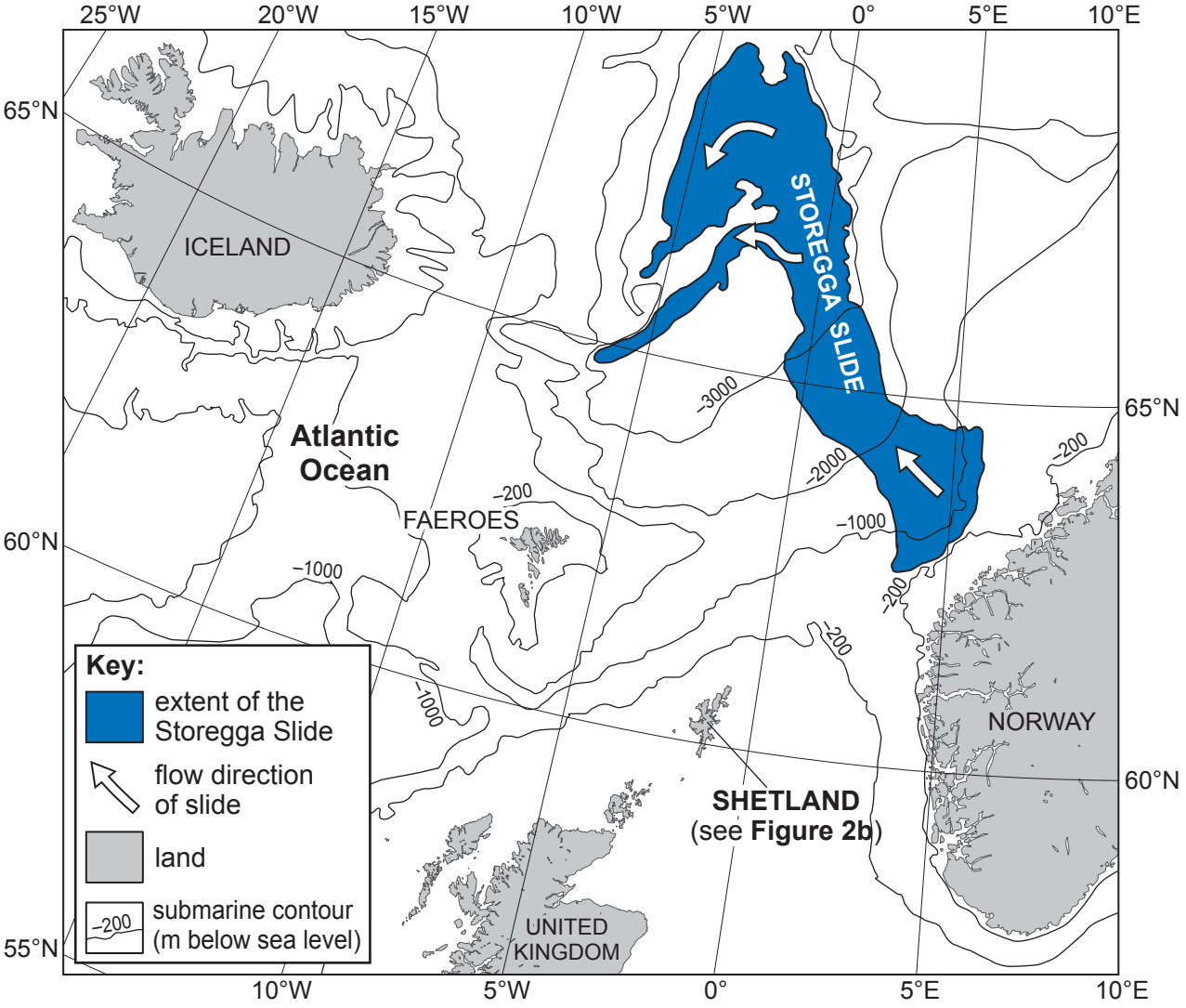


Figure 2a

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

(i) Suggest how a submarine mass movement, such as the Storegga Slide, could be caused. [3]

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(ii) Suggest how such a submarine mass movement could generate a tsunami. [1]

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(b) **Figure 2b** is a map showing the location of Garth, Shetland, the site of two possible tsunami deposits. **Figure 2c** is a graphic log of a core of Quaternary sediments at Garth with radiocarbon dates for organic material.

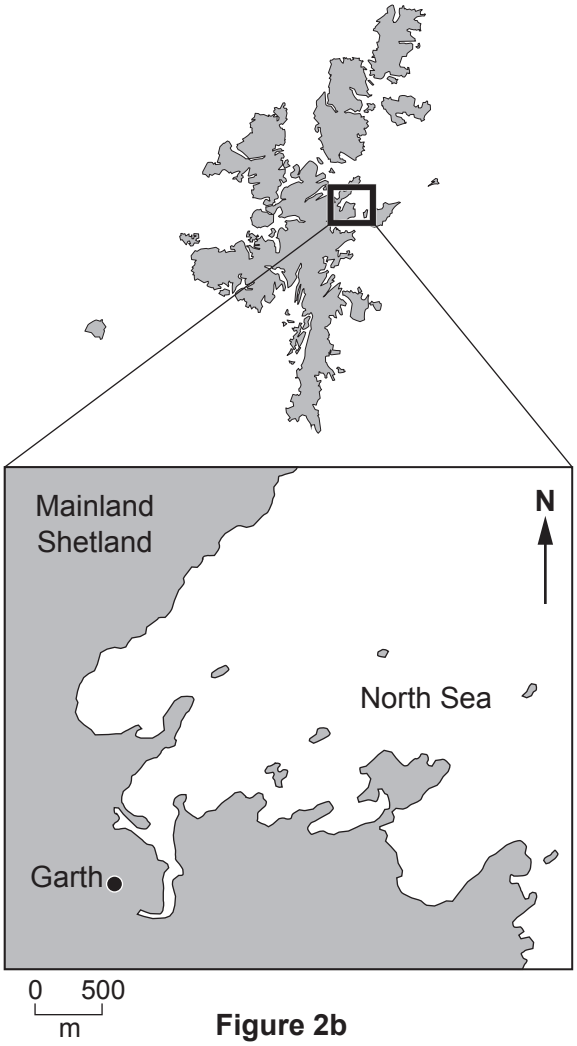


Figure 2b

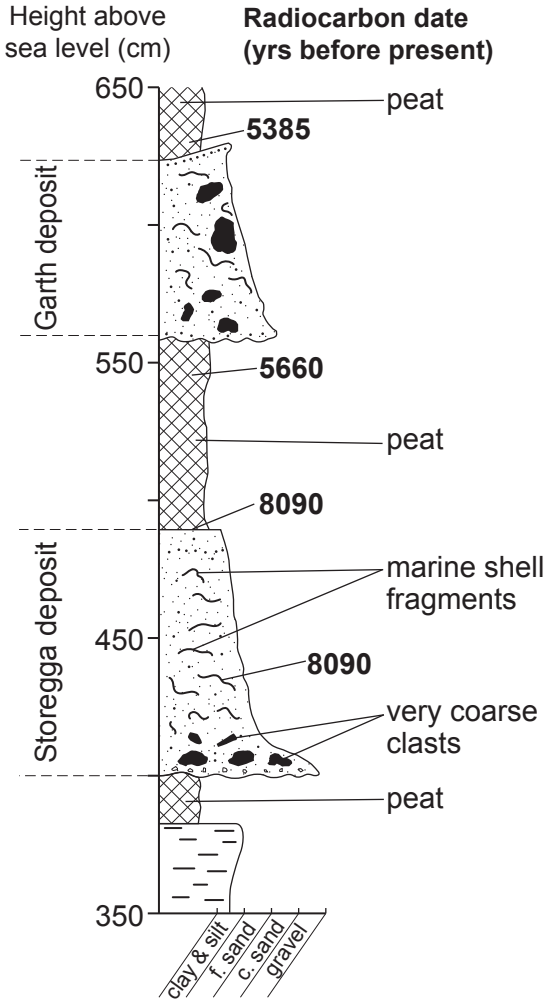


Figure 2c

Refer to **Figure 2c**.

(i) Describe the texture of the Storegga deposit. [2]

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(ii) Explain why the Storegga deposit has been interpreted as a tsunami deposit. [3]

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(iii) Refer to **Figures 2a** and **2b**. Suggest why the location of Garth made it particularly vulnerable to a tsunami generated by the Storegga Slide. [2]

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Refer to **Figures 2a**, **2b** and **2c**.

(c) Evaluate the current level of risk from tsunamis in Shetland. [3]

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SECTION B

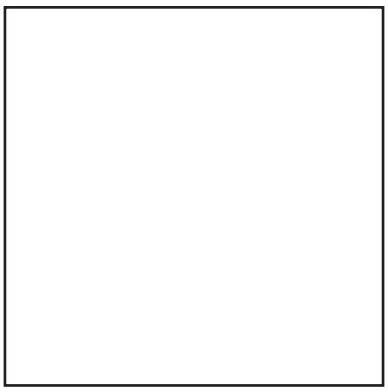
Answer **all** questions in the spaces provided.

Questions **3–5** relate to the **British Geological Survey 1:25 000 geological map** extract from the Ludlow sheet (Solid and Drift)

3. (a) (i) State the rock type which crops out at grid reference **GR 605765**. [1]

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(ii) In **box A** on the **geological map** there is an unconformity between the Cornbrook Sandstone Formation (**CoS**) and the Lower and Middle Coal Measures (**LMC**). In the blank box below, draw and label the map evidence in **box A** for this unconformity. Label the position of the unconformity and rock units on your diagram. [3]



(iii) **Table 1** shows a student's interpretation of the relative age of the rock units in **box B** on the **geological map**.

Relative age	Rock unit
Youngest	Rg
	Head
Oldest	BFL

Table 1

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Evaluate the interpretation of relative age shown in **Table 1**. [2]

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(b) (i) There is an abandoned vertical mineshaft at **GR 581757** in the Lower and Middle Coal Measures (**LMC**). State the name of the only coal seam that was penetrated by this mineshaft. [1]

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(ii) Explain why no other coal seams can be penetrated by this vertical mineshaft. [2]

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(c) (i) From the **geological map alone** the igneous body at **GR 605765** could be interpreted as a sill or a pluton. Explain how the map evidence could support either interpretation. [4]

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(ii) The igneous body found at **GR 605765** is a sill. It is overlain by the Lower and Middle Coal Measures (**LMC**) at **GR 595760**. Explain **one** piece of evidence you would look for in the field to confirm that the sill is younger than the Lower and Middle Coal Measures (**LMC**). [2]

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4. **Figure 4** is a simplified version of the geological map of the Cleehill area.

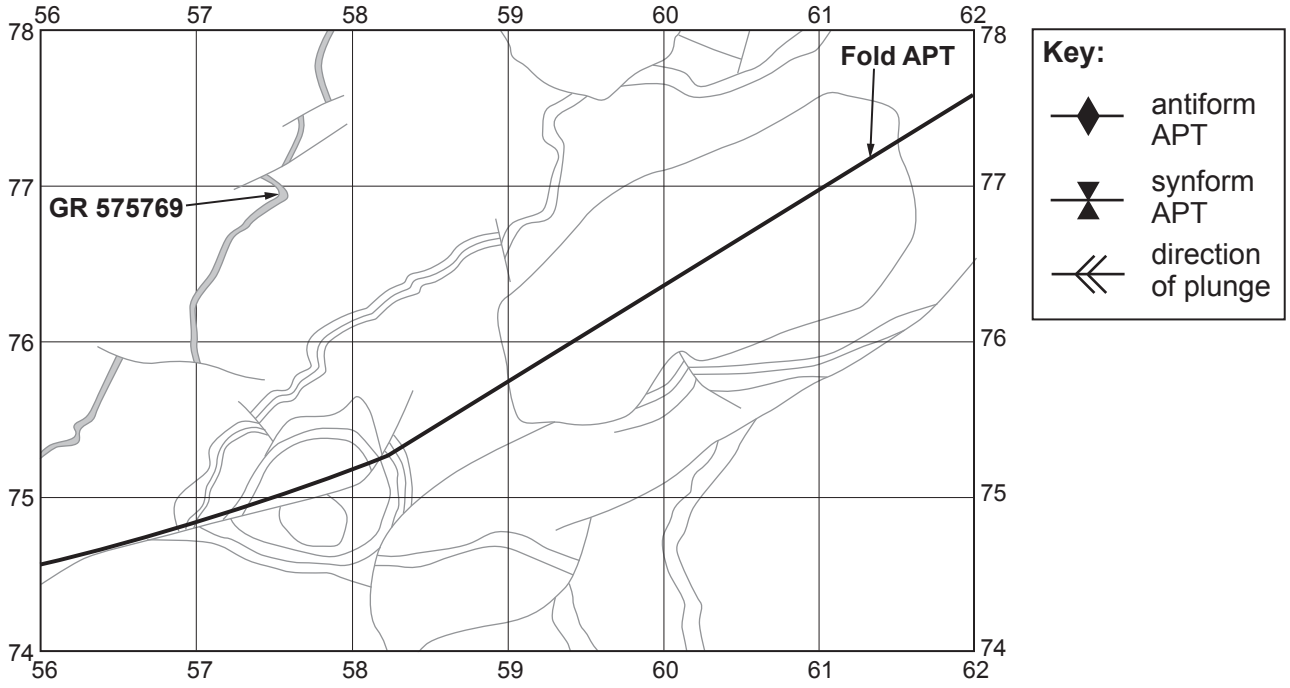


Figure 4

Refer to the **geological map**, the **generalised geological column** and **Figure 4**.

(a) (i) Explain the presence of the "v" shape in the Bishops Frome Limestone (**BFL**) at **GR 575769**. [2]

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(ii) **Figure 4** shows a fold axial plane trace (APT). Draw on **Figure 4**, using the symbols in the key:

- the symbol to indicate whether the fold is an antiform or a synform
- the direction of plunge of the fold. [2]

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(iii) The sill which crops out at **GR 605765** is an area of younger rock completely surrounded by older rocks. Explain how the geological structure and lithology have resulted in this outcrop pattern. [3]

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(b) (i) The fault at **GR 599751** dips steeply to the north-northwest. State the type of fault and explain the map evidence for your answer. [3]

Fault type .....

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(ii) Evaluate the statement:
"The fault at **GR 599751** and the fold shown on **Figure 4** were formed at the same time and by the same direction of principal stress." [4]

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5. The Cleehill area has been mined for limestone, coal, aggregate and iron ore.

(a) (i) State the geological meaning of the term aggregate. [1]

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(ii) The presence of iron ore was confirmed by the drilling of boreholes. State and explain **two** suitable prospecting techniques that could have been used to explore for the ore prior to drilling. [4]

Technique 1 .....

Explanation .....

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Technique 2 .....

Explanation .....

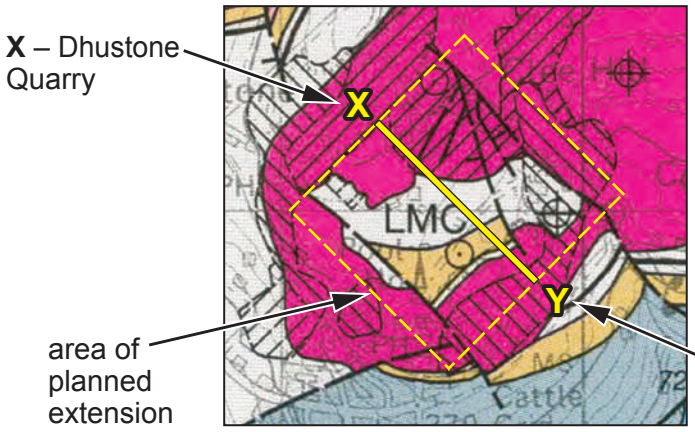
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(b) **Figure 5a** shows an area of two quarries in the Cleehill area. A quarrying company has planned to extend Dhustone Quarry and Incline Quarry by removing rock between **X** and **Y** on **Figure 5a**. **Figure 5b** is a simplified cross-section through the area.



Scale 1:25 000

Figure 5a

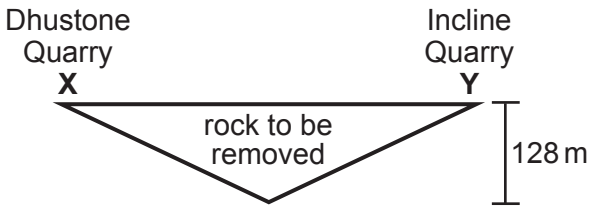


Figure 5b

Refer to **Figure 5a** and **Figure 5b**.

(i) Show that the cross-sectional area of the rock to be removed in **Figure 5b** is approximately 48 000 m^2. [2]
You must show your working.

(ii) Calculate the total volume of rock to be removed. [2]
Show your working.

..... m^3

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(c) **Figure 5c** shows a polluted spring at **GR 599760** on the **geological map**.

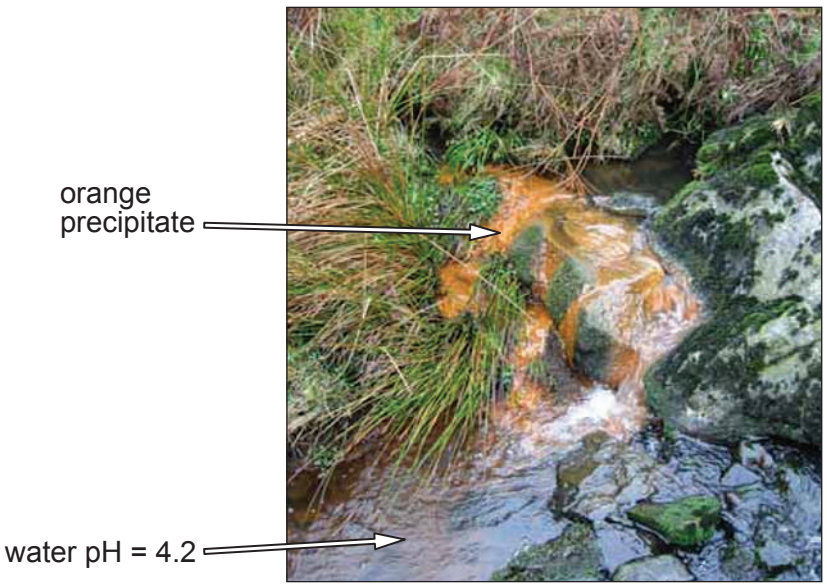


Figure 5c

Explain a probable origin of this pollution. [3]

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(d) The area of the planned quarry extension is located in **box C** on the **geological map**. Evaluate the geological suitability of the extended quarry as a potential landfill site for domestic waste once the rock has been extracted. [4]

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SECTION C

Answer the questions from only **one** option.

Tick (✓) **one** of the boxes below to indicate which **one** option you have selected.

☐	☐	☐
Option 1: Quaternary Geology page 18	**Option 2: Geological Evolution of Britain** page 24	**Option 3: Geology of the Lithosphere** page 34

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Turn over.

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Option 1: Quaternary Geology

If you have chosen this option, answer **all** the questions within this option.

6. **Figure 6** is a diagram showing a cliff section of sedimentary deposits from two different Quaternary interglacial periods at Whittlesey, eastern England.

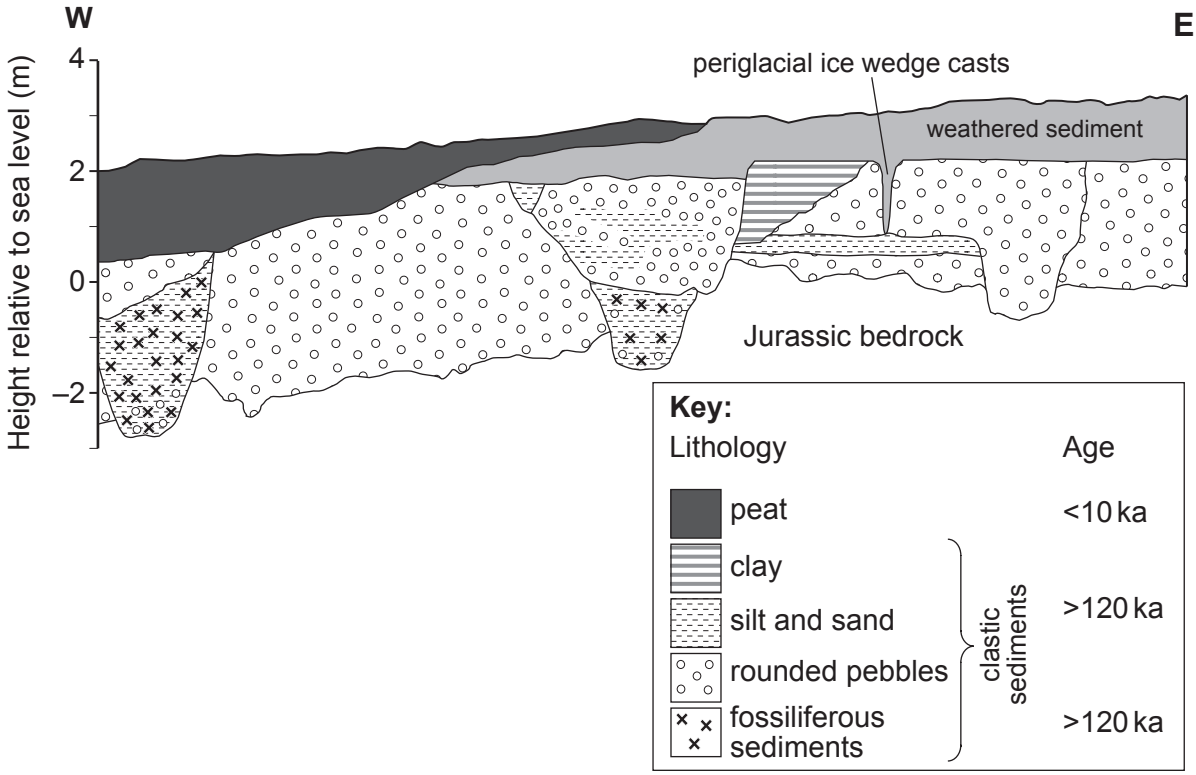


Figure 6

Refer to **Figure 6**.

(a) The peat deposit has been interpreted as being from the most recent interglacial period (<10 ka), whereas the clastic sediments are from a much older interglacial period (>120 ka). Explain **one** piece of evidence to support the idea that there is a significant time gap between these two deposits. [2]

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(b) Over 80 different species of beetles were recovered from the fossiliferous deposits shown in **Figure 6**. **Table 2** shows a selection of beetle species from this assemblage.

Beetle species	Present-day habitat	Present-day distribution
Agabus guttatus	small rivers	widespread across western Europe
Octhebius minimus	shallow water, streams & lakes	Europe, from southern Spain to Norway
Oulimnius troglodytes	rivers	Spain, Britain and southern Sweden
Caccobius schrebri	dry grassland	North Africa and southern Europe
Orthophagus massai	dung	southern Europe

Table 2

Refer to **Figure 6** and **Table 2**.

(i) Explain why beetles are very effective fossils in the reconstruction of Quaternary palaeoenvironments. [2]

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(ii) The clastic sediments at Whittlesey have been interpreted as being deposited:
- in a fast-flowing river,
- during an interglacial.

Explain the evidence used to make these interpretations. [4]

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(iii) Using your knowledge, explain **one other** piece of evidence that could be used to support one of the interpretations in question (b)(ii). [2]

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7. **Figure 7a** is a map showing the present-day height of part of the Himalayan mountains and present-day climatic data for two locations.
Figure 7b shows oxygen isotope data from marine microfossils and an interpretation of global climate change for the last 50 Ma.
Figure 7c shows a model of the uplift of the Tibetan Plateau over the last 50 Ma.

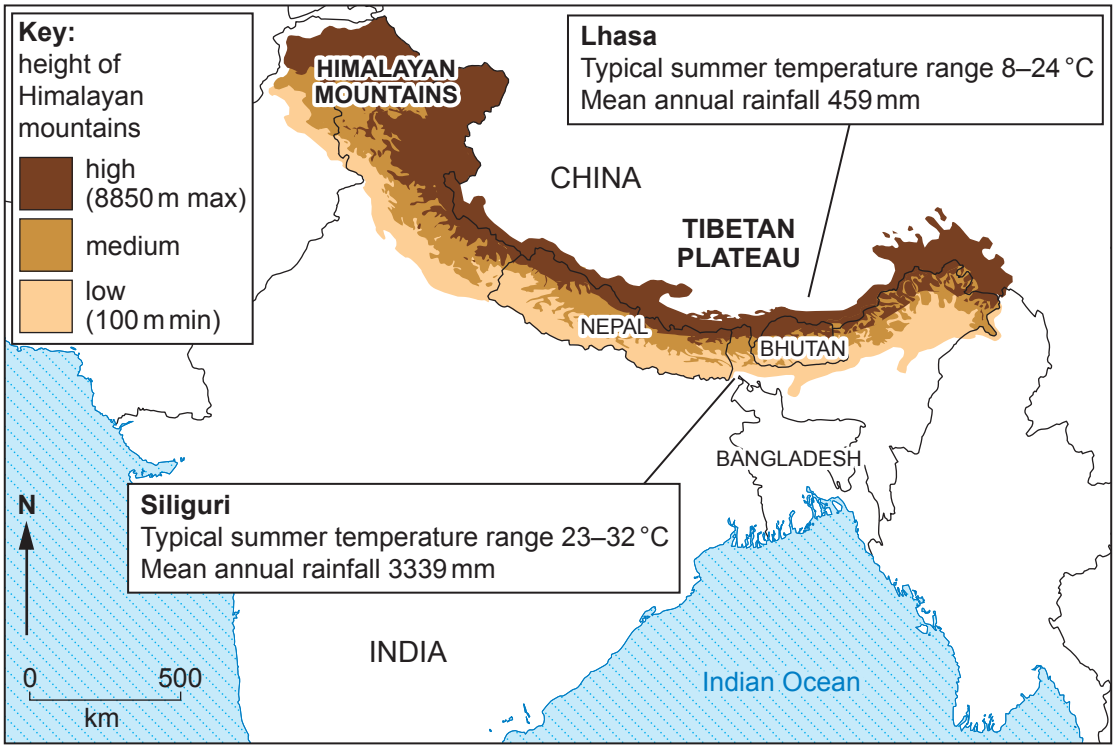


Figure 7a

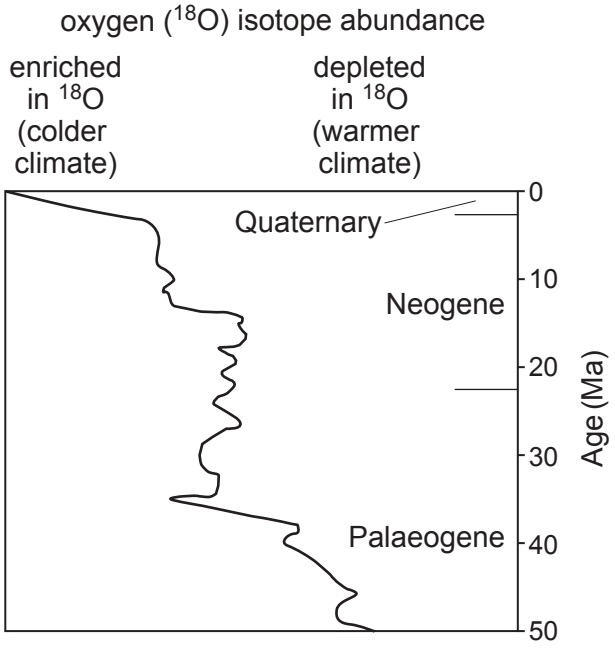


Figure 7b

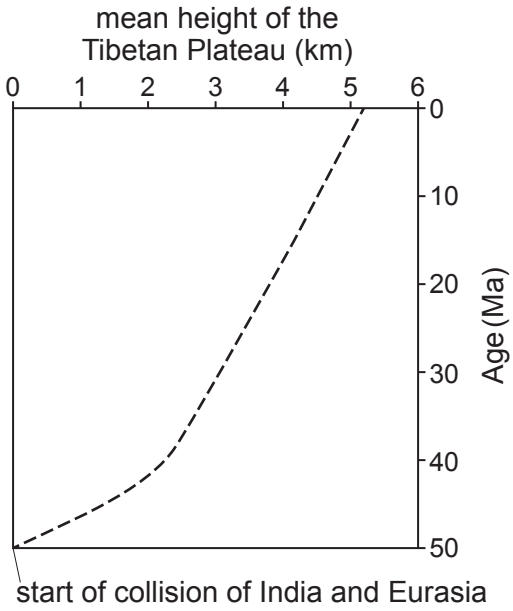


Figure 7c

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Refer to **Figure 7a**.

(a) Describe the differences in present-day climate between the south and north of the Himalayan mountains. [2]

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(b) Refer to **Figures 7b** and **7c**.

(i) Explain how oxygen isotope evidence preserved in the shells of marine microfossils may provide evidence for global climate change. [2]

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(ii) Describe how the global climate, indicated by the change in the marine ^{18}O isotope record shown in **Figure 7b**, has changed over the last 50 Ma. [2]

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(iii) Explain how an increase in the height of the Himalaya and the Tibetan Plateau may have contributed to this climate change over the last 50 Ma. [2]

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(c) (i) Describe the degree of correlation between the height of the Tibetan Plateau in **Figure 7c** and the interpretation of global climate change in **Figure 7b**. [3]

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(ii) "The uplift of the Himalayan Mountains was the only tectonic influence on global climatic change over the last 50 Ma."
Evaluate this statement with reference to your knowledge. [3]

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8. Explain the link between continental ice sheets and sea levels. [6 QER]

6

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Option 2: Geological Evolution of Britain

If you have chosen this option, answer **all** the questions within this option.

9. **Figure 9a** is a simplified geological map of Great Britain.

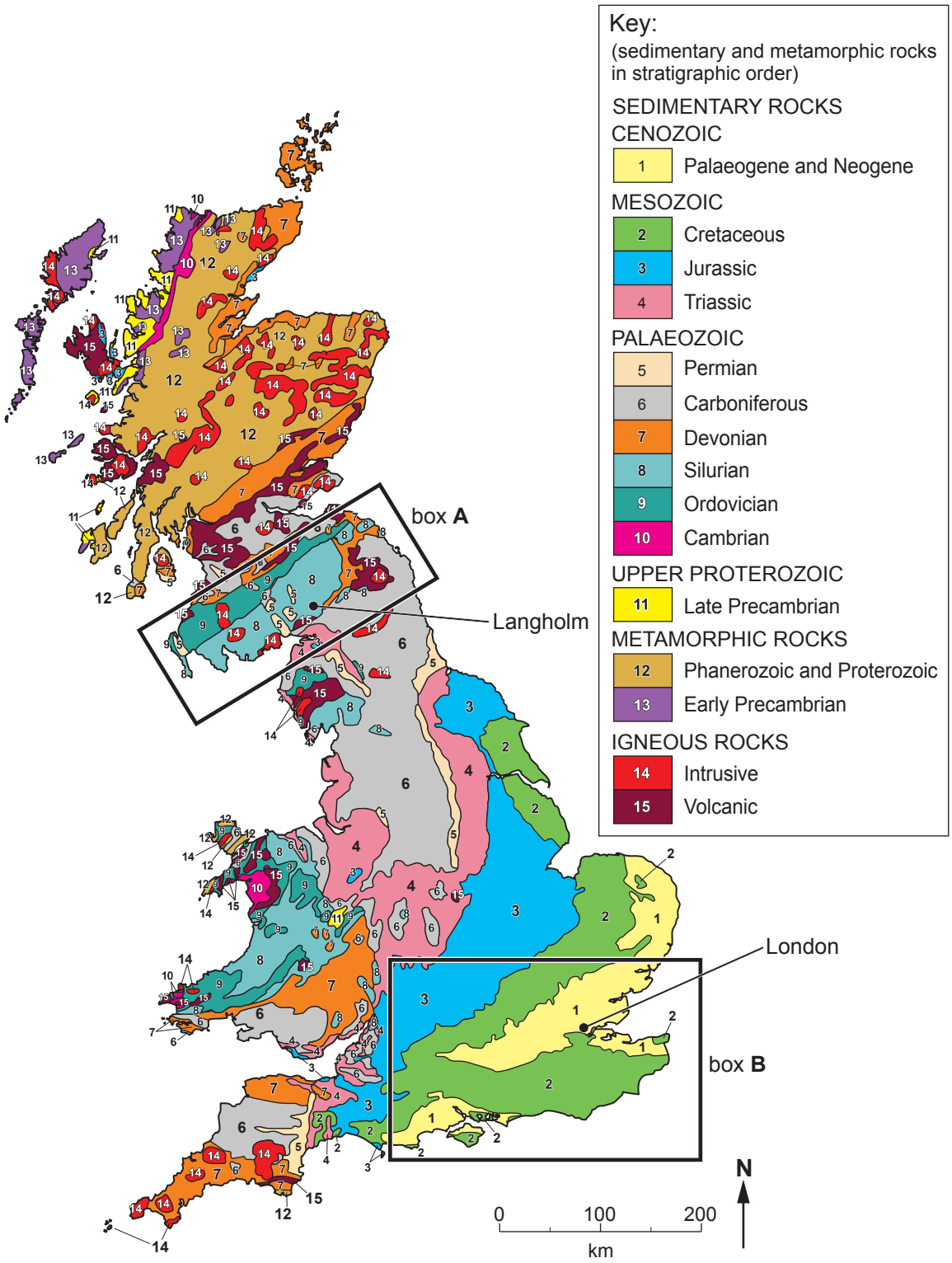


Figure 9a

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(a) Describe the age range and general distribution of rock ages between Langholm and London on **Figure 9a**. [2]

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(b) **Figure 9b** shows two polar equal-area "stereonets" showing the dip direction and dip angle of major fold limbs in southern Scotland (box **A**) and south-eastern England (box **B**) on **Figure 9a**.

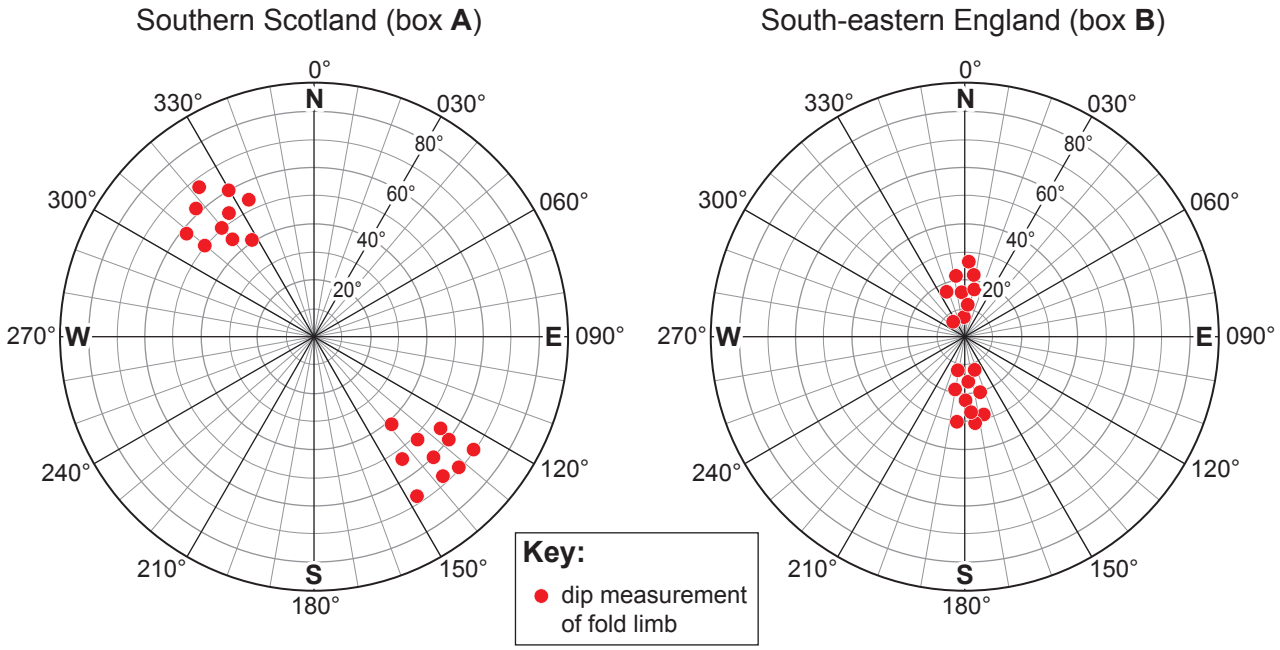


Figure 9b

(i) Refer to **Figure 9b** only. Describe **two** differences between the major folds in southern Scotland and south-eastern England shown in **Figure 9b**. [2]

Difference 1:

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Difference 2:

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(ii) Refer to **Figures 9a** and **9b**.

Explain why there are differences between the major folds in southern Scotland and south-eastern England. [3]

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(c) The folded rocks of southern Scotland have been intruded by granitic plutons (rock unit **14** on **Figure 9a**), whereas the folded rocks of south-eastern England have not. Suggest why this is the case. [3]

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10. **Figure 10a** is a palaeographic map of the British area during the Devonian period, showing representative graphic logs of sedimentary sequences from four locations (**A**, **B**, **C** and **D**).

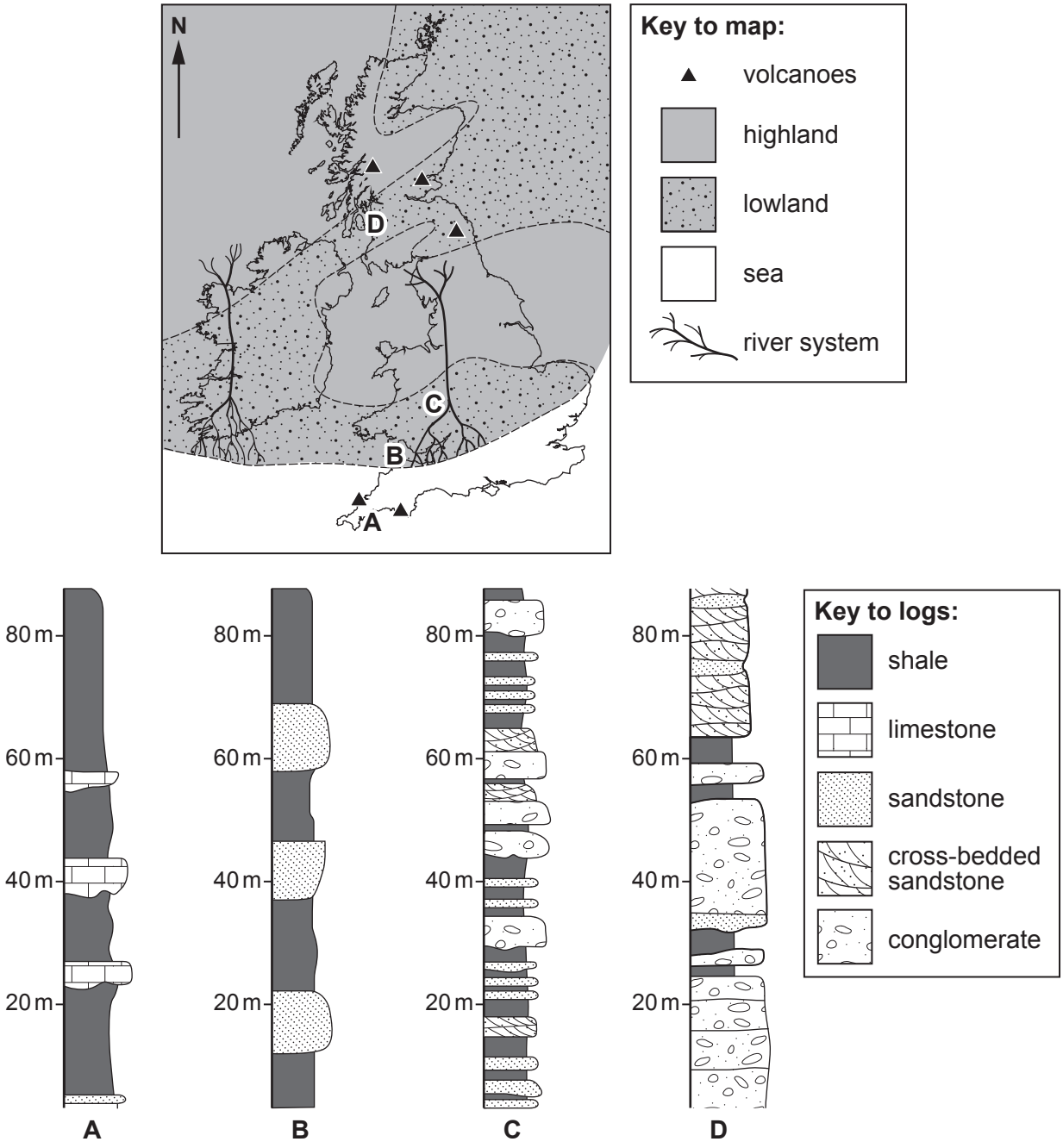


Figure 10a

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(a) Refer to **Figure 10a**.

(i) Describe **three** changes in the Devonian sedimentary rocks from south to north (**A** to **D**) as shown on the graphic logs. [3]

1. .....

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2. .....

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3. .....

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(ii) Explain why the changes you described in (a)(i) occur. [3]

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(b) **Figure 10b** is a photograph of a sedimentary rock from locality **C** on **Figure 10a**.



Figure 10b

Refer to **Figure 10b**.

Describe the texture of the sedimentary rock shown in **Figure 10b**. [3]

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(c) **Figure 10c** shows the percentage of limestones and red beds deposited at different palaeolatitudes.

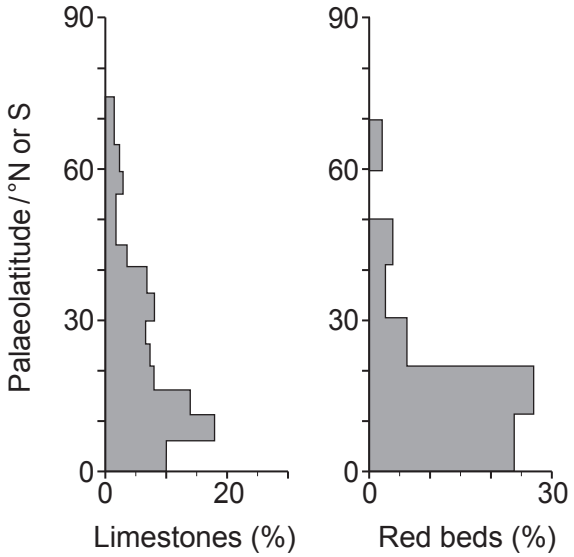


Figure 10c

Refer to **Figures 10a**, **10b** and **10c**.

(i) "Devonian sedimentary rocks have been interpreted as being deposited at palaeolatitudes between 15° and 20° south of the Equator."
Evaluate this statement with reference to **Figures 10a**, **10b** and **10c**. [3]

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(ii) Explain one other way to determine the palaeolatitude at which the Devonian rocks shown in **Figure 10a** have formed. [2]

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11. Explain how Britain's geology provides evidence for the early history of the opening of the North Atlantic Ocean. [6 QER]

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Option 3: Geology of the Lithosphere

If you have chosen this option, answer **all** the questions within this option.

12. **Figure 12a** shows patterns in global heat flow.
Figure 12b shows the age of the oceanic lithosphere.

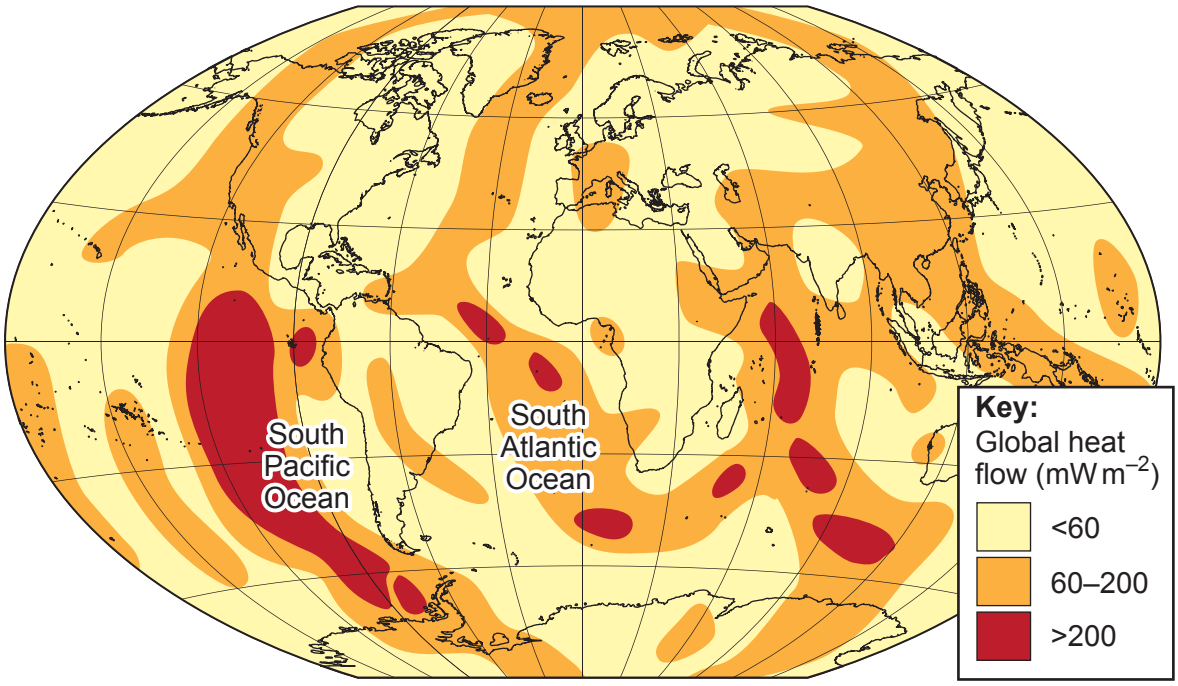


Figure 12a

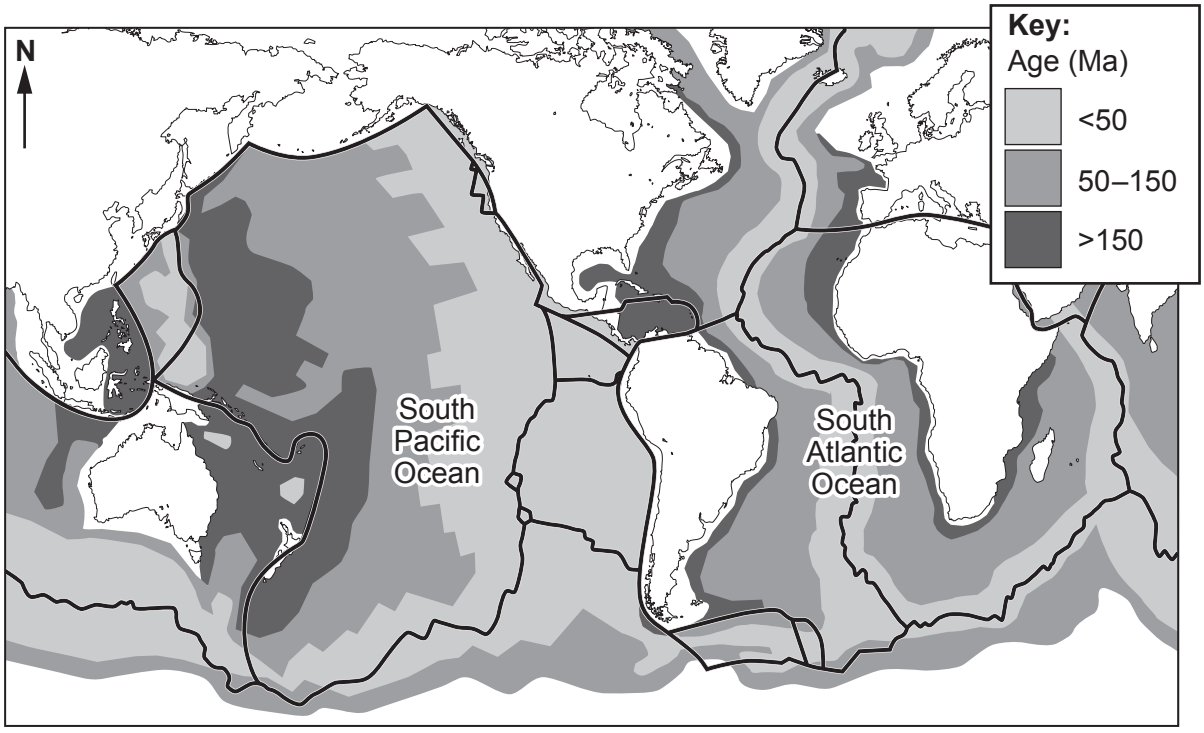


Figure 12b

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(a) Describe the variation in global heat flow shown in **Figure 12a**. [3]

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(b) (i) Refer to **Figure 12b**. State which ocean (South Pacific or South Atlantic) is spreading at a faster rate. Give the evidence for your answer. [2]

Ocean .....

Evidence .....

.....

.....

(ii) Refer to **Figures 12a** and **12b**. Explain the difference in heat flow between the South Pacific and South Atlantic oceans. [2]

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(c) (i) Refer to **Figure 12b** and your knowledge. Describe and explain the likely variation in thickness of sediment across an ocean basin. [3]

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(ii) Suggest how the variation in sediment thickness might have affected the heat flow values in **Figure 12a**. [2]

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12

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13. **Figure 13a** shows the structure of an orogenic belt.

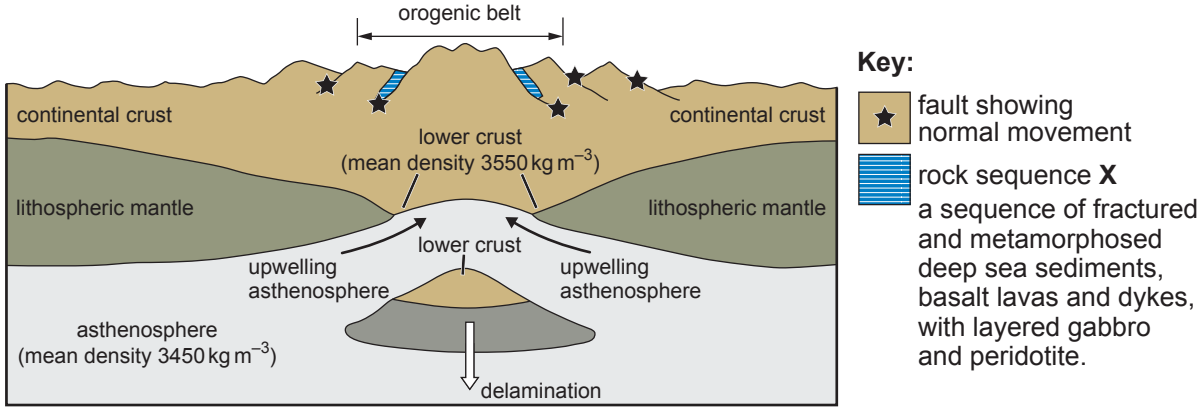


Figure 13a

(a) (i) Describe the location of rock sequence **X** shown in **Figure 13a**. [2]

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(ii) Explain why rock sequence **X** can be found in an orogenic belt [2]

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(b) (i) **Figure 13a** shows delamination at the base of the orogenic belt. This process can lead to isostatic uplift. Explain why isostatic uplift can occur in orogenic belts. [3]

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(ii) Explain the presence of normal faults within the orogenic belt shown in **Figure 13a**. [2]

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(c) **Figure 13b** is a graph showing the percentage of the Earth's surface at different heights and depths from sea level.

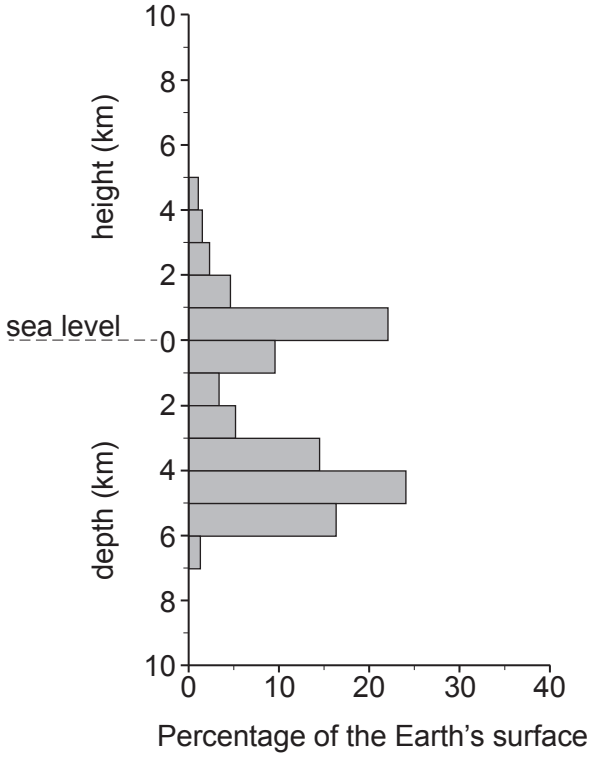


Figure 13b

Explain why the percentage of the Earth's surface with an elevation greater than 4 km is only 0.5%. [3]

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12

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14. Explain the geological and palaeomagnetic evidence used to reconstruct supercontinents. [6 QER]

6

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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Acknowledgements

Figures 1a and **1b** adapted from Woodcock, N. (1994) Geology and Environment in Britain & Ireland. UCL Press.

Figure 1c adapted from: http://www.quakes.bgs.ac.uk/hazard/Hazard_UK.htm#hazard

Figure 2a adapted from: Long, D. (2001) Proceedings of the International Tsunami Symposium, Seattle, August 2001 p355-366

Figures 2b and **2c** adapted from: Bondevik, S. et al. (2005). Evidence for three North Sea tsunamis at the Shetland Islands between 8000 and 1500 years ago. Quaternary Science Reviews 24, 1757-1775.

Figure 6 adapted from: Langford, H.E. (2017). Evidence for the early onset of the Ipswichian thermal optimum: palaeoecology of Last Interglacial deposits at Whittlesey, eastern England. Journal of the Geological Society 174, 988-1003

Figure 10b https://www.lyellcollection.org/cms/10.1144/pygs2022-002/asset/5ae639f7-1fe6-477a-8d2c-71eab0a12fb1/assets/images/large/pygs2022-002.08.jpg. Acknowledgement not found

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