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GCSE

4250/01

S18-4250-01

GEOLOGY

Theory Paper
(Paper version of on-screen assessment)

MONDAY, 21 MAY 2018 – MORNING

1 hour 30 minutes

For Examiner's use only		
Section	**Maximum Mark**	**Mark Awarded**
1.	**19**	
2.	**13**	
3.	**13**	
4.	**17**	
5.	**12**	
6.	**16**	
7.	**10**	
Total	**100**	

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ADDITIONAL MATERIALS

In addition to this examination paper you will need a:

- Data Sheet;
- calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Answer **all** questions. Where numerical answers are required figures should be used.

Write your answers in the spaces provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets alongside each question.

You are reminded that assessment will take into account the quality of written communication *(QWC)* used in your answers to **Section 3 Q5** and **Section 6 Q10**.

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Answer **all** *questions in each section.*

Section 1 – answer questions 1 – 9

Figure 1 shows the dates on two gravestones, one made of granite and the other made of limestone.

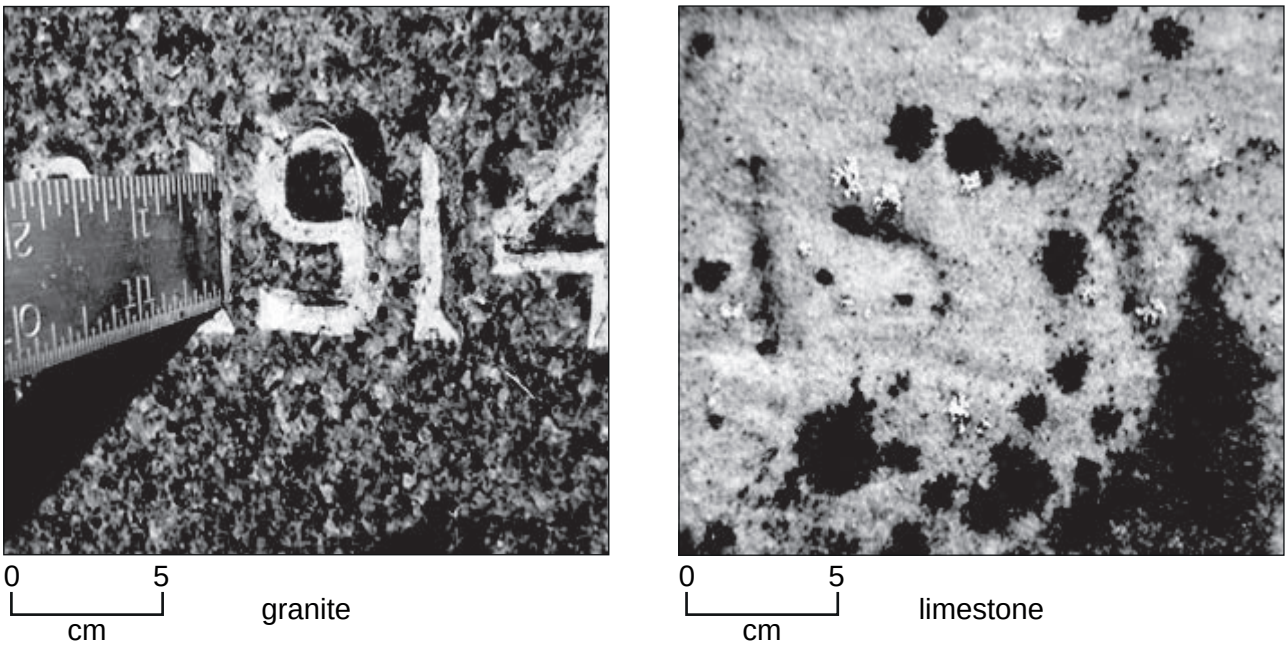

Figure 1

1. Which **two** of the following statements about **Figure 1** and weathering processes are **correct**? Tick (✓) only **two** boxes. [2]

the date on the granite gravestone is still clear because granite contains quartz which weathers quickly by chemical processes ☐

reaction with organic acids is a process of biological weathering ☐

the date on the limestone gravestone is difficult to read due to the effects of freeze thaw weathering ☐

chemical weathering is most rapid in dry climates ☐

acidic rain water, due to dissolved carbon dioxide, chemically weathers limestone producing only insoluble materials ☐

chemical weathering of the limestone gravestone by weak acids has made the date difficult to read ☐

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Table 1 shows the strength of four rocks using a hammer test (striking with a test hammer). The scale is from 10 – 100 with 100 being the strongest.

rock	strength (10-100)
shale	36
sandstone	48
basalt	54
marble	72

Table 1

2. **Table 1** shows that the strength of the shale compared to the marble has a ratio of 1:2. Calculate the ratio of the strength of the shale compared to the basalt. Show your calculation below. [2]

Calculation

Ratio of shale to basalt 1: .....

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Figure 2 shows scarp and vale landforms and a cross section showing the underlying geology.

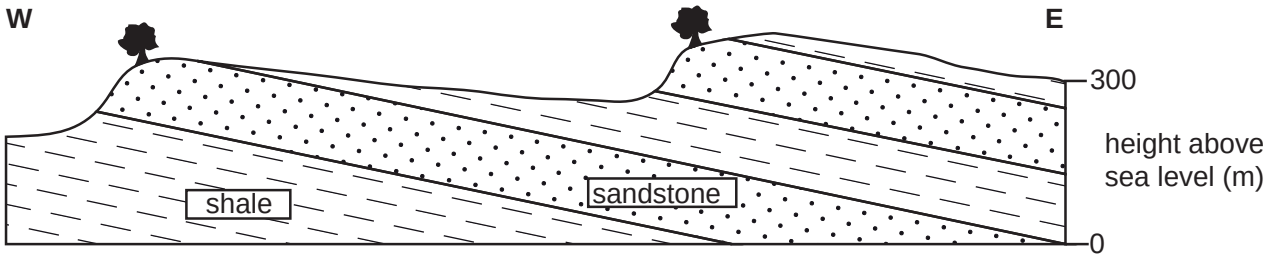

Figure 2

3. Explain how the landforms in **Figure 2** illustrate the link between rock strength measured in **Table 1** and resistance to weathering and erosion. [3]

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Figure 3 shows how the amount of carbon dioxide (CO_2) in the atmosphere has varied over the past 420,000 years.

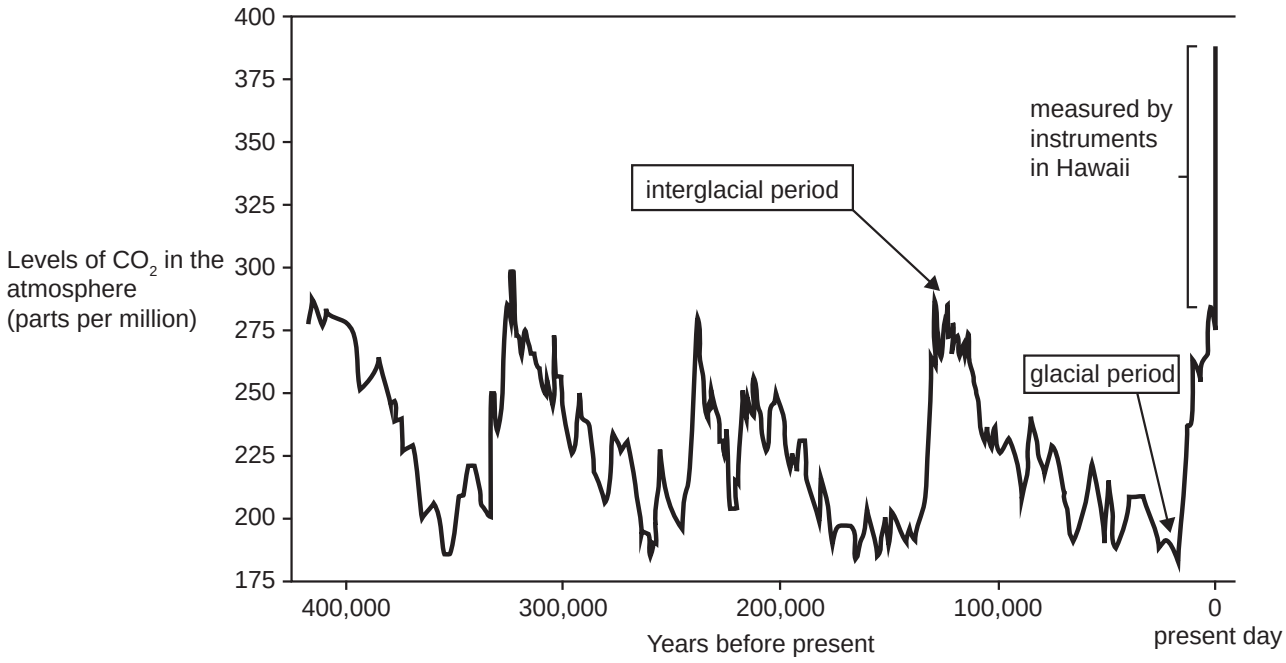

Figure 3

4. Which **one** of the following statements about **Figure 3** is **incorrect**? Tick (✓) only **one** box. [1]

before the present day the maximum level of CO_2 in the atmosphere has not been above 320ppm in interglacial periods ☐

CO_2 levels in the atmosphere are variable ☐

CO_2 levels are lowest during glacial periods at approximately 160ppm ☐

CO_2 levels today are much higher than any time in the last 420,000 years ☐

glaciations have occurred approximately every 100,000 years ☐

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5. Instruments in Hawaii have measured CO_2 in the atmosphere during historical times. Explain how data about atmospheric composition can be obtained for the geological past. [3]

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6. Which **one** of the following statements about CO_2 in the atmosphere is **incorrect**? Tick (✓) only **one** box. [1]

increased atmospheric CO_2 leads to an enhanced greenhouse effect ☐

formation and burial of limestone leads to an increase in CO_2 in the atmosphere ☐

increased volcanic activity leads to an increase in CO_2 in the atmosphere ☐

increased burning of fossil fuels leads to an increase in CO_2 in the atmosphere ☐

dissolving of carbon dioxide in sea water leads to a decrease in CO_2 in the atmosphere ☐

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One way in which humans can reduce their impact on the atmosphere is to increase the use of renewable energy. **Figure 4** shows two areas of housing and different sources of energy.

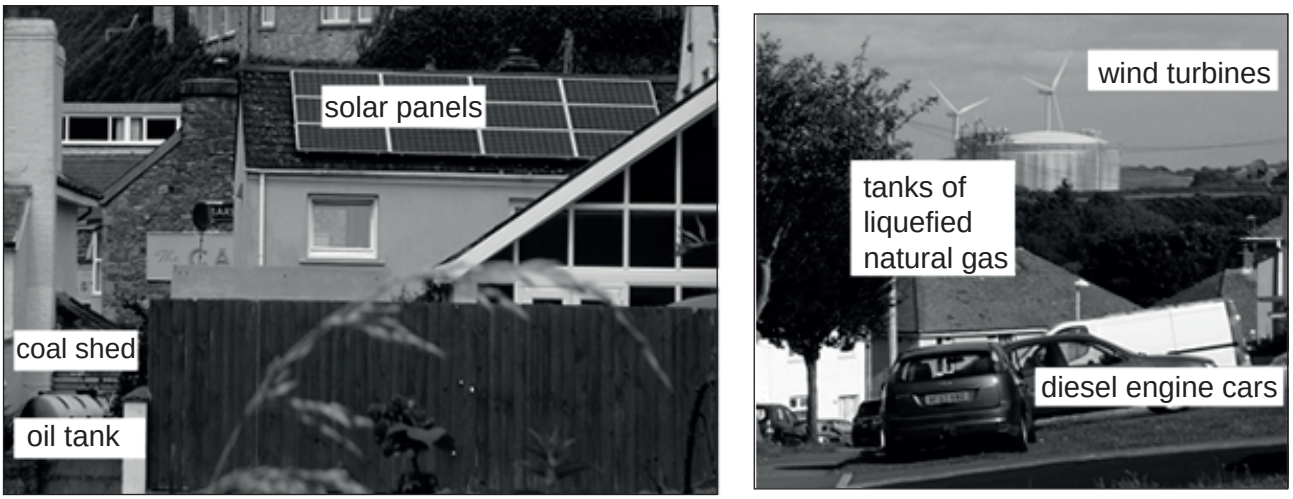

Figure 4

7. Name the **two** types of renewable energy being used in **Figure 4**. Tick (✓) only **two** boxes. [2]

coal	☐
oil	☐
solar	☐
diesel	☐
wind	☐
liquefied natural gas	☐

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8. Explain why an increase **OR** reduction in the area covered by ice caps has an influence on the Earth's atmospheric temperature. [3]

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Figure 5 is a newspaper article describing the storms of the winter of 2013-2014 which affected the UK.

During the 2013-2014 winter parts of the United Kingdom were flooded following severe storms. The flooding affected the majority of the Somerset Levels and saw the main railway line to Cornwall and West Devon at Dawlish damaged for several weeks. This was the most exceptional period of winter rainfall in at least 248 years. Met Office forecasters said changes in sea surface temperatures and a reduction in the amount of Arctic sea-ice could be influencing the increase in rainfall. Another theory is that the 0.7°C increase in global temperatures since pre-industrial times is causing the wet weather because a warmer atmosphere can hold more moisture, leading to the greater risk of heavy rain.

Figure 5

9. Which **two** of the following describe weather extremes in the UK **correctly**? Tick (✓) only **two** boxes. [2]

when it rains without warning	☐
could be caused by global warming or melting Arctic sea ice	☐
when temperature reaches 25° C	☐
when night temperature drops below 0° C	☐
could be caused by a warmer atmosphere holding less water	☐
when a weather event is significantly different from the historical average	☐

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Section 2 – answer questions 1 – 9

Figure 6 shows the earthquake intensity around the epicentre of an earthquake that took place in California in 1906.

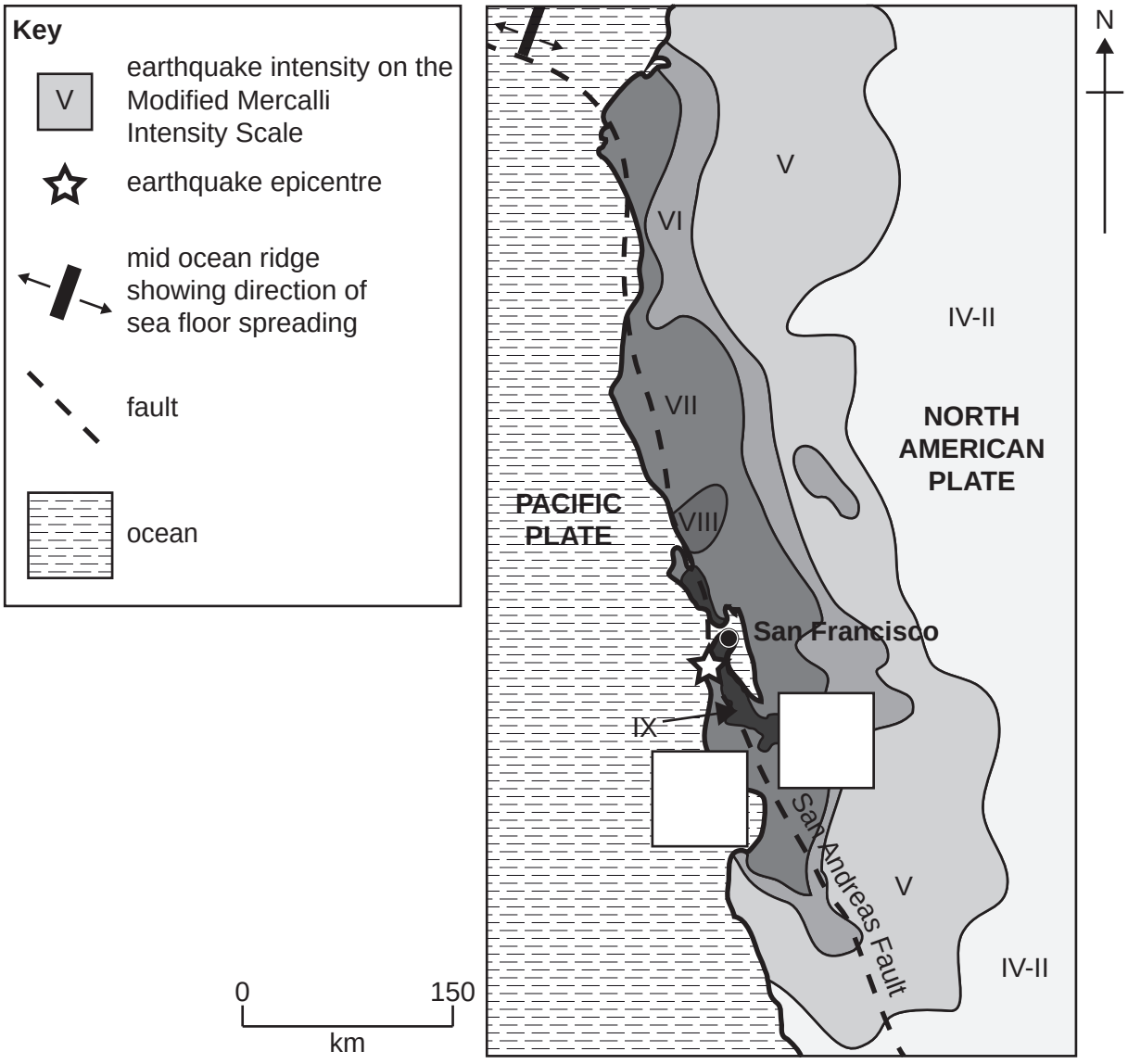

Figure 6

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1. Which **one** of the following statements about the earthquake shown in **Figure 6** is **correct**? Tick (✓) only **one** box. [1]

earthquake intensity decreases at an equal rate in all directions from the epicentre ☐

the epicentre of the earthquake is the point within the Earth where the earthquake originates ☐

earthquake intensity decreases more rapidly towards the northwest ☐

in San Francisco earthquake intensity was IX on the Modified Mercalli Intensity Scale ☐

earthquake intensity depends only on the distance from the epicentre ☐

2. The San Andreas Fault in **Figure 6** forms a plate margin. Draw **two** of the arrows shown below in the empty boxes in **Figure 6** to show the directions of relative plate movement at those locations. [1]

3. Name the type of plate margin between the North American and Pacific plate formed at the San Andreas Fault. Tick (✓) only **one** box. [1]

divergent (constructive) ☐

convergent (destructive) ocean-ocean ☐

convergent (destructive) ocean-continent ☐

convergent (destructive) continent-continent ☐

conservative ☐

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4. Which **two** of the following statements **correctly** describe the San Andreas Fault? Tick (✓) only **two** boxes. [2]

a normal fault ☐

a transform fault ☐

caused by tensional stress ☐

a strike-slip fault ☐

a reverse fault ☐

a thrust fault ☐

caused by compressional stress ☐

5. Which **one** of the following occurs at the San Andreas Fault? Tick (✓) only **one** box. [1]

shallow, medium and deep focus earthquakes ☐

volcanic activity without seismic activity ☐

deep focus earthquakes only ☐

volcanic activity and deep focus earthquakes ☐

shallow focus earthquakes only ☐

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Table 2 shows the Modified Mercalli Intensity Scale.

Modified Mercalli Intensity Scale	
Mercalli Intensity	**Eye–witness observations**
I	Felt by very few people.
II	Felt by a few people mainly on the upper floors of buildings.
III	Felt by people mainly on the upper floors of buildings. Cars may rock slightly. Vibrations similar to a passing truck.
IV	Felt indoors by most people and outdoors by a few. Windows and doors disturbed. Walls make a cracking sound. Objects on shelves shake. Vibrations like a heavy truck striking a building.
V	Felt by most people. Windows broken. Objects on shelves overturned.
VI	Felt by all people. Heavy furniture moved. Plaster falls off walls.
VII	Considerable damage to poorly built or badly designed structures. Chimneys broken. Slight to moderate damage in well-built structures. Damage negligible in buildings of good design.
VIII	Damage great in poorly built structures. Considerable damage in ordinary buildings with partial collapse. Chimneys, walls and chimney stacks fall. Damage slight in specially designed structures. Furniture broken.
IX	Damage considerable even in specially designed structures. Great damage in large buildings with partial collapse. Buildings shifted off foundations. Ground cracked.

Table 2

6. A woman living in the area shown in **Figure 6** observed that it was difficult to stand up, her chair collapsed and the chimney was broken and fell. An outside wall collapsed.

Using **Table 2**, state the intensity of the earthquake affecting the area where this woman lived on the Modified Mercalli Scale. Tick (✓) only **one** box. [1]

IV ☐

V ☐

VI ☐

VII ☐

VIII ☐

7. Describe **one** way in which the level of risk from earthquakes can be reduced through improved building design. [2]

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Figure 7 is a graph showing rate of sea floor spreading at the ocean ridge in the Pacific Ocean in **Figure 6** over the last 4 million years.

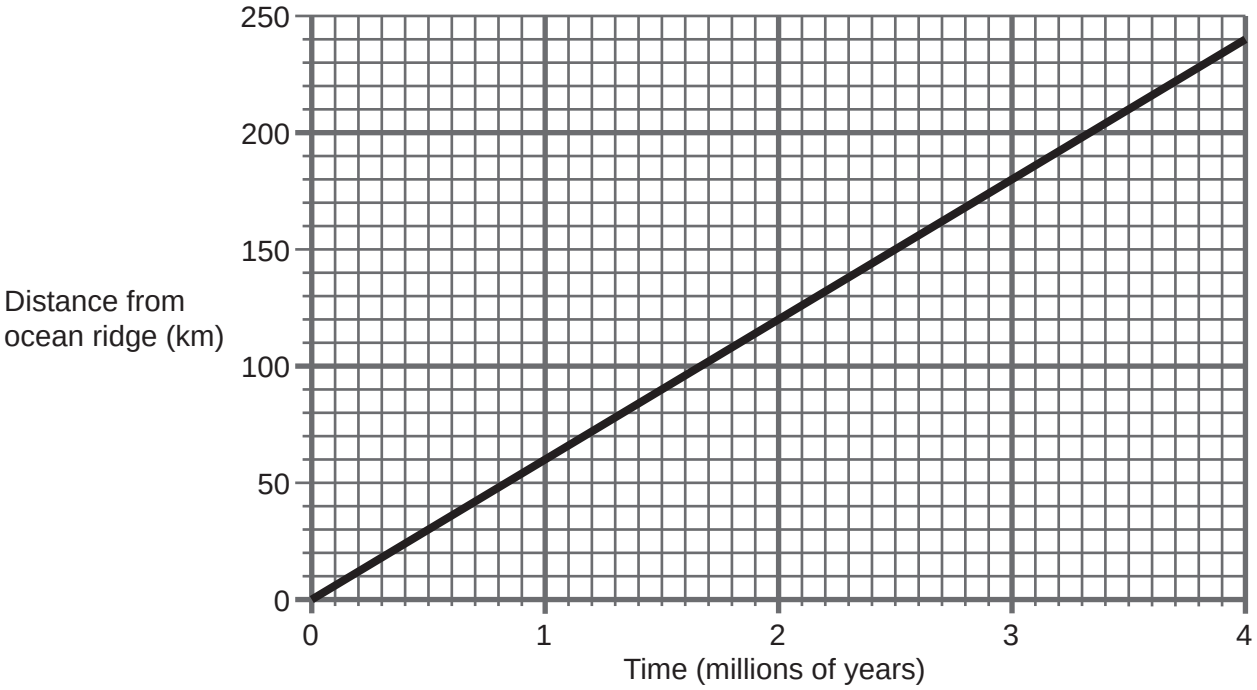

Figure 7

8. Using **Figure 7**, calculate the average rate of sea floor spreading of the ocean ridge (in cm per year) in **Figure 6** over the last 4 million years. Show your calculation below. [2]

Calculation

..... cm per year

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Figure 8 shows the changes in radon gas content in groundwater before and after an earthquake on January 17th 1995 in Japan.

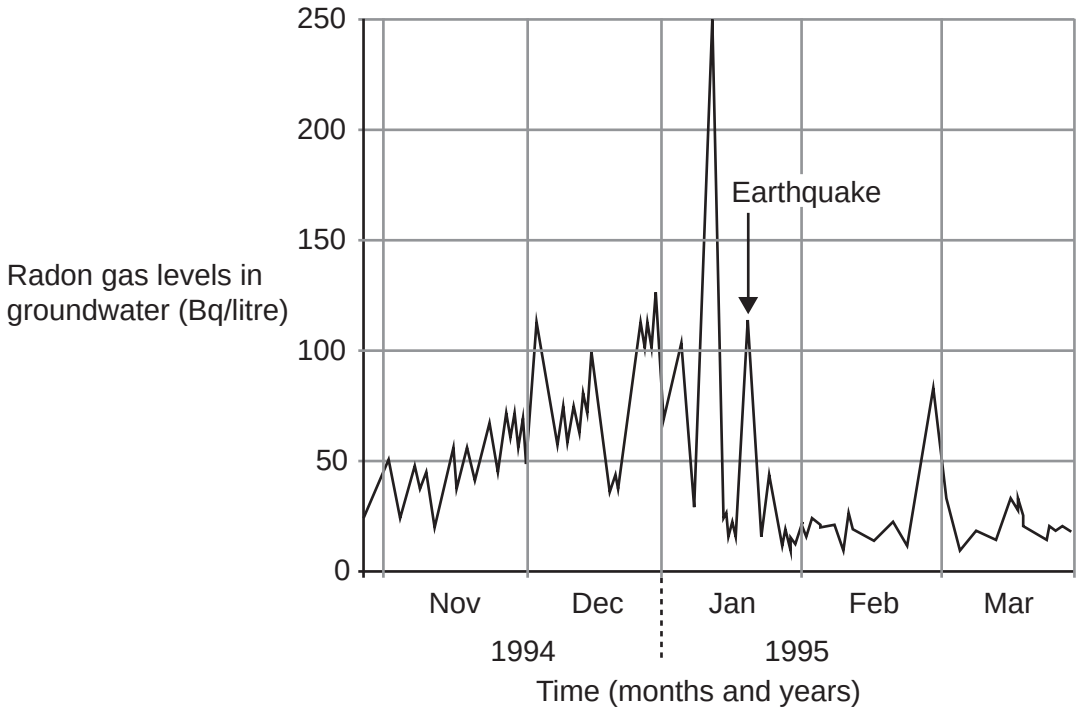

Figure 8

9. Which **two** of the following statements about the radon gas content of groundwater seen in **Figure 8** are **incorrect**? Tick (✓) only **two** boxes. [2]

in December levels did not exceed 140 Bq/litre ☐

levels reached their peak one month before the earthquake ☐

a marked increase coincided with the earthquake ☐

one month before the earthquake variations in levels were greater than the previous month ☐

for two months before the earthquake levels went up and down frequently but the general trend was a decrease ☐

after the earthquake levels were fairly stable with an increase over one month after the earthquake ☐

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Section 3 – answer questions 1 – 5

Figure 9 is a sedimentary log.

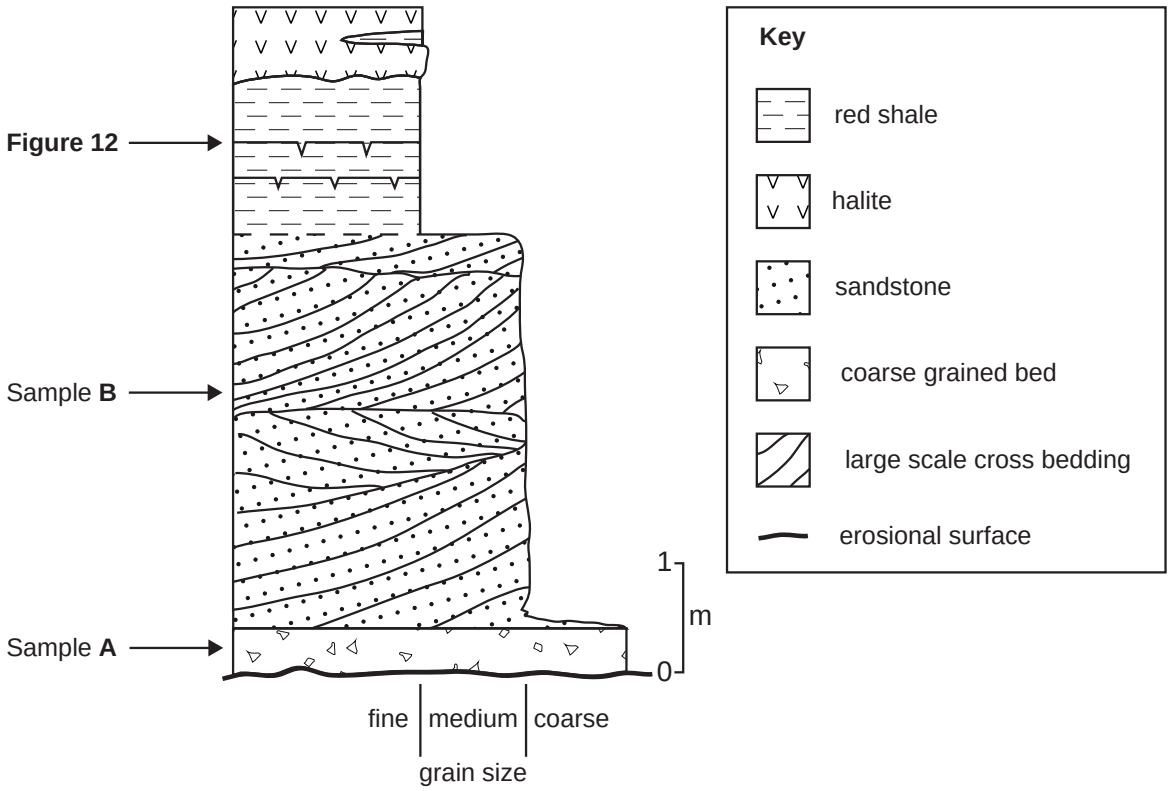

Figure 9

Figure 10 shows the texture of samples **A** and **B** taken at the locations shown in the sedimentary log in **Figure 9**.

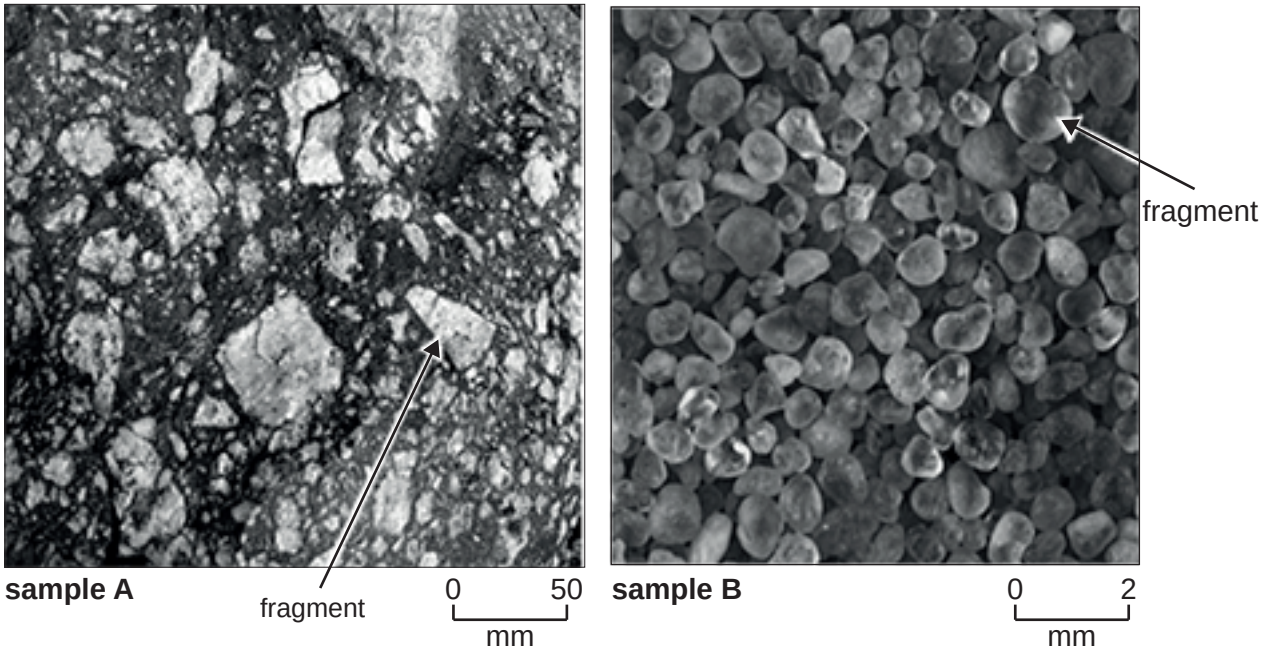

Figure 10

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Table 3, which has been partly completed, compares the size and shape of the labelled fragments in **Figure 10** and the sorting of the two samples (**A** and **B**).

texture	sample A	sample B
grain size	*fragment from **A** is coarse grained*	
grain shape		*fragment from **B** is subrounded to rounded*
sorting		

Table 3

fragment from **A** is rounded	poorly sorted	fragment from **B** is fine grained
well sorted	fragment from **A** is angular	fragment from **B** is medium grained
fragment from **B** is coarse grained	fragment from **A** has high sphericity	

1. Complete **Table 3** by writing the appropriate descriptions of samples **A** and **B** in **Figure 10** in their correct positions. Choose from the descriptions in the boxes below Table 3. [4]

2. Name the rock type forming sample **A** in **Figure 10**. Tick (✓) only **one** box. [1]

conglomerate ☐

sandstone ☐

breccia ☐

shale ☐

limestone ☐

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Figure 11 is a rose diagram showing the orientation of the dip of the large scale cross bedding in **Figure 9**.

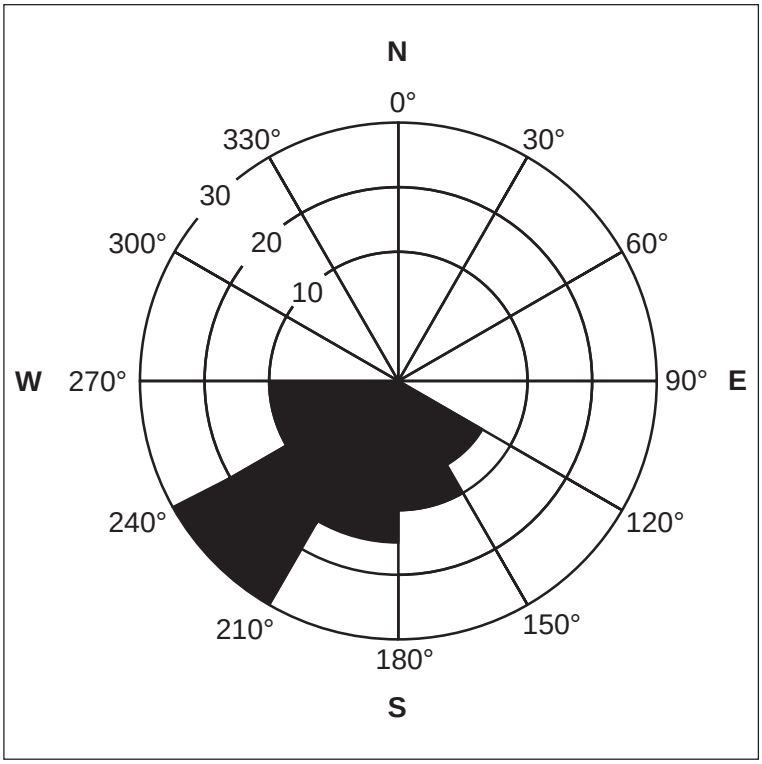

Figure 11

3. Which **two** of the following statements about the formation of the large scale cross bedding are **correct**? Tick (✓) only **two** boxes. [2]

formed by a river flowing from the south west ☐

formed from migrating sand ripples in between low and high tide ☐

formed by a river flowing towards the north east ☐

formed by wind blowing from the north east ☐

formed by wind blowing towards the south west ☐

formed in low energy conditions from suspension ☐

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Figure 12 shows two structures (**C** and **D**) on a bedding plane surface at the location shown in the sedimentary log in **Figure 9**.

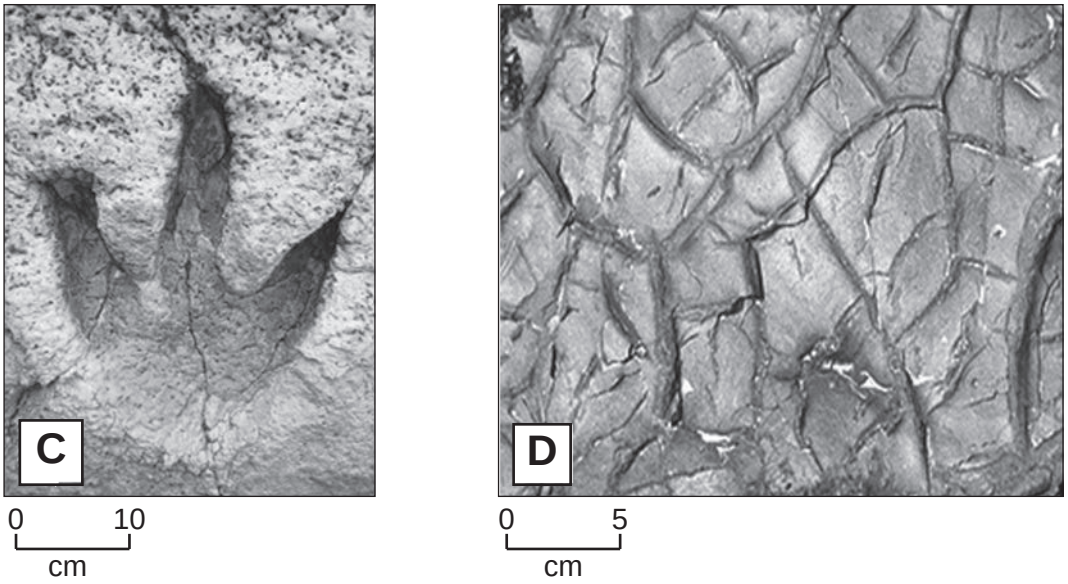

Figure 12

4. Name the **two** structures (**C** and **D**) in **Figure 12**.
Select your answers from the list below. [2]

trace fossil
cross bedding
desiccation cracks
plant
burrows
ripple marks

C .....

D .....

5. Using **Figures 9-12**, explain how the evidence suggests that the sedimentary environment changed during the deposition of the beds shown in the sedimentary log in **Figure 9**. [4 QWC]

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Section 4 – answer questions 1 – 9

Figure 13 is a geological map showing an area of Scotland with faults and igneous rocks formed during the Caledonian orogeny.

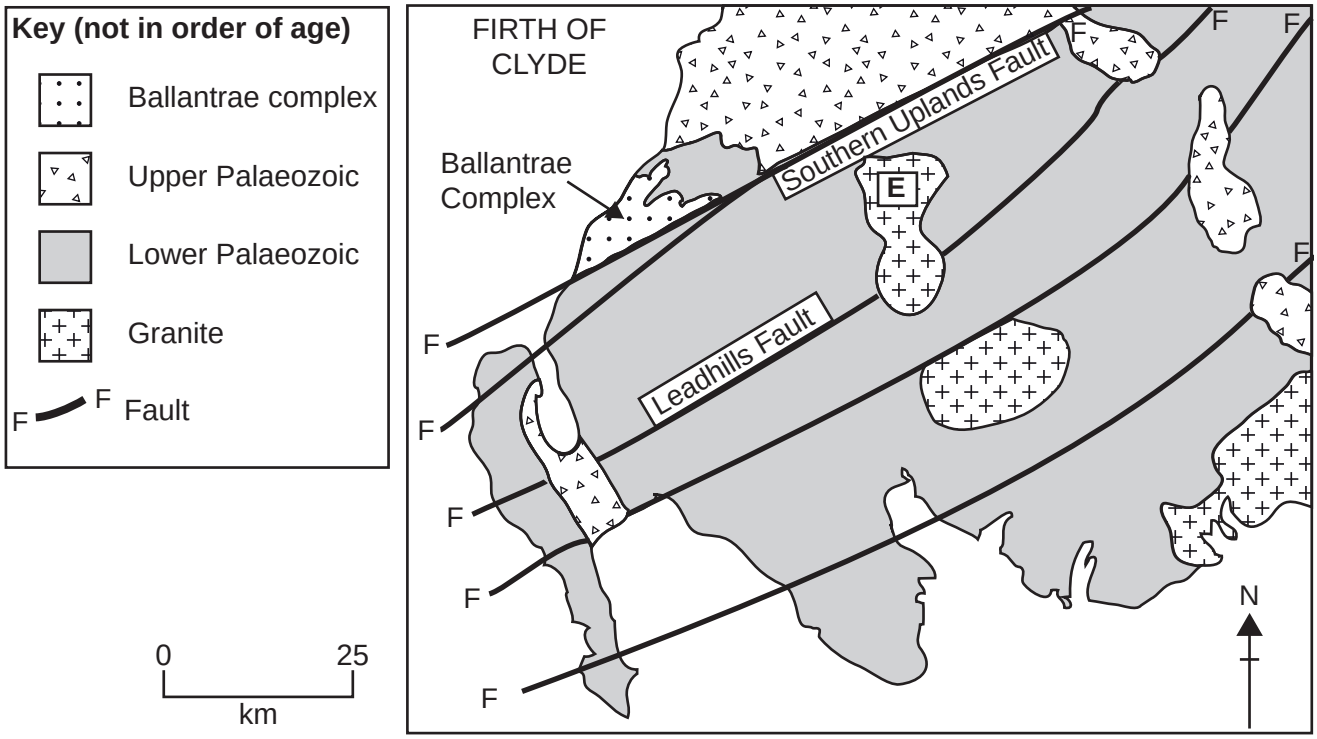

Figure 13

1. Which **two** of the following statements about the relative ages of granite **E**, the **Leadhills Fault** and the Palaeozoic rocks in **Figure 13** are **incorrect**? Tick (✓) only **two** boxes. [2]

granite **E** is younger than the **Leadhills Fault** ☐

the **Leadhills Fault** is older than the Upper Palaeozoic rocks ☐

granite **E** was intruded after the Lower Palaeozoic rocks ☐

granite **E** is older than the **Leadhills Fault** ☐

granite **E** could have been intruded before, during or after the Upper Palaeozoic ☐

the **Leadhills Fault** is older than the Lower Palaeozoic rocks ☐

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2. Which **one** of the following statements best describes the probable origin of granite magmas during the Caledonian orogeny? Tick (✓) only **one** box. [1]

partial melting of the mantle beneath the ocean ridge	☐
partial melting of the mantle at a transform fault	☐
complete melting of the mantle beneath an island arc	☐
partial melting of continental crust beneath a fold mountain	☐
complete melting of subducting ocean crust beneath a coastal mountain chain	☐

3. Which **one** of the following is **not** evidence for plate collision during the Caledonian orogeny? Tick (✓) only **one** box. [1]

thrust faults	☐
turbidites	☐
flood basalts	☐
regional metamorphism	☐
fold mountain chains	☐

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Figure 14 is a geological cross section across an area of the map in **Figure 13**.

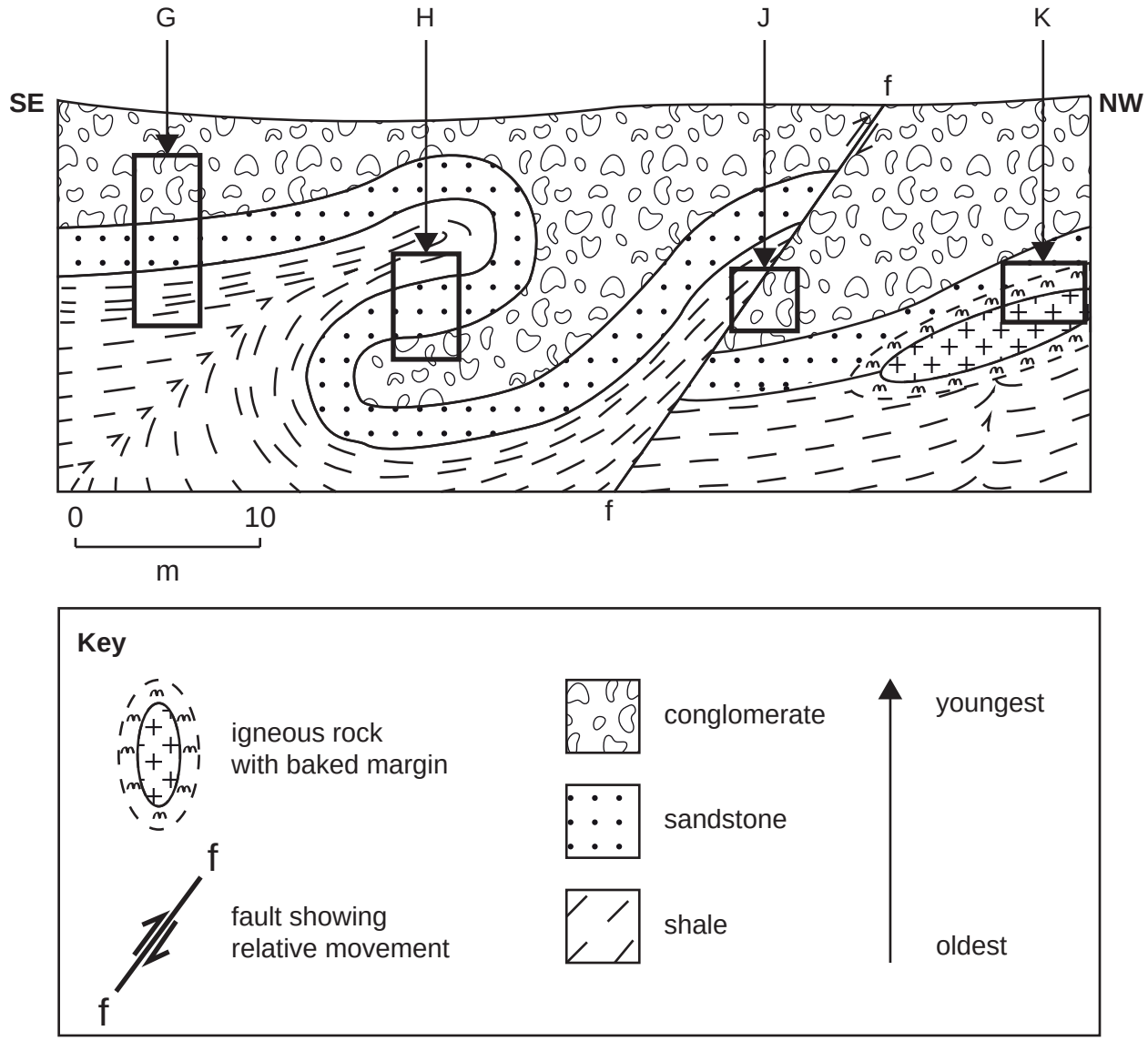

Figure 14

4. In which box in **Figure 14** is a younger rock unit on top of an older rock unit?
Tick (✓) only **one** box. [1]

G ☐

H ☐

J ☐

K ☐

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Figure 15 is a microscope view of an igneous rock forming part of the Ballantrae Complex in **Figure 13**.

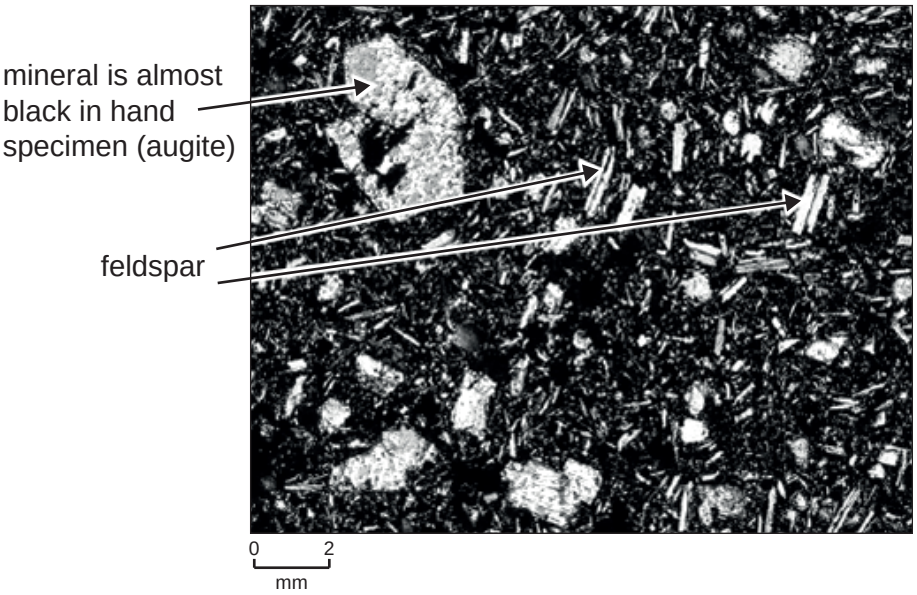

Figure 15

5. Which **two** of the following statements about the rock in **Figure 15** are **correct**? Tick(✓) only **two** boxes. [2]

the rock is granite ☐

the texture suggests two stages of cooling ☐

crystals are interlocking and show alignment ☐

the rock is gabbro ☐

the minerals are formed by crystallisation from solution in evaporating water ☐

the rock is basalt ☐

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Figure 16 is a photograph of structures within the rocks of the Ballantrae Complex in **Figure 13**.

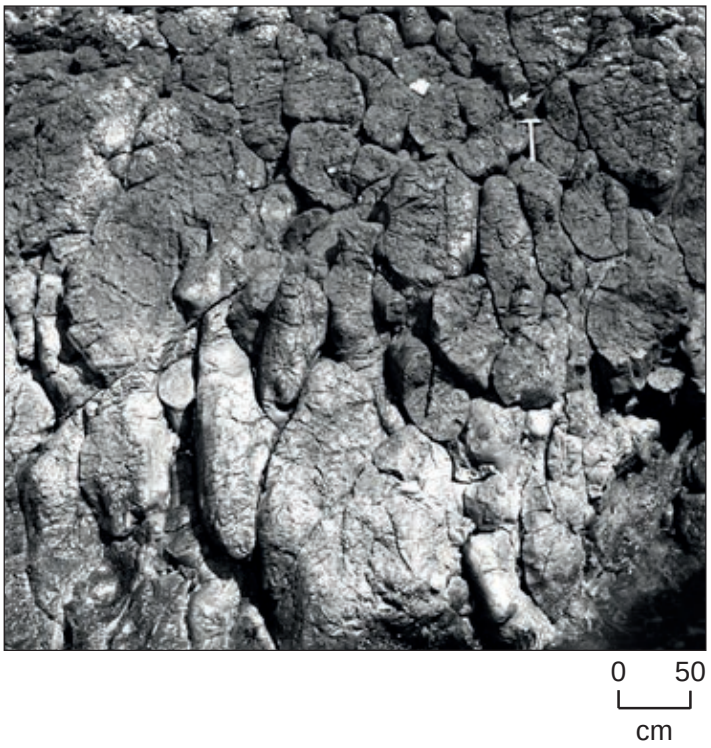

Figure 16

6. Name the structures in **Figure 16**. Tick (✓) only **one** box. [1]

included fragments ☐

pillow lavas ☐

dykes ☐

folds ☐

ripple marks ☐

7. Explain how the structures in **Figure 16** formed. [3]

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Figure 17 is a microscope view of metamorphosed limestone (marble) from the metamorphic aureole of a granite in **Figure 13**.

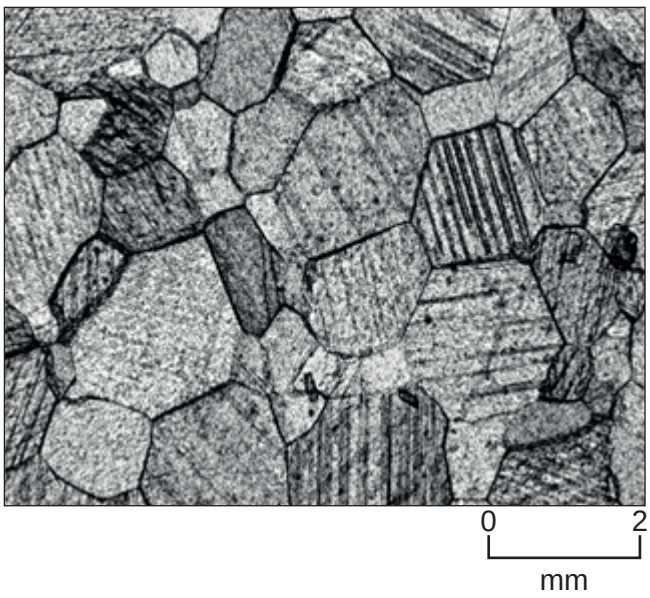

Figure 17

8. Which **two** of the following statements about the marble in **Figure 17** are **correct**? Tick (✓) only **two** boxes. [2]

foliated	☐
shows a schistose texture	☐
minerals in the rock are formed by recrystallisation	☐
non-foliated	☐
minerals in the rock are formed by crystallisation from magma	☐
has a slaty cleavage	☐

9. The texture of the rock in **Figure 17** could also be present in a quartz-rich sandstone which has then been metamorphosed. Using the **Data Sheet**, describe **two** practical tests that could be carried out to determine whether a rock is a metamorphosed limestone (marble) or a quartz-rich metamorphosed sandstone. [4]

Test 1 .....

Result .....

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Test 2 .....

Result .....

.....

17

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Section 5 – answer questions 1 – 7

Figure 18 shows the rock types and graptolite fossils in three boreholes. Lines of correlation are shown.

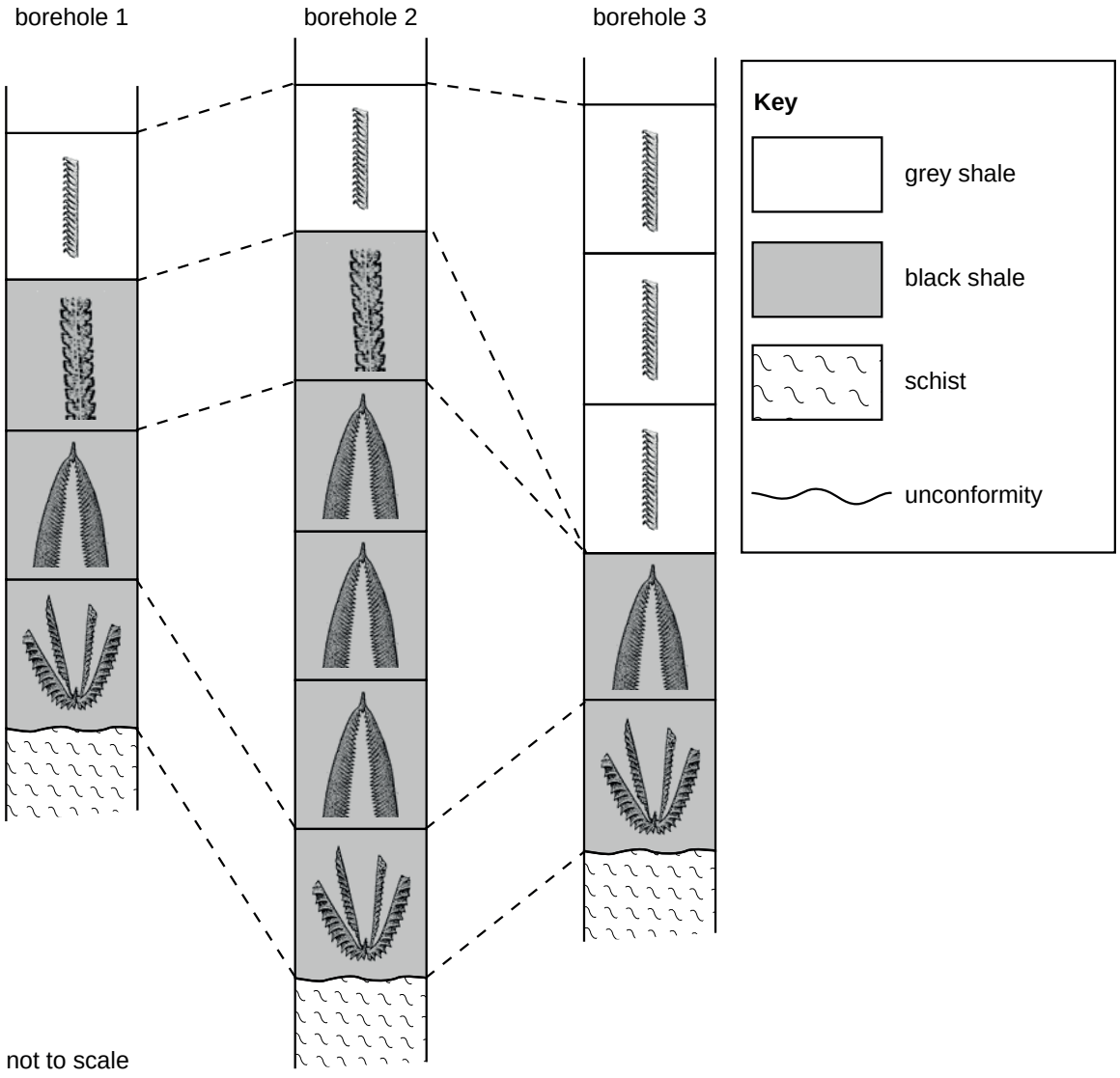

Figure 18

1. Which **one** of the following statements about **Figure 18** is **correct**? Tick (✓) only **one** box. [1]

four graptolite zones are present in all three boreholes ☐

as graptolites evolved there was an increase in the number of stipes ☐

the rocks are being correlated by using the principles of original horizontality and lateral continuity ☐

evolution of the graptolites allows the absolute dating of the beds in each borehole ☐

the beds in all three boreholes are the correct way up ☐

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2. Which **one** of the following is essential for fossils such as graptolites which are used in the dating and correlation of rocks? Tick (✓) only **one** box. [1]

not limited to a specific environment ☐

similar in form so that it is difficult to distinguish between them ☐

usually live on the sea floor and are not widespread ☐

should be found on one continent to allow world-wide correlation ☐

found in rocks from each geological period ☐

The fossil in **Figure 19** was found in rocks in Wales.

Figure 19

3. Which **one** of the following statements best describes the formation of the rock containing the fossil in **Figure 19**? Tick (✓) only **one** box. [1]

formed by the regional metamorphism of sedimentary rock deposited in a freshwater lagoon during the Cambrian Period ☐

formed by exceptional preservation in the Burgess shale formation during the Jurassic Period ☐

formed by deposition on the continental shelf during the Cambrian Period ☐

formed from the solidification of magma under water during the Ordovician Period ☐

formed by the deposition of sediment by glacial meltwater during the Pleistocene ☐

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4. Explain how changes in **one** morphological feature of extinct **cephalopods** can be used in the dating and correlation of rocks. [3]

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5. Which **one** of the following was the earliest to appear in the fossil record? Tick (✓) only **one** box. [1]

soft bodied animals such as jellyfish ☐

single cells such as bacteria ☐

multicellular organisms such as corals ☐

animals with hard parts such as trilobites ☐

sharks ☐

6. A very large, circular, meteorite crater near the coast of Mexico is believed to be approximately 65 million years old. Which **two** of the following events was the meteorite impact thought to be partly responsible for? Tick (✓) only **two** boxes. [2]

evolution of the earliest birds ☐

extinction of the amphibians ☐

extinction of the dinosaurs ☐

separation of Africa from America ☐

appearance of the earliest mammals ☐

a mass extinction event ☐

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7. Life originated on Earth approximately 3,500 million years ago. Describe the probable environment in which life originated. [3]

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Section 6 – answer questions 1 – 10

Figure 20 is a geological map showing folded beds. The surface of the ground is flat and the beds are the correct way up.

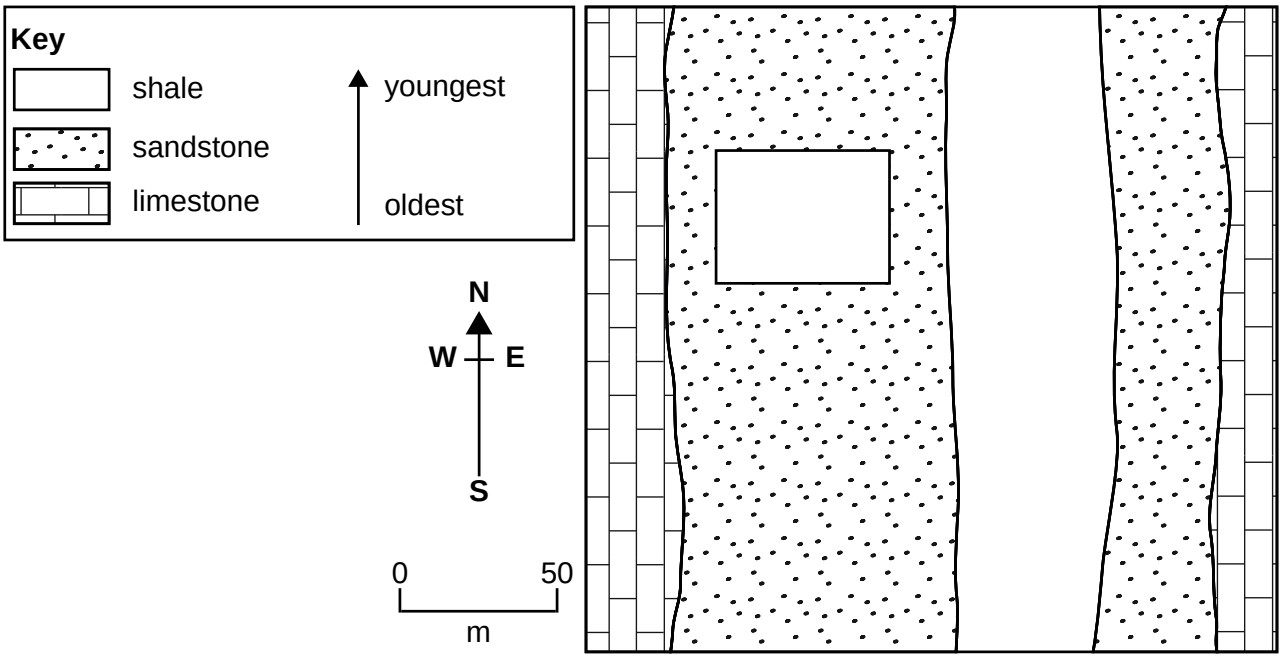
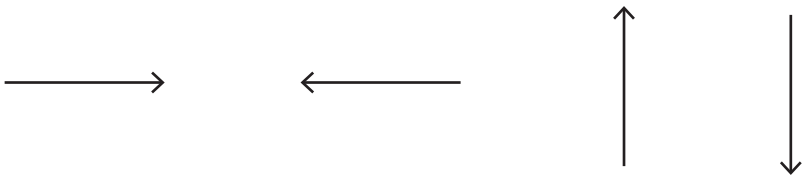


Figure 20

1. Draw **one** of the arrows shown below in the empty box on **Figure 20** to show the dip direction of the bed at this location. [1]



2. Using evidence from **Figure 20**, explain why the angle of dip on each limb of the fold must be different. [2]

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3. Which **one** of the following statements about the fold in **Figure 20** is **incorrect**? Tick (✓) only **one** box. [1]

the fold is a syncline	☐
the trend of the axial plane trace of the fold is N-S	☐
shale forms the core of the fold	☐
the axial plane of the fold dips towards the west	☐
the directions of compression are from the east and west	☐

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Figure 21 is a geological map showing two **vertical dip-slip faults**.

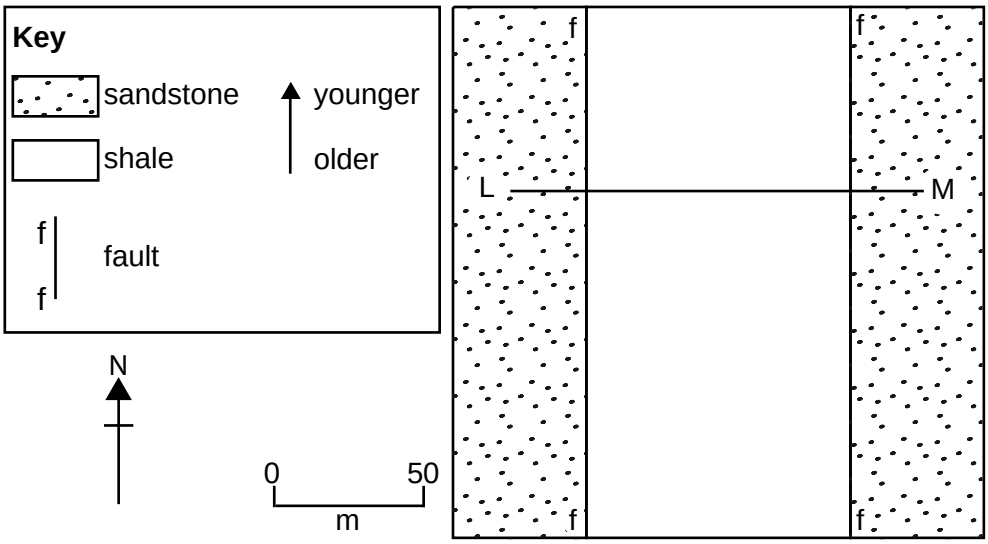
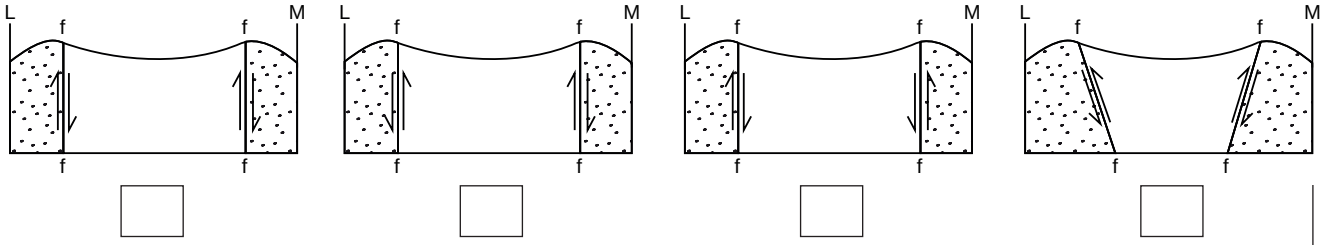


Figure 21

4. Which **one** of the four cross sections below best represents the geology along the line of section **L – M** in **Figure 21**? Tick (✓) only **one** box and explain your answer. [3]

The half arrows show relative movement along each fault.



Explanation

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Figure 22 shows the results of a survey to locate hydrocarbon traps in the North Sea.

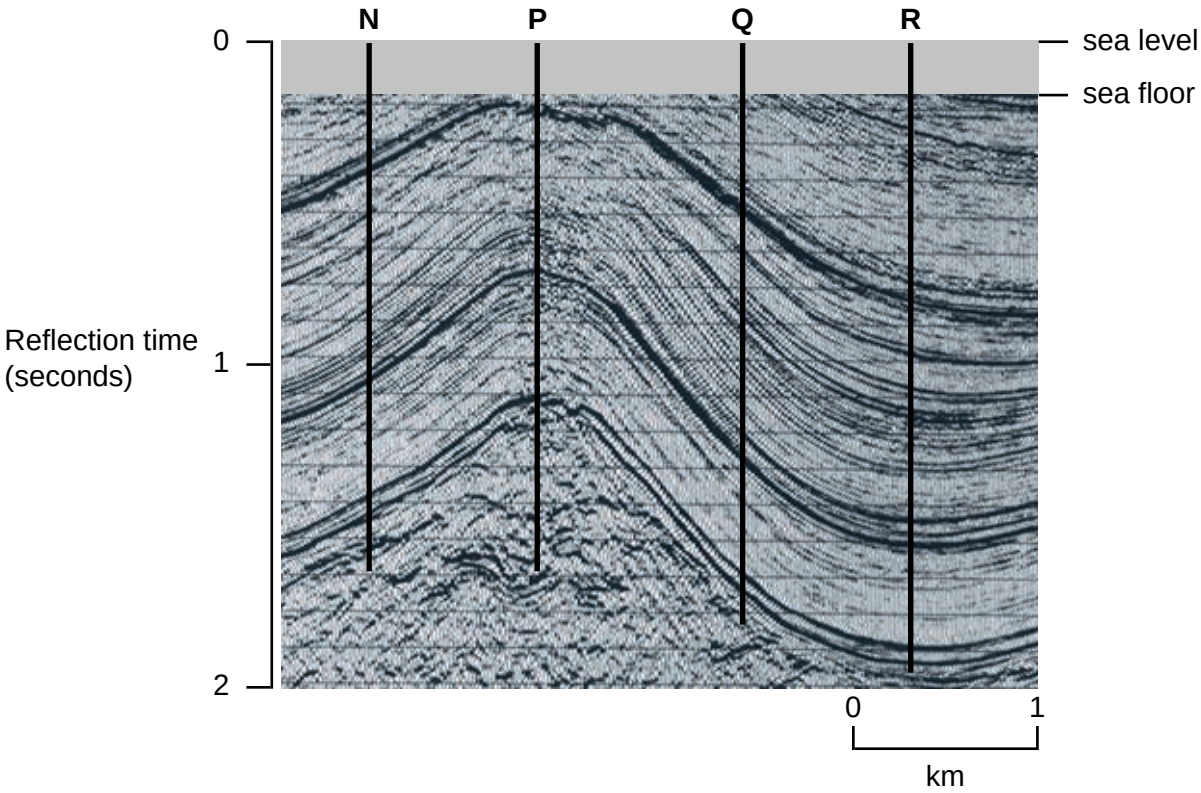

Figure 22

5. Which **one** of the following types of survey is shown in **Figure 22**? Tick (✓) only **one** box. [1]

surface mapping ☐

magnetic survey ☐

sampling of sediment ☐

seismic survey ☐

geochemical survey ☐

6. Which **one** of the following types of possible hydrocarbon trap is present in **Figure 22**? Tick (✓) only **one** box. [1]

unconformity ☐

anticline ☐

fault ☐

salt dome ☐

syncline ☐

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7. At which **one** of the locations in **Figure 22** (**N**, **P**, **Q** or **R**) would it be best to drill a test well to establish whether hydrocarbons are present at depth? Tick (✓) only **one** box. [1]

N ☐

P ☐

Q ☐

R ☐

8. Some oil wells in the North Sea can extract up to 60% of the oil whilst other wells can only extract 30%.
Which **one** of the following could explain the higher extraction rate? Tick (✓) only **one** box. [1]

reservoir rock has lower porosity ☐

reservoir rock is more poorly sorted ☐

reservoir rock is less well cemented ☐

reservoir rock is less permeable ☐

grain shapes in the reservoir rock are more angular ☐

9. Which **one** of the following environments will result in the formation of a suitable oil **source rock**? Tick (✓) only **one** box. [1]

deep sea conditions near the continental slope affected by turbidity currents ☐

a warm sea inhabited by corals in which limestone is forming ☐

high energy shore line conditions which preserve organic matter in a conglomerate ☐

organic-rich sea in a tropical climate which later evaporates ☐

low energy organic-rich conditions, often anaerobic ☐

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Figure 23 is a cross section through a hydrocarbon trap showing the fluids present in the pore spaces of the sandstone.

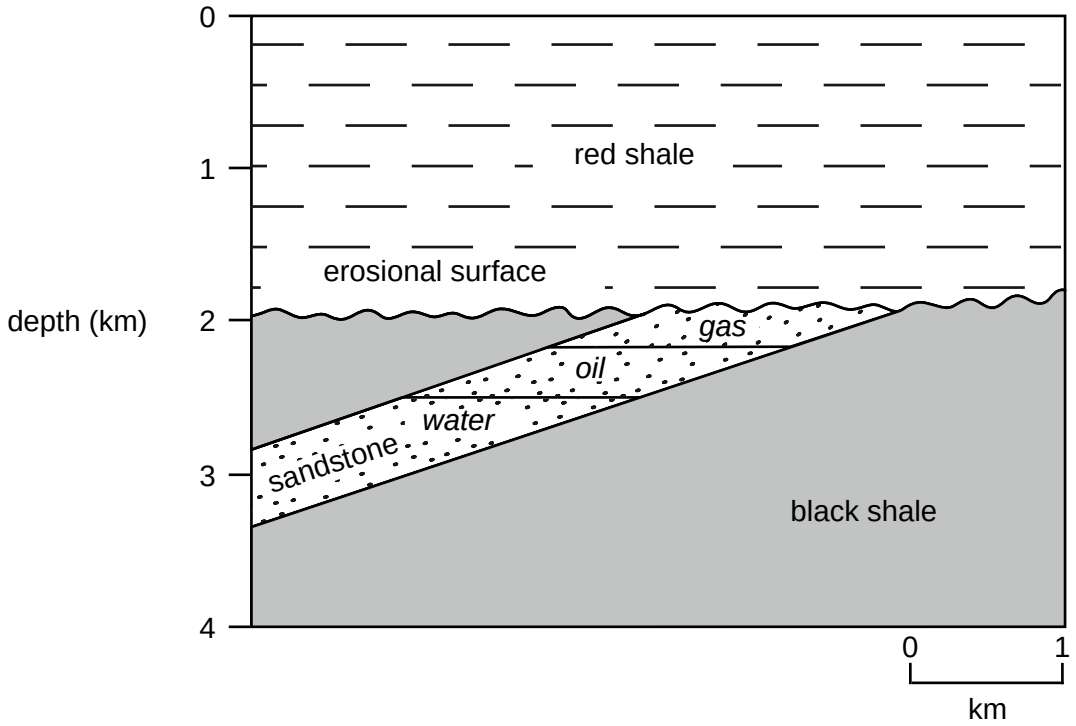

Figure 23

10. Explain how hydrocarbons have migrated from a source rock at depth and accumulated in the trap in **Figure 23**. [4 QWC]

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Section 7 – answer questions 1 – 5

Figure 24 shows where soil samples were collected, analysed for their copper content and the results plotted on the map. The figures show the levels of copper in parts per million (ppm). Lines have been drawn joining equal values for 300, 500 and 1000 ppm.

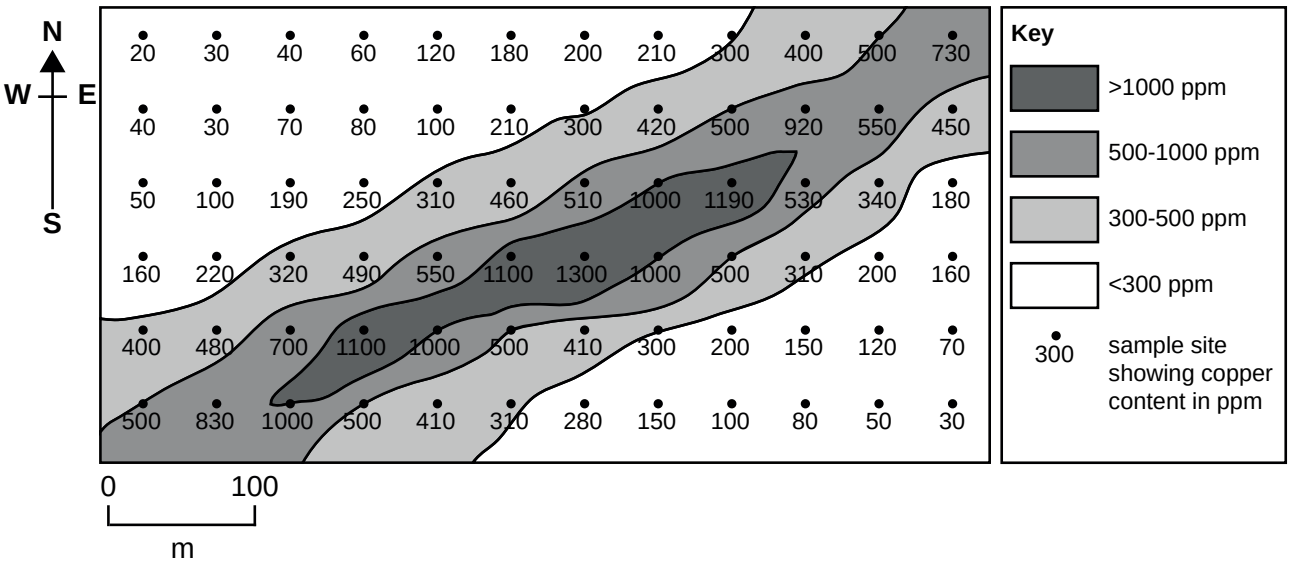

Figure 24

1. Which **one** of the following statements best describes the concentration of the copper over 300 ppm in **Figure 24**? Tick (✓) only **one** box. [1]

evenly distributed over the area covered by the map ☐

a linear pattern orientated NE-SW approximately 175m wide ☐

a circle of concentration with the highest concentration in the centre ☐

a linear pattern orientated NW-SE over 300m wide ☐

random sampling has caused an apparent concentration of copper ☐

2. Which **one** of the following underlying geological structures could have caused the copper concentration pattern in **Figure 24**? Tick (✓) only **one** box. [1]

a lava flow dipping southward at a low angle underlying the whole area ☐

a NE-SW trending fold with sandstone in the core ☐

a vertical dyke with a NW-SE strike cutting across the area ☐

a straight vertical mineral vein under part of the area ☐

a vertical fault with a NW-SE strike cutting across the area ☐

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3. Copper is a trace element in the crust making up 0.005% of the Earth's crust. A copper ore contains an average of 1% copper. Calculate by how much the copper in the ore has been concentrated above the value for the Earth's crust. Show your calculation below. [2]

Calculation

concentration .....

4. After mining, soils are often contaminated by metallic elements. Describe **one** way in which the metals in the soil can be returned to safe levels. [2]

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After quarrying and mining, quarries can be put to other uses. **Figure 25** is a geological cross section showing two disused limestone quarries (**S** and **T**), which are being considered for the disposal of domestic waste.

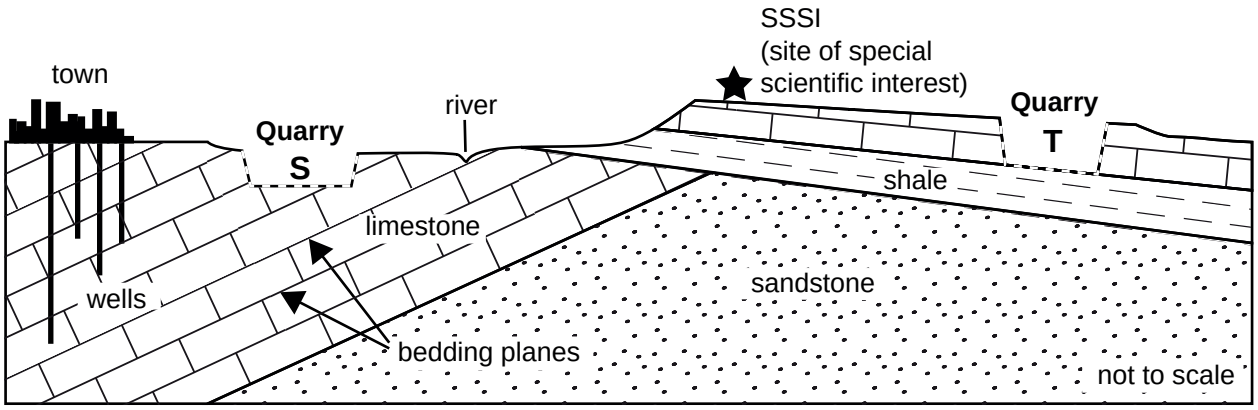

Figure 25

5. State which quarry (**S** or **T**) in **Figure 25** you consider to be the most suitable site for the disposal of domestic waste and explain the **geological** reasons involved in your choice. [4]

Quarry **S** or **T** ☐

Geological reasons

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