OCR
Oxford Cambridge and RSA

AS Level Geology

H014/01 Geology

Monday 14 May 2018 – Morning

Time allowed: 2 hours 30 minutes

You must have:
- a ruler (cm/mm)
- a protractor
- a pencil

You may use:
- a scientific or graphical calculator

First name									
Last name									
Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **120**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **32** pages.

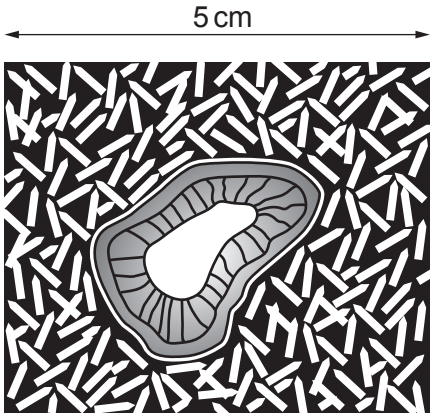
Section A

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box provided.

Answer **all** the questions.

1 The diagram below shows a thin section of igneous rock.



Which of the options, **A** to **D**, describes the texture shown?

A equicrystalline

B glassy

C vesicular

D amygdaloidal

Your answer [ ] **[1]**

2 The pyroxenes have unique physical properties. Which of the following describes a pyroxene?

A framework silicate, hardness 6.5

B sheet silicate, one perfect cleavage

C hardness 6, two good cleavages at 90°

D hardness 7, poor cleavage

Your answer [ ] **[1]**

3 Friedrich Mohs developed a simple scale to help geologists identify minerals.

Which physical property of minerals does the scale help identify?

A density

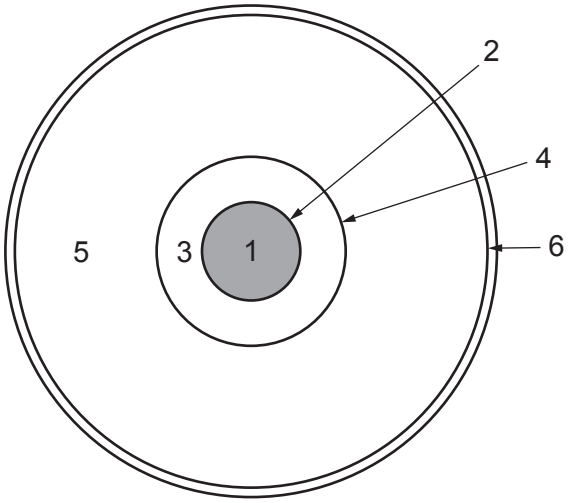
B hardness

C lustre

D cleavage

Your answer ☐ **[1]**

4 The diagram below shows a simplified cross-section through the Earth. **1**, **3** and **5** are layers, **2**, **4** and **6** are discontinuities.



Which of the following statements is correct?

A The Gutenberg discontinuity divides the inner from the outer core.

B The Gutenberg discontinuity divides the upper and lower mantle.

C The Gutenberg discontinuity divides the upper mantle and the crust.

D The Gutenberg discontinuity divides the lower mantle and outer core.

Your answer ☐ **[1]**

5 Which of the options, **A** to **D**, has provided evidence for the **state** of the outer core of the Earth?

A meteorites

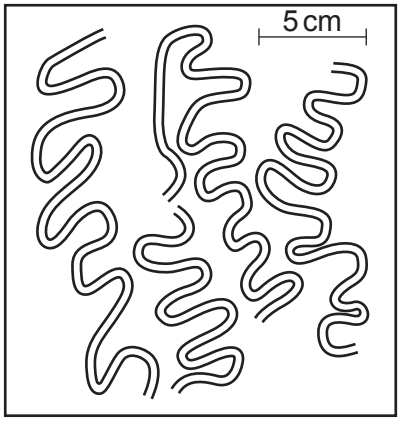
B changes in the magnetic field

C heat-flow measurements

D ophiolites

Your answer ☐ **[1]**

6 Which of the options gives the most likely purpose of the burrow shown **on the bedding plane**?



A for protection in shallow waters

B for dwelling in deep waters

C for feeding in deep waters

D for protection in deep waters

Your answer ☐ **[1]**

7 Which of the following fossil groups, **A** to **D**, is extinct?

A bivalves

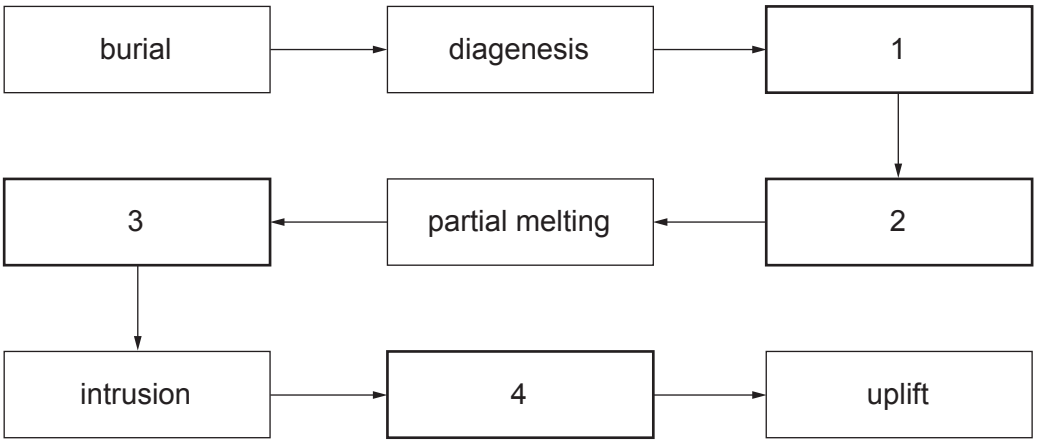
B brachiopods

C corals

D graptolites

Your answer ☐ **[1]**

8 The diagram below shows part of the rock cycle with four stages in the sequence shown as numbered boxes.



Which of the options, **A** to **D**, correctly completes the numbered boxes in the sequence?

A 1 = increased temperature and pressure, 2 = metamorphism, 3 = magma accumulation, 4 = crystallisation

B 1 = metamorphism, 2 = magma accumulation, 3 = re-crystallisation, 4 = crystallisation

C 1 = lithification, 2 = increased temperature and pressure, 3 = crystallisation, 4 = magma accumulation

D 1 = magma accumulation, 2 = increased temperature and pressure, 3 = metamorphism, 4 = crystallisation

Your answer ☐ **[1]**

9 The rock cycle that Hutton understood is now amended by the addition of which process?

A metamorphism

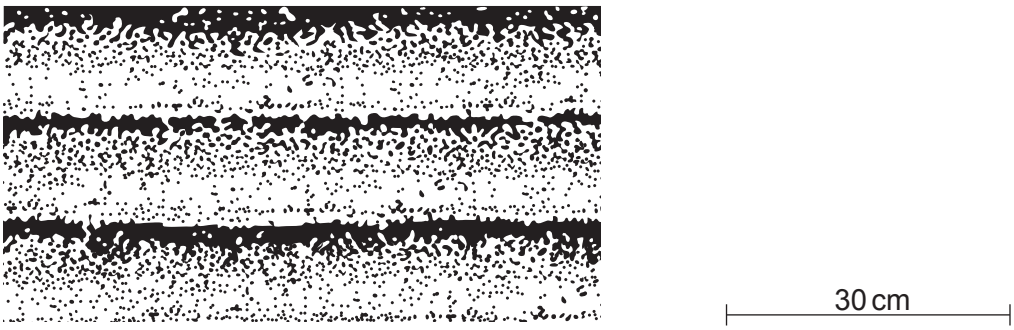
B erosion

C subduction

D mountain building

Your answer ☐ **[1]**

10 What sedimentary structures are shown in the diagram?



A graded bedding in an inverted sequence

B cross-bedding laid down in a delta sequence

C imbricate structures with current flow left to right

D salt pseudomorphs indicating a desert environment

Your answer ☐ **[1]**

11 An apparent dip of a bedding plane measured on a quarried face is 27°. Which of the following statements could be correct?

A The apparent dip is less than the true dip.

B The apparent dip is in the same direction as the strike.

C The strike is in the same direction as the true dip.

D The apparent dip is greater than the true dip.

Your answer ☐ **[1]**

12 Goldschmidt classified the elements into four groups. What term refers to those elements concentrated in the core?

A lithophile

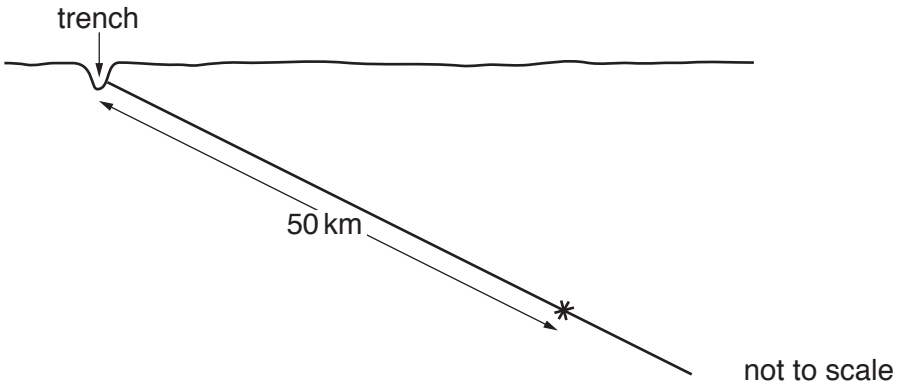
B siderophile

C chalcophile

D atmophile

Your answer ☐ **[1]**

13 An earthquake occurs on the Benioff zone 50 km from the trench shown in the diagram below.



If the epicentre is 40 km from the trench, which of the options, **A** to **D**, is the correct focal depth?

A 15 km

B 20 km

C 30 km

D 40 km

Your answer ☐ **[1]**

14 Which of the following statements on the mechanism that causes earthquakes is **incorrect**?

A Rock is under stress due to opposing forces acting on it.

B The rock is deformed and put under strain.

C Deformation increases until the stress exceeds the strength of the rock.

D Stored elastic stress energy is released partly as seismic waves.

Your answer ☐ **[1]**

15 Which of the following fault types results from plate movement at transform boundaries?

A thrust

B strike-slip

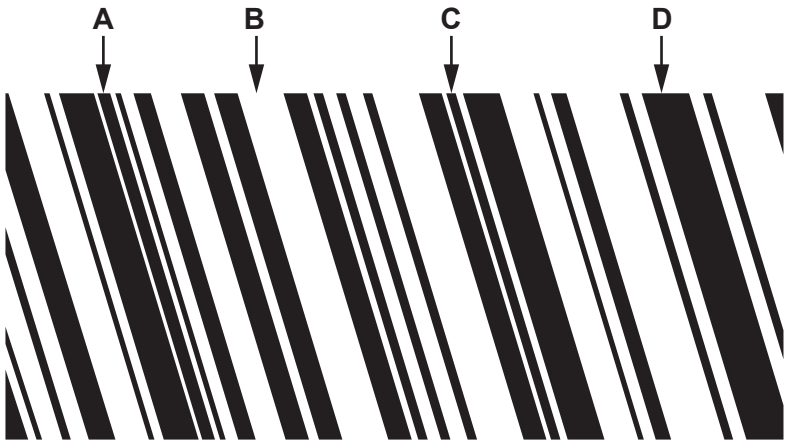
C reverse

D dip-slip

Your answer [ ] **[1]**

16 The diagram shows an area of sea floor with magnetic anomalies. Black indicates a positive anomaly and white a negative anomaly.

Which of the options, **A** to **D**, is the most likely position of the present-day spreading ridge.



Your answer [ ] **[1]**

17 Which of the following geophysical techniques would **not** show evidence of a rising mantle plume?

A seismic tomography

B electromagnetic survey

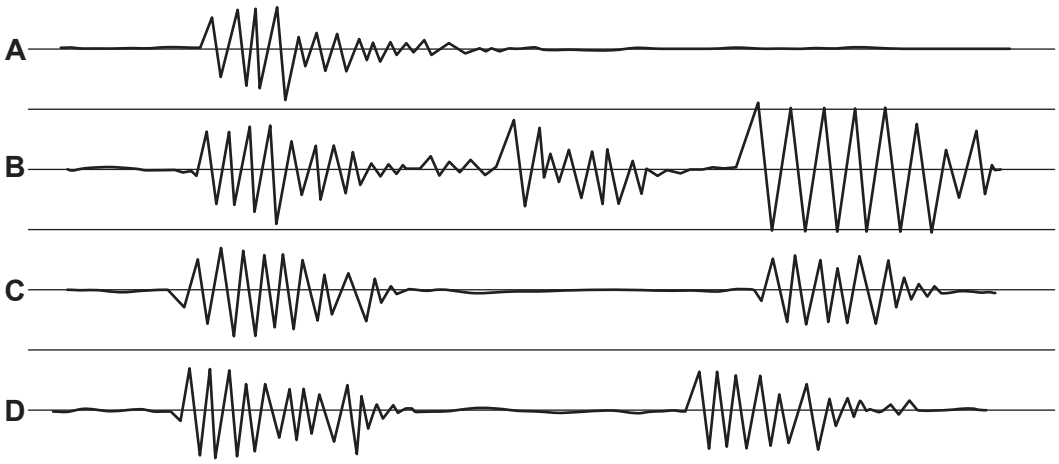
C magnetic survey

D gravity survey

Your answer [ ] **[1]**

18 The diagrams below represent seismograms recorded for a major earthquake. The amplitude scales (y-axis) have been normalised but the time axes (x-axis) are the same scale for each station.

Which of the seismograms, **A** to **D**, was recorded **furthest** from the focus?



Your answer ☐ **[1]**

19 A positive Bouguer gravity anomaly is evidence for which of the following options?

A the roots of a mountain chain

B an area undergoing isostatic uplift

C a descending lithospheric slab

D an area above an upwelling in the mantle

Your answer ☐ **[1]**

20 Which of the following statements about evaluation of experimental results is **incorrect**?

A The measurement result is considered precise if it is judged to be close to the true value.

B The measurement is precise if values of repeated experiments cluster closely.

C Uncertainty can be expressed in terms of standard deviations.

D Uncertainty is the interval within which the true value can be expected to lie.

Your answer ☐ **[1]**

Section B

Answer **all** the questions.

21 Four students have each been given five samples of different rocks labelled **A** to **E** and asked to determine their density.

They used the method below and apparatus as shown in Fig. 21.

1. Measure the mass of the sample using a digital balance
2. Submerge the sample in a displacement can
3. Measure the mass of displaced water
4. Calculate the volume of the sample

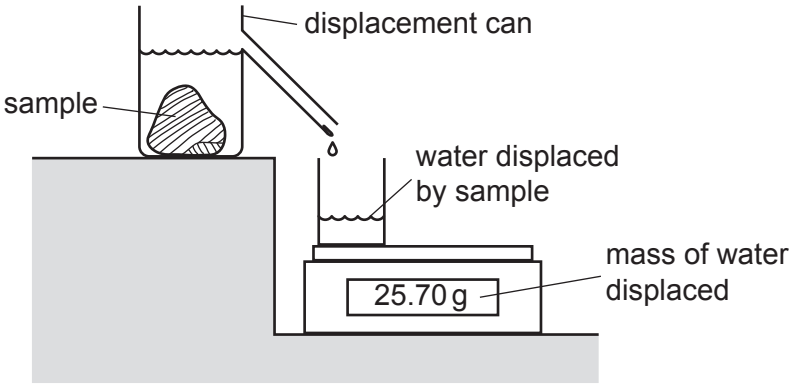


Fig. 21

The results from the students' experiments are shown in Table 21 below.

Student	Measured material	Mass (g)				
		Rock A	Rock B	Rock C	Rock D	Rock E
1	dry sample	210.2	132.7	208.4	224.7	160.5
	displaced water	70.3	47.9	86.1	77.4	68.6
2	dry sample	267.6	135.5	173.2	242.7	165.2
	displaced water	89.2	48.4	67.8	83.7	71.5
3	dry sample	183.9	152.9	223.4	186.9	202.1
	displaced water	61.7	55.6	90.6	63.8	84.2
4	dry sample	80.5	88.9	47.3	108.8	51.4
	displaced water	27.3	32.7	18.9	36.9	25.3

Table 21

(a) **(i)** Using the results from the four students, calculate the mean density of Rock **A** in $g\,cm^{-3}$.

Show your working.

Rock **A** mean density = ... $g\,cm^{-3}$ **[2]**

(ii) What is the density of Rock **A** in SI units of $kg\,m^{-3}$?

Rock **A** average density = ... $kg\,m^{-3}$ **[1]**

(b) The crystalline Rock **A** consists of 40% dark minerals with 60% of a grey mineral. The crystals are larger than 5 mm in diameter.

Suggest the name of this rock. Describe its cooling history and suggest a tectonic setting depth where it might have been formed.

Rock name .....

Cooling history and tectonic setting .....

.....

[2]

(c) Student 4's results show larger errors than any of the rest of the group despite carefully following the same method.

What is the average **percentage difference** between the results of student 2 and student 4 for Rock **A** and Rock **B**?

Give your answer to **3** significant figures.
Show your working.

Answer = ... % **[3]**

(d) Repeated experiments on Rock **E** showed that the rock density **appeared** to increase with time.

Explain what may have caused these results.

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(e) Describe **two** ways in which the precision of the results in this experiment could be improved.

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2 .....

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[2]

(f) The students noted that there was variation in results due to experimental errors. However there were variations even with the most careful methodology which were put down to differences in the density of the samples of each rock type.

Give **two** examples of geological changes in the samples that could cause these variations in density.

1 .....

2 .....

[2]

(g) (i) The same experiment was repeated with a different light-grey igneous rock. The experiment failed because the sample floated in the water.

Suggest the name of this rock.

..... **[1]**

(ii)* Explain how geophysical and other surface measurements can help to predict volcanic eruptions.

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..... **[6]**

22 The layered structure of the Earth has largely been determined from interpretation of the paths of seismic waves generated by earthquakes.

(a) (i) There are some parts of the surface that cannot receive seismic waves after an earthquake. What is the term used to describe these areas?

..... **[1]**

(ii) Explain why these areas receive no P-wave arrivals.

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..... **[2]**

(iii) P-wave velocities show a sudden increase at 5100 km depth.

Describe the change in properties which results in differences in P-wave velocities.

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..... **[1]**

(b) (i) The radius of the Earth is 6371 km. The volume of a sphere is given by $\frac{4}{3}\pi r^3$.

Given that the radius (r) of the Earth's core is approximately half that of the Earth, what proportion of the Earth's volume is taken up by the core?

Answer = ... **[2]**

(ii) The density of the whole Earth has been measured as approximately 5500 kg m^{-3}. The densest silicate rocks accessible at the surface rarely exceed 3000 kg m^{-3}.

Using your answer to **(b)(i)** above, explain the implications for the density of the core.

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(c)* Describe and explain evidence that the asthenosphere is a rheid layer and explain its importance to plate tectonics.

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..... **[6]**

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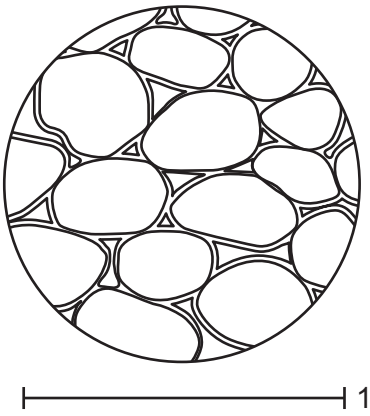
23 The two thin-section diagrams of sedimentary rocks shown in Fig. 23.1 below show contrasting characteristics as a result of their different environments of deposition.

Rock Y



Rock Z

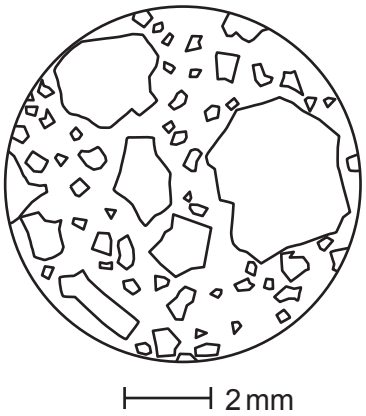


Fig. 23.1

(a) (i) Describe the texture of rocks **Y** and **Z**.

Rock Y	**Rock Z**
Mean grain size	Largest grain size .....
Sorting	Sorting .....
Grain shape	Grain shape .....

[3]

(ii) Suggest an environment which could result in the deposition of rock **Z.**

..... **[1]**

(b) Rock **Z** was made up of a variety of minerals and rock fragments in a clay-rich matrix – it is immature. By contrast, rock **Y** is said to be super mature, its grains are all composed of a single mineral.

Explain the concept of sediment maturity using these two rocks as examples.

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..... **[4]**

(c) (i) Rock **Y** is from the bed marked on the graphic log below in Fig. 23.2. The bed contains **large-scale** cross-bedding. What environment of deposition does this imply?

..... **[1]**

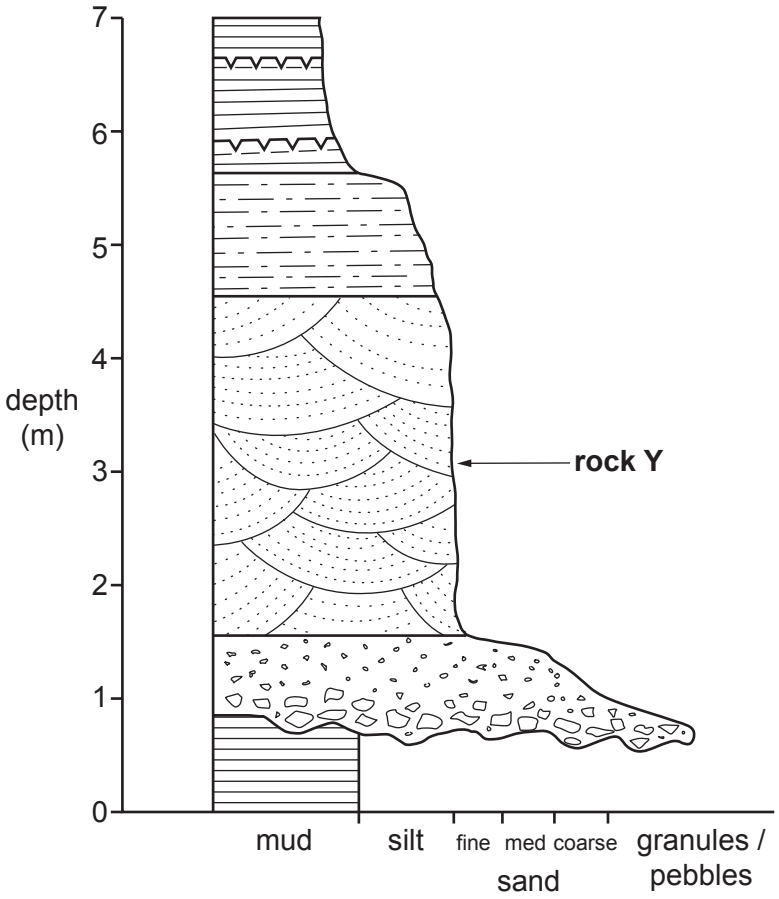

Fig. 23.2

(ii) Using an annotated diagram, explain how **large-scale** cross-bedding is formed.

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..... **[4]**

(d) **(i)** The uppermost bed shown on the graphic log in Fig. 23.2 contains polygonal 'V'-shaped cracks. Explain how they are formed.

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(ii) All the rocks in the graphic log were deposited in the same environment. Explain why the cracks are only found in this particular bed.

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..... **[1]**

(e) Describe and explain the deposition of the coarse grained bed containing pebbles, shown on the graphic log in Fig. 23.2.

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..... **[2]**

24 A student mapped an outcrop containing two igneous rocks parallel to the sedimentary beds, as shown in Fig. 24. The igneous rocks looked similar but on closer inspection showed differences.

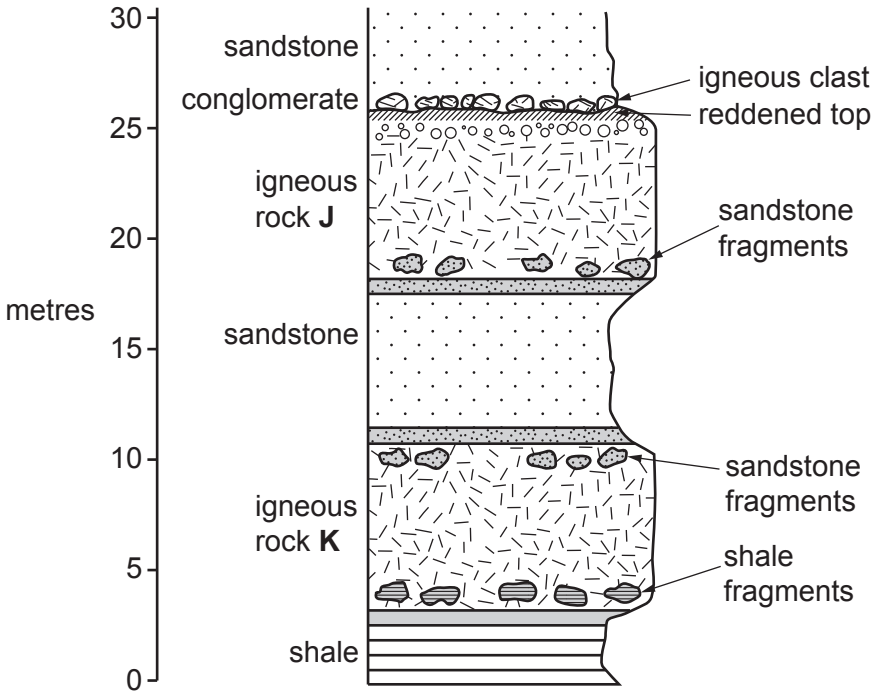

Fig. 24

(a) (i) Igneous rock **J** has small bubbles at the upper surface. What does this suggest about the formation of this rock?

..... **[1]**

(ii) State the geological term for these bubbles and explain the mechanisms by which they are formed.

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..... **[3]**

(b) The lower igneous rock **K** has no bubbles or reddened upper surface but contains fragments of the beds above **and** below it.

(i) Explain the significance of these **two** diagnostic characteristics.

1 .....

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2 .....

..... **[2]**

(ii) The centre of igneous rock **K** had significantly coarser crystals than are seen at its contacts with the sedimentary rocks above and below it.

Explain this observation.

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(c) **Within** the sedimentary rocks in contact with the igneous rocks there were changes at the contact margins.

Describe **and** explain these changes.

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25 **(a)** The map in Fig. 25 shows index minerals in shales that have undergone metamorphism.

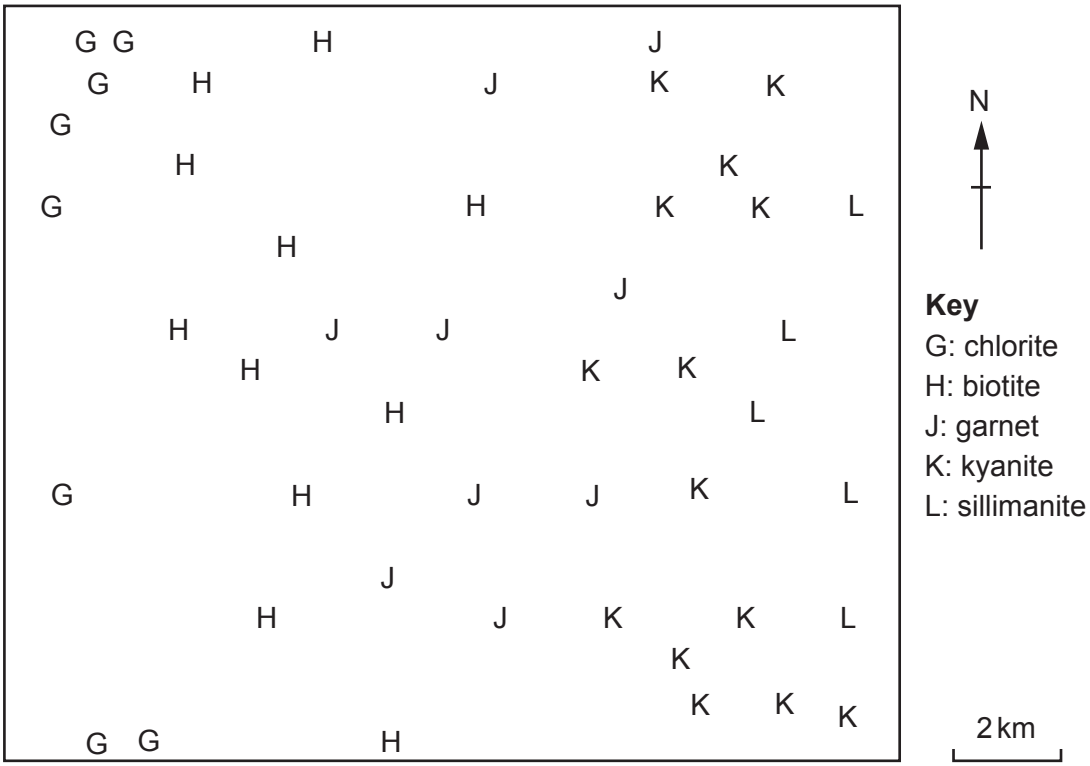

Fig. 25

(i) On the map, draw in the contours of equal metamorphic grade for this region of metamorphosed shales. **[2]**

(ii) How do index minerals allow the mapping of metamorphic grade?

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..... **[2]**

(iii) These shales were heated by the intrusion of granites. In which direction are these intrusions compared to the map area?

..... **[1]**

26 (a) (i) Mid-ocean ridges are created at divergent plate boundaries.

Explain how magma is generated beneath these boundaries.

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..... **[3]**

(ii) An ophiolite is a piece of ocean crust and mantle exposed on land.

Explain the importance of ophiolites in the understanding of plate tectonics.

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..... **[2]**

(b) Many ophiolites are found at both mid-ocean ridges (MOR) and island arcs above subduction zones (IA). The geochemistry of the lavas and dykes is a good indicator of the tectonic setting, as some elements are more likely to be part of the magma than others.

Fig. 26 shows the expected range of Chromium (Cr) and Yttrium (Y) concentrations found at both MOR and IA settings. Data from a known ophiolite, Troodos, has been plotted onto the graph.

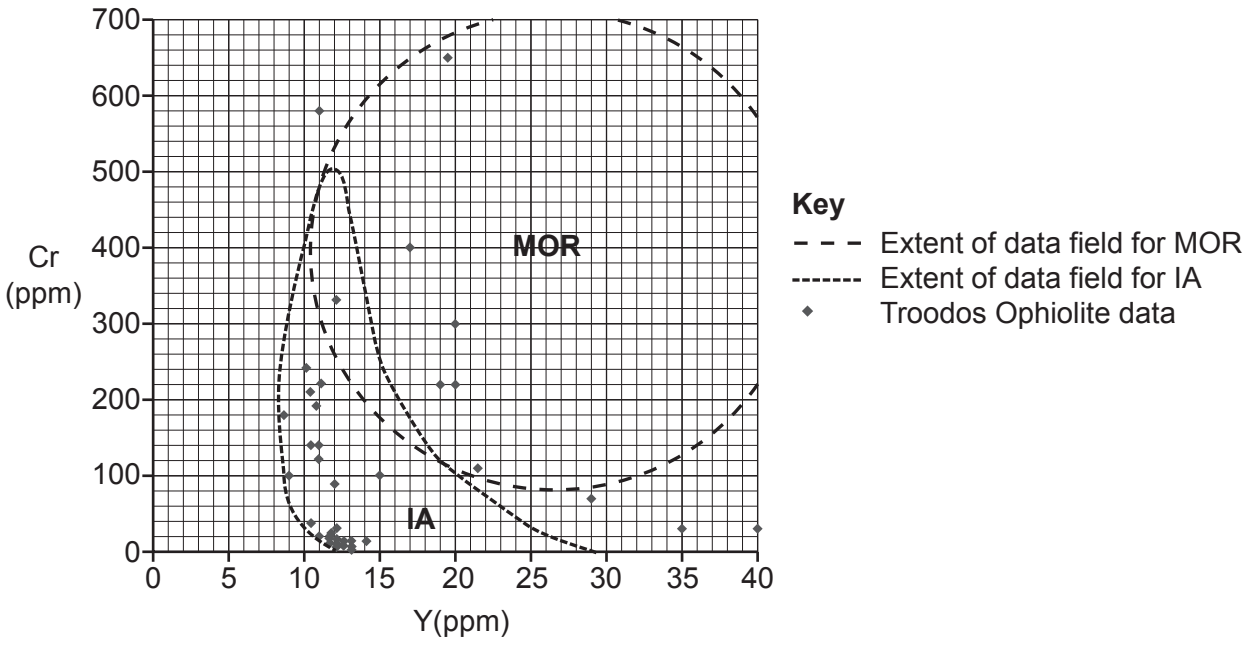

Fig. 26

(i) Table 26 contains data from a newly discovered ophiolite. Plot the data onto the graph in Fig. 26. Ensure the points are distinct from the Troodos Ophiolite data points already provided.

Y (ppm)	Cr (ppm)
11	140
11	580
12	90
18	208
19	650
20	220
23	105
28	68
35	38
40	33

Table 26

[2]

(ii) Fig. 26 contains measurements from the Troodos Ophiolite. What evidence is there to suggest that it was **not** formed at a mid-ocean ridge?

.....

..... **[1]**

(iii) What percentage of the **new** ophiolite values lies entirely within the MOR and IA data fields?

Percentage within the MOR data field .....

Percentage within the IA data field .....

[2]

(iv) Interpret the tectonic setting of the new ophiolite data you have plotted and compare it with the Troodos Ophiolite data. Evaluate these data as a way of interpreting the tectonic setting of ophiolites.

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..... **[5]**

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27 The map in Fig. 27 shows outcrops of folded and faulted Carboniferous and Triassic rock. The area is flat-lying.

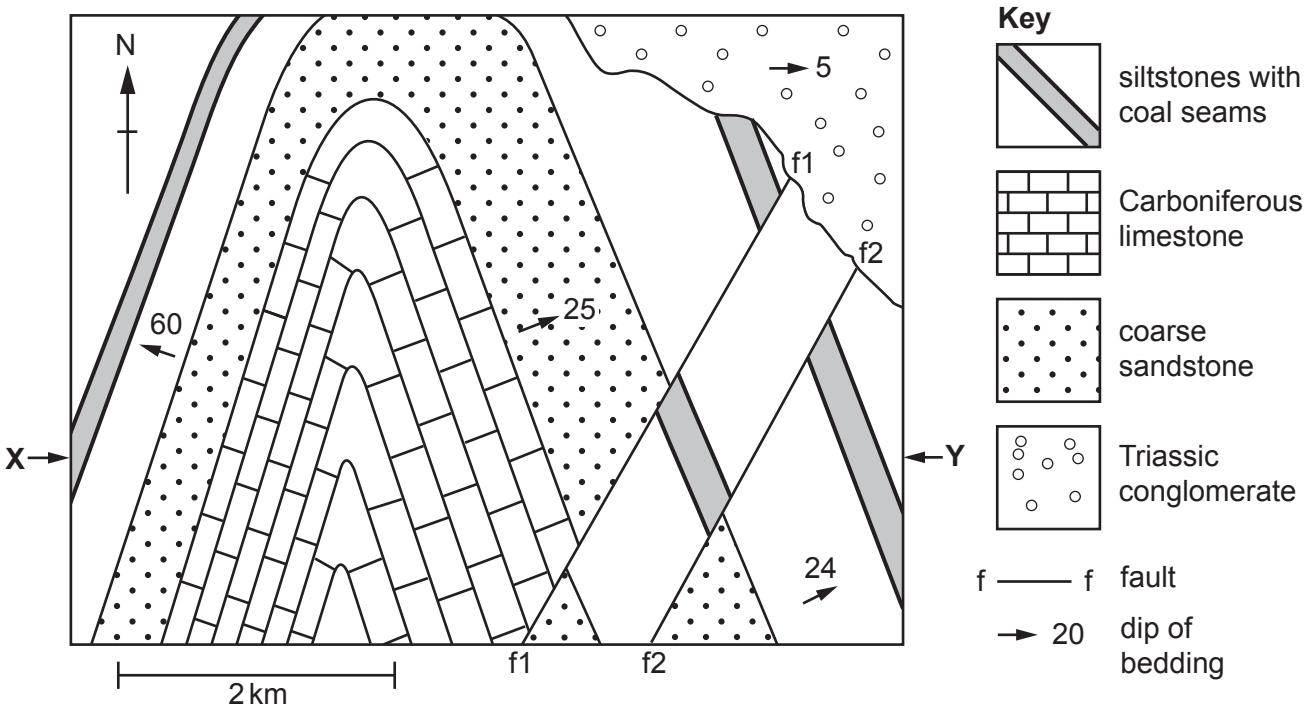


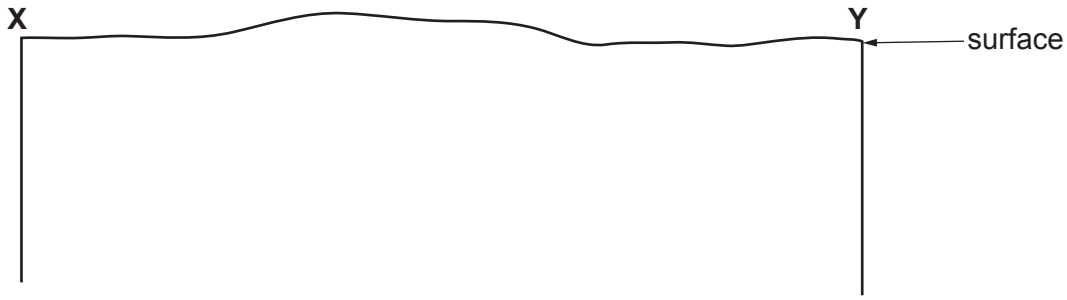
Fig. 27

(a) (i) Faults 1 and 2 have **no** strike-slip component. Mark the downthrown sides of **both** faults on the map with the standard symbol ▬■▬. **[1]**

(ii) What structure has been created by the two faults?

..... **[1]**

(b) (i) Sketch a cross-section between **X** and **Y** from Fig. 27 in the space below showing the geological structures.



[3]

(ii) What is the relationship between the Triassic and the underlying Carboniferous rocks?

Explain the evidence for your answer.

Structural relationship .....

Evidence .....

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..... **[3]**

(iii) What type of force is responsible for the faulting?

..... **[1]**

(iv) What type of force is responsible for the folding?

..... **[1]**

(v) Explain how it is possible for two different forces to have affected the map area.

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..... **[1]**

(c) Describe the folding seen on the map in Fig. 27.

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..... **[2]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).