Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1214/01

GEOLOGY - GL4
INTERPRETING THE GEOLOGICAL RECORD

A.M. TUESDAY, 12 June 2012

2 hours

			Examiner only
Section A	1.	16	
	2.	16	
	3.	14	
	4.	14	
Section B	5.	11	
	6.	17	
	7.	12	
Total		100	

1214
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:
- the Geological Map Extract (Bristol);
- 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. Do not use gel pen or correction fluid.

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 continuation page 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.

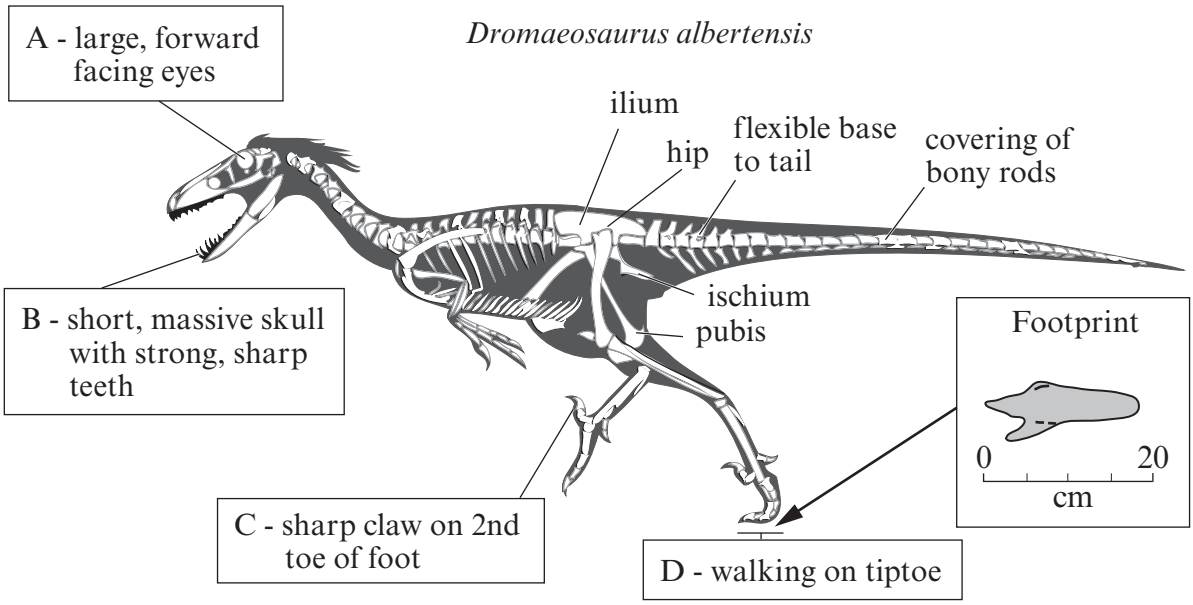
Candidates are reminded that marking will take into account the quality of communication used in their answers.

SECTION A

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

This section should take approximately 1 hour to complete.

1. **Figure 1a** shows the morphology of the dinosaur, *Dromaeosaurus albertensis*, and information on how dinosaurs are classified.



Source: http://the_dinosauria.tripod.com/dromaeosaurus.html

Classification of Dinosaurs

Dinosaurs are sub-divided into two Orders – **Saurischian** or **Ornithischian** - based on the structure of the pelvis. In Saurischian dinosaurs, the pubis bone is at an angle to the ischium bone, whereas in Ornithischian dinosaurs these bones are parallel, nearly touching along their whole length. Ornithiscian dinosaurs were plant-eaters.

Figure 1a

Refer to **Figure 1a**.

(a) Using the data in **Figure 1a**

(i) complete the classification of *Dromaeosaurus albertensis*, [2]

Classification	
Class	Reptile
Order	•
Genus	•
Species	•

(ii) complete the estimates of the size of *Dromaeosaurus.* [2]

Size	
Footprint length	•
Approximate hip height (4 times footprint length)	•
Approximate body length (10 times footprint length)	1.8 m

Examiner only

(b) (i) Choose **two** of the characteristic features (labelled **A-D**) and explain how they support the conclusion that *Dromaeosaurus* was a carnivorous, predatory dinosaur. [4]

Chosen characteristic feature (**A-D**) ☐

Explanation .....

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Chosen characteristic feature (**A-D**) ☐

Explanation .....

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(ii) Fossil evidence suggests that *Dromaeosaurus* could run with its tail carried sharply erect (upturned). Explain the morphological evidence from **Figure 1a** to support this conclusion and explain how this might be of benefit to a predatory dinosaur. [3]

Explanation .....

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Advantage .....

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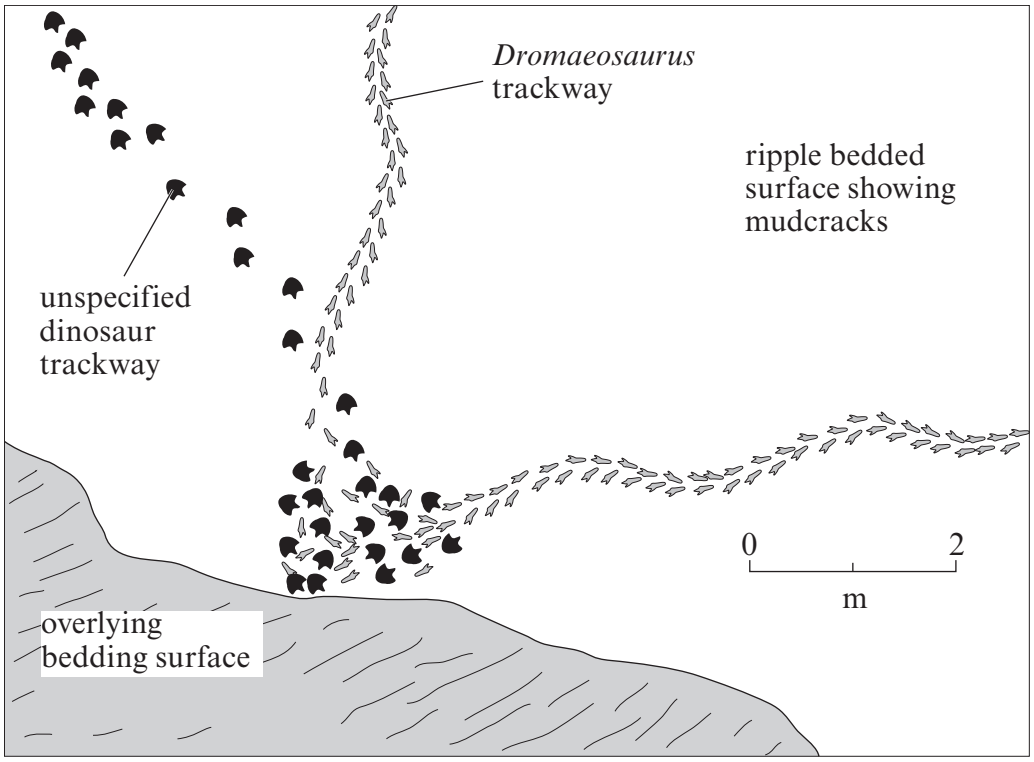
Examiner only

(c) **Figure 1b** shows dinosaur trackways on a bedding surface.



Source: http://aegsrv2.esci.keele.ac.uk/earthlearningidea/PDF/Dinosaur_Footprints.pdf

Figure 1b

A student concluded that the tracks provide evidence that, despite its small size, *Dromaeosaurus* was able to prey on larger dinosaurs.

(i) With reference to **Figure 1b**, analyse the **evidence** that might support this conclusion. [3]

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(ii) Suggest likely alternative explanations for the events leading to the formation of these tracks that do not necessarily involve *Dromaeosaurus* actively hunting. [2]

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Total 16 marks

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Examiner only

2. **Figure 2a** is a map of the NW Pacific Ocean showing the distribution of active and extinct volcanoes. **Figure 2b** is a graph of the age of extinct volcanoes in the Hawaiian-Emperor chain plotted against distance from the currently active Hawaii volcanic centre.

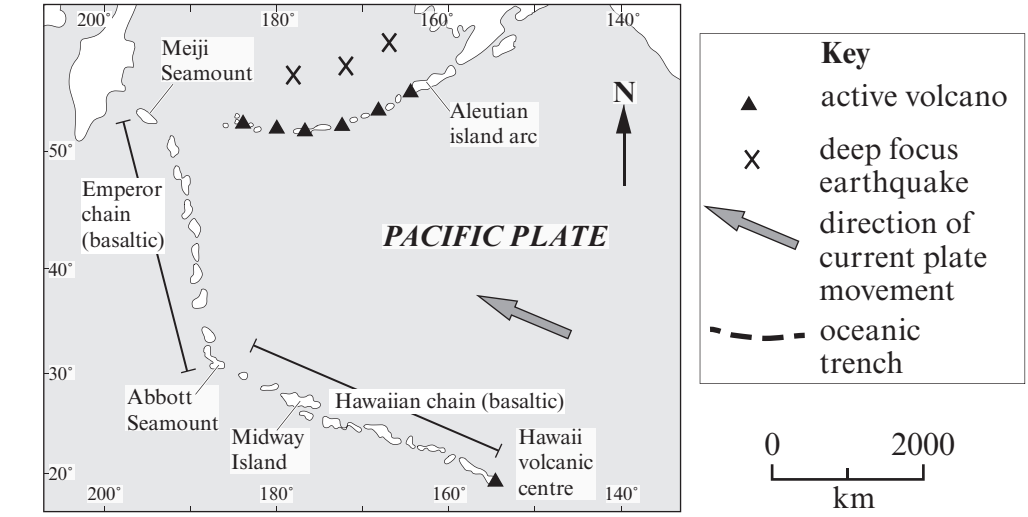

Figure 2a

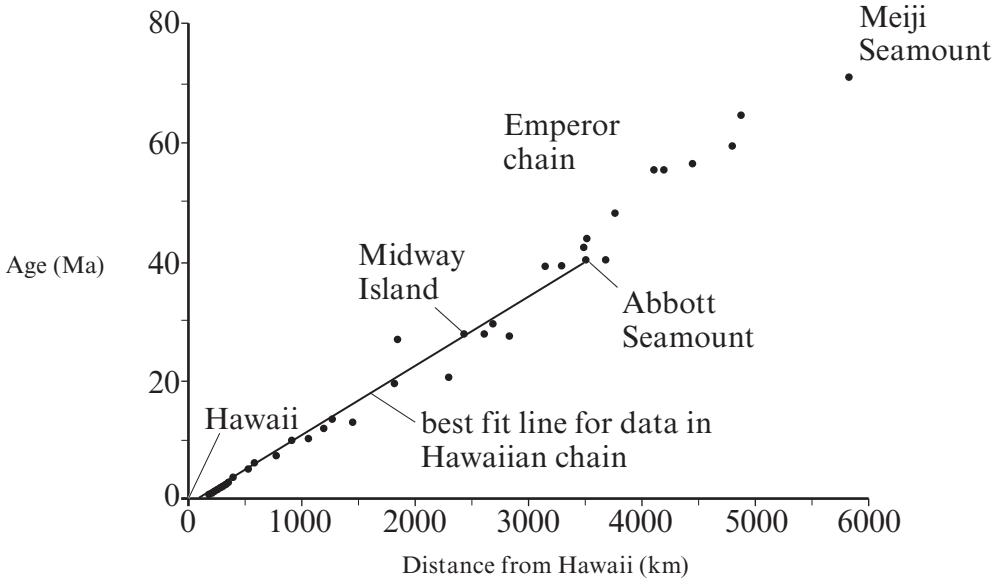

Figure 2b

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

(a) (i) On **Figure 2a**, mark the **position** and **extent** of an oceanic trench associated with the Aleutian island arc using the symbol in the key. [2]

(ii) State the type of magma typically associated with island arcs. Explain your answer. [3]

Magma Type .....

Explanation .....

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(b) The Hawaiian-Emperor chain is thought to be associated with a fixed mantle plume (hotspot) beneath the current Hawaii volcanic centre, over which the Pacific Plate is moving.

(i) Using **Figure 2b** state the age of Midway Island (2400 km from Hawaii). [1]

..... Ma

(ii) Calculate the mean rate of plate movement (in cm yr^{-1}) shown by the Hawaiian chain data according to the fixed mantle plume model. Show your working. [2]

Mean rate of plate movement ..... cm yr^{-1}

(iii) Outline the evidence from **Figure 2a** and **Figure 2b** that supports the theory that the Hawaiian-Emperor chain formed by the Pacific Plate moving over a fixed mantle plume. [3]

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(c) Explain how the data in **Figure 2a** and **Figure 2b** may suggest that the Pacific Plate changed direction and rate of movement about 42 Ma ago. [3]

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(d) An alternative theory for the formation of the Hawaiian-Emperor chain, without involving a mantle plume, involves increasing **tension** and **thinning** of the Pacific Plate along the line of the chain. Explain how tension and thinning of the lithosphere might lead to the generation of basaltic magma, and a chain of volcanoes. [2]

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Total 16 marks

Examiner only

3. **Figure 3** shows a sequence of folded strata together with the textural details of some beds.

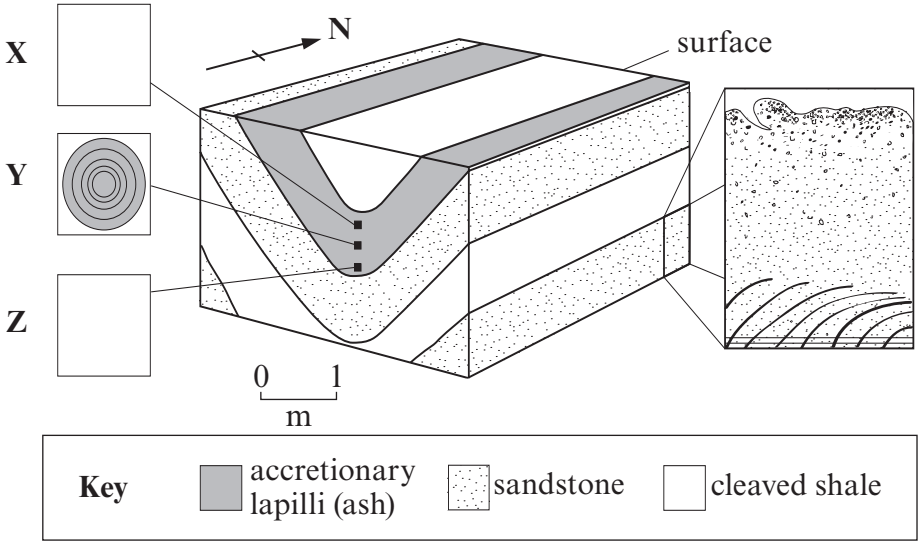

Figure 3a

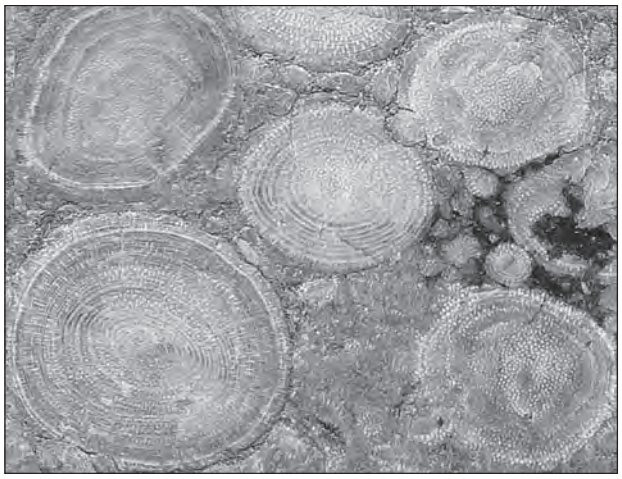

Figure 3b

Formation of accretionary lapilli

Accretionary lapilli are small spherical balls of volcanic ash. They are believed to grow when very fine ash particles collect around the nucleii of condensing water droplets (or solid particles) as they fall through volcanic ash clouds during an eruption.

Figure 3c

(a) Refer to **Figure 3a**.

(i) State the compressive stress direction of the fold (**σ** *max*). [1]

.....

(ii) Draw in axial planar cleavage on **Figure 3a** on the top and side faces of the shale bed that crops out at the surface. [2]

Examiner only

(b) **Figure 3b** is a photograph of a polished surface of the accretionary lapilli (ash) deposit, the formation of which is described in **Figure 3c**.

(i) Describe the **evidence** in **Figure 3b** which might support this mode of formation. [3]

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(ii) Beds are subjected to different stresses in the hinge area of a fold. Draw sketches in the spaces provided on **Figure 3a** to show how the stresses at locations **X** and **Z** might result in a distortion of the accretionary lapilli. (Location **Y** is undeformed). Explain your answers. [3]

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(c) A student described the fold in **Figure 3a** as *"...an overturned, symmetrical, syncline"*. Critically evaluate this statement, explaining the available evidence for your conclusions. [5]

Overturned .....

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Symmetrical .....

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Syncline .....

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Total 14 marks

Examiner only

4. **Figure 4a** is a graph showing estimated changes in mean global surface temperature during a typical *Snowball Earth* event. **Figure 4b** is a simplified section from Namibia used as evidence in support of the *Snowball Earth* hypothesis. **Figure 4c** shows further detail from the Namibian section.

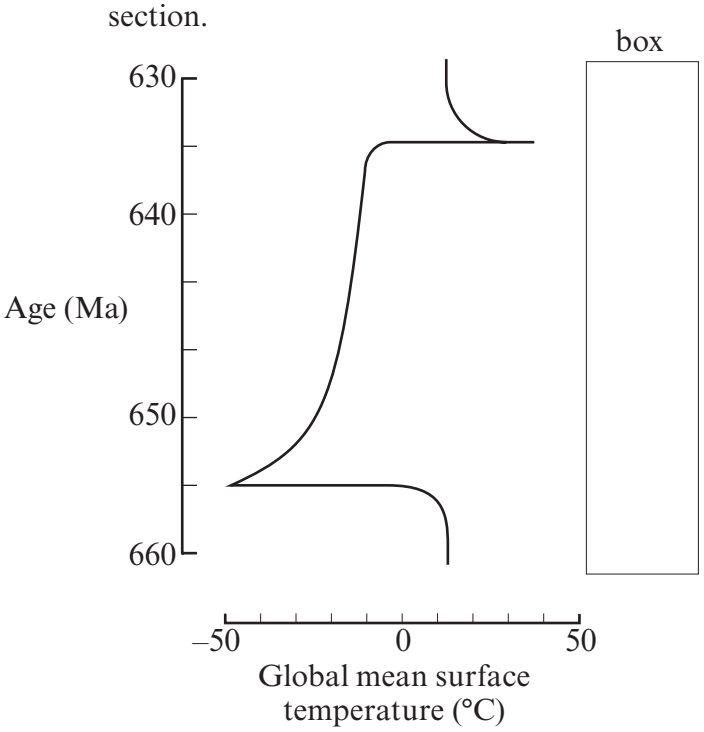

Figure 4a

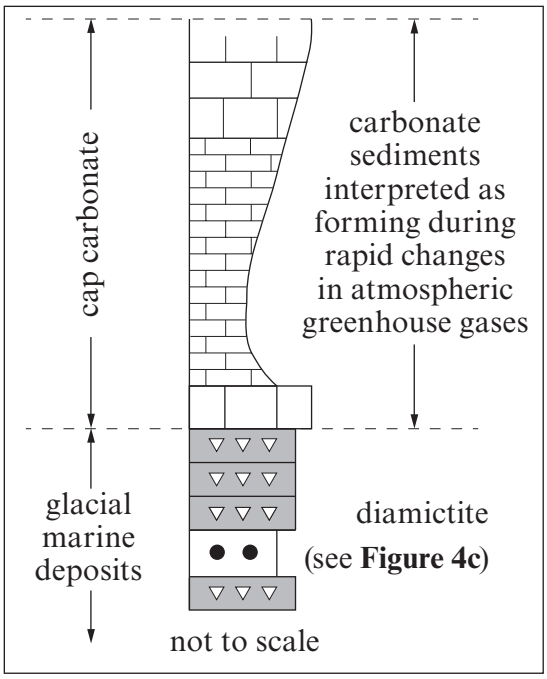

Figure 4b

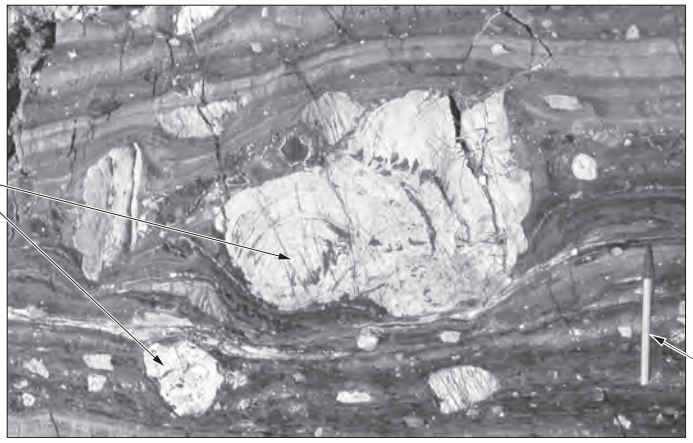

Figure 4c

Source: snowballearth.org

(a) Refer to **Figure 4a**.

(i) Describe the changes in mean global surface temperature in **Figure 4a**. [3]

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(ii) Draw a labelled arrow (labelled ← **R**) in the box on **Figure 4a** to mark a time of probable rapid sea-level rise associated with the *Snowball Earth* event. [1]

(b) Refer to **Figure 4b** and **Figure 4c**. Explain how evidence from the following supports the theory that ice once extended from the poles to the Equator during the *Snowball Earth* event.

(i) Inclination of the remanent magnetism [2]

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(ii) Dropstones in fine-grained, deep marine sediments [2]

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(c) The *cap carbonate* in **Figure 4b** may be interpreted as providing evidence of rapid changes in atmospheric greenhouse gases at the end of the *Snowball Earth* event.

Explain how the following natural processes may have contributed to the rapid changes in atmospheric greenhouse gases which ended the *Snowball Earth* event and produced *cap carbonates*. [6]

Volcanic activity .....

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Rock weathering .....

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Methane hydrates .....

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Total 14 marks

Examiner only

SECTION B

Questions **5-7** *relate to the* **British Geological Survey 1:50 000 geological map** *extract of* **Bristol**

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

This section should take approximately 1 hour to complete.

5. *(a)* Using the key on the **Geological Map**, identify the feature represented by the symbol at the following grid references (**GR**). [2]

Grid reference (**GR**)	Feature
498649	•
494644	•

(b) **Figure 5** shows a typical boundary between the base of the Triassic Dolomitic Conglomerate (**MMMF** within the Triassic Mercia Mudstone Group) and the underlying strata in this area.

Source: British Geological Survey (P006750)

Figure 5

Draw and annotate a sketch of **Figure 5** in the space below to explain the formation and significance of this boundary. [5]

(c) (i) With reference to the **Geological Map**, describe the outcrop pattern of the Dolomitic Conglomerate (**MMMF**). [2]

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(ii) The Dolomitic Conglomerate (**MMMF**) was deposited by high-energy streams. Explain the evidence for this from **Figure 5**. [2]

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Total 11 marks

Examiner only

6. A student recorded dip arrow directions for the main outcrop of Carboniferous Limestone shown on the **Geological Map** as part of an investigation into the major fold structure. **Table 6** is a partly completed tally, and **Figure 6** a partly completed rose diagram, of these dip directions from the **Geological Map**.

Direction	N	NE	E	SE	S	SW	W	NW
Tally	𝍸 𝍸 /	𝍸 //	///	𝍸	𝍸 𝍸 /	///	𝍸	𝍸 //
Total number of dip arrows	•	•	•	5	11	3	5	7

Table 6

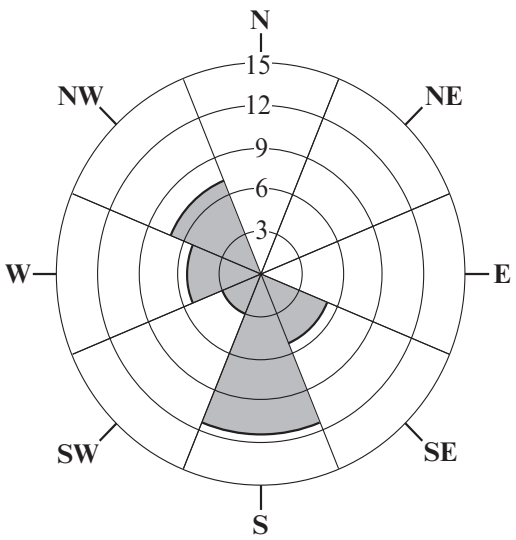

Figure 6

(a) (i) The tally in **Table 6** does not include the directions of the 3 dip arrows in **grid square 5167**. Add these to the tally and complete the totals for the data set. [2]

(ii) Complete the rose diagram (**Figure 6**) to show the total number of dip arrows for the completed data set in **Table 6**. [2]

(b) In analysing the data the student concluded that the main outcrop of Carboniferous Limestone forms *"an elongated, dome-shaped fold which plunges to the west and east"*.

(i) Evaluate this statement with reference to the **evidence** from the **Geological Map** and the rose diagram (**Figure 6**). [4]

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(ii) State **two** limitations of the use of rose diagrams of dip angle directions to show the structure of folds. [2]

1. .....

2. .....

(c) (i) Using the **Geological Map** and **cross-section**, describe the general characteristics of the Wrington Hill Fault that crops out at **GR 478642** by completing **Table 7** below. [4]

Fault characteristic	
Average dip angle	•
Strike direction	roughly E-W
Throw [as measured by vertical displacement of Portishead Formation (**PoB**)] (m)	• m
Downthrow side	south
Hanging wall side	•
Type of fault	•

Table 7

(ii) The student further concluded that *"the major faults affecting the Carboniferous Limestone are largely compatible with the principal stress directions that formed the major fold structure".* Evaluate this statement. [3]

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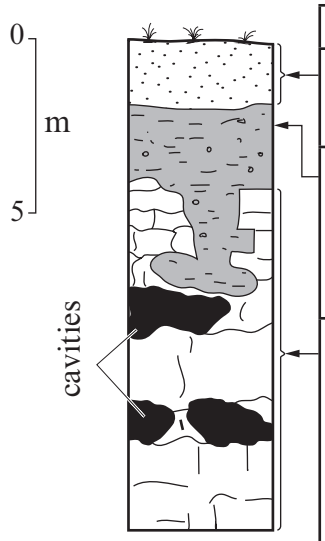
Total 17 marks

Examiner only

7. Bristol Airport is situated in **grid square 5065**. **Figure 7** is a summary of typical ground conditions at Bristol Airport. Five disused landfill sites and a number of disused lead mines are located on or close to the site.



Deposit	Thickness/Depth	Comment
Made ground	<1 m-2 m thick	Tarmac, limestone gravel, sand and clay
Superficial deposits (drift)	2 m-5 m thick but up to 8 m infilling solution hollows	Red-brown clay with limestone fragments and cobbles
Black Rock Limestone	Typically 2 m-4 m to rockhead – but locally up to 8 m	Grey, crystalline, shelly limestone Regular steeply inclined joints and fractures with gently dipping bedding surfaces showing solution cavities and hollows

The Carboniferous Limestone is classified by the Environment Agency as *"a major aquifer... able to support large water abstraction for public supply and other purposes from boreholes surrounding Broadfield Down. The regional groundwater flow from Broadfield Down follows the dip"*.

Figure 7

(a) With reference to **Figure 7**, explain why cavities and hollows typically form in limestone. [3]

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Examiner only

(b) The borehole at **GR 532641** is used to abstract groundwater from the Carboniferous Limestone aquifer for public supply. State **two geological** advantages of this location.

[2]

1. .....

2. .....

(c) With reference to **Figure 7**, the **Geological Map**, **cross-section** and **previous data**, identify the possible **geological** implications associated with the further development of this site as an airport.

You may consider why the engineering activities associated with this development (building of runways, taxiways, car parks, airport buildings, aviation fuel depot, etc.) needed to take account of any of the following:

- Interference with the hydrological system
- Surface/groundwater pollution
- Ground stability
- Geological hazards from past human activity

[7]

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Total 12 marks

Question number	Write the question numbers in the left-hand margin

Examiner only

Question number	Write the question numbers in the left-hand margin

Examiner only

Question number	Write the question numbers in the left-hand margin

Examiner only

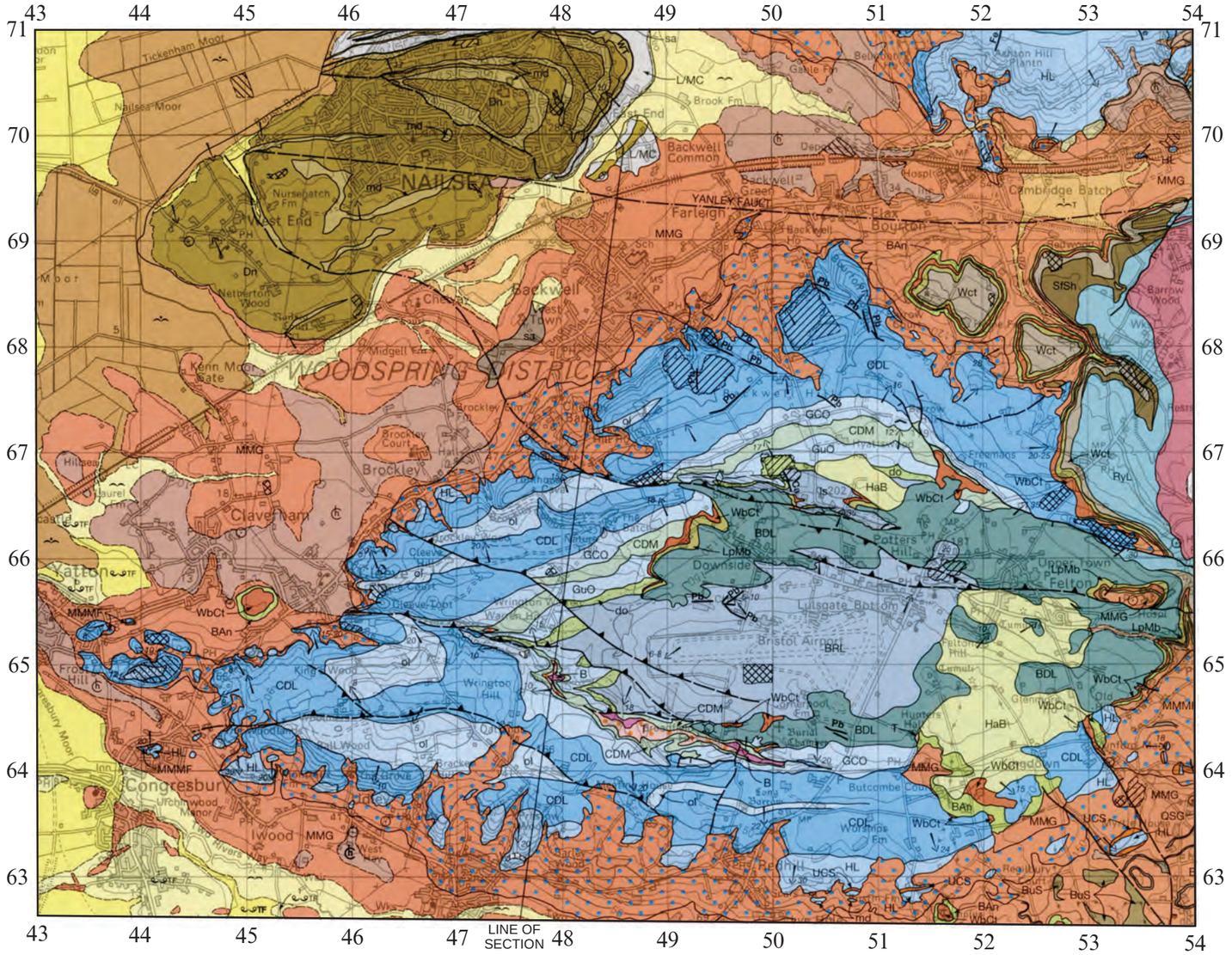
GCE A level

1214/01-A

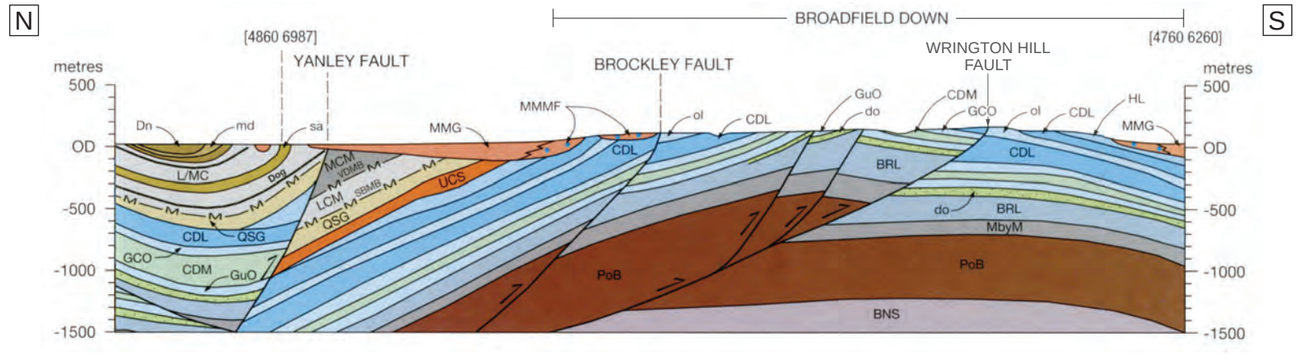
GEOLOGY - GL4
Geological Map Extract

A.M. TUESDAY, 12 June 2012

WJEC 1214/01-A ADVANCED GEOLOGY GL4 JUNE 2012
Extract from Bristol Sheet 264 (Solid and Drift) 1:50 000 (1 cm to 500 m)

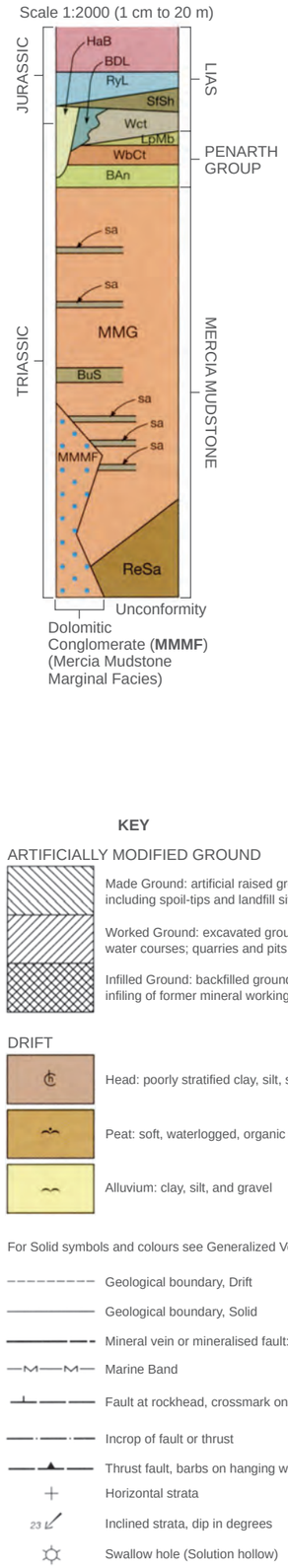


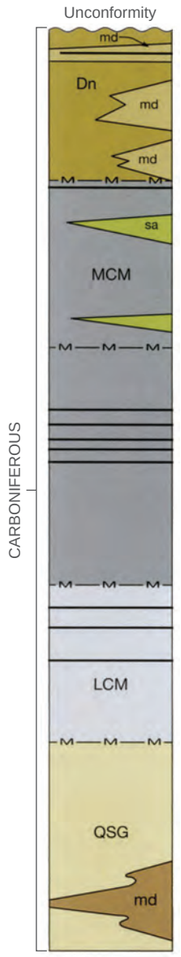
CROSS-SECTION SHOWING THE GENERAL RELATIONS OF ROCKS ALONG THE LINE of SECTION
Horizontal and Vertical Scale 1: 50 000

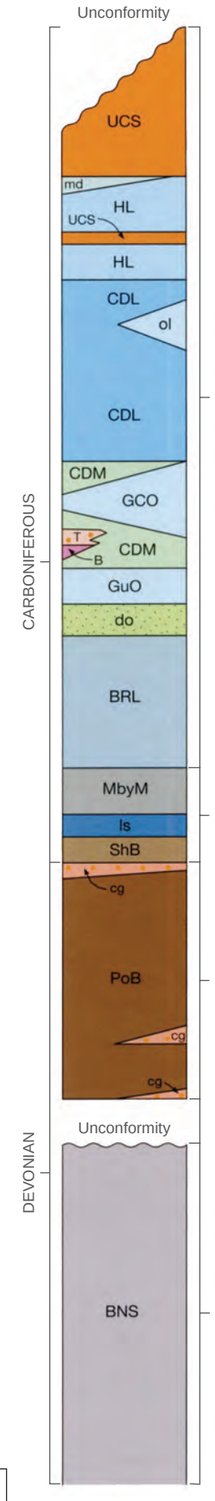


(1214-01A)

GENERALISED VERTICAL SECTIONS
Scale 1:6 000 (1 cm to 60 m) - unless stated







KEY

ARTIFICIALLY MODIFIED GROUND

- Made Ground: artificial raised ground, including spoil-tips and landfill sites
- Worked Ground: excavated ground for water courses; quarries and pits
- Infilled Ground: backfilled ground, including infiling of former mineral workings

DRIFT

- Head: poorly stratified clay, silt, sand and gravel
- Peat: soft, waterlogged, organic deposits
- Alluvium: clay, silt, and gravel

For Solid symbols and colours see Generalized Vertical Section

- Geological boundary, Drift
- Geological boundary, Solid
- Mineral vein or mineralised fault: - **Pb** lead (galena)
- Marine Band
- Fault at rockhead, crossmark on downthrow side
- Incrop of fault or thrust
- Thrust fault, barbs on hanging wall
- Horizontal strata
- 23 Inclined strata, dip in degrees
- Swallow hole (Solution hollow)
- Borehole