Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced

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455/04

GEOLOGY GL5

THEMATIC UNIT 4

GEOLOGY OF THE LITHOSPHERE

P.M. TUESDAY, 19 June 2007

For Examiner's Use only.

Section A	**1**	
	2	
Section B	**3**	
	4	
	5	
	Total 50	

Answer **both** *questions in Section A (25 marks) and* **one** *question in Section B (25 marks).*

SECTION A

Answer **both** *questions in the spaces provided.*
This section should take approximately half an hour to complete.

1. **Figure 1a** shows the magnetic anomalies within a surveyed area of the oceanic lithosphere to the southwest of Iceland.

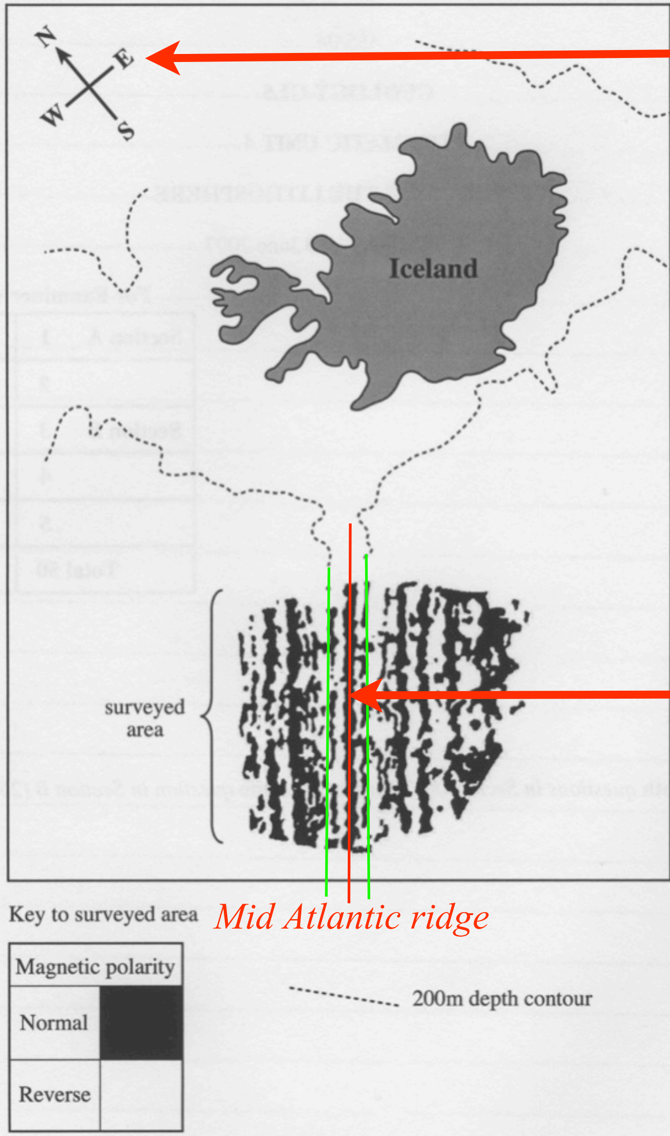


Figure 1a

This caused very few problems. Hardly any candidates claimed that the trend of the anomalies was N-S.

(a)(ii) line has to be parallel to the anomalies and within the 200m contours (the two green lines) to get any marks at all.
The red line shown gets 2 marks. Any other line parallel to this and between green lines gets 1 mark. Anything else = 0 marks.

This was very well done with very few lines outside the green lines.

(a) (i) Describe the pattern of the magnetic anomalies. [2]

alternating normal and reversed anomalies

with irregular boundaries

(ii) Draw within the surveyed area on **Figure 1a** a line to show the axis of the Mid Atlantic Ridge. [2]

(iii) Give **two** reasons for your choice of position of the axis. [2]

Reason 1 *anomalies symmetrical about axis*

Reason 2 *line parallel to anomalies*

Relatively easy starter.
Many gave the trend (NE-SW).
Most gave the normal / reversed pattern.
By far the most popular was the symmetry.

This is where the symmetry of the pattern was expected.
Few wrote that the axis had to be parallel to the anomalies.
Many stated that the axis had to pass through a "normal"

Figure 1b shows polarity changes for the past 5 Ma. Major periods of magnetisation are called **chrons**. Four chrons have been recognized, two normal and two reversed, and these are named.

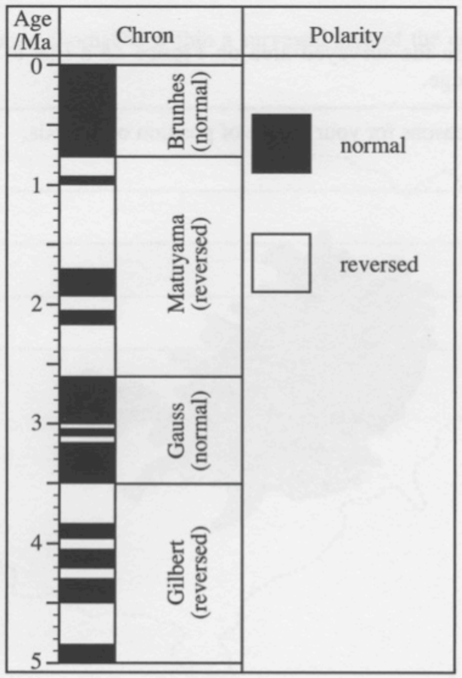


Figure 1b

(b) (i) State the name of the shortest chron shown on **Figure 1b**. [1]

Brunhes

Most were able to work this out.
It was anticipated that someone might claim that the Brunhes Chron had not finished and could end up being longer than the Gauss Chron. No examiner reported such a response but it would have been readily credited.

(ii) The Gilbert chron contains an equal number of normal and reversed episodes of magnetisation. State the **total** number of episodes in the Gilbert chron. [1]

8

Well answered with only a very small number claiming there were 4 episodes.

(iii) Suggest why the Gilbert chron is described as a period of reversed magnetisation when it contains equal numbers of normal and reversed magnetisations. [1]

the time of reversed magnetisation is greater than the time of normal magnetisation

No need to work out the the time of normal and reversed magnetisation although examiners are more easily impressed by quantitative responses (and so give the marks more readily).

Figure 1c shows how the magnetic striping varies with distance from the axis of the ridge in part of the North Atlantic. The boundaries between the Gauss chron and the Matuyama chron to the east and west of the Mid-Atlantic ridge have been marked with arrows labelled $\mathbf{G_1}$ and $\mathbf{G_2}$.

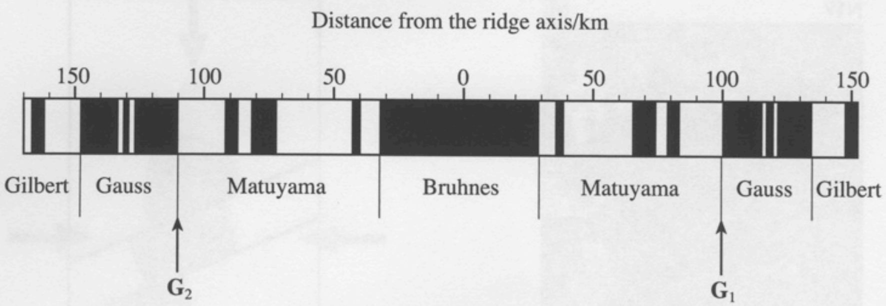


Figure 1c

(c) Refer to **Figures 1b** and **1c**.

(i) Calculate the rate between $\mathbf{G_1}$ and $\mathbf{G_2}$ at which the Atlantic Ocean is widening. Show your working and give your answer in centimetres per year (cm y^{-1}). [2]

A note here (for this and similar questions). The preferred unit for years is 'a', so that a million years is 1Ma. However, many text books use 'y' for year and students, when given the choice, usually opt for 'y'. Examiners readily accept either.

Distance G1 to G2 = 210 km = 210 x 1000 m

= 210 x 1000 x 100 cm = 210 x 10^5 cm

Time for widening = 2.6 My = 2.6 x 10^6 y

Rate of widening $= \dfrac{210 \times 10^5}{26 \times 10^5} = 8.08$

Three possible places to score. 1 mark for the 210 km; 1 mark for 2.6Ma and 1 mark for the answer (just 8 accepted). This allows you to make one careless mistake but still get the 2 marks.

Ocean widening at ....*8*........ cm y^{-1}

(ii) The plates are moving at different velocities to the east and west of the ridge axis. Suggest reason(s) to explain this. [2]

Reason(s) *There may be a greater force opposing movement to one side rather than the other. There may be a subduction zone on one side and not the other.*

Plenty of leeway here BUT last part of the question so examiners are looking for a quality answer. You could have written about how the convection currents may not be uniform or the plates on either side are not of the same size (mass). Also there is depth versus breadth. Brief mention of two possibilities or a more in depth discussion of one.

Total 13 marks

2. **Figure 2a** is a photograph of a faulted pebble found within a conglomerate. **Figure 2b** is a drawing of the pebble together with the directions of two of the principal stresses which caused the faulting.

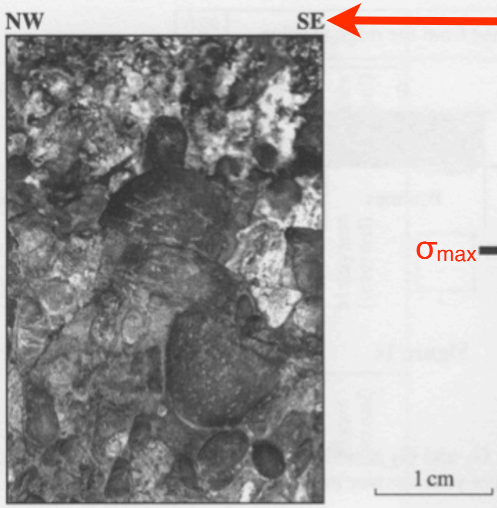


Figure 2a

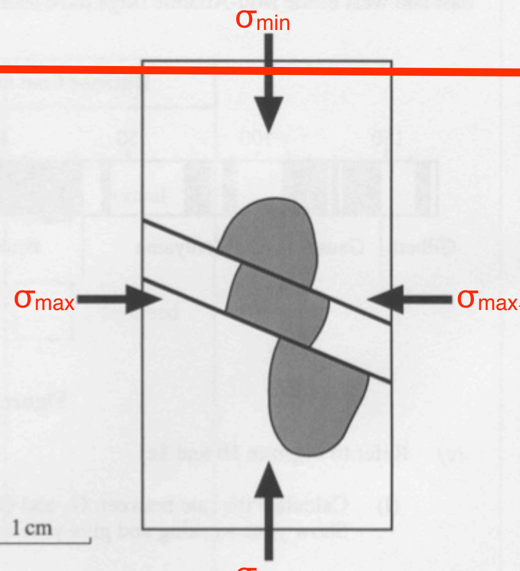


Figure 2b

This seems to have caused problems to many candidates (possibly not noticed). Many thought this was a plan view and hence the faulting tear (or wrench).

This still causes problems to many candidates even though it is (probably) the most common question in this Unit. ☹

(a) (i) Label the two principal stress directions (σ_{min}, σ_{int}, or σ_{max}) in **Figure 2b**. [2]

(ii) State the direction of the third principal stress which is **not** shown on **Figure 2b**. [1]

NE-SW

Out of (or into) the paper was acceptable, as was a right angles to the other two.

(iii) Name the type of faulting that has affected the pebble.
Give a reason for your answer. [2]

reverse

Reverse or thrust was acceptable.

Figure 2c is a cross-section showing the conglomerate between two sandstones, together with sketches of two sedimentary structures **X** and **Y** found within the sandstones.

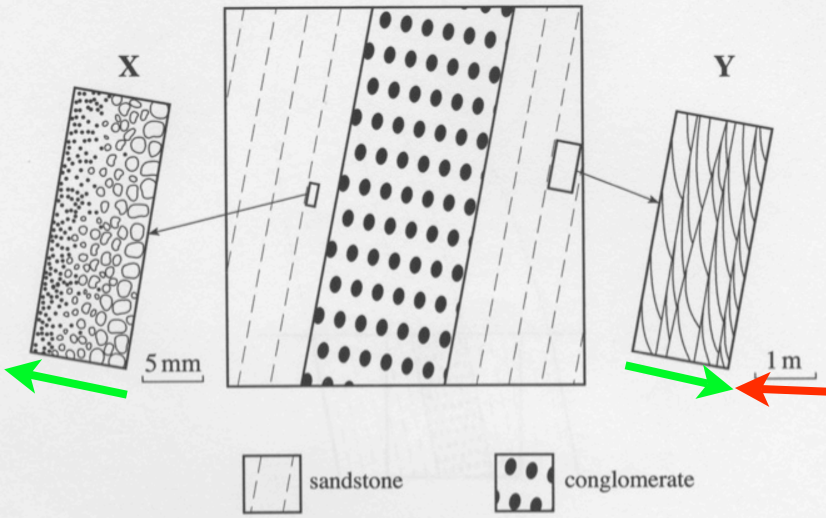


Figure 2c

(b) It has been suggested that the rocks may be upside down.
Use **Figure 2c** to evaluate this claim. [5]

(1) X is graded bedding and it is

(2) the right way up

(3) Y is current bedding and it is

(4) inverted

(5) Thus the two features contradict each other

Some candidates impressed by showing the direction of younging on the figure. They (almost always) explained this in the discussion but had already received the 2 marks available.

Five points were looked for here :
(1) and (3) turned out to be the easiest marks to get.
Most candidates got (2) but not (4).
(5) discriminated as only the best candidates managed to get this far.

The biggest problem seemed to be that as the beds were nearly vertical many candidates doubted whether they could be described as the right way up or upside down. It looks as though most candidates are only completely happy with horizontal beds that are either the right way up or (completely) overturned.

(c) It has also been suggested that the cross-section might be part of a fold as shown in **Figure 2d**.

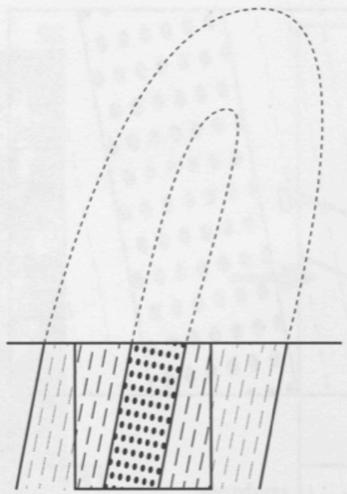


Figure 2d

Discuss whether the fold in **Figure 2d** and the faulting of the pebble in **Figure 2b** may both have been formed at the same time by the same stresses. [2]

The folding suggest a compressional force

while the faulting also suggests a compressional force

Therefore they may have formed at the same time due to the

same forces

Total 12 marks

The end of the question where examiners are, as usual, looking to see what candidates can make of some (often ambiguous) data.

The simplest way out of this question is as given. Credit being given for the ability to link the two pieces of evidence.

However, it would be valid to question how brittle (faulting) and plastic (folding) behaviour can have been brought about by the same stress field.

Again, a reminder here, that examiners are not always looking for the “right” answer - there probably isn’t one ! What is being tested is your ability to interpret data. The examiner might not agree with you BUT, if your reasoning is sound, you will be credited.

SECTION B

Answer **one** *question from this section.*

Write your answer in the remaining pages of this booklet.

3. Describe how the use of seismic studies may contribute to an understanding of the theory of plate tectonics.
Discuss the importance of the different depths of earthquake foci to the theory. [25]

Very disappointing that a number of good candidates, who had scored well on Section A, did not read this question very carefully. Instead of confining their arguments to plate tectonics (and so the lithosphere) they discussed how seismology has helped us to understand the deep interior of the Earth. Thus there was much (excellent but irrelevant) consideration of (for example) the size, shape and state of the core. These essays scored few marks. ☹

4. *(a)* Describe the J. Tuzo Wilson Cycle.

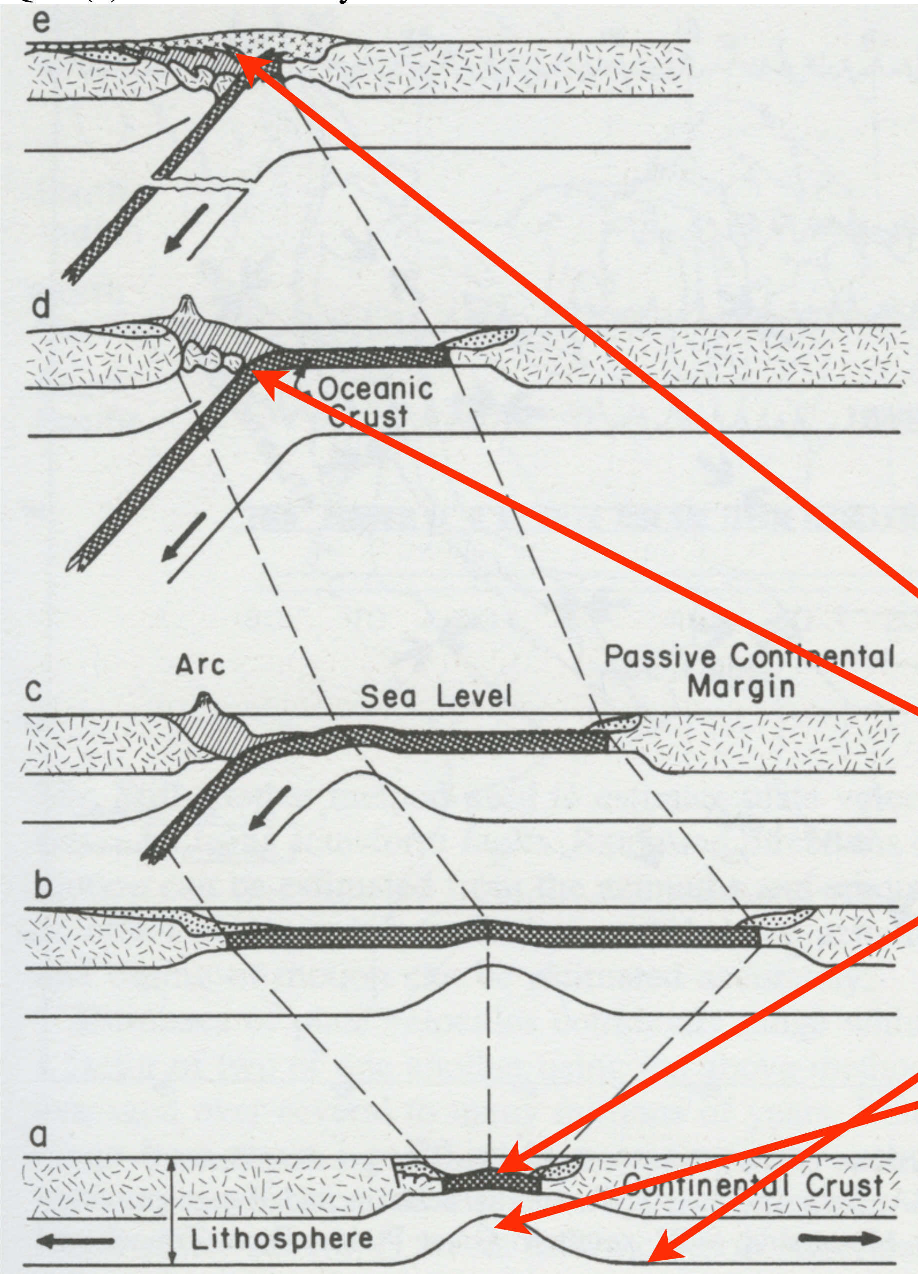
(b) Discuss how the present-day distribution of rift valleys might support the J. Tuzo Wilson theory. [25]

BY FAR THE MOST POULAR CHOICE SO LET'S TRY THIS ONE. ✎

5. Describe how sedimentary basins may be formed.
Evaluate the importance of isostasy in the formation of sedimentary basins. [25]

This essay was not attempted by many candidates although there were some excellent attempts. It is only expected that you have studied ONE type of basin although some candidates discussed both tensional and compressional basins. The North Sea Basin was by far the most popular. There were some very good diagrams which helped candidates to score high marks easily on the first part. The second part was not so well done and all that was really wanted was an appreciation that as the weight of sediment increases the floor of the basin will subside, making more room for additional sediment.

Q.4. (a) The Wilson Cycle



The diagrams show the stages in the Wilson Cycle, starting at the bottom and working up.

How many marks so far ?
More than you might think. (You would get half marks just for these).
*It is (almost) essential that you answer this part of the question with **diagrams**. It would be almost impossible to get so much information across in so short a time (and I'm not even going to try !)*
What has been done so far shows that you understand the concept well.

The statement above does not add anything - in fact, if I am arguing that this is a cycle - where does a cycle begin and end ?

The diagrams are of a higher standard (from a drawing point of view) than examiners would expect - so don't let that put you off. Also, you can always overcome poor drawing with good labeling. Some things certainly need to be explained. For example :

What do the arrows mean ?

What's going on here ?

and here ?

and here ?

What do the dotted lines mean ?

What's the line along the bottom ?

Why does it bulge here ?

Answer some of these questions (and / or possibly others) either on the diagrams or in the text and this is well worth full marks.

Do you think that the constructive plate boundaries (mid-oceanic ridges) are well drawn (and labelled in these diagrams ?)

(b) Significance of rift valleys.

Rifting is very important in understanding the Wilson Cycle. In diagram (a) the continental crust has been split apart (rifted) due to convection in the mantle. Therefore, rifting is the first stage in the Wilson cycle. Rifts are fault systems that show us that tensional forces have been in operation. As the rifting continues the continents get further and an ocean forms inbetween.

Rifting today can be seen in two different geological situations. The first is best seen in the East African Rift Valley. It is believed that this is the first stage (a) in the Wilson Cycle. The continental crust is very thin there and the whole area has been uplifted. Together with the high heat flow and volcanic activity this is very strong evidence in support of the initial rifting of a continent.

Rifting is also very evident in the oceanic lithosphere at constructive plate margins. Mid-oceanic ridges have a central rift which is lower than the ocean floor on either side. This supports the suggestion that ocean-floor spreading is due to tensional forces. These forces may be due to convection currents in the mantle and result in either slab push (from the ridge axis) and /or slab pull (where the ocean floor subducts).

Therefore, rifting is seen to support Wilson's theory although there is always the problem that rifting (and graben) could result due to compression.

This is seen as the part of the question (if not the paper) where we would expect Grade A / B candidates to show their true worth.

This is not an easy question. You need to be aware of what rift faulting is; what it implies; and how it can or cannot be used in support of the Wilson cycle.

This is just about the minimum that would be expected. It (sort of) addresses the question but only at a very superficial level. With a couple of labelled sketches this is what might be expected of a Grade C candidate.

This is much better. We could still do with one or two sketches (or refer to better labelled diagrams in (a) to be sure of getting full marks).

However, this candidate shows an awareness of rifting in the ocean floor and in continents. The relationship between the two is (fairly) clear and both have been related to the Wilson cycle.

One or two nice "extras" have been thrown in (such as slab push and pull) which show that this candidate has a wider appreciation of the concepts involved as does the last sentence (but please don't leave the examiner in suspense !)

There is also ample opportunity here for you to make the usual trade off between breadth and depth. This candidate could do with more depth in at least one place (e.g. "high heat flow and volcanic activity")

You could get full marks by only discussing oceanic rifting. However, in such a case, you would have to give ***much more*** *detail than is given here.*

Please note that the diagrams shown in (a) are not the usual way in which the Wilson cycle is drawn by candidates. They were especially selected for this reason, and to make the point that there are many varied ways in which the cycle can be drawn. No one way is considered to be better than any other - but whichever one you choose, you should be aware that the examiner will come across many different diagrams purporting to be showing the same thing so you must explain fully what you have drawn and not expect the examiner to do it for you.