455/03

GEOLOGY GL5

THEMATIC UNIT 3

GEOLOGICAL EVOLUTION OF BRITAIN

P.M. TUESDAY, 20 June 2006

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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).*

1. **Figure 1a** is a cross-section between Moreton-in-Marsh and the Mendip Hills. The Inferior Oolite (a division of the Jurassic) is divided into the Lower, Middle and Upper Inferior Oolite. **Figure 1b** shows simplified sedimentary logs of the Inferior Oolite and underlying rocks at the four locations shown. **Figure 1c** is a field sketch of a quarry at Vallis Vale in the Mendip Hills.

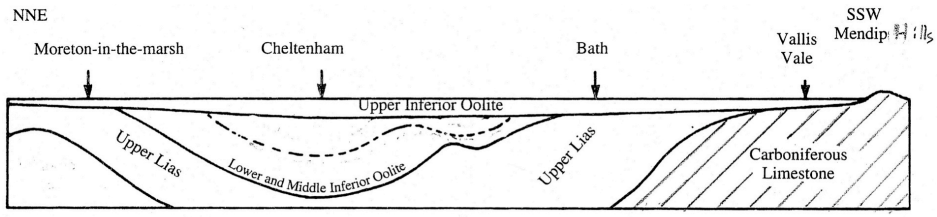


Figure 1a

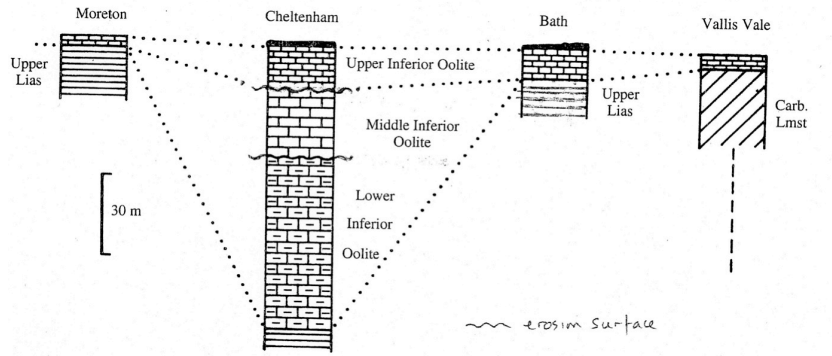


Figure 1b

Upper Inferior Oolite - yellow, oolitic limestone with worn and broken brachiopods. Horizontal bedding with conglomerate at the base. The conglomerate lies on a bored surface covered with bivalves.

Carboniferous Limestone - beds dipping at 40° North. Grey, massively bedded, shelly limestone with colonial corals in position of growth.

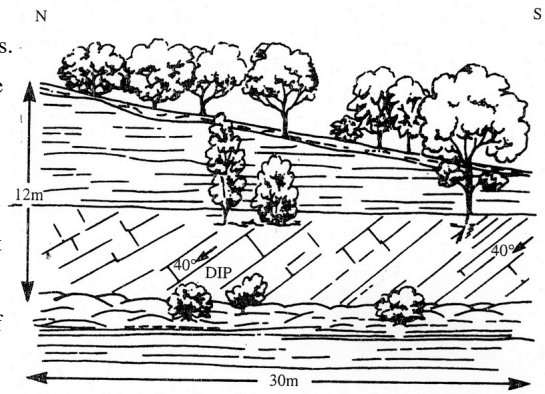


Figure1c

(a) Using **Figure 1a** and **Figure 1c**, name the type of boundary between the **Upper Inferior Oolite** and the underlying beds. Give **one** reason for your answer. (2)

Type of boundary ……*unconformity*……

Reason ……*the Upper Inferior Oolite is horizontal while the*……

……*underlying beds dip at 40˚ to the north*……

This was generally very well answered.

Most recognised the unconformity and were able to describe it. Some said beds on top are horizontal while those below are dipping. Others said the beds were discordant.

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

(i) Measure the thickness of the **Inferior Oolite** sediments at Cheltenham and Vallis Vale. (1)

Cheltenham……*100*……m Vallis Vale……*6*……..m

There is always some leeway allowed for measurements such as this. In this case 90-100m and 4-8m were the limits. This is because the scales are sometimes not printed precisely (although in this case it was) and often they are so small on the page that the thickness of the markings on a ruler might be significant.

(ii) Give **two** possible reasons for the difference in thickness between these two locations. (2)

……*there is Upper, Middle and Lower Inferior Oolite at*……

Cheltenham while only the Upper Inferior oolite is present at Vallis Vale……

This is the simplest explanation to be awarded 2 marks. Other common alternatives included : - basin at Cheltenham and erosion at VV (VV above sea level for a time).

(c) (i) Using evidence from **Figure 1c**, describe **two** characteristics of the environment of deposition of the **Upper Inferior Oolite** at Vallis Vale. (4)

Characteristic……*marine*……

Evidence ……*brachiopods only lived in marine environments*……

Characteristic……*shallow*……

Evidence……*conglomerates are deposited in shallow waters*……

Again the 2 most common correct answers.A great deal of leeway. See comments below which generally apply here.

(ii) Contrast the environment of deposition of the **Carboniferous Limestone** and the **Upper Inferior Oolite** at Vallis Vale as shown in **Figure 1c**. (3)

……*colonial corals indicate tropical, warm-water conditions*……

……*the conglomerate indicates shallow water conditions*……

Much of the data / conclusions here are debatable. This answer is not very good. Major objection is that it does not CONTRAST the 2 environments. This was specifically asked for so must be attempted for 3 marks. It would get a begrudging 2 as it is very basic and also repeats some of answer for (c)(i).

You could argue there are NO RIGHT ANSWERS here. Examiners are looking for good geological reasoning.

What about these for responses ? “The brachiopods are broken and so are of little use. They might have lived elsewhere and been moved to this location, being broken on the way”; or, “corals are of little use because they are found today in all water temperatures”. Although unconventional, they are based on good geological knowledge and understanding. As such they would be credited.

Total 12 marks

Before we move on. To continue with the argument above.

It is important that you realise that in many parts of the examination papers (particularly the last parts of Section A questions and the essays) examiners are NOT looking for the RIGHT ANSWER (whatever that might be !). You only have to listen to politicians to realise that just about any data can be interpreted in (often many) different ways.

In your geology papers examiners will be looking for good reasoning. They might not agree with your assessment, but that will not stop them giving you full marks. Examiners work on the principle that if they have to think for more than a few seconds about the validity of your reasoning, then you must have a point and it should be credited.

The main thing to bear in mind is that you must make your reasoning clear. Thus if you claim that “corals are poor palaeoenvironmental indictors” you will be given no credit. If, however, you say they are poor because today corals have been found at most depths and most temperatures you would be credited.

The obvious place to develop such arguments is in the Section B essays.

Any (reasonably) successful attempt to question or evaluate data is always readily credited and it is the most obvious way to obtain the highest marks.

2. (a) **Figure 2a** shows North America and Europe fitted together prior to the opening of the North Atlantic and also shows their apparent polar wandering curves.

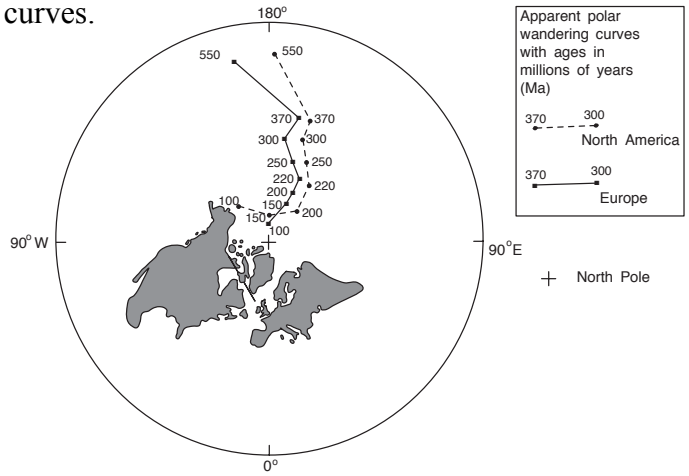


Figure 2a

(i) Apparent polar wandering curves can be used to identify continental movements. Complete the table below using **Figure 2a**, to suggest whether North America and Europe were joined or separated at particular times. Also suggest a time for the opening of the North Atlantic using **Figure 2a**. (3)

Age	North America and Europe joined or separated
Prior to 370Ma the apparent polar wandering curves for North America and Europe follow different paths.	*separated*
After 370Ma the apparent polar wandering curves for North America and Europe follow similar paths until the opening of the North Atlantic.	*joined*
200 ……Ma	The North Atlantic opened.

This was well answered.

Different paths indicate they were separated. similar paths indicate they were joined.

Few had any problems with the first two and any figure less than 220Ma was accepted for the last part.

The last part is an example of different ways at arriving at an answer. Figure 2a suggests 200Ma (after which the curves follow different paths). However, you could just argue it might have happened sometime between 200 and 220Ma.

At the same time, it looks as though some relied on their knowledge. Depending on which book you rely on, the date of separation can be as low as 45Ma. So, "any" figure below 220Ma was accepted.

(ii) Explain why the curves are termed **apparent** polar wandering curves. (2)

It is not the poles that (significantly) wander but the continents.

However, is is easier to plot the results as though it is the pole that moves.

This was one of the worst answered questions on any of the papers.

Polar wandering curves are just the most convenient way of (graphically) representing the data and showing the extent of continental drift (plate movement). The true way to show what has happened would be to draw the moving continents, presumably in the form of some sort of cartoon. This is very difficult to do convincingly, except with a computer animation. It is much easier, especially if the data is to be put in printed form, to draw a polar wandering curve instead.

(b) **Figure 2b** shows the angle of inclination (dip) of a freely suspended magnetised needle at various latitudes on the Earth's surface. **Figure 2c** is a log of sedimentary red beds from the Devonian of southwest England.

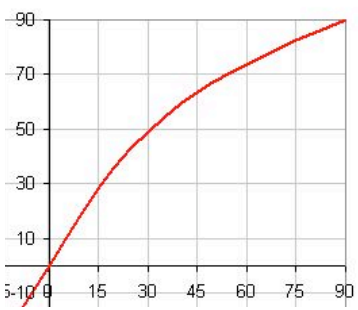
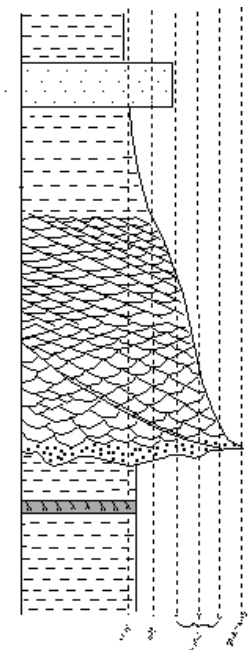


Figure 2b



HERE ARE A FEW NOTES AS TO WHAT MIGHT BE CONSIDERED FOR (B)(ii)

Cross-bedding common in fluvial sediments. Are they uni-directional ?

Conglomerates / pebbles common in shallow, fast-flowing currents. Red beds indicate terrestrial environment. Desert / flash floods ?

Vertebrates, plants, rootlets, footprints all found in fluvial environments. Need some explanation as to why. For example, footprints suggest terrestrial creatures walking on soft sediment which then becomes lithified.

Grain sizes / log give a fining-up sequence. Water gradually becoming deeper ?

(i) A palaeomagnetic inclination of 35º has been recorded from the Devonian rocks of Britain.
Use **Figure 2b** to determine the latitude of Britain during the Devonian. (1)

20 ..... º South

(ii) The environment of deposition of the Devonian sedimentary rocks in **Figure 2c** has been interpreted as fluvial. Describe **three** characteristics of the log which support this interpretation. (3)

plant fossils suggest a fresh-water (river)

cross-bedding indicates a current which could be the flow of a river

an erosional surface might be formed by the erosive effects of a

river, particularly if it changed direction.

There are numerous ways to approach this. There are some notes above.

These were the most common correct responses.

This is yet another example of where examiners are looking for sound reasoning rather than a "right answer".

(iii) '*Sedimentary rocks and palaeomagnetic data are reliable indicators of palaeolatitude.*'
Evaluate this statement with reference to **Figure 2b** and the Devonian log shown in **Figure 2c**. (4)

sediments indicate what climate was like when they were deposited things may have changed since then (as global warming may be changing things - climatic zones, at the present day)

palaeomagnetic and dating data may be inaccurate

could be north or south of the equator

The final part of a question. Examiners are looking for an ability to EVALUATE.

This gives YOU a bit of leeway. Just need to make sure it is RELEVANT.

That said, you can just about consider "anything" !

The answers given were the most common sorts that scored marks.

Always remember DEPTH versus BREADTH. You do not necessarily have to make 4 points for 4 marks (although that is the general rule). Take, for example, the first answer given. That is an excellent evaluation. It questions the Law of Uniformitarianism (to a point).

You could also expand on the second answer. Why might they be inaccurate (e.g. radiometric dating is always ± x % depending on the method used) ? Can you give an example (e.g. K/Ar might be ± 10%) ? Why (e.g. loss of argon, which is a gas) ?

Both methods could be effected by metamorphism ? Could you explain why ?

What do mean - could be north or south of the equator (e.g. dip 90° at north and south magnetic poles) ? Isn't there a way to tell (i.e. direction of dip of the remanent magnetism) ? Again, more marks could be obtained here.

NOTE THAT IT IS EXPECTED THAT YOU WOULD MENTION BOTH SEDIMENTARY ROCKS AND PALAEOMAGNETISM - AS THEY ARE BOTH IN THE QUESTION. THE POINT BEING MADE IS THAT IF YOUR ANSWERS ARE EXCEPTIONAL, YOU WILL BE GIVEN CREDIT - UP TO 4 MARKS - AS LONG AS WHAT YOU WRITE IS RELEVANT.

Total 13 marks

SECTION B

Answer one question from this section

3. Describe major differences in the geology of the Caledonian and Variscan orogenic belts in the British Isles. Include in your answer a discussion of location, age, structural styles and trends, plutonic and metamorphic rocks. (25)

Generally well answered. Make sure you consider all SIX of the listed items if you want to get high marks. Having said that, remember BREADTH versus DEPTH (again) ! If you have extra insight into one or more of the items then that could compensate for a very brief consideration of the others. The ability to CONTRAST the two is the most difficult skill here and that is what the examiner is looking for to award high marks.

Also, the best answers nearly always made use of labelled diagrams.

4. (a) Explain how a study of the mineralogy, texture, sedimentary structures and fossil content of sedimentary rocks can be used to interpret the variation in palaeoclimate in Britain during the Permo-Triassic.

We'll have a go at this one.

(b) Evaluate the reliability of the evidence. (25)

5. *'The geology of Britain can contribute to an increased understanding of plate movements within and beyond the British area.'* Evaluate this statement with reference to Cenozoic igneous rocks and Alpine structures. (25)

Before you attempt a question like this, make sure that you are CERTAIN what CENOZOIC means !

There were some "excellent" essays (mainly about the Caledonian orogeny) produced BUT they did not confine their discussion to igneous rocks from the CENOZOIC. This is where the BREADTH argument falls down. What you write has to be relevant to the question set. Going outside the Cenozoic here is IRRELEVANT (or extremely difficult to justify) and so is not credited.

4. *(a) Explain how a study of the mineralogy, texture, sedimentary structures and fossil content of sedimentary rocks can be used to interpret the variation in palaeoclimate in Britain during the Permo-Triassic.*

(b) Evaluate the reliability of the evidence. *(25)*

Key words : EXPLAIN; mineralogy ; texture ; sedimentary structures ; fossil content ; palaeoclimate ; PERMO-TRIASSIC ; EVALUATE.

Must EXPLAIN the items to get a reasonable (pass mark).
(Again!!!) remember the depth versus breadth argument.
You can get high marks for a "lobsided" coverage. For example if your discussions of mineralogy and texture are outstanding, but the rest is a bit thin, you could still end up with a high mark. There is always a trade off.

Make sure it is not a essay of : "all I know about palaeoclimates". Your essay must be relevant to the PERMO-TRIASSIC.

EVALUATE - second part of the question and the most difficult skill. The essay is meant to allow you to get (up to) fairly high marks on part (a) plus some consideration of (b). The high marks of 20+ are only really possible if you show that you can evaluate the evidence.

(a) The Permo-Trias was a time when Britain was close to the equator and experiencing desert conditions. The most common types of rock were red sandstones. They were red because of the iron oxide cement. This shows that there was plenty of oxygen to turn the rocks a rusty colour. This happens when the sediments are exposed to the atmosphere. That is, they are on land. The grains are nearly all quartz, usually at least 95%.

Good, though basic. Has confined argument to PT and identified a common rock type and explained well the significance of the red colouration. Also, quartz the most common mineral, but why ? Any feldspar or mica ?

BUT - is sandstone the only rock formed in the PT ? Anything finer (shales) ? Or, coarser (breccias or conglomerates) ? What would these tell us about the palaeoenvironment ?

The sediment is sand and is blown about by the wind. This causes the grains to become rounded. So, red sandstones are made up of well-rounded grains with an iron oxide cement.

Same again - good but basic. Diagram would have helped here. Frosting of grains or millet-seed sandstones ?

The most common sedimentary structure is dune bedding. This is formed when the sand is blown along by the wind. As it is blown along it falls down the front of the dune to produce what is called "cross-bedding". That is, it is at an angle to the top and bottom of the layer of sandstone. As the wind increases in strength it may erode this cross-bedding and eventually deposit more sand on top. This is how an eroded top is formed. It may be used as a way-up structure.

Although this description is very good, it is far from perfect. It is almost impossible to answer this satisfactorily without the use of labelled diagrams. Are there any other sedimentary structures found in red beds ?

Because red sandstones are formed in deserts there will be no fossils because animals cannot survive in such conditions.

Is this true ? Is there no life in deserts or is it that the conditions needed for preservation are not found ?

(b) All of the examples above are very good at indicating the conditions. An unfossiliferous, cross-bedded red sandstone can only be deposited in desert conditions.

Again, very (too) basic. Really all that has been said here is “yes”.

There is some overlap between (a) and (b) in that some arguments to support (b) have been given in (a). Examiners are not impressed by repetition so the overlap is accepted and taken into account.

So, if you’ve made the point in (a) - no need to repeat it.

Overall, this essay is a good plan of an excellent essay - it’s an excellent essay trying to get out !

How many marks would it get ? Most essays similar to the one above (usually with a diagram or two) obtained about half marks. With a few improvements such as diagrams and a better account of (non)fossilisation it would be worth 16 or 17 out of 25.

Still not satisfied ?

The choice is (the old one !) more breadth or depth. If the above included a little more detail as follows :

TEXTURE : clastic (apart from evaporites), grain sizes fine (shale / mudstone) to coarse (breccia / conglomerate). Grain shape rounded (to angular).

STRUCTURES : imbricate and desiccation cracks (etc in evaporites).

FOSSILS : vertebrate remains but conditions for preservation very poor. Scavenging, desiccation, erosion etc are not good !

It is not reasonable to expect you to cover ALL of this but with some of this (particularly the fossilisation, and some reference to evaporites which were missing in the example essay) you could get into the 17-19 region (with a bit more evaluation here or in (b)).

The alternative strategy, of course, is to go for depth. Nothing, so far has been covered to any great depth. The choice is yours. Look at the example below which considers cross-bedding. Another good example would be evaporites. In the examination the moderate to weak essays tended to ignore these while nearly all of the 17+ essays at least mentioned them.

EVALUATION : this is the key area for the 22-25 marks. Such marks are not awarded unless a reasonable attempt is made to evaluate the evidence. If you are ever short of time and you have to decide how to spend your last 5 minutes, in a case such as this, go for the evaluation. Something along the lines of the example below would secure very high marks even if there were some deficiencies in part (a). Especially as it brings fieldwork into the argument. Examiners are always more impressed by higher skills such as evaluation at the expense of simple recall. Some good candidates ignored the (a) / (b) division of the essay and just discussed mineralogy etc and added the evaluation as they went along. So long as the essay is coherent and addresses the question set, marks will be awarded.

The other important thing to remember is that you should not be afraid of expressing your opinions. In answers to this part of the essay examiners are interested in arguments and NOT “right answers”. It is not necessary for the examiner to agree with your arguments - just to agree that you have a point of view and that you have argued it competently. It is hoped the example below gives some insight into this.

(b)

Red, cross-bedded sandstones, particularly those interbedded with evaporites are excellent indicators of an aeolian, hot, desert environment. Having said that, although the cross-bedding is usually dune-bedding, it sometimes appears to be current bedding (and may show some grading). This may have been produced by flash floods. However, it could also be interpreted as river deposits in an oxidising environment - say at the edge of a desert. The evaporate deposits would also indicate the presence of significant amounts of water which is prone to evaporation.

This has recognised evaporites. There is little discussion of them but it is an excellent argument showing that the candidate is aware of some of the problems of interpretation. It is as obvious as it can be that this candidate has studied red beds.

I have seen several examples of red sandstones in the Midlands e.g. in working quarries around Mansfield, Nottinghamshire and it has not been possible for me to decide whether the cross-bedding is dune bedding or current bedding. The exposures have not been big enough to enable me to see the scale of the cross-bedding. I would have expected dune bedding to be on a much larger scale than current bedding. Also, in nearly all of the examples I saw there was a consistent direction of "current" flow. I would have expected this to indicate current bedding rather than dune bedding as wind direction is not so permanent as water current direction.

Evidence of fieldwork. ALWAYS highly rated by examiners. Would have preferred a more precise location but adequate. Again, definite evidence that the candidate is aware of problems of interpretation. A sketch or two would also have helped.

Now, if we consider the essay above.

The section (a) needs a few additions (some of those that have been highlighted). The major deficiency is the consideration of fossils. Not ALL of the things suggested would have to be included but there should be more than is there.

If you add to this the section (b) above, there is now evidence of higher skills.

(a) could have been learnt without ever seeing a red sandstone.

(b) shows an insight into problems of interpretation. This is a higher skill.

Only the problems with cross-bedding have been considered but there is enough (from a depth point of view) to fulfil the requirements.

The essay is now in the 22-25 category.

Section (a) with a mention of feldspar ± mica ; breccias ; frosted grains (and their significance) together with a few more lines on the fosilisation; and then (b) above would be worth 25 marks. That is even allowing for very poor coverage of evaporites. You are not expected to do everything !