Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced

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455/02

GEOLOGY GL5

THEMATIC UNIT 2

GEOLOGY OF NATURAL RESOURCES

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. **Figures 1a** and **1b** show details of an evaporite deposit formed by the evaporation of seawater in a shallow lagoon. The minerals have been formed by precipitation from solution.

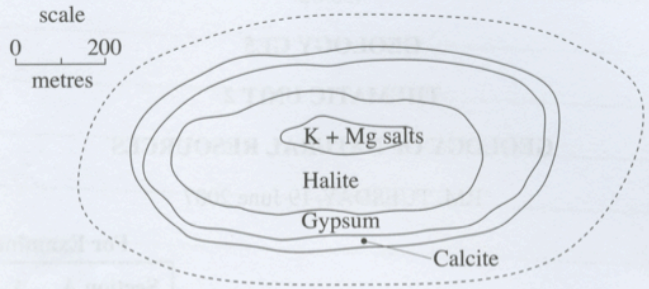


Figure 1a

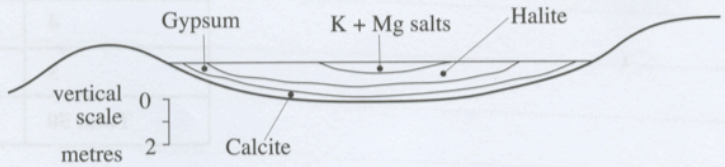


Figure 1b

(a) (i) Using **Figures 1a** and **1b**, describe the shape and structure of the evaporite deposit.[2]

oval

0 to 2m thick

Easy starter except that there should be one for shape and one for structure. Plenty of alternatives. Quantitative answer welcome.

% of seawater evaporated	Minerals precipitated
50-60	Calcite ($CaCO_3$)
75-80	Gypsum ($CaSO_4.2H_2O$)
85-90	Halite (NaCl)
95-98	Salts of potassium and magnesium (K+Mg)

Table 1

(ii) State which one of the four evaporite minerals shown in **Figures 1a**, **1b** and **Table 1** is the least soluble. Give one reason to support your answer. [2]

Name of mineral *calcite*

Reason *precipitated out by least evaporation*

(iii) Seawater on average contains 35 parts per thousand (3.5%) of minerals dissolved as ions in solution. Suggest a source for these ions. [1]

from the sea water

(b) **Figure 1c** shows a typical environment where evaporite sequences form.

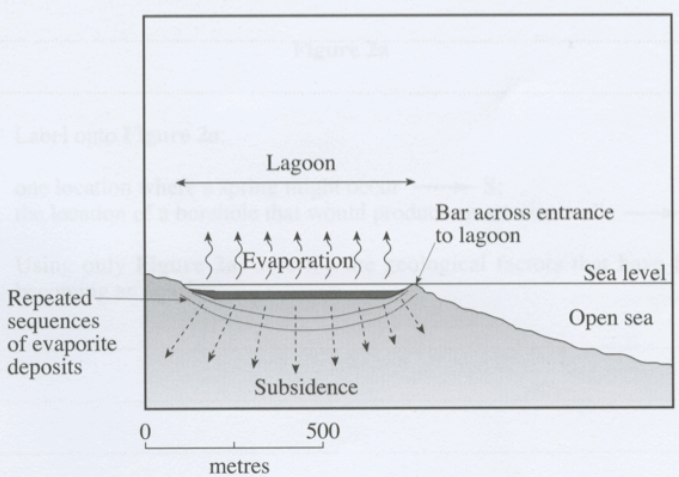


Figure 1c

(i) Suggest **one** way in which the lagoon could become replenished. [1]

rising sea level

Calcite the only possibility.
Several ways to get the second mark e.g. lowest solubility, precipitated first, at the bottom of the sequence etc.

Popular answer but not good enough ! This is not the SOURCE. ☹
The ions are weathered out of continental rocks / minerals.
Stating that the ions get into sea water via rivers was accepted.

Another popular answer but not good enough. ☹
A rising sea level would result in the basin being flooded but replenishment means repeated filling of the basin.
(High) tides would be sufficient to replenish the basin.
It is even possible that tsunamis would do the trick (over geological time) although no-one suggested this.

(ii) Evaporite sequences found in Cheshire are 200 metres thick in places. If 3 metres depth of seawater produces 5 centimetres thickness of evaporite minerals, calculate the depth of seawater needed to produce evaporites 200 metres thick. Show your working. [2]

5cm from a 3m depth
1m from 3 x 20m depth
200m from 3 x 20 x 200 = 12 000m = 12km depth

(iii) Suggest how it is possible for thick sequences of evaporites to form in shallow water environments as shown in **Figure 1c**. [2]

sea level has to rise to replenish the basin

water evaporates so the water level in the basin falls

this is replenished when sea level rises again

(c) Suggest why it is unlikely that thick sequences of evaporites will form in the present day Atlantic Ocean around the shores of the UK. [3]

the climate is too cold so there will not

be enough evaporation (at least 50%)

to get the precipitation of calcite etc

Total 13 marks

No problem with the calculation.
Well set out so it is clear how it has been done.

"Sea level" not accepted for (b) but will be taken as neutral here (neither right nor wrong) so you are not penalised twice for the same thing. Two good points here (= replenishment and evaporation) BUT the repetitive nature of the process is not absolutely clear. ALSO, whatever else happens, it is not possible to accumulate thick sequences unless there is subsidence of the area. Thus this was a RESERVE MARK.

Really only two points but there is some elaboration (precipitation) and there is a quantitative input (50%).

This is a concise answer that is **just** worth the 3 marks.
Most candidates mentioned deep water and a lack of suitable basins.

2. **Figure 2a** shows a cross section of the geology below London.
The Chalk is an important aquifer which supplies the city with a significant amount of fresh water.

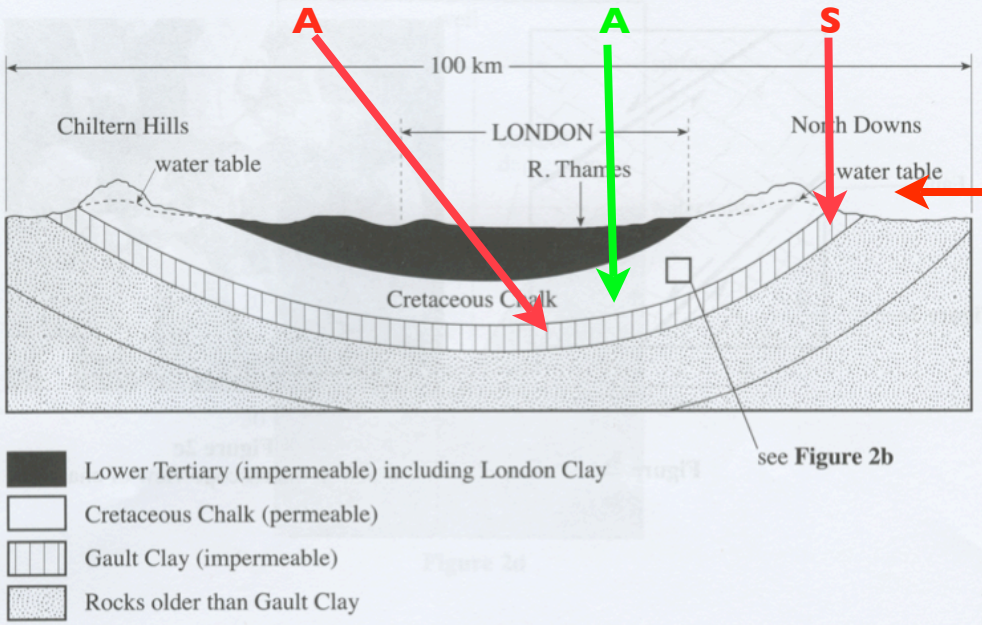


Figure 2a

(a) (i) Label onto **Figure 2a**:

- one location where a spring might occur ⟶ **S**;
- the location of a borehole that would produce an artesian well ⟶ **A**. [2]

(ii) Using only **Figure 2a**, describe the geological factors that have led to the Chalk becoming an aquifer. [2]

the Chalk is in the form of a syncline
it is permeable and has impermeable
beds above and below

Is the point of the "S" arrow close enough to the correct location ? In cases such as this we allow about 1mm. This one is doubtful - no mark.

☹ ☹

"A" Why has this been drawn at an angle? Would have preferred the green arrow but the positioning of the red one is OK so will allow as this is the first part of the question.

Descriptions asked for - not explanations.
Also, "geological factors"

"syncline" - good
"permeable Chalk" - good
"impermeable beds above and below" - good
= 3 valid points / 2 would have sufficed for 2 marks.

Figures 2b and **2c** show details of the internal structure of the Chalk.

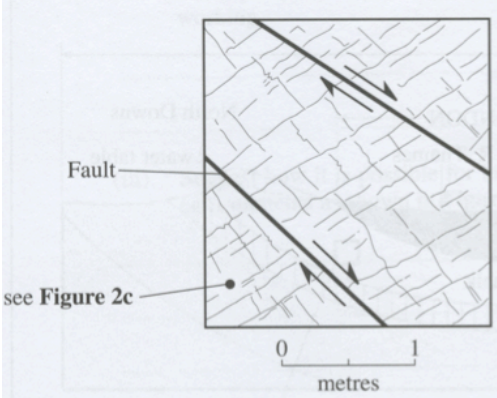


Figure 2b

Figure 2c
Electron microscope view of chalk

(b) Using **Figures 2b** and **2c** only, explain why the Chalk has both high porosity and permeability. [3]

there are very large gaps between the grains in Fig 2c

there are joints and faults in Fig 2b

Not sure if this is an example of not reading the question carefully or just not understanding what is being asked. Perhaps a very good example of how easy it is to "know" the right answer but still not get all the marks.

☹ ☹ ☹

Three good points (= gaps + joints + faults) so should be full marks. HOWEVER the question asks you to EXPLAIN **not** to STATE. If you read this question carefully it must be obvious that it is impossible to answer it adequately without some reference to porosity and permeability. In fact, as part of your answer you really need to define porosity and permeability (e.g. porosity because of the pore spaces where water may be stored and permeability because of the joints and faults along which the water may flow.)

Another point to note is that this is the end of a question; it is meant to be more demanding; and, not so much leeway is allowed in your response.

A minor footnote here. The vast majority of candidates who produced good answers to this question referred to the "large" or "very big" pore spaces in Fig 2c (and this was accepted.) Do you think that this is an accurate description ? As this is the last part of the question, should examiners have accepted it or were they being too lenient ?

(c) **Figure 2d** shows a section through a well in the Chalk during pumping.

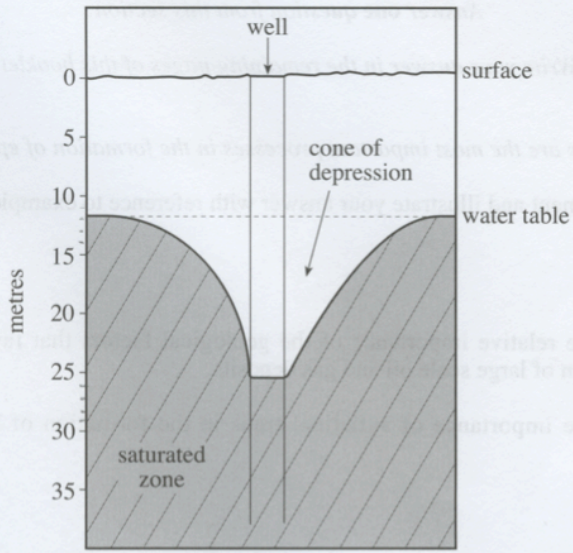


Figure 2d

(i) Calculate the maximum amount of the lowering of the water table that has taken place due to pumping. Show your working. [2]

25 - 12 = 13m

(ii) Suggest why groundwater extracted from aquifers is often of better quality than water obtained from surface reservoirs. [3]

the water will be filtered and impurities removed

Total 12 marks

No problem with the calculation.
Well set out so it is clear how it has been done.

End of a question. Looking for real insight - 3 marks available.
What does this answer tell us ?
= "...water...filtered.." = 1 mark
= "...impurities.." = what impurities ? Not enough so no mark.

The other 2 marks could have been obtained e.g. by explaining how the filtration occurs and what will be filtered out (particulates.) This could be worth 2 marks.
Also, surface reservoirs are more likely to contain for e.g. nitrates.

Section B

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

3. *"Igneous processes are the most important processes in the formation of epigenetic and syngenetic mineral deposits."*
Evaluate this statement and illustrate your answer with reference to examples you have studied. (25)

Case of knowing igneous processes and what syngenetic and epigenetic mean. A few got the two (latter) terms mixed up but were not penalised too much. Don't be put off doing a question just because you are not absolutely certain. Just need to be aware that one of them means "formed at the same time as country rocks" and the other "....after..." You could get round your problem by just avoiding using the actual terms in your essay. Examiners are much more interested in principles than terminology.

Wide range of approaches to this essay. Work to your strengths. What were your case / field studies and how do these fit into (or not) the above statement ?

Key word is "evaluate" if you are looking for 20+ marks.

4. (a) Evaluate the relative importance of the geological factors that favour the formation and accumulation of large scale oil and gas deposits.

(b) Evaluate the importance of anticlinal traps in the formation of large scale oil and gas deposits. (25)

By far the most popular so we'll try this one.

5. Evaluate the role of geophysical and geochemical techniques in the search for energy and mineral deposits. (25)

First decide on the depth versus breadth argument BUT you must do at least one of each to qualify for high marks.

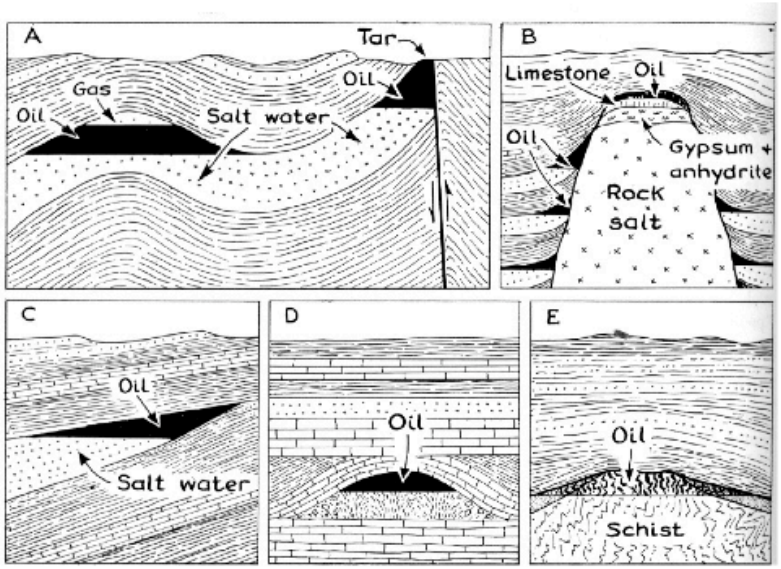
Most attempts at this went for breadth and listed all the techniques they knew anything about, plus varying amounts of discussion on each.

The weak link was invariably the geochemical part.

Must "evaluate" for 20+. i.e. how good are the methods you describe ?
Also must make some reference to energy and mineral deposits.

4. (a) Evaluate the relative importance of the geological factors that favour the formation and accumulation of large scale oil and gas deposits

Oil and gas form due the breakdown of organic material. Usually this is due to the burial of large amounts of vegetable material in swampy anaerobic conditions. Both of these are less dense than the rocks in which they form so will rise up towards the surface. They easily pass through rocks that are porous and permeable, such as sandstones. Eventually they come to an impermeable layer such as shale. They can no longer rise so they start to build up in the permeable rock. This rock is called the reservoir rock (sandstone) and the rock above is called the cap rock (shale). If the cap rock is horizontal the oil and gas will be spread out and may not be valuable. There needs to be some sort of trap. There are several different types of trap, as shown below.



Not a good start - but (unfortunately) not uncommon.

This shows a lack of understanding as to how oil and gas form. Looks as if the candidate thinks that coal, oil and gas are all formed in the same way. Admittedly there is some overlap but this should be explained if that line is to be taken. As far as (present day) economic resources are concerned, they are not formed in the same way. ☹ ☹ ☹

The very best candidates here (23 to 25 marks) all discussed marine plankton (and one or two even described the oil window.)

Not too bad. Density / buoyancy argument good.

Along the right lines BUT not absolutely clear what the difference is between porosity and permeability (and what their significance is.) Also, sounds as though it is just sandstones and shales. No mention of a source rock.

The fact that the oil will be "spread out" unless there is a trap to concentrate it is sound.

Having said that, not too bad, though basic.

This is the sort of thing that was quite common, although perhaps not these actual examples or quite this much detail. www.geo.umn.edu (not sure about some of the details in these sketches. If you produced drawings like this you would certainly need to add descriptions or more informative labelling !)

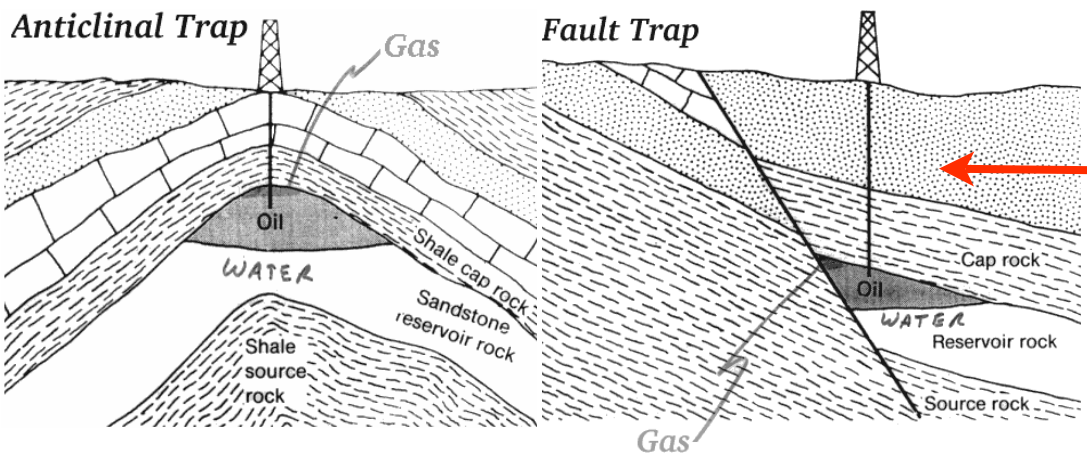
Best place for this really was in (b). It has made this part of the essay very lob-sided = traps in depth, the rest minimal.

(b) Evaluate the importance of anticlinal traps in the formation of large scale oil and gas deposits.

Anticlinal traps (as shown below) are extremely important traps for oil and gas.

However, there are other types of trap both structural and stratigraphic. An anticlinal trap is a structural trap. A good example of a structural trap is a fault trap, also shown below.

In both anticlinal and fault traps the oil and gas rise until they meet an impermeable cap rock. In the case of the anticlinal trap it is the folded shale while in the case of the fault it is where the fault plane has brought the impermeable shale into direct contact with the permeable sandstone.



Stratigraphic traps mentioned but not discussed.

The specification states that you need to be aware of both types but the choice is up to you. Most candidates appear to have studied antiforms, faults and salt domes. This is more than sufficient for structural examples, again a case of breadth versus depth. Stratigraphic traps are not so well explained although just the one example would suffice (reefs or sediment wedges being perhaps the most obvious.)

No attempt at "evaluate" and this is essential for the 20+ mark category.

Would need something along the lines of : "Many of the earlier discoveries were anticlinal traps. Relatively easy to locate using geophysical and mapping techniques. Most have now been located and exploited."

These are better diagrams. Clear drawings that are well labelled. Would not expect you to spend too much time on the ornamentation of the beds.

Pity one of these isn't a stratigraphic trap.

http://earthsci.org/education/teacher/basicgeol/fossil_fuels/fault-trap.gif
http://earthsci.org/education/teacher/basicgeol/fossil_fuels/anticlinal-trap.gif

How does this essay do ? Good labelled diagrams a big plus.

Not an easy one to assess. Many of the right ingredients and the (fictional) candidate obviously has a reasonable idea of what are the main areas of consideration.

(a) is competent. Not enough detail on porosity and permeability - which are key considerations, but there is enough to show that they are aware of their importance. Generally, breadth is fine but depth lacking. The biggest omission is the lack of understanding on how oil and gas are formed.

(b) The diagrams in (a) would have been better placed in (b) but, unless we are looking to give this candidate high marks (20+) this is not too significant - so long as it is relevant (which it is). There is the NON-discussion of a stratigraphic trap. However, for very high marks more important is an EVALUATION.

As it stands, this essay is "reasonable." It is helped **very much** by the labelled diagrams - without those it would be a low scoring essay. It is worth about half marks. The easiest way to improve would be to include an adequate discussion of hydrocarbon formation. That could put it into the 16+ mark area which is where the better candidates start to come in. Next, some discussion of stratigraphic traps in (b) would put us into the high teens. Finally, there has to be some evalutaion to get into the twenties. Often, the last bit (the evaluation) does not have to be a lengthy piece. This is judged VERY MUCH ON QUALITY.