RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE **A2 H487**

Advanced Subsidiary GCE **AS H087**

Report on the Units

January 2010

HX87/MS/R/10J

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REPORT ON THE UNITS

Chief Examiner Report

General Comments

Geology papers continue to have a rationale of lines allocated per question. The general rule used is two lines per mark unless part of the answer is a diagram or it is a single word or phrase. For most candidates there are adequate answer lines for each question, but some candidates may use more space than that provided and continue answers on other parts of the page or paper. This is not a problem, as examiners will mark all answers. Candidates run the risk of wasting time and effort on a question that does not warrant it, if they are exceeding the line allocation.

Where an answer is crossed out because the candidate has made a mistake, a clear link to where the replacement answer can be found is essential. The location of any additional information should be clearly indicated as close as possible to the lines provided for the question. This is particularly important as all the papers are marked by examiners on-line. This involves looking at a scanned image of each individual answer and so if additional material needs to be considered, then this needs to be very clear.

Teaching tip:
Encourage candidates to look critically at the number of lines available for the answer, as this helps to give an indication of the detail required in the answer. If they need to exceed this, then they should indicate clearly where the rest of the answer may be found, making sure that this information is as close as possible to the lines provided for the question.

Diagrams should be drawn with an HB pencil so that the lines are not too faint to scan. Labelling can be in pen or pencil, but labels should be clearly joined to the feature drawn. Making diagrams clear and accurate with suitable scales is an important skill.

Some candidates fail to use the command words for their answers and will then lose marks. If a question asks for both description **and** explanation, candidates should expect to be rewarded for demonstrating **both** skills.

This session had the first of the A2 papers – F794 examined. It was good to see such a wide mark range with candidates scoring very highly in all areas of the paper.

Overall, there was evidence of good geology on display, indicating that many candidates had been well prepared and had worked hard to understand basic principles and processes. Centres should continue to stress the importance of using specific geological terms in their correct context.

F791 Global Tectonics

General Comments

In general candidates performed very well with this paper with a mean of 37.7. Marks ranged from 4 to 59. There were some excellent scripts from candidates who demonstrated very good subject knowledge and were able to express themselves clearly and concisely using good technical terminology. Performance at the top end was excellent with a significant number of candidates gaining more than 50 marks out of 60. Very few candidates gained less than 23 out of 60 which indicates that they were well prepared. This is the third time that the new specification has been assessed and it would appear that candidates are very well prepared for the new topics as well as the more familiar aspects of the specification.

In addition:

- Candidates showed a sound knowledge of planets and meteorites which is encouraging.
- Candidates had a good understanding of Earth structure although the detail of the characteristics of oceanic and continental crust is still not fully understood.
- Structural geology remains an area of difficulty for many candidates especially fault structures. There were, however, many impressive geological histories given.
- Candidates showed a good knowledge of hot spots and convergent plate margins although an understanding of heat flow at plate margins is not so strong.
- The question asking for evidence for continental drift was quite well answered in the extended prose question although relatively few candidates gained full marks mainly due to weak diagrams or lack of detail.

Very few candidates omitted questions and there was little evidence of their running out of time.

Comments on Individual Questions

Question 1

1 Candidates found this question relatively straight forward averaging 8/11. Detailed knowledge of meteorites was lacking in some candidates.

a) (i) Almost every candidate gained full marks when completing the graph. Some candidates drew bar graphs whilst some others joined the points – all were credited if the points were accurately plotted.

(ii) The majority of candidates knew the location of the asteroid belt, the commonest error was to say between Jupiter and Saturn

b) (i) The majority of candidates knew the names of two types of meteorite; usually iron meteorites and stony meteorites. A minority named carbonaceous chondrites and stony irons which were also credited.

(ii) Most candidates achieved at least 2 out of the 4 marks, with most providing a good explanation of iron meteorites. Knowledge of the composition and specific layer within the Earth for stony, stony irons and carbonaceous chondrites were less well known.

Teaching tip
It is well worth candidates knowing the meteorites in some detail. The table below summarises composition and possible evidence that they provide regarding the composition of layers within the Earth.

type of meteorite	composition	evidence provided
Iron (metallic)	Iron and nickel	composition of the core
stony (rocky, silicate)	Silicates/olivine, (pyroxene and plagioclase)/peridotite	composition of the mantle/asthenosphere
stony iron	Iron, nickel and silicate minerals	composition of the core mantle boundary
carbonaceous chondrite	composition of Sun minus some volatiles with water and carbon has organic molecules	approximate composition of the whole Earth

c) Many candidates could name impact craters as evidence for meteorite impacts but relatively few candidates knew of a second method which could include shocked quartz, spherules, tektites and Iridium spikes.

Question 2

2 Many candidates performed well in this question averaging 10/14. Many candidates were familiar with the location and state of the lithosphere and asthenosphere although they were less confident with the various properties of oceanic and continental crust.

a) (i) Most candidates were able to recognise that the crust and the uppermost part of the mantle form the lithosphere and were able to spell *lithosphere* correctly.

(ii) The majority of candidates were aware that the lithosphere is solid.

(iii) Many candidates were aware that the asthenosphere is immediately below the lithosphere.

(iv) The majority of candidates knew that the asthenosphere was partially (5%) molten. Candidates must be careful not to describe the asthenosphere as semi molten as this suggests 50% which is not the case.

b) (i) 65% of candidates were able to locate the Moho between the crust and mantle.

Teaching tip
It is well worth candidates having an A3 sheet with an annotated cross-section of the Earth locating the various layers and boundaries with the names, depths, state and composition.

(ii) There was major confusion evident amongst candidates regarding the distinction between the mantle/asthenosphere/lithosphere and the position of the Moho. This is definitely an area that candidates need to work on. Many thought that seismic waves slow down going from crust to mantle and thought this was due to their going into the asthenosphere/LVZ. This is clearly a misunderstanding as waves speed up in the uppermost mantle before slowing at the asthenosphere.

c) Candidates still have difficulty in gaining full marks (less than 25% of candidates) when answering questions on oceanic and continental crust. Candidates had a good knowledge of average composition and density. Many candidates misread the rubric and gave the *oldest* rocks rather than the *range*. Candidates need to be aware that in both oceanic and continental crust there are rocks of 0 Ma age. Many candidates also gave a range of thicknesses rather than the average.

d) Candidates tend to do well in this style of question with matching technical terms and definitions. Half the candidates gained full marks.

Question 3

3 As is often the case, candidates did tend to find the question on structural geology the most difficult of the paper. The average mark was 7/13.

a) **(i)** Many candidates were able to recognise that the fold is an antiform. The second mark, however, was harder to gain although many did recognise that the fold was asymmetric. There was some confusion about what was meant by the *northern* fold with candidates referring to an antiform and synform. As neither of the limbs was inverted, the fold could not be described as an overfold.

(ii) The majority of candidates were able to draw the axial planes.

b) **(i)** About half the candidates were able to recognise that the fault was a normal fault

(ii) Many candidates recognised that the stress involved in forming the normal fault was tension (not extension). It should be made clear to candidates that the stress is *tension* and the strain is *extension* which can be easily confused.

(iii) Almost half the candidates gained no marks at all with this question. Candidates often struggle with slickensides and fault breccias. This question clearly showed it required correct spelling but many candidates misspelled *slickensides* as *slickenslides* so gained no marks. Marks were available for the diagram and description. Quite a few candidates misinterpreted the question and wrote about horst/graben, transform faults/reverse faults, unconformities, joints, nappes, etc.

c) **(i)** Half the candidates correctly located the unconformity surface.

(ii) Candidates often find the order of events in a cross-section straightforward. In this case, however, there was a wide variation in the marks gained. The deposition of the mudstone was often placed after the folding in the geological history; some also described the last event as *deposition of the unconformity of coarse sandstone* or similar – an unconformity is a plane/surface formed by uplift and erosion followed by deposition of the younger beds.

Teaching tip
It is worth candidates practising geological histories of maps and cross sections. Candidates should be encouraged to add as much detail as possible such as the type of fold or fault produced, the angles of dip, the downthrown side etc.

Question 4

4 Candidates averaged about 9/14 in this question. Candidates found aspects of the question such as labelling the convergent plate margin straightforward but struggled with the heat flow. Hot spots were reasonably well understood.

(a) (i) Candidates were able to label the Benioff zone and island arc correctly. Errors included drawing the island arc elsewhere and not shading an area of Benioff zone but doing a single point instead.

(ii) Almost 100% of candidates were aware that the arrows converged.

(iii) Only 60% placed the rising magma at least in part below the island arc which is a product of the rising magma.

(iv) Perhaps aided by the hint in the previous question, most candidates could name the convergent plate margin (many also still called it a destructive plate margin). Candidates are to be encouraged to use the terms convergent and divergent plate margins so that they are in line with the specification and the terms used in examination papers.

(b) (i) Candidates struggled with the heat flow graph with only 37% gaining the mark. Many did recognise the high heat flow over the island arc but fewer recognised the low heat flow over the trench.

Teaching tip
An easy way for candidates to remember the shape of heat flow variation (and also gravity variation) over plate margins is to just draw the line so that it mimics the shape of the land. Over mountains both heat flow and gravity will be high and over trenches the heat flow and gravity will be low. This in itself will not allow candidates to understand why the patterns occur but it is a starting point.

(ii) Most candidates could gain one mark as they knew about the high heat flow being caused by rising magma and volcanic activity at the island arc. Only about 10% realised that the low heat flow at the trench was due to the cold sinking convection currents rather than just cold water.

(c) (i) Most candidates could name an oceanic plate.

(ii) Very few candidates were aware that the Arabian plate is the only plate that is essentially continental. Most candidates gave a plate that was a mixture of oceanic and continental crust.

(d) **(i)** 62% of candidates were able to give a sound definition of a hotspot. Candidates must be clear that a hotspot is not a mantle plume but the *surface expression* of a plume which is stationary and usually away from plate boundaries and so is *intraplate*.

(ii) There was a wide range of responses to the explanation of the pattern of islands with 40% gaining full marks. Many were aware that the hotspot was stationary and the plate moved over it. The marks then depended on the detail of the description of the volcanic activity gradually diminishing and the extinct volcano moving off the hotspot to create a line of islands that get older with distance from the hotspot.

Question 5

5 There was an even distribution of marks relating to this question with unusually only 6% of candidates gaining full marks. The average was 4 or 5 out of 8.

Many candidates described the jigsaw-like fit but they needed to add detail or an annotated diagram to gain marks. In particular, marks could be gained with discussion of areas of overlap or gaps.

Candidates gained most marks with sound knowledge of the fossil evidence with many being able to quote 2 or 3 appropriate species.

Often candidates would talk vaguely of rocks or mountain ranges joining up but really needed to discuss similar rock type, age of rocks or structural trends to gain full marks. Diagrams certainly needed to be of a higher quality.

Some candidates did not stick to the question and so went beyond Africa and South America. Others discussed evidence in the oceans like magnetic stripes and Mid Ocean Ridges which are not appropriate for this question.

F792 Rocks - Processes and Products (Written Examination)

General Comments

There were 348 entries for the paper. Because it was marked online, it was not possible to gain an impression of variation by centre. There was a wide range of performance from candidates with some excellent answers showing first class understanding and an ability to interpret, explain and apply concepts. Many had a sound grasp of geological terms but there was scope for improvement in some cases. There was no evidence that the paper could not be completed on time.

Comments on Individual Questions

Question 1

Candidates were generally successful in answering this question.

(a) (i) Granite and granodiorite were the hardest rocks to distinguish. Rocks in the right hand column (BDF) which were shown as thin section drawings were more often correct than those in the left hand one (ACE) which were descriptions.

(ii) Candidates very often stated *porphyritic* as the texture even when the rock had been correctly identified as a schist. The spelling of the correct texture - *porphyroblastic* - was often incorrect. *Garnets* were sometimes confused with *vesicles*. If *gneiss* was given as the answer for B, an error carried forward mark was allowed for *gneissose banding* in this response.

(iii) *Sorting* was sometimes described using terms that mean something else in geology: for example, *intermediate* presumably instead of *moderately* sorted. This was incorrect anyway. Rock D was well sorted. Sometimes candidates showed uncertainty by adding words like *moderately* or *relatively* to their descriptions of sorting. It is better to be definite and use the correct technical terms rather than try to cover more than one possibility with a vague answer.

(iv) There were quite a few answers that referred to *desserts*! This is worth trying to correct, as this word may be necessary in an answer where quality of written communication is important.

(b) (i) There was some variation in the range of silica content given in answers, particularly for mafic. Sometimes the range was stated as beginning at 44% but this falls within the range used to describe ultramafic. The minimum value for silica in mafic rocks should be 45%.

(ii) Some thought mistakenly thought that biotite mica was felsic. Some large streaky ticks went across more than one box – fitting them into the box avoids any risk of ambiguity.

(iii) Mostly answered correctly, but some offered *plagioclase feldspar*, *carbon* or *magnesium* regardless of the mineral data provided in the table.

Teaching tip
Rock Art
Use the thin section diagrams from past exam papers and enlarge them using a photocopier so that they can be mounted and displayed on the wall. The task is to produce a catalogue for visitors to your gallery. Each work of art should have a name (the name of the rock) and a scale bar instead of the artist's signature. The catalogue should say where each work of art came from (the environment of deposition). Arrange a guided tour and describe the works in the exhibition to visitors.

Question 2

Many candidates were successful in matching the definitions of igneous terms and the calculation. Only a few did not show their working. Diagrams of shield volcanoes were generally drawn with the sides at too steep an angle of slope.

(a) A few candidates couldn't believe they only had to write the appropriate numbers in the boxes and so copied out the full descriptions, which cost them time. Some equated *effusive low viscosity* or *assimilation* with *a layer of early formed minerals at the base of an intrusion*. *Partial melting* and *assimilation* were sometimes confused.

(b) **(i)** A difficulty here was in drawing the slope angle correctly. Usually it was too steep, although a mark was given if it was labelled as having a slope of $<10^{o}$. Some labelled the slopes as *shallow,* but then added a measurement which was $>10^{o}$. Sometimes fissure volcanoes were drawn rather than shield. A central crater was often labelled but occasionally wrongly spelled as *creator* - which is a different thing!

(ii) Drawings of strato volcanoes were more accurate in terms of angle of slope, although some were almost vertical and looked like a chimney. A mark was given if they were labelled as having a slope of $30\text{-}50^{O}$. Credit was given if a comparison had been made between the two types of volcano on each drawing. Alternating layers of ash and lava were often correctly labelled.

(c) **(i)** There were several good responses. The main problem with the batholith was drawing it much too big or locating it so that it wasn't under the mountains. There were some oddly shaped batholiths. The area of partial melting was often correctly shaded but there was a degree of random shading in illogical places.

(ii) Most candidates gained both marks here. Only a few did not show their working. Some rounded their answer to 26.5 which was not correct. If rounded to one decimal place the correct answer was 26.6.

(d) Generally well answered. Some candidates just repeated that the rocks had been metamorphosed rather than referring to alteration or change.

Question 3

The definition of *polymorph* was often not set out clearly and the meaning of the term *index mineral*, although better known, was not always expressed effectively. The graphs and map produced a wide range of responses.

(a) (i) There were several good attempts that were quite accurate, and more that gave an overall impression of the relative positions of the types of metamorphism on the graph without necessarily being precise. These still gained credit. Some drew the diagram upside down. Perhaps they were unable to transfer the information from the diagram they had memorised or misread the axes. This question did discriminate between candidates who had memorised the answer and those who could apply their knowledge.

(ii) A mark was given for shading the area of diagenesis below 2kb and <200^{o}C. Many realised that this was a process that occurred in sediments and so shaded the correct area. There were quite a few random guesses and candidates who did not attempt this part of the question.

(b) (i) Some precise definitions, but many candidates were not able to clearly state what a polymorph is. Some confused the terms *mineral* and *rock* in their answers.

(ii) Many well-learnt responses. Some had the correct names in the wrong places.

(iii) Almost all could use the diagram to obtain both marks here.

(c) (i) The definition of *index mineral* was better known than that of *polymorph*, but the terms *mineral* and *rock* were still confused by some candidates.

(ii) The map was often well interpreted. There were the usual 'join the dots' answers which gained a maximum of one mark. There were some that were not quite carefully enough drawn and had the same index mineral on both sides of an isograd. Simple interpretations were best without unnecessary 'wiggles'.

(iii) Many candidates didn't seem to realise that the correct answers had to be the names of metamorphic rocks. Almost everything was offered by someone or other with *igneous, sedimentary, metamorphic* not infrequent.

Teaching tip
Upside down?
There is a well known graph that shows the relationship between regional metamorphic rocks, pressure and temperature, and another that shows the relationship between the Al_2SiO_5 polymorphs. Practise drawing these graphs with the scales arranged in different ways, for example with pressure increasing and then with pressure decreasing from the top of the diagram.

Question 4

The rose diagram was accurately completed by most candidates. Diagrams of cross bedding proved to be more difficult.

(a) **(i)** Most candidates understood the concept of migration of river channels. The majority showed the movement of the channel and the places where erosion and deposition would occur.

(ii) The processes were clearly explained by most. A minority were not able to explain effectively and omitted details. Usually this was where there was no reference to which side of the river channel the erosional and depositional processes occur.

(b) **(i)** *Imbricate structure* was correctly identified by most candidates though some opted for *cross bedding* or *graded bedding* as old favourites. There were a few interesting but incorrect terms that were entirely new (eg *dipples, rock dominoes*)

(ii) Many sensible explanations and some sound knowledge of the formation of imbricate structure. Most could only vaguely state how current direction related to the dip of the pebbles. Although this was not essential to gain full marks it was one way that a mark could have been earned.

(c) **(i)** A variety of diagrams was used but some did not show cross bedding properly. Dunes should have a gentle upstream slope and a downstream slope which should be no steeper than 37^{o} from the horizontal. Cross bedding should be concave upwards and is truncated at the top. Some drew almost vertical cross bedding.

(ii) Almost all candidates completed the rose diagram correctly.

(iii) Many candidates successfully identified the current direction. Some gave answers in words and some in degrees from North.

(d) **(i)** Candidates generally knew that ripple marks formed in a river channel would be asymmetric and those on a beach symmetric. The quality of drawings could have been improved by giving the ripple mark pointed crests and rounded troughs and by not giving asymmetric ripple marks unrealistic 'overhangs'. The correct angles and scales should be known.

(ii) Most correctly identified the current directions, even when their diagrams had not been very realistic.

Teaching tip
Make your own cross bedding
Make a narrow trough using two sheets of Perspex with a 1cm gap between the sheets. The sheets can be supported using a pair of clamp stands. Make a mixture of very fine sand and granulated or caster sugar. At one end hold a funnel in place between the Perspex. Pour the sand and sugar mix into the funnel. Watch the cross bedding form between the Perspex sheets as you move the funnel along. The sugar will enable you to see the cross bedding, which will be concave upwards – one way of telling that it is the right way up.

Question 5

Sound descriptions and some good explanations of sedimentary processes and products.

(a) **(i)** *Solution* was sometimes offered instead of *suspension* for M. In this case there was an error carried forward mark allowed if *suspension* was given as the answer in 5aii. *Traction* was sometimes confused with *attrition*.

(ii) *Solution* was well known and most candidates gained this mark.

(iii) Many candidates did not name the grain sizes as asked. One mark was allowed for *fine* and *medium*. *Clay/ silt* and *sand* were the names expected.

(b) **(i)** Characteristics of sediments were generally clearly described, especially angularity and poor sorting, but explanatory comments were sometimes lacking or unclear. *Lack of attrition* was sometimes indicated by mentioning *lack of erosion* and this was credited. Poor sorting was often not clearly explained. *Plucking* was sometimes offered as an explanation for angularity but often without explaining what the term meant.

(ii) Successfully answered by the majority. Products were required, not glacial landforms such as drumlins and kames.

(c) **(i)** The diagram showed fragments that could only be described as *angular*. *Sub-angular* was not a correct response here. It separated candidates who were confident from those who were less secure in their interpretation.

(ii) Sediment with a mix of sizes was drawn by almost everyone.

(iii) Some answers referred to *grain size* rather than *roundness*. Others wrote about distance rather than time. Most were relevant though and knew the relationship. Again, the term 'attrition' was not always used where it would have been appropriate.

(iv) Many correctly said that quartz is harder than mica (or that mica is softer than quartz) with some quoting the numbers from Mohs' scale. Lack of cleavage in quartz was also correctly given. The fact that quartz is less reactive is not a reason why quartz grains survive transport better than mica. Some candidates were too vague and commented that quartz was 'stronger'.

Teaching tip
Geological Ball Game
Ask students work in pairs. They face each other at opposite ends of a bench or table, or even on opposite sides of the room. They have a sponge ball or tennis ball which represents a grain of sediment. The challenge: how do you get the ball from one person to the other? Walking is not allowed, neither is leaning across the bench, or passing the ball on by hand – they should be far enough apart to make this impossible. Of course, the only three methods are throwing the ball (suspension), rolling it (traction) and bouncing it (saltation). By describing what they did the students are then able to clearly describe these three processes of transportation.

Question 6

Exfoliation was sometimes confused with freeze-thaw. Temperature changes needed to be on a diurnal basis. Statements like *a short time period* were not precise enough. The *onion skin* effect was sometimes effectively shown by a diagram and was credited.

Hydrolysis was the least well learnt. It was quite often confused with the erosion process of hydraulic action, with stirring descriptions of wave battered cliffs not uncommon. Some candidates tried to link it with freeze-thaw.

Burrowing was sometimes thought to be done by plants as well as animals. There are no burrowing plants and there was confusion with root action here. Diagrams of burrowing cats, rabbits and moles were decorative but not useful.

Carbonation was often well described with the occasional correct use of notation describing chemical reactions. Freeze-thaw was sometimes described, although it was not one of the options. Many candidates wrote sound descriptions and several were excellent. The full range of marks was awarded.

Question 7

Most candidates were able to describe some differences between sills and lava flows. There were very few who were unable to describe any differences. Answers generally did not integrate the explanation with the difference to which it related, so that the answer sometimes fell into two halves with an account of differences and then an account of possible explanations. All explanatory remarks in the mark scheme were credited. Some high performing candidates wrote very well integrated answers, with ongoing explanations very clearly linked to differences. Diagrams ranged widely in quality with some first class examples.

Some diagrams had baked margins and chilled margins the wrong way round. Some candidates thought that vesicles represented trapped air in lava flows. Some said that lava flows only had xenoliths at the bottom, but didn’t say that they were from the underlying rock only. Overall, most candidates wrote capable answers showing that they can distinguish and account for some of the differences clearly.

F794 Environmental Geology

General Comments

This was the first A2 examination of the new GCE Geology specification and the overall standard was high. Most candidates appeared well-prepared for the examination and there were some excellent scripts demonstrating an in-depth knowledge of the subject. There was no evidence that time was an issue, with virtually all candidates attempting the final extended question on geothermal energy.

The following points should be noted:

- Synoptic assessment – Some candidates seemed poorly prepared for the synoptic element of the question paper. It clearly states in the specification that all the A2 units are synoptic. The synoptic assessment is designed to test candidates' understanding of the connections between different elements of the subject. It involves the explicit drawing together of knowledge, understanding and skills learned in the different parts of the GCE course. 20% of the F794 paper is synoptic. Although any synoptic question can be asked, the most obvious links with the AS level specification are geological structures from F791 and many aspects of the F792 *Rocks - Processes and Products* unit.

- How Science Works – Environmental geology includes many areas that are relevant to How Science Works. Questions will address issues of sustainability and economic viability as well as environmental impact.

- Stretch and Challenge – 10% of the questions on the F794 paper are high level questions designed to "stretch and challenge" and differentiate between A* and A grade candidates. These may appear as a whole part question or as individual mark(s) within a question. Command words like *assess* and *evaluate* may be used for these questions.

- Quality of Written Communication – On this paper, quality of written communication is assessed by the requirement for candidates to *use the appropriate technical terms, spelled correctly.* Although the majority of candidates wrote clear, legible answers that used correct specialist terminology for the specified questions, a significant minority of candidates penalised themselves by writing answers that were poorly spelled and extremely hard to read and decipher. Candidates should be encouraged to learn the correct spelling and use of key geological words and terms. In addition, bullet point lists should not be used to answer questions that ask for descriptions or explanations.

- Labelled diagrams – The drawing and labelling of diagrams is also a key skill in Geology and candidates should be encouraged to practise this skill at every opportunity. Some candidates lost marks due to inaccurate diagrams, with poor or no labelling. This was particularly notable in the synoptic question that asked for *labelled* thin section diagrams, with scales, to compare *textures*.

Comments on Individual Questions

Question 1

1 Most candidates showed a good understanding of the requirements for the accumulation of hydrocarbons in traps, but were less sure of the new part of the specification covering unconventional petroleum.

(a) (i) About half of the candidates correctly identified the fault as a normal fault. This synoptic question clearly differentiated between candidates who had revised structural geology and those who hadn't.

(ii) Most candidates were able to give two correct reasons why hydrocarbons would be found at location A in the fault trap. A few lost marks as they didn't specify which rock type was the reservoir rock, or which was the cap rock. Some did not look at the key carefully enough and stated shale was the cap rock – if they clearly showed an understanding that the cap rock was impermeable and immediately above the reservoir rock they still attained a mark.

(iii) About half of the candidates correctly answered this high demand question to explain the reason why the trap was likely to contain only natural gas. Of the correct answers, most recognised that the source rock was likely to be the underlying coal which would only produce natural gas.

(iv) The vast majority of candidates were able to correctly label the positions of a salt dome and unconformity trap on the cross section diagram. Unfortunately, some indicated the correct positions of the traps but did not label them B and C.

(v) Most were also able to correctly name and spell the two traps they had identified. However, a small number of candidates' handwriting was very difficult to read and it wasn't always possible to award the mark as it was unclear if the spelling was correct. The most common error was misspelling *unconformity* as *uncomformity.*

(b) (i) This synoptic question asking candidates to draw *labelled* thin section diagrams to compare the textures of a poorly-cemented desert sandstone and a greywacke was not done particularly well. Some candidates drew the same diagram for both the desert sandstone and the greywacke, while a few others thought that *greywacke* was a metamorphic rock and drew the texture of a schist. Even if the diagrams themselves were acceptable, many candidates ignored the word *labelled* and others did not correctly label any textural features. The scales also proved problematic: many candidates have obviously forgotten that both rock types are sandstones and therefore, by definition, should have a grain size between 2 and 0.0625 mm, with a desert sandstone having medium size sand grains. Others forgot to put units on their scales or the units used did not match the size of grains drawn and also lost the mark.

(ii) Most candidates attained one of the two marks available by stating the desert sandstone would have a higher porosity and permeability and be a more suitable reservoir rock than the greywacke. Few, however, gained the second stretch and challenge mark by explaining *why* it would have a higher porosity and permeability. Just stating the desert sandstone is well sorted and the greywacke is the opposite was also insufficient for the second mark – a correct assessment of both rock types with reasons was required.

(c) **(i)** Many candidates gave the correct definition that reserves are the *amount of the resource that can be extracted (at a profit) with existing technology.* Some lost the mark as they omitted the key word *amount* and others were confused by the term *reservoir rock*. A large number of candidates continued the theme of the rest of the question and described this in the context of oil only, but this was acceptable for the mark.

(ii) The vast majority were able to carry out the simple calculation to arrive at the correct answer of 10%. A few left the answer blank and others failed to spot that the question asked for an answer to the nearest whole number, which takes into account the fact that reserves are estimated, rather than precise values. Unfortunately, some candidates calculated the correct answer of 10.18% and then rounded it up to 11%!

(d) Candidates found this question on why unconventional sources of petroleum would be unlikely to completely make up any shortfall in oil and natural gas production very demanding. Few were able to go beyond the idea that extracting them is *more* difficult or *more* expensive. Many were under the impression they are present in quantities that are too small to be economic – given the Athabasca tar sands have massive reserves of 1,700 billion barrels this is clearly not the case. Only the strongest candidates appreciated the high viscosity of unconventional petroleum mean that recovery rates may be too low to be economic – a subtle difference.

Question 2

2 Road and dam construction, and ground improvement strategies were well known areas of the specification, but few candidates were familiar with the geological materials used in the manufacture of concrete.

(a) **(i)** Most candidates were able to complete the diagram to show the geological problem that could occur as a result of the beds on the western side dipping in towards the road cutting. Some candidates, however, ignored the dip angle of 20° shown on the map and drew very steeply dipping beds – angles greater than 45° or parallel to the slope were not accepted. Answers that confused *shale* with *slate* and discussed *foliation* or *cleavage* were not awarded the second mark.

(ii) The fact that deeply weathered rock would be loose or have a high permeability was well known, but some candidates used non-geological terminology. The fact that strategies such as rock bolts cannot be used in weathered rock was less well known.

(b) **(i)** There were many excellent, well reasoned evaluations as to which site, E or F, shown on the map would be the best choice for the location of a dam and reservoir. Weaker candidates focused on the faults and possibility of seismic activity at E for 1 mark, but most were also aware that the limestone at E would be permeable whereas the shale at F would be impermeable. Only the strongest candidates realised that although F is the best choice, it still isn't ideal as shale is incompetent and has a low load-bearing strength.

(ii) The geological materials used in the manufacture of concrete were poorly known. Candidates struggled to attain one, let alone two, marks despite the very generous mark scheme that allowed a list of ingredients or just simply *sand and gravel is added* for 1 mark. There were many random discussions of just about every geological material you could think of, including bitumen!

(c) Most candidates were very familiar with ground improvement methods to stabilise rocks and prevent leakage of water and scored the full 4/4 on this 'match the method with its application' question.

Question 3

3 This question on mineral deposits and disposal of nuclear waste produced good answers. However, the part of the question on how underground mining of metals can affect groundwater quality was done very poorly.

(a) **(i)** The process of secondary enrichment of copper was well known and many candidates attained the maximum 3 marks available. There were many excellent answers that fully described the changes in conditions from oxidising above to reducing below the water table and an impressive knowledge of soluble "ates" above and insoluble "ides" below.

(ii) This part question asking why secondary enrichment is important to the economics of a copper mining operation was not very well answered. Many candidates wrote a definition of concentration factors, failing to appreciate that the copper in the primary ore is already concentrated above its average crustal abundance. Few expressed the idea that the grade of the ore is high*er* that the rest of the deposit or that it is concentrated into a smaller *volume* (rather than area).

(b) **(i)** Again there were some excellent responses to this question asking for a description and explanation of how uranium deposits form in sandstones and conglomerates. A minority were confused with gravity settling or placer deposits and thought that fragments of uranium ore were washed down, missing the fact that it is a highly soluble element in oxidising conditions. A small number of candidates gave no response at all suggesting they were unfamiliar with this part of the new specification.

(ii) As expected, candidates found this question asking about the significance of the fossil wood in the sandstone and conglomerate unit challenging. Correct answers were evenly split between those that discussed the association of uranium ore deposits with organic matter and those that related the presence of wood to a terrestrial palaeo-river channel environment. Some thought it was simply an environmental indicator of anoxic conditions but didn't say why. Sadly, there were a number of erroneous answers stating wood contains elements of uranium or that uranium is made from wood suggesting these candidates have little understanding of basic chemistry.

(c) Candidates' knowledge of how underground mining of metals can affect groundwater quality was very poor. There were many bland answers merely repeating the question that metals from mining could pollute or contaminate groundwater. Few showed an understanding that the metals or chemicals used in mining operations could be toxic or harmful; even fewer discussed the ideas of solubility or movement through permeable rocks to reach aquifers; and only a handful had any knowledge of acid mine drainage water.

(d) **(i)** The vast majority of candidates knew nuclear waste is radioactive and that this causes problems in its disposal.

(ii) There were some excellent, detailed answers to this question asking for an outline of the requirements for the safe storage of nuclear waste in an underground repository in rocks, that gained the maximum 3 marks available. Others were confused with landfill waste disposal and some had no idea at all.

Question 4

4 The origin and formation of coal was well known by candidates but surprisingly, many struggled to explain why coal is a non-renewable energy resource and geothermal energy is renewable.

(a) There were some very pleasing responses to this question, with the majority of candidates scoring at least two marks for good descriptions of the environmental conditions required for the formation of peat and coal. Many candidates, however, did not attain the third mark as they failed to differentiate between *climate* (long term weather conditions) and *environment* (the surroundings) and lumped them together in one description.

(b) **(i)** Virtually all candidates correctly plotted the line graph showing the changes in carbon and oxygen content with rank. In some graphs, the plotted points were obscured by the use of a thick line to join them up. Using crosses instead of dots is a better technique, as is using a sharp pencil with which to draw the line.

(ii) The processes of coalification and compaction responsible for the changes shown on the graph were well known. A few candidates lost marks as they described the pattern shown on the graph, rather than explained the process responsible for them.

(iii) The reasons why anthracite is more valuable than lignite were well known with most correctly citing the higher carbon content or calorific value of anthracite.

(c) **(i)** This straightforward question asking for an *explanation* as to why coal is an example of a non-renewable energy resource was surprisingly poorly answered. Many gave a Key Stage 3 answer stating *it can only be used once*; others gave the definition *it is finite* rather than an explanation; while many others were confused with sustainability, asserting it is being extracted/used at a faster rate than it is being replaced. Only the strongest candidates appreciated the time scale of millions of years for coal formation or that when coal is burned, the products are lost as gases into the atmosphere.

(ii) This question asking for an explanation as to why geothermal energy is an example of a renewable energy resource was also answered rather badly. Many candidates had the idea it could be used over and over again or that it is being replaced as fast as it is being used, but few explained *what* could be used again or *how* it is being replaced. The minimum response that was required to gain a mark was an understanding that the Earth's *heat* will not run out or that the *water* can be reused. Better answers discussed the idea of radioactive decay of heat-producing elements or that magma is constantly rising.

Question 5

5 There were a number of excellent, well-illustrated answers to the extended question on geothermal energy. It was encouraging that there were very few omissions and virtually all candidates gained some credit for their answers.

Some candidates, however, ignored the question which asked for *two* methods from volcanic sources, geothermal aquifers and hot dry rocks and described all three, thus diluting their effort and spending longer on the question than they needed to. Others did not make it clear which method they were describing, limiting themselves to a maximum of 5 marks.

The biggest issue was confusion between the three different methods. Many wrote the same description under two or three different headings and very few correctly described the heat source for each – magma for volcanic sources; geothermal gradient for geothermal aquifers; and radioactive decay in granites for hot, dry rocks.

In addition, there was a lack of good technical terminology. Another area of confusion was *geothermal aquifers*. Many candidates thought that, rather than water in the aquifer being at a modest 60° to 70°C, it would be superheated and would rise as steam to be able to drive a turbine!

The standard of diagrams was variable. While there were some excellent accurate diagrams, complete with detailed annotations describing the processes, that were a credit to the candidates, others were so poor as to be worthless.

A common error was to draw one borehole as a continuous U-shape, which is beyond the powers of modern technology! The importance of labels should be reinforced while teaching, as some well drawn diagrams gained no marks due to lack of annotations.

Teaching tip

	No. of boreholes	**Purpose**	**Additional boreholes**
Volcanic source	1	To allow hot water/steam to rise to the surface	To recycle used water
Geothermal aquifer	1	To pump the warm water to the surface	To recycle used water
Hot dry rocks	2	To pump cold water down; To pump hot water/steam up	

Grade Thresholds

Advanced GCE Geology (H487)
Advanced Subsidiary GCE Geology (H087)
January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
F791	Raw	60	47	42	37	32	27	0
	UMS	90	72	63	54	45	36	0
F792	Raw	100	76	67	58	50	42	0
	UMS	150	120	105	90	75	60	0
F794	Raw	60	48	43	39	35	31	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H087	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
H087	5.8	32.7	51.9	82.7	98.1	100.0	55

55 candidates aggregated this series

For a description of how UMS marks are calculated see:

http://www.ocr.org.uk/learners/ums/index.html

Statistics are correct at the time of publication.

INSET event for GCE Geology

An INSET event is being planned for the autumn term 2010 at the British Geological Survey, Keyworth, Nottingham. See the OCR website next term for details.

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