RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE **A2 7884**

Advanced Subsidiary GCE **AS 3884**

Report on the Units

June 2009

3884/7884/MS/R/09

Oxford Cambridge and RSA Examinations

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REPORT ON THE UNITS

2831 Global Tectonics and Geological Structures (Written Examination)

General Comments

There were some excellent scripts and many candidates demonstrated very good subject knowledge and were able to express themselves clearly and concisely using good technical terminology. Many of these candidates were sitting the paper for a second time and the quality was certainly high. Very few candidates gained less than 10 out of 60 which indicates well prepared candidates. There was no evidence that time was an issue – almost all candidates attempted the extended question.

Some candidates need to pay far more care and attention to the quality of their diagrams, especially of the plate margins. If a feature cannot be recognised or is not labelled then it will not gain marks. Poor handwriting and spelling continue to be issues for some candidates and they should be encouraged to learn the correct spelling of key geological words and terms.

Comments on Individual Questions

Q 1 This question gave a wide range of marks with some students gaining full marks.

a) **(i)** Half the candidates knew the answer. Candidates tended to struggle with locating high and low heat flows. Many candidates knew that high heat flow was found in active mountain ranges and volcanic areas. Locating mid ocean ridges accurately proved difficult for many candidates. A number of candidates did identify New Zealand and Hawaii as areas of high heat flow. Candidates need to be more precise with shading to make sure that trenches are *just* offshore and that fold mountains are completely on land and not partly in the sea. In general locating the high and low heat flow areas accurately was the main problem.

> **Teaching Tip**
> It would be useful for candidates to have an outline map of the World on an A3 sheet that is then coloured in with all the significant tectonic features. The marine features tend to be difficult for candidates to locate so a map with mid ocean ridges, island arcs, trenches and hot spots would be of great use. Candidates could then shade in areas of high (red) and low (blue) heat flow.

(ii) Although candidates may have had difficulty locating areas of high heat flow accurately, most did know why the high heat flow existed, often indicating how it related to partial melting, rising magma or volcanic activity.

(iii) Candidates tended to be better at locating low heat flow areas in the oceans whilst locating cratons tended to prove difficult. *See the comments for (i) above.* Over half the candidates knew the reasons for low heat flow which include:

- being away from a plate margin, within the centre of a plate
- cold sinking convection currents at convergent plate margins
- old (stable) crust or thick crust
- no igneous activity or rising magma

A number of candidates gave *cold water over a trench* which is not the full explanation.

b) **(i)** Although many candidates gained at least 3 of the 5 marks available, the standard of drawing, however, was generally poor. These are diagrams that all candidates should know thoroughly and be able to reproduce in an examination. Often little care was taken in placing the various features in the right location and labelling was careless – marks therefore being lost unnecessarily.

> Teaching tip
> Because the question asks for an island arc, candidates should start by drawing the sea level (using a ruler). This will help candidates to lay out the rest of the diagram. The question requires oceanic plates with the correct shape and thickness, not just the crust. Candidates should take care with the precise placement of the earthquake foci on the top of the descending plate. Convection currents are a possible cause of the converging margin, so they should be drawn in the appropriate position on either side of the descending plate.

(ii) Most candidates knew the reason for the occurrence of earthquakes and achieved both marks. There was, however, confusion about the terms *stress*, *energy* and *friction*, which were often used synonymously. Candidates should be encouraged to mention frictional resistance to the subducting plates which builds up stress. This stress is then released as seismic waves.

c) While most candidates could name the methods that are used, there were a lot of incorrect explanations. For example, base isolation systems allowed the building to "move with the earthquake" whereas the aim is for the ground to move with the building remaining more or less stationary. A number of candidates wrote vaguely about "shock absorbers" without any detail. Explanations of counterweights, flexible structures and pyramid shaped/wide based buildings were often very good. A number of candidates included diagrams which often helped their explanation.

Q2 Candidates found the divergent plate margin question straight forward as was the plotting of the graph. Calculating spreading rates, though, remains a difficulty for many.

a) **(i)** Most candidates (95%) gained at least 3 marks for this straightforward diagram of a divergent plate margin. The main error tended to be marking the volcanoes at a distance from the axial rift. Candidates must make sure that they draw convection currents that clearly rise beneath the ridge/rift and diverge at the surface.

(ii) Most candidates knew about the role of convection currents but were often vague about exactly how they operated by diverging and pulling the plates apart under tension. Many were also aware of the role of rising magma but again could not give a description of the forceful intrusion of magma pushing plates apart. An increasing number of candidates are aware of ridge push and slab pull and so gained credit.

b) **(i)** Most candidates gained full marks for plotting the graph showing spreading of the East Pacific Rise. Problems only occurred when lines and points were drawn without care - sometimes the line did not go through the origin.

(ii) Calculating rates of spreading remains difficult for many candidates. Fewer than half the candidates could calculate the rate correctly with clear working shown.

Teaching tip
Candidates should practise the various types of spreading rate calculations including tabulated data as in this case. Candidates may need to measure distances on a cross-section and work out the age of the rock from magnetic stripes as in May 2007. Other examples of such calculations are to be found in June 2001, January 2002, May 2002, May 2003, May 2004, January 2007, and May 2008.
When showing working, candidates ideally should show the formula and then substitute the numbers clearly in an organised way such that the examiner can follow the working.
Rates are normally between 1 and 12 cm/year

c) (iii)

Most candidates were aware that a steeper gradient indicated a faster spreading rate.

The majority of candidates knew the structure in great detail even adding annotated diagrams. Clearly well understood by candidates.

Q3 The structural questions especially those regarding stress, strain and competency proved difficult.

a) Relatively few candidates could define stress and strain with few gaining full marks. A number of candidates described stress as a compressive force and strain as a tensional force indicating no real understanding. Strain as the "effect" is too vague an answer.

Teaching tip
Make sure that candidates fully understand these terms (and any other term in italics in the specification as they may well be asked to define them).

Stress: the force per unit area which acts on or within a body.
(This is similar to pressure. Think of stress as a directed force due to earth movements, and pressure as the result of overlying air, water or rock)

Strain: the change in shape or volume of a body in response to the stress acting on it.

Competent: a rock which folds without a change in its original thickness. Tends to form joints.

Incompetent: a rock which flows and changes its original thickness as a response to folding; the flow may lead to the development of cleavage.

b) (i) Many candidates had some understanding of the term competent but fewer knew about incompetent rocks.

(ii) The relevant rock types were better known.

c) (i) Faults were generally well known with many gaining full marks. However common errors included shear / transform (for strike-slip), dip slip (for thrust / reverse / normal).

(ii) Most candidates knew the position of the footwall. However, as is often the case many labelled the fault *plane* and not the *area* so gained no mark. An arrow should clearly indicate the appropriate side of the fault.

(iii) Many candidates knew the type of stress that formed the faults.

d) **(i)** *Slickensides* were often quite well done, but often lost a mark for a poor or unlabelled diagram or failing to say that they are formed by fault movement. Some answers were vague or ambiguous, referring to *rocks rubbing over each other*, or *pieces of rock moving past each other*.

(ii) *Fault breccia* was less well known than slickensides. Poor diagrams, or failing to appreciate that fault movement causes rocks to be broken, were common failings of candidates. Quite a few candidates did not respond to this question.

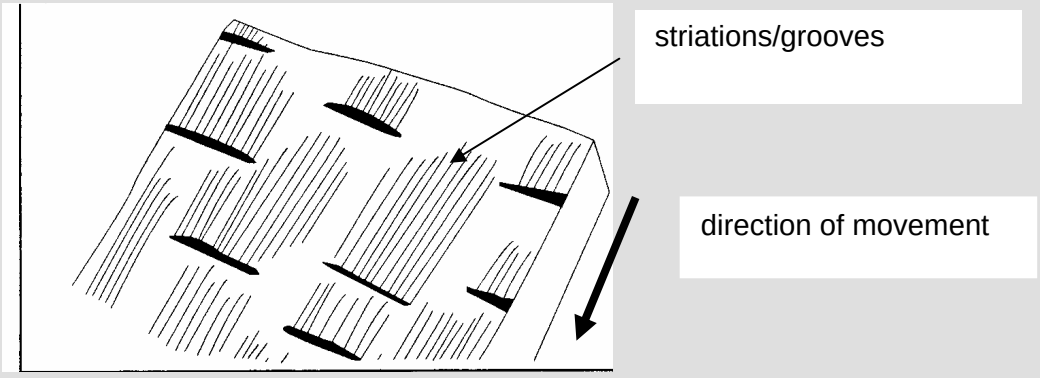
Teaching tip

Questions about slickensides and fault breccias always prove difficult for students and so teachers need to emphasise this to candidates and try and make it a strength.

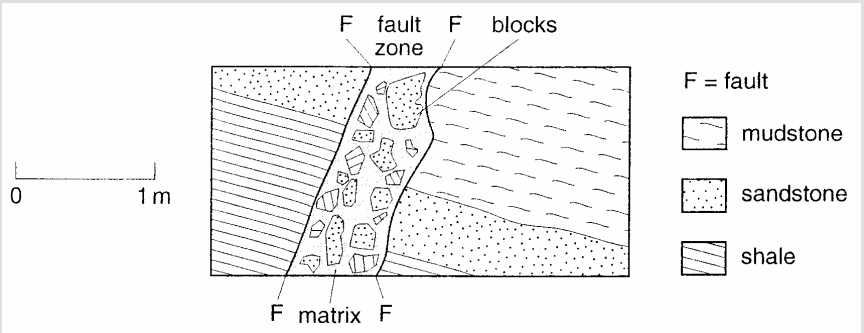
The question refers to fault planes. Candidates should make sure that their diagrams clearly show the fault and the written answers refer to movement along the fault plane. Breccias and striations can be formed in more than one way, so candidates must be clear which process they mean.

Below are the kind of diagrams candidates should aim for:

SLICKENSIDES



FAULT BRECCIA



Q4 This question provided a wide range of responses.

Candidates tended to have a very sound understanding of the composition and state of the core including the names of the discontinuities. The mantle in contrast was less well known. Most candidates knew the mantle composition but details of the structure including the lithospheric part of the mantle and the asthenosphere were poorly understood. Many candidates knew that part of the mantle is a rheid / partly molten but few tied this down to the asthenosphere. Some candidates knew all the depths but many appeared to guess or did not know them at all. In an extended prose question, candidates should be encouraged to use the wording of the question to construct the answer. In this case describe the depth, physical state and composition

of the mantle, and then depth, physical state and composition of the core.

Teaching tip
The lithosphere includes the crust and the uppermost mantle, it is solid and rigid.
The asthenosphere included the next layer of the upper mantle. It is rheid due to partial melting.
The rest of the upper mantle, down to a depth of 700 km is solid.

2832 The Rock Cycle - Processes and Products (Written Examination)

General Comments

There was a wide range of performance from candidates but very many had a sound grasp of geological terms and concepts and produced some high quality answers. Marks ranged from 21 to 58 out of the maximum 60 marks. 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 but definitions of the term *rock* were sometimes unclear and the need to explain processes causing mineral alignment was quite often ignored.

1 **(a)** Some candidates entered the names of rock types rather than broad rock groups, but this was allowed if they were appropriate. *Metamorphic* or *sedimentary* was credited as a correct answer for box C

(b) (i) Most candidates could offer satisfactory definitions of these terms.
(ii) Less well done. Quite a number described one type of rock only, so that their answer excluded other types of rock.
(iii) This part of the question also proved to be more challenging. It called for an explanation and candidates often did not focus on the processes involved in metamorphism. A simple statement like 'directional stress' or 'pressure during folding' was all that was needed by way of explanation.

(c) (i) Most candidates identified F correctly, but some thought that E was metamorphic.
(ii)This was generally well done and if the drawings were wrongly identified the candidate was not penalised twice. Some had a tendency to say why they had not chosen another rock group, rather than say why they had chosen the one they did.
(iii) The fossils and the cement were given as reasons by almost everyone.

(d) This was generally well answered by almost everyone although there were a few candidates who were unable to gain a mark.

Teaching Tip

Alignment of minerals

Use dry spaghetti, or pens and pencils from students' own pencil cases to represent rod shaped or platy minerals. Drop them onto the bench so that they fall in random order. Use two rulers and move them towards each other, either from the sides or from top and bottom to represent directional stress, showing how the minerals line up perpendicular to the stress direction.

Question 2

Many candidates were successful with the graph and the calculations although some did not know how to calculate the cumulative mass for the sediment sample and others found describing the difference between sediments difficult.

2 **(a)** (i) A large majority were able to calculate cumulative mass, but a minority seemed to have no idea and entered apparently random numbers in the table. Candidates who entered incorrect data were still able to gain credit for plotting it and drawing a curve, provided it was 's' shaped. All points should be plotted, but full marks were allowed even if points 5 and 6 (100%) were not.
(ii) Candidates gave good definitions of *sorting*. The main mistake was the inclusion of *shape* in some definitions.
(iii) The correct method and accurate answers were the norm. Those who had no idea in (i) tended not to know how to do this either.
(iv) Some candidates used the coefficients to describe the difference in sorting. It was enough to state that H is better sorted than G.
(v) Environments of formation caused a few difficulties and answers sometimes had an air of 'lucky dip' about them.

(b) (i) A few candidates confused *suspension* with *solution*, but most were able to define the term properly
(ii) Many candidates realised that variation in the energy of the current was the key explanation. Some stated that an initially large grain could become smaller during transport and this would affect how it was carried.
(iii) Responses were quite mixed. Some candidates did not describe a difference, merely stating what a wind transported grain or an ice transported grain would be like. A description of the difference between grains needs some reference to both grains. Others described a difference but did not give a reason that explained the difference.

Teaching Tip

Suspension and Solution

Place a tablespoon of mixed sediment into a beaker of water and stir it up. The heavier material will sink but the finer material stays within the column of water – it is in suspension.

Add a teaspoon of salt to a beaker of warm water. Watch it disappear – it is in solution.

Question 3

Good diagrams and descriptions of frost shattering showed that this weathering process is well understood by many candidates. Being able to name a climatic zone was much more challenging.

3 **(a)** (i) Candidates who used *transport* as the first process tended not to do well with the rest of the answer. There was some confusion about where *crystallisation* and *recrystallisation* should be used.
(ii) There were some clear descriptions of compaction although not everyone described what the *pressure* was. Something that meant load pressure was needed. Just *pressure* is too imprecise.
(iii) Often well described but in some cases it tended to be a repeat of compression, with more squeezing out of fluids and greater reduction in pore

space. *Minerals in solution in percolating pore waters* and *precipitation to form named mineral cements* all gained credit here.

(b) (i) The most frequently stated similarity was that both processes break down rocks. Relatively few candidates said that they were both surface processes. When it came to differences most knew that weathering occurs in situ but erosion involves transport. Some mistakenly suggested that weathering was to do with the weather but erosion was not.
(ii) This was very well done. An improvement that could have been made in some cases was to the diagrams, some of which were unclear or occasionally surreal. Process knowledge was good.
(iii) Naming the climatic zone was found to be difficult. Some did not know where chemical weathering was most significant and offered *glacial* or *arctic*. One mark was lost by just stating *tropical* rather than *humid tropical.* The best answer was *equatorial* – not *tropical rainforest* which is a type of vegetation and not a climatic zone.
(iv) Carbonation was most frequently chosen and often capably explained. Sometimes carbonation was stated as the process but the candidate went on to describe atmospheric pollution and general *acid rain* instead. Hydrolysis and hydration were sometimes confused with each other.

Question 4

This question was well answered by many candidates and a wide range of marks was awarded. Written communication was usually clear. Candidates appeared not to have run out of time and the diagrams were often of a high standard.

Less successful answers tended to describe how the two features were formed with perhaps a diagram illustrating a lava flow moving down the side of a volcano and a sill being sandwiched between two other layers of rock. They did not identify and explain differences between sills and lava flows, responses largely being a description of their origins.

Good answers, which were the majority, had well labelled diagrams which illustrated the differences in the number of baked and chilled margins, the composition of xenoliths, the presence or absence of vesicles, the orientation of phenocrysts, the differences in crystal size and the presence or absence of a weathered top. Many candidates also gave very clear explanations of the differences. Some were not aware that the presence of vesicles at the top of lava flows is due to pressure being lower at the Earth's surface than at depth. Instead there was sometimes the mistaken idea that air had been trapped inside the lava. A few candidates labelled the chilled margins and the baked margins the wrong way round. Many candidates, however, produced excellent answers showing that they can both recognise and account for the differences between sills and lava flows and can convey their ideas clearly both in writing and in the form of labelled and annotated diagrams.

2833/01 Economic and Environmental Geology

General Comments

There were some very good scripts and these candidates demonstrated excellent subject knowledge being able to express themselves clearly and concisely using good technical terminology. It did seem that, on the whole, candidates were better prepared for the examination than in previous years. There was no evidence that time was an issue as all candidates attempted the final extended question.

Parts of question 1 on mineral deposits were not answered particularly well, and this question had the worst performance on the paper and returned the most blank answers. Question 2 on engineering geology was for the most part answered well but some candidates did not use good geological terminology in their answers, thus limiting marks. The quality of answers to question 3 on oil, coal and water supply were generally good although the part on oil exploration was poorly answered. The extended question on water supply from artesian basins was done well with good diagrams and many candidates attained 6 or 7 marks out of 7.

Some candidates still need to pay far more care and attention to the quality of their written communication. Poor handwriting and spelling continue to be an issue for some. The most memorable answer for question 2 (a) (ii) was *stables the fountains* instead of *stabilises the foundations*!

Comments on Individual Questions

Q 1 This was the lowest scoring question on the paper.

a) **(i)** Candidates struggled to define the term *concentration factor*, with many incorrectly defining it as the *concentration of metal in the ore*, i.e*. the grade*. To attain the mark, candidates needed to demonstrate clearly an understanding of the idea of the ore being concentrated above its average crustal abundance.

(ii) Even though candidates struggled with part (i), more were able to calculate successfully the concentration factor for tin as 8 ÷ 0.002 = 4000. The most common incorrect response was to multiply the two numbers to arrive at 0.016 as the answer.

Teaching tip
Candidates should be encouraged to learn the key definitions on the specification. They have done this successfully for water supply and coal and should be encouraged to do the same for mineral deposits.
Concentration factor is *the amount by which a metal is concentrated above its average crustal abundance to make an ore deposit,* whereas **grade** is *the amount of metal in the ore.*

b) **(i)** Bauxite was well known as the ore found in a residual deposit of aluminium.

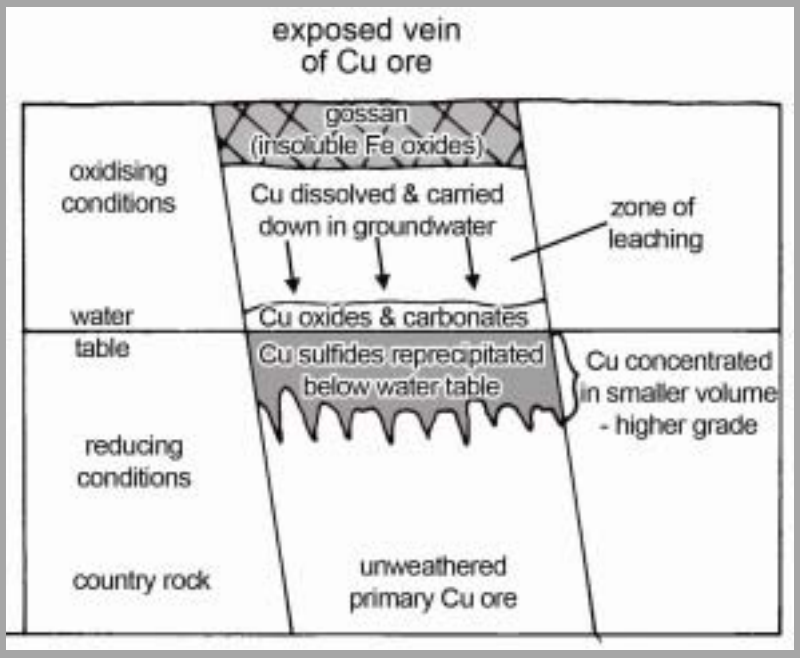
(ii) The majority of candidates were able to attain at least 1 of the 2 marks available for describing how residual deposits of aluminium form. A few confused their answer by describing other ore-forming processes, particularly hydrothermal and gravity settling.

c) **(i)** Fewer candidates knew the ore mineral likely to be formed by secondary enrichment of copper. The majority of those that answered correctly stated chalcopyrite, but there were many other valid answers given, including

chalcocite and malachite.

(ii) This high demand question asking for a labelled diagram to explain how the grade of copper ore can be increased by the process of secondary enrichment was the least well done on the paper with a significant number of no responses. However, stronger candidates produced superb, accurate, well labelled diagrams and explanations that attained the maximum 3 marks with ease.

Teaching tip



d) The reasons why metal mining is an example of unsustainable resource exploitation were well known. Most candidates attained at least one of the two marks available, but some let themselves down with poor grammar making their meaning unclear. Most knew metal deposits are non-renewable and many showed an appreciation that the rate of extraction is greater than the rate of formation of new deposits. Some of the best responses discussed the idea of high grade deposits being worked out leaving only low grade deposits for future generations and some also gained credit for suggesting that the pollution associated with metal mining is too great or irreversible.

Q2 Road construction, ground improvement strategies and tunnelling were well known areas of the specification with all but the weakest candidates attaining some credit.

a) **(i)** Most candidates attained credit for giving an advantage and a disadvantage of the cut and fill method of road construction across a slope. Some lost marks because they were not specific about *where* the chance of rock falls or landslips would be decreased (i.e. on the cutting wall) as an advantage, or *where* the chance of landslips or slumping would be increased (i.e. down slope of the fill material) as a disadvantage. In addition, some erroneously thought there would be a increased chance of rock falls on to the roadway, but in comparison to other road construction techniques this is not the case as the cutting wall is not as high as it would be if fill material was not used to build up the level of the roadway.

(ii) Although most candidates were clearly familiar with the slope stabilisation methods of rock bolts, retaining walls, rock drains and gabions, many did not do themselves justice on this straightforward part question. In all cases candidates needed to give *geological* reasons for the strategy. For example, rock drains: –

merely stating they remove water was insufficient; candidates needed to show an appreciation that water adds weight or increases the pore fluid pressure, making slope failure more likely.

b) Very few candidates gained 2 marks for explaining why it is difficult to stabilise weathered rock in road cuttings. Most appreciated that weathered rock is weak, but few could expand on this to explain that some strategies such as rock bolts, cannot be used as there are no secure attachment points in weathered material.

c) **(i)** Most candidates attained 1 mark for realising shale would be weak and therefore class IV and/or V. Fewer classified granite as class I, with a significant minority putting it as class II. Even though the question clearly asked candidates to write *granite* and *shale* in the correct box for each, a small number thought they had to fill in all the boxes and wrote other rock names in the spaces. Provided they had *granite* and *shale* in the correct boxes they were still credited the marks.

(ii) The quality of responses to this part question asking for a description of the geological problems that could be encountered during the construction of a tunnel through limestone, granite and shale was variable. Some candidates did not give *geological* reasons for the potential problems. In the case of limestone, many realised flooding could be a problem but some erroneously cited *high porosity* rather than *permeability* or *jointing* as the cause. The problems of tunnelling through granite were well known, but candidates should have elaborated on their answers by suggesting tunnelling would be difficult because granite is hard. In the case of shale, most correctly suggested that collapse would be the problem, but not all stated that is because shale is weak and incompetent.

Q3 For the most part question 3 on oil, coal and water supply produced good answers, but the part of the question on oil exploration was poorly done.

a) **(i)** Only about half the candidates correctly identified the potential oil trap as a salt dome, with an anticline trap being the most common incorrect response. Even fewer could then correctly explain why it was a salt dome trap. Some erroneously suggested the gravity readings were increasing into the centre, ignoring or not understanding the significance of negative numbers. Of those that correctly stated it showed a negative gravity anomaly, most then went on to attain the third mark for explaining that evaporites have a lower density than the surrounding rocks.

(ii) Even candidates who correctly suggested the trap was a salt dome, then struggled to mark on the map where exploration drilling for oil should be carried out. Most failed to appreciate that the oil would be trapped around the edges of the salt dome, i.e. close to the 0 milligal line. Those that had incorrectly identified the trap as an anticline were allowed *error carried forward* if they then suggested drilling in the centre of the anomaly, i.e. inside the -30 milligal line.

b) **(i)** Factors affecting the percentage recovery of oil from reservoir rocks were well known with *permeability, pressure* and *viscosity* being the most commonly cited correct answers. Some candidates, however, did not understand the significance of the word *percentage* and erroneously discussed the size of the trap or how oil could be lost from a trap due to faults. Others failed to appreciate that porosity is not a factor in percentage recovery; it controls the amount of oil in the trap as a whole, not how much oil can be extracted.

(ii) Secondary recovery methods for oil were well known but a small minority of candidates had no idea and left the question blank. *Water flood drive* or *gas cap drive* to maintain the pressure were the most common correct answers.

Although these answers gained the 2 marks available, few candidates were specific as to *where* the water or gas should be injected. This type of question may not be marked as generously in the future!

c) This question about the environmental consequences resulting from offshore extraction of oil was answered well. It was very pleasing to note that candidates had taken on board the advice given in previous reports and most cited specific types of pollution with reasons.

d) **(i)** There were some very pleasing responses to this question about the environment of formation of coal with the majority of candidates scoring all three marks available. In addition to the swampy, delta top, hot and humid, tropical climate, anoxic conditions and rapid burial answers, it was pleasing that some candidates were discussing in detail *why* these conditions promote the formation of coal as part of a cyclothem.

(ii) Most candidates gave a correct definition for the term *rank.* The most common correct response was the *percentage carbon in the coal*, with others rightly stating it was the *maturity* or *calorific value of the coal*.

(iii) The differences between bituminous coal and anthracite were well known. Most correctly answered that anthracite has a higher carbon content, while others cited its higher hardness, density or reflectance, or lower content of volatiles and impurities. A small number of candidates penalised themselves by stating the carbon content, density or hardness differed, but did not state *how* it differed.

e) There were many excellent answers to the 7 mark extended question on the geological conditions needed to provide drinking water supplies from artesian basins and wells. It was encouraging that there were very few blank answers and virtually all candidates gained some credit for their answers. Even though the question did not ask specifically for diagrams, most candidates chose to include labelled diagrams which attained credit as labels were marked as text. A small number of candidates confused *aquifers* with *reservoir rocks,* and *aquicludes* with *cap rocks* and a tiny minority wrote about the requirements for reservoir and dam construction.

2833/02 and 2836/02 Coursework

General Comments

The entry for 2833 was predictably low as there were only a small number of candidates re-sitting this unit; many of the resit candidates opted to carry forward their mark from the previous year, or submitted the work from the previous year with minor amendments in the light of any feedback received by individual centres last year.

Candidates for 2836 in general produced some good quality coursework and there were fewer adjustments made than normal, as centres are very familiar with the mark descriptors, as well as acting upon the advice from moderators received in previous years.

Many centres were submitting coursework where one piece of work was being used to test all four descriptors. A smaller number were using two pieces of work, each for two skills. The most common pairings were for P and E to be assessed together and I with A.

This year there appeared to be another increase in the number of administrative errors, such as arithmetic errors, or the wrong mark being carried across so that either the MS1, Coursework summary sheet or even the cover sheet on the work did not match up. In cases such as these, the moderator has to contact the centre for the other work to be checked and this can cause considerable delays. It would be very helpful if all documentation could be carefully checked before submission.

If centres have candidates entered for exams who then decide not to submit work, it is very important to let OCR know of this change to their submission. Otherwise the moderator may spend a lot of time trying to contact the centre's exams officer who may also spend a lot of time trying to chase up the "missing coursework"! It would be very helpful if the teacher who is submitting the coursework sample could provide a reliable email address for the moderator to contact them directly.

Comments on Individual Descriptors

Skill P

P3a Candidates should be encouraged to develop a question, rather than a vague title which is often given by the teacher. *An investigation into the Geology of NE Arran*, could be better expressed as a question: Does *the geology of the NE Coast of Arran show evidence of climate change?* or even an hypothesis: *I think the rocks of the NE coast of Arran will show that they were deposited in a deltaic sequence.*

Whilst the expression *fair testing* is not actually expressed, the descriptors asks candidates to cover what factors they will vary and those they will keep constant. The use of sub headings can really help in the moderation process.

Teaching tip
It would be useful for candidates to write the plan in advance as it can make them a lot more careful about the detail of their planning. When done retrospectively it is often obvious, as they don't often fully explore what they might find.

It is acceptable in any guidance sheets given to candidates to list the types of headings they should aim to cover.

P3b Candidates should mention how many times they are to measure/record their stated data

P5a Candidates need to have sufficient background information to develop their plan. This should at A2 include reference to more than one module of work e.g. referring to faulted sills and dykes would cover 2831 - the fault and 2832 - the sills and dykes. This detail does need to be adequate, a couple of sentences is probably not enough.

Preliminary experiments can be used instead of extensive background information, when candidates can include an initial experiment and assess its worth in light of their final requirements. Making changes to this plan works particularly well.

Safety must be mentioned for this descriptor. Many centres are now getting candidates to come with detailed risk assessments covering more than one page. This is not really necessary, as a sensible couple of sentences will suffice. However it is impressive what some candidates are considering under safety!

P7a Evidence of the background texts, websites used etc. MUST be included. Moderators cannot often tell just by reading the text, as different teachers will use different resources, although as increasing use is made of the OCR text, this problem may well reduce. Candidates need to be encouraged to either put the author's name after the section where the text/website has been used, or to put it in as part of a bibliography.
It should be noted that due to the authentication issues with Wikipedia, using only this is not a good idea!

P7b Candidates should be encouraged to justify in full why their equipment is needed and why their chosen method should give them reliable results. This is easier if a preliminary experiment is carried out.

Teaching tip
Encourage candidates in writing up Skill P to include a bibliography. Maybe use class texts to illustrate how this can be achieved.

If the work is fieldwork, write up P7b after they have done some fieldwork, or some class work on the likely methods they will use e.g. practising taking dip and strike readings using sloping surfaces in the class such as angled text books can make then realise how precise the method needs to be.

Skill I

As this skill is based upon how the candidates performed, it is vital to get some information from the teacher marking the work about how the candidate performed in the exercise. A tick box sheet can be very useful to show which skills the candidate could do and with which they needed help.

It can be very difficult to moderate a centre when a range of candidate marks out of 60 are submitted with some scoring very high and others low, yet all are given 7 for skill I. The majority of centres give all their candidates 7 for this skill.
Skill I *does* need to be differentiated and the actual field notes, or data included often clearly shows huge difference in quality. Candidates who needed support from other candidates or teachers to either use equipment or collect data cannot be awarded 7 marks. Likewise candidates who did not collect as much information as others, especially if it was clearly outlined in the instructions cannot be awarded 7 marks. Poor quality, erroneous or incompletely labelled graphs, logs, maps etc cannot be awarded 7 marks.

It is worth noting that a few centres are being very harsh on their candidates here! A few

centres were awarding 3 or 4 marks for data collection which was clearly exceeding that given 7 by another centre!!

7 should be given for all required data being collected and presented in a suitable and accurate way. 3 or 4 should be awarded if there have been many omissions and errors or considerable help needed to gain that information.

Teaching tip
Use a marking grid to assess candidate's performance in practical tasks. Grade candidates as *competent*, *no help needed*, or *less confident*. This will then help the teacher in coming to a balanced overview of marks and will show which are deserving of the 7 marks and which candidates in reality should be awarded less

Skill A

A1b Trends must be included

A3a This descriptor requires the evidence from the practical part to be processed and presented using graphical / numerical techniques. Most centres are opting for graphs, rose diagrams or logs. Some are doing some impressive statistics. A lot of the work used for this descriptor if detailed enough can be used for A5a.

A small number are not doing anything more than descriptive work and this does not meet this descriptor. The use of photographs for this descriptor is also not acceptable.

Teaching tip
Plan to ensure that candidates collect some numeric data which can then usefully fit this descriptor. E.g. Dip and strike readings could be plotted onto a base map.
Widths of dykes could be plotted, bearings of dykes etc.
Laboratory work especially lends itself well to data production and graph plotting.

A5a This requires detailed processing of evidence and analysis including the use of advanced numerical techniques. Candidates must be encouraged to discuss their results here, rather than looking at background theory and conclusions (this is A5b).

A lot of centres this year used statistics very successfully. This included vector analysis on dykes in Arran, and a range of exercises using Spearman Rank, Chi Squared and standard deviation. In all cases, the candidates were able to make sound geological sense of their findings showing that this section had been taught to a very high standard. Centres should note that the use of pre-published graphs such as the sea level change graphs and descriptions is not acceptable for this skill.

Many other centres used more traditional geological methods such as scaled maps, - some excellent ones from Arran and the South West, and some superb graphic logs from a variety of locations. It should be noted that rose diagrams are not acceptable for this descriptor, but they do fit A3a very well

Teaching tip
For field work, this descriptor can be made easier with the use of a base map. E.g. take an A4 or A3 sheet and mark onto it some obvious features at the site for example the coastline, the line of higher ground, the edge of a wood. This can act as a useful reference point especially if there is a strong link to the underlying geology. At Sannox shore in Arran the line of the high land marks the position of a fault scarp. If this line is drawn at roughly the correct bearing, the candidates then have an accurate baseline on which to then plot their dyke bearings and widths. This then can give an impressive map. A suitable scale should always be marked onto the base line

A5b For this section, detailed scientific knowledge needs to be used to make sense of the candidates' findings. This section was in general done to a high standard this year, although it should be noted that it cannot be given for just a couple of sentences on each analysed feature. Detailed work should be at least half a page.

For A2 there is also a requirement that reference will be made to more than one module of the course to cover the synoptic element.

A7a
A7b For this high level descriptor there is a requirement for modules from both the AS and A2 parts of the course to be included. Most centres awarding this level did produce work of a high standard.

It should be noted though, that a few centres did get candidates to produce high quality work, meeting A7a and A7b, yet A5a had not been achieved. In these cases it can mean a considerable downward adjustment has to be made, as if A5a is not met, only 4 marks should be awarded.

Skill E

E1b Anomalies must be mentioned. If there were none, then this should be stated.

E5a/7a Candidates produce some good detailed improvements and most are now also including significant limitations, so on the whole, this section is done well. To then go on to access E7a they need to say how these suggested improvements will then make their future results more reliable. It can be quite difficult to envisage what might happen, and candidates often struggle with E7a.

E5b/7b Candidates are now better at this descriptor and gain 5b much more frequently than in the past, although some do still struggle with 7b. For this descriptor they need to assess the errors they have highlighted that were made during their coursework and decide if these errors had actually led them into making serious final errors in their analysis or if the errors were in actual fact minor. A common fieldwork example would be a lack of sufficient data measurements e.g. for a rose diagram, but the candidates may still have been able to recognise the depositional environment if not the actual direction of flow. This would not be a significant effect on the validity of their final conclusions.

2834 Palaeontology (Written Examination)

General Comments

Overall, the paper is of appropriate difficulty for the A2 candidates. Candidates were well prepared for this subject, a reflection of increased calibre of teaching over the past years and the advent of a new geology text book. Most of the centre entries were small, reflecting a large number of resit candidates. The questions were answered well and this generated a good spread of marks for these individual questions. All questions had a few candidates who gained full marks, underlining the suitability of the questions for A2 level. The majority of candidates appeared to have had sufficient time to answer all questions on the paper.

Comments on Individual Questions

Question 1

1) **(a)** (i) Most candidates identified the fossils correctly. Some candidates could not identify the phylum to which graptolites belong. Some candidates identified fossil D as a trace fossil, such as a resting trace of a trilobite and a few identified D as the skeleton of a coral. It was apparent that some centres had not prepared candidates to recognise obvious fragments of plants.
(ii) Gastropod morphology was well known, and even incorrect answers had some scientific merit, such as apical angle rather than apex or aperture rather than outer lip. Some candidates could not recognise the guard in fossil C.
(iii) Most candidates knew, or correctly guessed, the mode of life of belemnites. There were correct comparisons with modern squids by some candidates and some detail of how the position in the water column was maintained.
(iv) Most identified fossil A as planktonic, but some quite clearly did not understand the meaning of the term and did not link the evidence to the mode of life.

(b) (i) Most candidates were able to recognise that plants require careful preservation and low energy. Some described loss of volatiles and carbonisation. Others thought that the detail meant that this fossil was exceptionally preserved and went into detail about the Burgess Shale or similar.

Teaching Tip
Students often think that good preservation or detailed preservation means that these fossils are exceptionally preserved. You must encourage students to think about the soft parts which are the key for exceptional preservation and get them to discuss this (instead of hard parts). A good photograph showing exceptional preservation such as a trilobite with legs can be compared with ones without and the difference exemplified. This is a good starter or plenary to a lesson.

(ii) Candidates knew the correct answer to this question, but struggled to put it into words. The obvious answer that the UK had moved northwards was often omitted from even good answers.

Question 2

2) **(a)** (i) This question was answered well, with the majority of candidates gaining full or near full marks for this part question, reflecting the popularity of trilobites in the fossil record. Incorrect answers included providing multiple modes of life, as contradictions, thus gaining no marks and the terms *pelagic* and *planktonic* were used interchangeably.
(ii) Most candidates knew how to label the trilobites, but many did so lacking the precision expected at A2. The preferred option was for candidates to shade the area of the cephalon or to use brackets showing the top and bottom, rather than a single line to a point on the cephalon.
(iii) Most candidates correctly identified that the trilobite had 11 pairs of legs. Fewer candidates counted the fused segments on the pygidium.

(b) (i) The quality of the diagrams was variable, many superb and others unrecognisable and unlabelled. The description of the mechanism for making the traces was often omitted, leading to marks lost. Some thought that trilobites lived in U shaped burrows.
(ii) Few good answers appeared for this question. Few candidates discussed jointed legs and a chitinous exoskeleton. Many talked about segmented bodies, but failed to discriminate this from worms and so gained no marks.
(iii) This was poorly answered, as many described a derived fossil rather than a death assemblage. Few candidates gained full marks for this part of the question.

Question 3

3) **(a)** (i) There were very few completely successful answers, despite only having to identify four out of the five fossil groups correctly. A lot of incorrect answers were due to candidates not reading the question and offering any fossil group as possibilities rather than corals and ammonoids. Many chose trilobites and brachiopods and it was clear that the subject matter was not well known.
(ii) Few candidates described using fossils as a biostratigraphic tool, and many vague answers were given here. Many mentioned zone fossils without any clear understanding of how these could be used.

(b) (i) A good number of candidates could explain that ash layers form a near instantaneous layer over the globe. Few were able to suggest how they could provide an absolute date and fewer still mentioned minerals that may contain radioactive elements. Some incorrectly discussed carbon dating, perhaps expecting the ash to be produced by burning vegetation.
(ii) The understanding that varves were seasonal deposits found in bands was well understood. There were many good descriptions of how absolute dates could be calculated by counting pairs of bands.

(c) (i) Most candidates could cite the Cretaceous-Tertiary mass extinction event. Few confused this date with other mass extinction events.
(ii) The majority of candidates answered this question correctly. Others provided a variety of both extinct and extant species which were incorrect. *Trilobites* was the most favoured incorrect answer, presumably as they were the focus of the previous question.

(iii) Many candidates did not gain full marks for this part of the question. Most were able to describe two pieces of evidence but were unable to show how this pointed to a meteorite impact. Low level language and lack of specific terms were the downfall of many candidates who did not gain full marks. Simply specifying *the presence of a mineral* rather than *iridium* was a common oversimplification of the subject matter.

Question 4

4) (a) (i) Many correct answers here were a credit to good teaching of a previously neglected part of the specification. Most labelled the pedicle valve and growth lines correctly. Incorrect answers labelled the pedicle *foramen* instead of the pedicle *valve*. The hinge line was often shaded and clearly labelled.
(ii) Many candidates described the function of the lophophore but few could describe the function of the brachidium. Occasionally extremely good answers were transposed, gaining no marks.
(iii) The understanding of the musculature of brachiopods was surprisingly well understood. Most could describe two sets of muscles and a good number could name which set opened and which set closed the valves. There were some exceptional answers including the cardinal process mechanism which were worthy of note.

(b) (i) Candidates found this difficult to answer despite being able to draw and label a suture in part (ii). Many talked about it being a structure only on the outside of the ammonoid, as if it was some external ornament. Very few answers described the physical separation between chambers.
(ii) Many poor diagrams here meant that sutures were virtually unrecognisable. Saddles and lobes were interchangeable on the labelled diagrams and goniatitic sutures were often drawn instead of ceratitic ones.

(c) (i) Some candidates associated the siphuncle with feeding, perhaps mistaking the word for siphon. Some described how they were used to force water out of the animal for jet propulsion. Most gave an excellent account of their function.

Question 5

5) (a) This essay was successful in differentiating the candidates and a spread of marks was generated. Overall the standard was good, with many following instructions producing well drawn diagrams that were suitably labelled. These diagrams were often annotated with descriptions that were informative and detailed. Some candidates drew diagrams that were very small, showing one feature at a time, enabling marks to be accrued, but should be discouraged.

Poorer answers were extensive descriptions of the modes of life of these two types of echinoids, showing either lack of knowledge or simply that the question had not been read correctly. There was much discussion of echinoid hygiene, but this coupled with the relative position of the anus and mouth allowed marks to be accessed.

Some candidates gave long lists of similarities, gaining no marks. Fewer candidates only discussed one type of echinoid, again not hitting the marking criteria. Common errors included the anus in the anterior groove and the anus and mouth transposed.

5) (b) This essay generated a similar spread of marks as question 5 (a). Overall the standard was good, but there were many accurate diagrams showing bivalves that were unlabelled, gaining no marks. Some diagrams were very small and simplistic.

The modes of life described mirrored an early exam question in a previous year, where diagrams were provided. These seem to have been replicated in many good answers.

A common error was to explain how *Pecten* swam, rather than the adaptations that allowed this to happen. The command word *explain* was overlooked in the question and the reasons were not discussed and perhaps not understood by the candidates.

There was no evidence that the candidates had run out of time, as many had used extension sheets to complete their answers for question 5 (a) and (b). Many candidates scored between 18 and 22 marks for question 5 overall, making this a reasonably high scoring paper.

The quality of written communication was generally of a good standard although the spelling of technical terms is an issue.

2835/01 Petrology (Written Examination)

General Comments

The examination paper this session gave a full range of responses, with a large variation between centres. There were many excellent scripts utilising technical terms very effectively and clearly demonstrating a clear knowledge and understanding of the relevant subject matter and concepts. There was, however, an inconsistent performance across the questions that led to underachievement on some topics. In this A2 examination it is essential that answers include sufficient detail and not just a general statement. This paper is synoptic on the three AS modules and it was clear that some candidates had not revised the AS material. There was clear evidence that certain topics such as *pegmatites*, *cumulates* and *paired metamorphic belts* had not been taught by some centres. Where terms from the new specification such as *mafic* rather than *basic* were used candidates were not penalised.

Comments on Individual Questions

Q 1) This question on volcanoes and plate boundaries led to a wide range of marks including several maximum marks. The marks were readily available if the specification had been covered and this question was synoptic to Modules 2831 and 2832.

(a) (i) Most candidates were able to recognise that the key difference was one of grain size, but too few were able to say what the rocks - tuff and agglomerate - were made from.
(ii) The majority of candidates successfully completed the isopachytes for 5 m and 10 m respectively. The thickness points for 11 m and 6 m led to the occasional incorrect response.
(iii) The majority of candidates were able to describe and explain the pattern shown by the isopachytes and referred to depth variations as well as prevailing wind direction.

(b) (i) Although a large number of candidates were able to place the volcanic rocks in the correct sequence only about 50% explained the significance of cross cutting relationships. Some candidates were able to explain the order in relation to the 'Law of Superposition', but had the relative ages incorrect.
(ii) The majority of candidates were able to describe radioactive decay but were less confident in explaining how it could be used to give an absolute age. A small number of candidates described measuring the half life of the rocks rather than the constituent minerals. Few candidates clearly understood *half life* and its relationship to time and the significance of parent to daughter ratios. A minority of candidates incorrectly referred to litho and chronostratigraphy as methods of absolute dating.

(c) The knowledge and understanding of magma composition and volcanic activity is well known and this part question led to some good responses.
(i) The majority of candidates were able to name the plate tectonic situation synonymous to the volcanic activity. Some candidates' answers were too general and described subduction zones, while weaker candidates thought it was a constructive plate margin.
(ii) The magma composition and type of related volcanic activity were generally well known. Some candidates judged from the diagram that the lava had flowed a significant distance and thus incorrectly interpreted the lava as basic.

Q 2 This question on metamorphism, metamorphic rocks and metamorphic minerals was generally well answered and a number of candidates did score maximum marks.

(a) (i) The vast majority of candidates were able to recognise at least two of the three metamorphic rocks. Common mistakes included identifying D as gneiss, E as orthoquartzite and F as slate.
The quality of labelled diagrams for parts (ii) and (iii) was varied with few very good diagrams. The majority were poorly labelled and often unrecognisable.
(ii) There were very few maximum marks with most candidates failing to name the different minerals or able to describe schistosity. Some weaker candidates confused porphyroblastic and porphyritic textures.
(iii) This part question was less well answered than (i), with many diagrams displaying rounded grains and sedimentary characteristics. Some candidates lost marks by showing the interlocking crystals aligned, a characteristic of rocks that have undergone directed pressure and thus showing a foliation.

(b) (i) The majority of candidates were able to describe accurately the differences between biotite and muscovite mica, referring most commonly to colour although chemical composition was occasionally mentioned.
(ii) Most candidates recognised the porphyroblast as garnet, weaker candidates incorrectly linked the hardness of 7 to quartz.

(c) The responses to this part question depended very much on a candidate's ability, stronger candidates scoring well. Those with a clear understanding of the temperature and pressure conditions required to form each of the aluminium silicates scored well. There was, however, a tendency to fail to emphasise the significance of high pressure in the formation of kyanite.

(d) Part (d) proved to be a good discriminator with a wide range of responses. The responses were very centre-dependant and on the whole the quality of diagrams was poor.

(i) This question provided candidates with a lot of difficulty. Most candidates were able to draw a subduction zone. There were however, many diagrams drawn that did not gain credit as they had few labels or were badly drawn. Only a minority of candidates were able to identify correctly high pressure / low temperature at the trench and high temperature / low pressure beneath the non-subducting plate. Often only temperature or pressure was referred to in isolation with no reference to the other factor. There were patterns between centres with some providing excellent responses while others failed to score.
(ii) This part question led to very few maximum scores. Many candidates were able to recognise compressive stress as a factor but often failed to link it to specific situations. Temperature was rarely referred to in terms of rising magma or the geothermal gradient.

Q 3 There was a wide range of responses to this question which focussed on igneous processes and products, with a few candidates scoring the maximum mark.

(a) (i) This part question was very well answered by the majority of candidates. The laccolith was only rarely incorrectly identified as a lopolith or batholith. The cone sheets were identified as dykes, ring dykes and radial dykes though reference to the term *dyke* meant that credit was given.
(ii) Most candidates were aware that crystal grain size was the differentiating factor between the two intrusions, only occasionally was reference made to the reasons for these differences in relation to rates of cooling. It is expected that at A2 level students can explain the reasons for differences in crystal grain size.
(iii) This part question was very well answered with almost all candidates able to draw a clear labelled diagram of a transgressive sill. Marks were occasionally lost when candidates failed to show and label the bedding, showing that the intrusion 'jumped beds'.

(b) Knowledge and understanding of pegmatite formation is poor. Many candidates confused pegmatites with hydrothermal fluids. Reference was regularly made to late stage formation and coarse crystal grain size but there was little appreciation of the composition of the fluids that created them or the role they played in causing the crystals to grow to such a size. It was regularly incorrectly assumed that coarse crystal grain size was a result of very slow cooling.

(c) The knowledge and understanding of magmatic processes was very much centre-specific and as a result candidates either scored very well or poorly.
(i) Well prepared candidates correctly labelled the edges of the intrusion (the chilled margin), as the areas that would show the original magma composition. This required an understanding that the chilled margin would have the original magma composition because there was insufficient time for magma differentiation to take place,
(ii) Only a very small number of candidates were able to correctly identify the cumulate layer. This is surprising as it is a term taken directly from the specification and used regularly in a variety of reference and resource material. Incorrect responses ranged from *graded bedding* to *cyclothems* although regular reference was made to gravity settling.
(iii) The majority of candidates were able to explain how the layering formed, even at a basic level and used a variety of technical terms. Candidates were aware of the significance of early formed crystals and Bowens Reaction Series. Density and gravity settling were often discussed, with more able candidates referring to the significance of convection currents
(iv) Despite candidates scoring well on part (iii), this part question turned out to be an Achilles heel for a large number of candidates. Many almost repeated their previous response without referring specifically to the processes of differentiation. Very few candidates had a clear understanding of fractional crystallisation and many responses discussed filter pressing and / or assimilation. Changes in chemical composition with depletion in iron and magnesium and increasing silica was only rarely covered. If a candidate had referred to gravity settling and fractional crystallisation they would have scored at least two marks.

Q 4 This question led to a wide variety of responses with a large number of candidates showing a limited knowledge and understanding of the economic and environmental aspects associated with limestone. Only a small number of candidates scored over 18 of the 21 marks available.

(a) (i) The majority of candidates were able to identify the fossil content of limestone K but occasionally failed to identify the limestone type
(ii) This part question was generally well answered with most candidates recognising the presence of crinoid stems and ossicles which were often correctly described. Incorrect responses referred to a calyx or occasionally the crinoids were mistaken for corals.
(iii) Detailed knowledge on environmental conditions required for limestone formation was surprisingly weak. Many candidates gave very brief responses referring just to shallow seas. Only the stronger candidates described high energy conditions, warm water or clear seas. The mark scheme gave credit to a wide range of responses.
(iv) Although most candidates recognised limestone M as oolitic they failed to explain how it formed. Only the stronger candidates referred to the significance of a nucleus and of its being rolled and getting coated in layers of calcium carbonate to form concentric rings. The diagram proved a problem to some candidates who identified the ooliths as corals and hence gave a different explanation of their formation. This was given credit as an alternative.

(b) (i) There were some varied responses to this part question, and a minority of candidates gained maximum marks. Reference to strength was often given as a valid reason, along with jointing and ability to be shaped. Some weaker candidates were unable to differentiate between weathering and erosion and this lost a mark here. Only a small number referred to aesthetic properties shown by the limestone which was equally valid and worthy of credit.

(c) This part question involving a synoptic element from 2833 was not well done; few candidates had any understanding of concrete formation or the environmental implications of quarrying other than pollution.
(i)This part question was very poorly answered with only a small number of candidates scoring any marks at all. Numerous candidates confused cement with concrete and thus wrote at length incorrectly about different aggregates. Only the more able candidates referred to the addition of clay and / or gypsum and even those rarely linked this addition to setting rates.
(ii) The majority of candidates were able to give one environmental implication of quarrying and this usually related to pollution whether noise, visual or air. Rarely was reference made to a finite resource or implications of quarrying on the water table or water contamination.

(d) This part question discriminated well between candidates, although there was some confusion regarding the incorrect idea that oozes were formed as a result of diagenetic processes. Many candidates identified that the sediment was an accumulation on the deep ocean floor, thus scoring one mark. Only rarely was reference made to the micro-organisms that formed these deposits. There was some confusion between calcareous and siliceous oozes.

(e) (i)The majority of candidates were able to describe the order in which evaporite minerals formed, which was a marked improvement on previous examinations. Disappointingly few made reference to solubility which is expected at this level. One mark was usually obtained by referring to evaporation. Weaker candidates wrote at length about barred basins, with responses irrelevant to the question set.
(ii) Nearly all candidates were able to name a sedimentary structure found in an evaporite sequence as desiccation cracks or salt pseudomorphs.
(iii) Only the more able candidates were able to score maximum marks for this part question. There is still the tendency to confuse *equatorial* with *tropical* even though this has been referred to in previous reports. Many candidates gave brief answers rarely linking *hot* and *arid* together, usually referring to one or the other. Few candidates were able to relate the deposits to former climatic conditions for the British Isles.

Q 5 The long answers give candidates an opportunity to provide detailed answers with diagrams and explanations. The organisation of the answers needs to be logical and structured in order to obtain the marks for the Quality of Written Communication (QWC)

5) **(a)** This question was the least well answered of the long answer questions. Candidates had a limited knowledge of fluvial environments although there were some excellent answers.

Candidates had a reasonable knowledge and understanding of alluvial fans and were able to describe the rocks found within them. Few were able to elaborate in terms of textural and mineralogical maturity. Only a minority of candidates had an appreciation of a lenticular structure or lateral variation or that sedimentary structures would be absent. Graded bedding was often incorrectly cited as a valid sedimentary structure.

Knowledge and understanding of river channels was much weaker and there was a lot of confusion within answers. Many candidates described any sedimentary structure they could think of, with no link to depositional environment! There were a large number of candidates who incorrectly discussed turbidite sequences often in great detail. A large number of candidates were able to clearly and accurately describe asymmetric ripples and imbricate structures often with clear labelled diagrams. Cross bedding was often referred to but all too often marks were lost due to a failure to link the structure to the point bar. Detailed descriptions of types of deposit were often lacking.

There was a general appreciation that fine grained sediment would be found on the flood plain. Few candidates, however, identified laminations as a common sedimentary structure although some mentioned rootlet beds and were given credit for this. A large number of candidates knew that argillaceous muds and silts would form mudstone and siltstone respectively. The most common mistake was to assume that flooding was high energy and a significant number of candidates described flash flood deposits as forming on the flood plain. Coarse grained rocks showing graded bedding were incorrectly described. Some weaker candidates discussed glacial meltwater deposits including varves.

(b) There were some excellent responses to this question proving that the classification of igneous rocks is an accessible topic from the specification. It was evident where candidates had not learnt factual information and weaker candidates tended to waffle, making general non-specific comments about silica content or crystal grain size. Whilst they had some appreciation of how igneous rocks were classified, the answers lacked the necessary detail to score marks.

The majority of candidates were able to state accurately the percentage ranges of ultrabasic, basic, intermediate and acidic rocks. It was interesting to note that some centres have already introduced the terminology from the new specification e.g. *silicic* rather than *acidic* and this was perfectly acceptable.

Colour was rarely used accurately, with candidates failing to use the correct technical terms e.g. *leucocratic*, and how this related to chemical composition.

Many candidates were able to give accurate crystal grain size boundaries but a common mistake was to give the size boundaries of the clastic sedimentary rocks.

Knowledge and understanding of the significance of mineral composition has also noticeably improved with many candidates fully aware of the essential minerals of all four main rock groups. There is still, however, confusion about the relationship between silica content and quartz content.

2836/01 Geological Skills

General Comments

There were some very good scripts and these candidates demonstrated excellent subject knowledge and were able to apply their knowledge to solve practical geological problems on maps and cross sections with confidence. However, others seemed poorly prepared for the examination and appeared unfamiliar with basic geological skills.

Question 1 on faults and geological histories on maps was answered well and was the highest scoring question on the paper. Reponses to question 2 on igneous rocks, absolute and relative dating and fossil preservation were variable. Virtually all candidates attained some marks, but their knowledge was patchy meaning that some parts of the question were answered poorly leading to an overall drop in marks. Many candidates struggled with aspects of question 3 on borehole data, galena mining and mineral identification so only a handful of candidates attained more than 8/12 for this question. Some candidates also struggled with parts of question 4 on photograph interpretation, triangular diagrams, sedimentary structures and sedimentary rocks. Question 5 on metamorphism and index minerals discriminated well and produced the full range of marks from 0 to the maximum of 7.

Comments on Individual Questions

Q 1 This question on faults and geological histories was the highest scoring question on the paper.

a) **(i)** The vast majority of candidates were able to use successfully the scale on the map to work out the correct displacement along the fault. A small number of candidates, however, clearly misunderstood the question and gave a description rather than a measurement.

(ii) Many candidates correctly identified the fault as a sinistral strike slip or tear fault and then went on to give a valid reason for their choice. Unfortunately, some thought it was a reverse fault and others contradicted themselves by giving more than one fault type in their answer. Candidates should be encouraged to note that there is no such thing as a shear fault and that a transform fault was incorrect in this setting.

b) This 8 mark question asking for a description of the sequence of events that produced the geology shown on the map scored highly. A large percentage of candidates produced excellent answers that attained the maximum mark with ease. Most were awarded the mark for quality of written communication. Common errors or omissions were:

- not stating the order of deposition of the siltstone and *then* the shale
- misidentifying the sill as dykes or not realising it was one folded sill
- not stating the correct type of intrusion
- not noticing the folding, or stating it was an anticline rather than a syncline
- describing a period of erosion to form an unconformity in situations where the beds were clearly conformable, e.g. between the conglomerate and limestone
- failing to notice the sandstone bed was tilted 10° to the west, but the overlying conglomerate and limestone were horizontal
- confusing sedimentary and igneous terminology e.g. stating beds *were intruded* or the granite batholith was *laid down.*

- not using the term *outlier* in the description of the last event to occur.

Q2 Reponses to question 2 on igneous rocks, absolute and relative dating and fossil preservation were variable. Virtually all candidates attained some marks but their knowledge was patchy meaning that some parts of the question were answered poorly leading to an overall drop in marks.

a) **(i)** Most candidates attained credit for correctly shading and labelling the baked margins of the intrusion. Shading a baked margin below the lava flow was neutral. A small number of candidates erroneously shaded the chilled margins of the intrusion. Others shaded a baked margin in the conglomerate above the unconformity clearly not appreciating that there would have been no rocks on top of the lava flow while it was cooling. Contradictions were not given credit.

(ii) Although many candidates were able to determine the width of the chilled margin, almost as many produced an incorrect answer of 30 cm. Some failed to notice the units given (cm) and gave their answer in metres – if they placed an m after their answer they were still given credit.

b) **(i)** The reason why ^{40}K-^{40}Ar dates are given a margin or error was not well known, with only a handful of candidates attaining the mark for this question. Many merely repeated the question saying *there are errors* or *it is inaccurate.* Very few had any awareness that the error stems from difficulties with the analytical method such as precisely measuring the small quantities of isotopes present or difficulties in correctly determining the half life. If candidates discussed analytical inaccuracies in part (ii) they were given credit.

(ii) Many candidates were aware that argon is a gas and that if it is lost it will give an inaccurate age, but few realised it would give an erroneously *young* age. Few went on to suggest a mechanism for the loss such as permeable rocks, weathering, or metamorphism leading to an open rather than closed system. If candidates discussed argon loss in part (i) they were given credit.

(iii) Although the principles of relative dating were well known, a significant number of candidates penalised themselves in this question by just giving the order of age but not *relative to the intrusion*. Sadly the candidates that stated *the sedimentary rocks are older than the intrusion* were not given credit as they did not differentiate between the older sandstone, limestone and shale and the younger conglomerate, so their meaning was unclear.

c) Most candidates correctly identified the photograph as showing a rock with a vesicular texture, but only about half correctly identified the rock as basalt. Those that stated it was pumice did not take into account the dark colour of the rock. The formation of the vesicular texture was well known but it is surprising how many candidates erroneously described *air* rather than *gases* escaping from the magma. Others had the sequence of formation the wrong way round with gas being trapped and then escaping rather than escaping gases leaving holes that were then preserved. In addition, many candidates did not appreciate that the question asked how the *rock* formed rather than how the *texture* formed.

d) **(i)** Despite this question clearly describing ammonites with complex suture lines, virtually every geological time period from the Silurian to Tertiary was given as the time period in which the rocks could have been laid down! Most candidates had either forgotten or had not learnt the stratigraphic ranges of the main zone fossils.

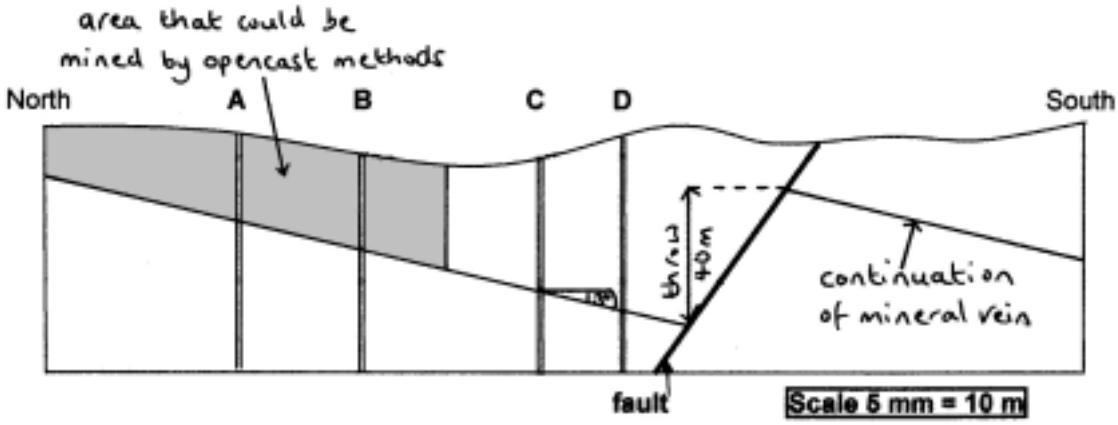
(ii) The vast majority of candidates were able to drawn a belemnite guard either on its own or inside a belemnite but a lot of “benefit of the doubts” were given.

(iii) Candidates either knew how pyritisation occurs and that the ammonites in the conglomerate would be derived fossils or they did not. While there were some

excellent answers that described the pyritisation process in detail using good technical terminology and invoking the involvement of sulfur-reducing bacteria in anoxic conditions, there were an equal number of very poor answers. Some incorrect answers described the process of carbonisation or how moulds and casts form. Those that did not realise the ammonites in the conglomerate would be derived fossils, erroneously suggested that ammonites lived in the same environment as conglomerates form in or suggested the ammonites were incorporated into the conglomerate by a turbidity current. Unfortunately, some candidates' use of geological terminology and their spelling, punctuation and grammar were so poor it was not always possible to award the mark for quality of written communication.

Q3 Many candidates struggled with aspects of question 3 on borehole data, galena mining and mineral identification, so only a handful of candidates attained more than 8/12 for this question.

Teaching tip



borehole	depth below surface to mineral vein / m
A	25
B	28
C	38
D	50

a) **(i)** Most candidates were able to use the borehole data and the scale to draw correctly the mineral vein on the cross section. Many candidates however, did not think to use a ruler to join up the points they had plotted, which led to problems answering the follow-on questions correctly.

(ii) The majority of candidates were also able to measure correctly the dip of the mineral vein they had drawn. Only a minority left the question blank or measured the dip from the vertical to get an erroneous value of 77°.

(iii) Only the strongest candidates attained the two marks available for continuing the mineral vein on the south side of the fault. Most drew a vein with the same dip for one mark, but virtually all candidates erroneously measured a throw of 40 m along the fault rather than measuring the throw *vertically* upwards to find the correct displacement.

b) **(i)** The majority of candidates were able to successfully use the scale to work out that the maximum depth of open cast mining would be to a depth of 15 mm on the cross section if the maximum thickness of overburden that could be removed was 30 metres. Although all candidates that shaded to a depth of 15

mm on the cross section were given credit, only a few realised that it would be only worth mining the area where the mineral vein was at depth of less than this!

(ii) Although many candidates realised galena is denser than fluorite and calcite for one mark, most had no idea how this difference in specific gravity could be used to separate the galena - for example, by using froth flotation or a method involving panning or a shaking table. There were some very confused answers suggesting the use of gravity surveys or stating that the galena would *fall to the bottom of the mineral vein during* gravity settling or if it was heated up and melted.

(iii) This straightforward question asking for a description of the potential environmental consequences of mining galena was not answered particularly well. Many attained one mark for discussing the general environmental consequences of mining metal ores, but few made their discussion specific to the problems of mining galena. Only the strongest candidates appreciated that galena is toxic because it is contains lead and that this could lead to surface and groundwater pollution, soil contamination and the poisoning of animals and plants.

c) Many candidates were able to correctly state one diagnostic property that could be used to identify calcite, but the diagnostic properties of fluorite was less well known. Some candidates were not familiar with the term diagnostic so gave properties that, although correct for the mineral, would not allow identification of it, e.g. *calcite is white* or *fluorite is vitreous*. Others gave lists of properties for each mineral some of which were correct and some of which were not – contradictions were not awarded marks.

Q 4 Some candidates struggled with parts of this question on photograph interpretation, triangular diagrams, sedimentary structures and sedimentary rocks so few attained the maximum marks available.

a) While there were some excellent, accurate and fully labelled sketches of the asymmetrical anticline shown in the photograph, others were poor suggesting a lack of practice in photograph interpretation. Although many candidates drew and labelled the joints/fault and interbedded thick and thin beds, it was surprising how many failed to label any features of the fold itself, which was the main structure shown on the photograph.

Common errors or omissions were:

- incorrect or no dip measurements on the fold limbs
- failure to label or describe the fold and any of its features
- failure to label accurately the position of bedding planes or joints – label arrows needed to touch the feature being labelled
- failure to show any displacement on labelled faults
- incorrect bed thickness measurements
- confusing sedimentary and metamorphic terminology – on the basis of bedding, the rocks in photograph were clearly sedimentary.

b) Many candidates appeared unfamiliar with the plotting of triangular diagrams despite this being an important technique for displaying grain composition in clastic sedimentary rocks, grain size in clastic sedimentary rocks and mineral composition in igneous rocks. The specification states candidates should be able to translate information between graphical, numerical and algebraic forms.

c) **(i)** About half the candidates correctly identified the geological features in the photograph of the sandstone as being ripple marks, but few stated they were asymmetrical. Sadly many candidates failed to look at the context of the photograph and didn't refer to the map which clearly shows the sandstone in a terrestrial environment. Consequently, many misidentified the features as flute casts or tool marks.

(ii) Surprisingly, even the candidates who correctly identified the features as asymmetrical ripple marks, struggled to attain the two marks available for explaining how they formed. Those that had misidentified the ripples as symmetrical penalised themselves by describing bidirectional water currents and others hedged their bets by saying the ripples could be the result of unidirectional or bidirectional currents and could be the result of transport by wind or water thus limiting their marks. Most explanations were very vague and few were worthy of one, let alone two marks. There was confusion with desiccation cracks with some candidates suggesting the ripples were left as the sand dried out.

(iii) Most candidates attained at least one of the two marks available for matching up the description of the sands to their environments of deposition.

Teaching tip
Identifying rocks and environments from written descriptions is quite challenging. Candidates should be encouraged to do this by a process of elimination – the obvious ones first and the less obvious ones last. It is useful to highlight the key pieces of information. For example, in this question, the calcite cement for sand 2 is the main point that gives it away as being marine (environment E). The fact that sand 1 contains muscovite and grains are sub rounded means it cannot be wind blown so it must be fluvial (environment G). This leaves environment F (terrestrial/aeolian) and the characteristics of the remaining sand (number 3) fit with this.

Q 5 This question on metamorphism and index minerals discriminated well and produced the full range of marks from 0 to the maximum of 7.

a) **(i)** Although many candidates correctly stated that the index minerals shown in the diagram would be produced by regional metamorphism, a significant minority thought contact metamorphism would produce them.

(ii) This question asking candidates to draw two vertical lines to show the limits of medium grade metamorphism produced a mixed response despite the generous mark scheme allowing from anywhere between the end of chlorite / start of garnet to anywhere between the beginning of kyanite / beginning of sillimanite. Some candidates had no idea and left the diagram blank or drew horizontal lines. The most common incorrect answer was to show the start of medium grade at the start of biotite – these candidates failing to appreciate biotite is a low grade index mineral.

(iii) Candidates either knew the rocks typical of low, medium and high grade regional metamorphism or they didn't. Unfortunately, many having answered *regional* correctly to part (i) then went on to list the three rocks characteristic of the different grades of *contact* metamorphism. In addition, some candidates

ignored the word *rock* in the question and listed minerals instead. Candidates would be well advised to ensure they know the difference between a rock and a mineral.

b) There were many excellent answers to this question asking for an explanation of how kyanite and sillimanite are related. Those that merely produced the Al_2SiO_5 polymorph phase diagram were awarded one mark maximum as they did not *explain* the relationship. Although many candidates got the chemical formula for the polymorphs correct, an equal number struggled to give the correct number of atoms of each element present. Some candidates clearly had no idea and left this answer blank, while others just repeated what was given in the diagram that accompanied the question.

Grade Thresholds

Advanced GCE (Geology) (3884, 7884)
June 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2831	Raw	60	46	41	36	31	26	0
	UMS	90	72	63	54	45	36	0
2832	Raw	60	50	45	40	36	32	0
	UMS	90	72	63	54	45	36	0
2833	Raw	120	98	86	74	62	50	0
	UMS	120	96	84	72	60	48	0
2834	Raw	90	68	59	50	41	33	0
	UMS	90	72	63	54	45	36	0
2835	Raw	90	62	54	46	38	30	0
	UMS	90	72	63	54	45	36	0
2836	Raw	120	96	85	74	64	54	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3884	300	240	210	180	150	120	0
7884	600	480	420	360	300	240	0

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

	A	B	C	D	E	U	Total Number of Candidates
3884	20.8	51.6	77.7	91.5	99.5	100	185
7884	25.7	52.0	73.4	90.1	97.2	100	818

1003 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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