RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE **A2 7884**

Advanced Subsidiary GCE **AS 3884**

Report on the Units

June 2006

3884/7884/MS/R/06

Oxford Cambridge and RSA Examinations

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Chief Examiner's Report Geology

General Comments

The examinations this summer performed well with no problems and a good range of marks achieved on all of the units.

The examiners continue to see that certain topics generally produce poor responses and suspect that areas that have rarely been examined may not be taught in some centres. The structural geology part of Unit 2831, for example, continues to be a problem for many candidates and as this is also fundamental for the maps and photos on the synoptic paper Unit 2836, it can have a major effect for candidates. Similarly, metal deposits which is part of economic geology in Unit 2833, was included in a synoptic question in Petrology Unit 2835 and this question was the worst answered on the paper. There are strong answers from some centres and consistently weak answers from others on topics like these.

AS requires a set of basic terms and limited detail while A2 requires a far wider range of terms and detailed responses that need to show understanding and often require explanations rather than just descriptions. Problems with a lack of detail at A2 are most noticeable for petrology which builds on the AS basics of Unit 2832, the rock cycle module.

Confusion between geological terms for igneous, sedimentary and metamorphic as well as minerals is a great concern as candidates can lose marks very easily. In several cases the questions included data on the rock group but this was ignored.

The examination papers for each unit will cover the entire content of the specification over a number of years. So even the minor topics will come up at some time and it is noticeable that when some of these topics do appear they are often omitted or poorly answered – often on a centre basis.

There are some standard examination techniques that would improve candidates' marks:

- Read the question carefully as it may ask for two separate points in the answer, for example 'describe and explain…….' , or it may ask for **three** features. In the latter case answers given often have two or four features (some of which might be contradictory) but marks can only be awarded for three.
- Read all parts of the question including the introduction as this often gives helpful information.
- All units regularly ask candidates to produce fully labelled diagrams, but it is common to see diagrams with no labels which therefore cannot gain full marks, or with label lines having vague endings in mid-air where candidates may again miss out on marks. Similarly, if a scale is requested it is likely that there is a specific mark for it.
- Using technical terms instead of generalisations is essential and correct spelling of these terms should be strongly encouraged.
- The last question may have only one side available for the answer and this will be adequate for concise answers to gain full marks. Where candidates wish to include more detail or if diagrams are large then extra sheets of paper should be requested and firmly attached to the exam paper.

2831: Global Tectonics and Geological Structures (Written Examination)

General Comments

The difficulty level was appropriate with candidates' marks ranging from 3 to 57 out of the maximum 60 marks with a good spread. There was no obvious problem with candidates running out of time.

As usual, it was the structural question (question 1) that proved most difficult for candidates. The remaining questions had better responses and many candidates gained high marks for the final extended prose question.

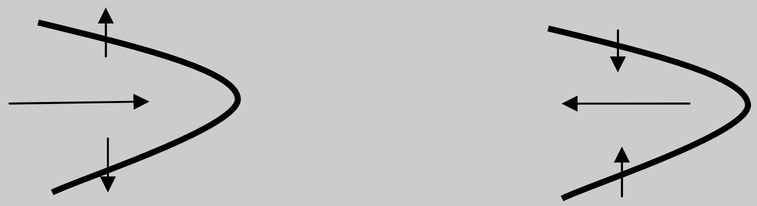
Comments on Individual Questions

Q1 This proved to be the most difficult question with a mark distribution skewed towards the lower end. The average mark was between 6-7 out of 16, with very few candidates gaining full marks.

(a)(i) Most candidates could mark on one part of the axial trace but few had it correct along the length of the fold. Candidates must get used to the axial trace sometimes being in different positions along the fold when it has been faulted by strike-slip faults, as in this case.
Candidates had difficulty with the plunge with few getting the correct answer. The concept of plunge is difficult and many candidates found it a problem.

Teaching Tip

When teaching this, give students coloured card which they fold and make it plunge before they then cut a horizontal (erosion) surface across the card. This shows that with an antiform the plunge is in the direction that the beds are converging and with a synform the plunge is in the direction that the beds diverge.



Antiform	Synform

An alternative is to use a swiss roll cut in half lengthwise to make both an antiform and a synform. Then slice across the swiss roll at an angle to give the plunge effect – chocolate swiss rolls give good colour contrast! The outcrop pattern shown is excellent and gives good visual memories.

(ii) Many candidates answered this question as if the map was a cross-section so described an overfolded asymmetrical antiform. Candidates must be able to recognise fold structures in maps as well as in a cross section.

Teaching Tip

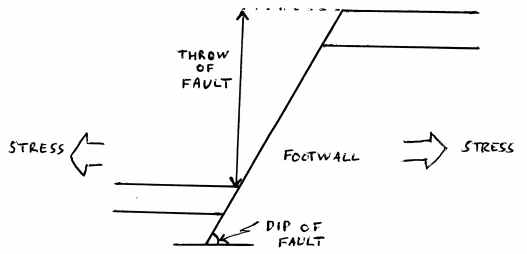
It is a good idea to show all the types of fold in both cross-section and map view so that students are familiar with the use of dip arrows and outcrop patterns. There is some confusion between maps and cross sections which can give very different answers. Terms for fold descriptions should be revised in a systematic way:

- antiform / synform
- anticline / syncline (if age of rocks is known)
- fold attitude (upright, overfold etc.)
- symmetrical / asymmetrical
- open, closed, tight
- plunging (including direction)
- trend of axial plane trace

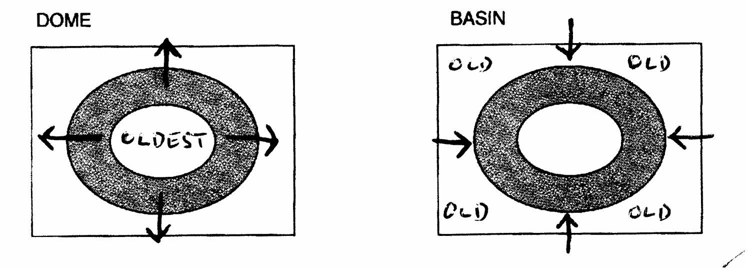
(b)(i) Similar problems occurred with describing the fault. Candidates should be able to recognise where there has just been horizontal movement (beds offset to right or left but bed width does not change). With dip slip faults, the width between beds will increase or decrease and candidates should learn how to tell the upthrown and downthrown side of a faulted antiform or synform. Part (ii) was generally well answered.

(iii) Very few candidates recognised a downthrown block (horst). There are few structures that occur between faults so horst or graben/rift valley are likely. Candidates need to use the changing distances between beds either side of the fault to work out the downthrown side of a fault.

(c) Diagrams were reasonably well done with candidates knowing the footwall, throw and stress directions. Many had an idea about fault dip but did not mark it as an acute angle between the fault and a horizontal surface. Throw is the vertical offset not the offset along the fault surface. Many candidates put the tip of the arrow for footwall on the fault plane and so did not gain the mark. The hanging wall and footwall are either side of the fault plane.



(d) Many candidates knew the correct dip arrows for the dome and basin although a few only used 2 arrows on each diagram which is not enough to indicate the full structure. Many put oldest rocks in the middle of the dome structure but few put the oldest in the white area at the edge of the basin structure.



Q2 This question was well answered with many higher marks.

(a)(i) Most candidates knew the wave paths although they need to be sure that the L wave is at the surface and not under it and that it stops at about 90º. The P and S waves should curve within the mantle.

(ii) The shadow zones were not so well known. Candidates need to be accurate especially at the 103º end as many were too close to 90º.

(b)(i) Many candidates knew about rigidity being important, although some preferred to describe the state, which was acceptable.

> The equation for S wave is $v_S = \sqrt{\frac{\mu}{\rho}},$ μ is **rigidity** (which speeds up waves) and ρ is **density** (which slows down waves) and it is advised that candidates use these two terms but can add descriptions about the state as well.

(ii) Many candidates knew that the asthenosphere is partially molten (not semi as this implies 50% molten which is not the case).

(c)(i) Many candidates knew that the mantle is made of peridotite - a name that should be spelt correctly.

(ii) Many candidates know about mantle xenoliths brought up in volcanic eruptions but some had difficulty actually describing these well enough to get the mark. Candidates should also be aware that peridotite is sometimes found at the base of ophiolites.

(iii) A number of candidates seem to be confused between composition and state and in this question many discussed state rather than composition. The use of iron meteorites was best known (although some just said meteorites) followed by the use of gravity and density data and the magnetic field.

(iv) Most candidates knew that S waves could not pass through the outer core as it is liquid (zero rigidity).

(d)(i) Most candidates found this easy and almost all gained both marks

(ii) Most candidates were able to construct the circles and worked out the epicentre. Some candidates struggled if they did not have a compass. Candidates should always bring a compass, protractor, pencil, ruler and calculator to every geology exam.

Q3 This question was quite well answered by candidates with an average of 9 out of 16.

(a) Candidates usually knew the position of the abyssal plain but were not so good at the continental shield, perhaps confusing it with the continental shelf. Areas of high heat flow were not clear and often candidates were not accurate enough. Most candidates knew where the trench is located but again some had the trench too far out into the ocean. Accuracy is essential.

(b) This was well answered; the main confusion was between the rift valley and transform fault. Seamounts were the most accurately matched.

(c)(i) Few candidates managed to gain all 4 marks. Composition and average thickness were best known. Age of the oldest rocks for the continental crust was not well known and many gave a range rather than the average.

This is a common question and candidates should know the differences between the 2 types of crust.

	Age of the oldest rocks	**Composition**	**Average thickness**	**Density**
Oceanic	200 Ma +/- 50 Ma Jurassic	Basic / basalt	10 km +/- 5 km	3.0 +/- 0.1
Continental	4000 Ma +/- 500 Ma Precambrian	Acid / intermediate / granite / granodiorite	33 km +/- 7 km	2.7 +/- 0.1

(ii) Most candidates gained 1 mark by reference to pillow lavas and the ocean floor / MOR but few knew any detail or mentioned ophiolites or seismic data.

(d) This topic is generally well known by candidates.

Q4 This question produced a wide range of marks with many gaining full marks and a few making no attempt.

Diagrams were frequently used and were often of a high quality with plenty of labels and this allowed candidates to gain high marks. The most frequently described features were volcanoes linked to rising magma, Benioff zone and subduction. The most frequent errors were:

- Melting of the oceanic crust (not partial)
- Less dense oceanic crust subducting under denser continental crust
- Reference to trenches, but not oceanic or deep sea
- Mountains referred to generally rather than specifically fold mountains
- Vague references to metamorphism

The best candidates discussed all 3 types of boundary and included information on ophiolites, accretionary prisms and occasionally heat flow and gravity anomalies.

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

General Comments

This session's examination paper gave a wide range of results, and again displayed variation between centres as well as between candidates. Marks ranged from 3 to 58 out of the maximum 60 marks. There was no evidence that the paper could not be completed in the time allowed.

Comments on Individual Questions

Q1 Many candidates gained their highest marks on this question. The diagrams were capably interpreted.

(a)(i) A high proportion of candidates gained full marks on this part of the question and had no difficulty in interpreting the diagram of the rock cycle. It proved accessible to all but the very least well prepared. A few were confused and wrote 'process' or 'product' as their answer.

(ii) This was successfully answered by many. The process terms seem to be well known for this part of the rock cycle.

(b) Sound explanations were widespread with candidates referring either to slow cooling and larger crystals at depth or fast cooling and smaller crystals near the Earth's surface.

(c)(i) Most correctly identified E as an igneous rock

(ii) Terms describing the texture of sedimentary rocks proved less well known. Some general words were used, for example 'rough', 'flaky', 'gritty' and scientific terms that are not appropriate for sedimentary rocks 'granoblastic', 'sugary' were also seen.

(iii) It was widely known that quartz is durable or hard but few appreciated that chemical weathering would change the feldspar and mica. Many thought that feldspar is soft.

(iv) Most were able to name or describe the processes of attrition and abrasion, often in colourful rather than scientific language.

(v) This was answered correctly by the majority of candidates.

Teaching Tip

A Practical Way to Learn Rock Textures
Texture is one of the ways in which sedimentary rocks are classified. Classification systems like this can quite easily be shown as flow charts. Question 1 in the January 2832 paper contains a flow chart for metamorphic rocks and it would not be difficult to construct one for sedimentary rocks. The criteria used in the boxes should be textural ones, such as crystalline or fragmental, average grain size, degree of roundness, grain shape. The flow chart can then be used to help identify hand specimens of sedimentary rocks and the correct textural terms are learnt along the way.

Q2 This question again resulted in the full range of marks being awarded, although it was found to be rather more challenging than Question 1. It was common to find gaps in candidates' knowledge and understanding relating to sedimentary structures, limestones and chemical weathering.

(a) (i) The structures were successfully identified by the great majority, but candidates in a few centres wrongly identified J as cross-lamination.

(ii) The majority only recognised the graded bedding as being inverted and were confused by what cross bedding should look like when it is either the right way up or inverted.

(iii) Of the minority who identified the cross bedding as being inverted, even fewer could explain how they could tell that the structure was not the right way up. Some resorted to diagrams, which were credited, because they clearly found it difficult to put their explanation into words.

(b) (i) Most were able to satisfactorily describe the formation of graded bedding, although it was often attributed to flash floods and rivers rather than turbidity currents.

(ii) This was capably described by the majority.

(c) (i) Responses here seemed to vary by centre, with all or most candidates in some centres getting both the limestone terms right but in other centres neither was correctly named.

(ii) 'Shallow' was sufficient to gain the mark. A noticeable minority gave depths in kilometres.

(iii) Descriptions were generally accurate and showed sound understanding of the formation of ooliths. Some candidates mistakenly suggested that a fragment was rolled in limestone, rather than carbonate mud

(d) Carbonation was not well understood and there was a range of creative guesswork evident in responses to this part of the question along the lines of 'carbon breaks the rocks down'. Sometimes the process was confused with carbonisation. A relatively small number of candidates referred to carbonic acid and many referred to rocks in general rather than being specific and mentioning carbonate or limestone in their answers. A few excellent candidates were able to give full and correct explanations, but these were the exception.

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.

Q3 Less well prepared candidates found it easier to gain at least some marks on this question than they did in Question 2; however, of all the questions, this one proved the most demanding in terms of gaining the highest marks, though some candidates did achieve it. The main difficulty candidates experienced was in showing an understanding of deltaic deposition in cyclothems.

(a) (i) Deltas were *described* rather than formal definitions being given, These answers generally contained the relevant points and were acceptable, so that most candidates were able to gain the marks available.

(ii) The rock types found in foreset and bottomset beds are listed in the specification and candidates who had learnt them did well in this part of the question. There were some wild guesses, including metamorphic and igneous rocks. Topsets were usually correctly identified as the missing layer.

(b) (i) There was a wide range of answers in terms of quality. There were again examples of candidates using the terminology in the question in their definition 'a *cyclothem* is where deposition is in a *cycle*' These attempts did not make clear the essential fact of vertical repetition of layers. Try the teaching tip (The Ten Word Challenge) given in the January report to help candidates to avoid this difficulty.

(ii) Candidates who made mistakes in naming the rock types in (i) were not penalised if they carried the same error forward when labelling their drawing of a cyclothem in (ii). Using the names of the layers (topset, foreset, bottomset) was one route to success adopted by many. When candidates chose to draw and label the rock types it was noticeable that many were unsure about where seat earth would be found. It was often placed in the wrong part of the sequence. The question asked for cyclothems in the plural and it was therefore necessary to draw at least part of the second cyclothem to gain two marks.

(c) (i) The most frequent response to this question was 'tropical' which was not precise enough and needed to be qualified by 'wet' or 'humid', since some tropical climates are dry for much of the year. The best answer, equatorial, was given by all candidates in some centres but by none in others. Rainforest is an ecological term, not a climatic zone.

(ii) Few correctly named a coal forming process. Marks were usually gained for an appropriate description without the name of the process being stated.

(iii) Some candidates could explain this very well, but in general this question revealed a lack of understanding of cyclic deposition. Quite a few offered explanations as to why coal seams were thick, rather than why there were many of them, so these answers unfortunately were not relevant. The concepts of changing sea levels, transgressions and regressions, subsidence and emergence were not always known.

(d) (i) Knowledge of metamorphism was good and most candidates gained the two marks available.

(ii) There was generally little difficulty in being able to distinguish between the conditions associated with thermal and regional metamorphism. The graph was capably interpreted.

Teaching Tip

Repeating Layers
Provide containers of materials for making bottomset (clay), foreset (sand) and topset (bark and leaves) layers in a coal measures delta. Each container has a label describing the environment of deposition. Clay = deep water, low energy, little or no current. Sand = shallower water, higher energy, medium speed currents. Bark and leaves = land, remains of trees. Place the materials into a beaker to form the layers of a delta, beginning with the clay and make a note of the depositional environment each time a layer is added. After the layer of plant material, which represents coal, the sequence begins again with clay as the next layer. The question then arises, how did the environment change from being land with trees to deep water? The answer will involve ideas like subsidence and the sea moving in over the land. Ideas about emergence and marine regression are likely to be suggested to explain how the next layer of sand and the final layer of bark and leaves are deposited. The beaker then contains two cyclothems and the notes made as it is constructed explain how it happened.

Q4 This question was well answered by very many candidates with over 20% gaining full marks. Written communication was usually clear. Candidates appeared not to have run out of time. Some did not share in this overall success and wrote in quite generalised terms describing sills and lava flows, with the result that quite high proportion also scored quite low marks. There was a noticeable distinction between centres in this regard.
Answers that were less successful tended to be descriptions of 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 were not very successful because they did not identify and explain the differences between sills and lava flows, they were largely a description of their origins.

Good answers, of which there were many, 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 very ably gave explanations of the differences.

Some were not aware that the presence of vesicles at the top of lava flows was 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 small number of candidates labelled the chilled margins and the baked margins the wrong way round and the difference in xenoliths was sometimes oversimplified along the lines that sills contain xenoliths but lava flows do not.

However, many candidates in a range of centres 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: Economic and Environmental Geology (written examination)

General Comments

The length of the paper appears to have been about right and there was a marked improvement in the performance of most candidates in comparison to the previous few years. This may be a reflection of the particular topics examined in this session or the fact that candidates are being better prepared for the examination.

Question 1 on landslips and slumping hazards and engineering geology, with the exception of the section on ground improvement strategies, was well known by candidates and was generally answered well. Although Question 2 was the lowest scoring on the paper, there was a pleasing improvement in the responses to the questions on mineral deposits. In the past this has proved to be a topic that many candidates struggle with and it appears that Centres have taken on board the suggestions given in the last few Geology subject reports and have paid careful attention to the teaching of this area of the specification. The quality of answers to Question 3 on oil and the extended question on dams was variable and produced a wide spread of marks.

The following points should also be noted:

- A significant number of candidates penalised themselves, particularly on question 1 and the dams question, because of a lack of correct geological terminology and clarity in their answers. Candidates should be encouraged to learn the correct spelling of key geological words and terms.
- The drawing and labelling of diagrams is a key skill in Geology and candidates should be encouraged to practise this skill at every opportunity. The quality of diagrams produced continues to show improvement, but candidates still lost marks due to inaccuracies and no or poor labelling, particularly in the question asking for a fully labelled diagram of a fault trap for oil.

Comments on Individual Questions

Q1 This question was often well done with some candidates achieving full marks. Most candidates attained at least 7 of the 13 marks available.

(a) (i) The reasons why the north side of the valley was likely to suffer landslips was well known. However, many candidates did not achieve the full two marks because they did not discuss the issue of the southwards <u>dip</u> of the beds. A common error was to cite the angle or gradient of the slope, rather than the dip of the beds. Candidates who discussed the angle or gradient of the beds/strata were given credit, but they should be encouraged to use the term dip and to give a full description of the direction of dip. A common misconception is that shale is permeable with some candidates stating that water would enter both the limestone and the shale. Not many candidates recognised that shale is incompetent and has low load-bearing strength and that the competent limestone is likely to slip off the shale.

(b) (i) Most candidates correctly stated that an incompetent rock type such as clay would be likely to fail by slumping. However, a significant number of answers were far too general giving sedimentary rocks or erroneously stating that limestone or sandstone would fail by slumping, not appreciating that although sedimentary, these are competent rocks that fail brittly.

(ii) The reasons why heavy rainfall increases the risk of landslips and slumping was well known. The most commonly cited correct answers were that water adds weight; rocks become saturated and waterlogged; and that water acts as a lubricant causing loss of friction and cohesion. However, some candidates penalised themselves with repetitive answers that really only gave one reason. Others let themselves down by a lack of clarity in their answers and incorrectly suggested water would "erode" the rock causing failure.

(c) The question asking for a description of the geological problems that could be encountered during the construction of the tunnel shown on the cross section diagram was done well with many candidates attaining all of the three marks available. The three <u>different</u> problems were the likelihood of collapse, the possibility of flooding and the presence of two faults. Some candidates lost marks by giving repetitive answers that quoted the same problem for more than one rock type and others did not <u>describe</u> the problem, e.g. stating that faults were present but not describing the problems they might cause.

(d) Most candidates attained the mark for giving one disadvantage of tunnelling through hard rock. Most stated that it would be expensive or the rate of tunnelling would be slow, but very few candidates suggested technical problems such as the possibility of overbreak or underbreak. Some candidates misread the question and gave an advantage of tunnelling through hard rock and others let themselves down by vague statements about machinery, not appreciating that soft rock tunnelling also requires the use of specialised, expensive machinery.

(e) What should have been a straight forward question matching up the most suitable ground improvement strategy for each application was surprisingly poorly answered with only a minority of candidates gaining all four marks. Many candidates did not appreciate that the only suitable strategy to prevent loose blocks falling from a tunnel roof would be rock bolts. Although many candidates correctly suggested that grouting or rock drains could be used to prevent leakage of water into a tunnel, others suggested the use of a cut-off curtain clearly not appreciating this is a technique used solely in dam construction. The use of gabions or rock bolts to support the sides of a road cutting was well known, but strategies such as the use of gabions or rock drains to prevent slumping of a slope was less well understood. A number of candidates suggested the use of rock bolts not realising that these can only be used for competent, hard rocks primarily to prevent rock falls rather than slumping.

Teaching Tip

Key ground improvement strategies to stabilise rocks listed in the specification:

Grouting – holes are drilled into the rock and cement is injected in a liquid or slurry form to fill pores, joints and fissures to reduce permeability and increase rock strength. This strategy can be used to prevent leakage of water from a reservoir, leakage of water into a tunnel or leakage of toxic leachate from a waste disposal site.

Gabion boxes - wire mesh boxes filled with rocks can be placed as lateral toe support at the bottom of slopes to prevent slope failure by slumping.

Rock drains – pore fluid is critical in providing weight and lubrication thus promoting landslips and slumping, particularly in incompetent rocks. Drains, relief wells and tunnels, etc., can be constructed to reduce the pore fluid pressure which could prevent slumping of a slope or leakage of water into a tunnel.

Rock bolts – Steel wires are glued/cemented into the rock face and tensioned in order to pin loose blocks of rock to the sound rock behind. Only useful for competent rocks to prevent rock falls from cliffs, road cuttings or in tunnels.

Retaining wall – usually constructed of concrete and used to support slopes in road cuttings.

Q2 There was a very pleasing improvement in the responses to the questions on mineral deposits. However, there was still a number of very poor answers, particularly to the part question on secondary enrichment, and in some cases, the quality of responses appeared to be Centre-dependent.

(a) (i) Few candidates could give a definition of the term ‘concentration factor’ though it is clearly stated in the specification that candidates should “show an understanding of concentration factors to produce economic deposits from low crustal abundances of metallic minerals”. Most candidates merely gave a definition of the grade (amount of metal in the ore deposit) or the cut off grade (the minimum concentration required to produce an economic ore deposit). Very few appreciated the idea of the amount / factor / number of times the metal has to be concentrated above its average crustal abundance to make an economic ore deposit. Some candidates discussed the idea of concentration of the ore rather than the metal above its crustal abundance and were given credit even though this is not strictly correct.

(ii) Again, a large number of candidates were unable to manipulate the data provided and correctly calculate the concentration factor for tin or the minimum % of metal required for an economic deposit of copper, even though it is stated in the specification that candidates should “be able to calculate concentration factors”. Some candidates appear unable to carry out simple mathematical calculations.

Teaching Tip

At the start of teaching the mineral deposits topic, it is a good idea to establish key definitions, which can then be referred to and reinforced throughout the teaching of the topic:

- Resource – A naturally occurring material or substance in the Earth's crust that is useful and/or valuable to man. Can be divided into energy and mineral resources.
- Ore – Rock which contains metal(s) of interest that can be mined at a profit. A mixture of ore minerals and gangue minerals.
- Ore mineral – Mineral containing the metal of interest, usually an oxide or sulphide.
- Gangue mineral –Uneconomic mineral mixed in with the ore mineral(s). E.g. quartz, calcite, pyrite (iron sulphide) - "fool's gold".
- Cut-off grade – Minimum grade required for an economic ore deposit.
- Grade – Percentage / amount of metal in the ore deposit.
- Average crustal abundance – Amount of the metal in average continental crust.
- Concentration / enrichment factor – Amount by which the metal in an ore deposit is concentrated above its average crustal abundance.

$$\text{Concentration factor} = \frac{\text{Concentration of metal in ore (or cut-off grade)}}{\text{Average crustal abundance}}$$

(b) (i) The question asking for the main ore mineral of tin produced a very varied response with less than half of candidates correctly giving cassiterite as their answer. Candidates gave all sorts of incorrect answers: bauxite, magnetite, galena, chalcopyrite, iron, aluminium, and cobalt to name a few! Some incorrectly stated tin oxide which is not a mineral name and poor spelling also let some candidates down.

(ii) In general, the formation of placer deposits at meander bends in rivers was well known and many candidates produced accurate, well-labelled diagrams that scored the full two marks. The most common correct diagrams had low current velocity and deposition on the inside of the meander bend and high current velocity and erosion on the outside of the meander bend. Far fewer cited high density leading to preferential deposition of the ore minerals and even fewer stated the required properties of the ore minerals. Unfortunately, a significant minority of candidates labelled their diagrams the wrong way round with low current velocity and deposition on the outside of the meander bend and others failed to produce accurate diagrams or to label them.

(iii) This part question asking for one reason why placer mining at the surface usually has a lower environmental impact compared to underground mining, was answered rather poorly. Many candidates had an idea that placer deposits tend to be mined on a smaller scale, but those suggesting extraction was by panning were not credited as they failed to appreciate the dredging operations carried out by modern mining companies. A few correctly stated that less waste rock and smaller spoil heaps are produced, but some candidates were under the impression that there was no waste material produced. Some correctly stated that placer mining does not cause subsidence and does not pollute groundwater. The significant number of candidates who suggested that placer mining would produce less visual impact, noise and dust, or disruption to habitats, ecosystems and wildlife clearly did not have any understanding of placer mining as a surface operation.

(c) (i) Most candidates were able to correctly plot a line graph showing the changes in copper concentration with depth in a secondary enrichment deposit. However, some candidates made careless mistakes plotting some of the points and others failed to join the points with a line.

(ii) Most candidates correctly labelled the water table as a horizontal line at between 15 and 25 metres depth, but a significant number failed to label it at all thus losing the mark.

(iii) This part question proved a good discriminator and, as expected, only the strongest candidates gained all three marks for explaining why the concentration of copper changes with depth in a secondary enrichment deposit. There were some excellent answers showing a very good understanding of the chemical reactions taking place above and below the water table. However, even though candidates were told in the question that this was a secondary enrichment ore deposit, common errors made by weaker candidates included discussing the density of copper (confusion with gravity settling and/or placer deposits perhaps) and metamorphic effects such as heat and pressure being responsible for the concentration of the copper.

Q3 The responses to the first part of the question on oil were variable and the question discriminated well between strong and weak candidates. Although there were some good answers to the extended question on dams, many answers suffered from being repetitive or having poor use of English.

(a) (i) This part question asking for a description of the origin and formation of oil in a source rock was not answered particularly well. Many explanations were of GCSE standard with vague descriptions such as “sea creatures die and sink to the bottom and are buried and subjected to heat and pressure”; others confused oil with coal formation; and a minority left the question completely blank. Some candidates erroneously stated that oil formed from blue-green algae rather than plankton. That said, some candidates produced excellent descriptions giving precise details of marine plankton accumulating in low energy, anoxic conditions on the sea bed, then being buried in fine sediment and converted to sapropel and kerogen due to partial decay by anaerobic bacteria, requiring temperatures between 50 to 200°C (the “oil window”).

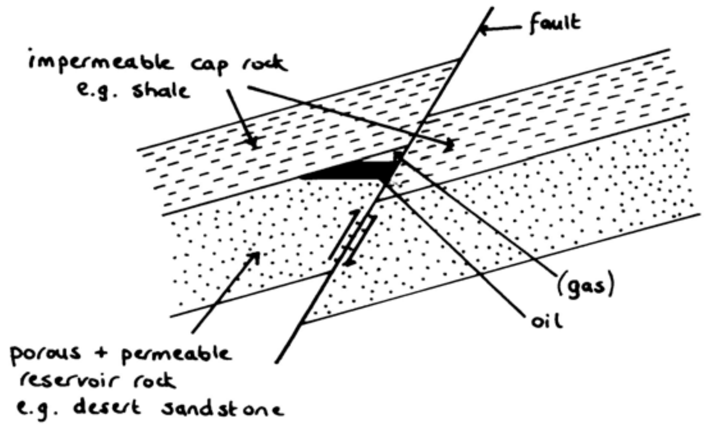
(ii) Responses to the question asking for two factors that control the migration of oil were variable. Most candidates cited the permeability of the rock to gain one mark, but many erroneously gave porosity as a factor too – highlighting confusion between these two terms. Other factors that gained credit were discussion of pressure, oil density and viscosity. However, candidates that compared the density of oil to the density of <u>rock</u> were not given credit as they failed to appreciate that it is the density difference between the oil and the <u>water</u> in the pore space that controls migration.

Teaching Tip
Porosity is the amount of pore space in a rock or sediment most correctly expressed as a percentage of the total volume.
Permeability is the ability of a rock or sediment to transmit fluids most correctly expressed as a rate of flow.
The difference between porosity and permeability can be demonstrated with the use of simple experiments:
Porosity:
1 Put marbles in a beaker and pour water in between the marbles.
2 Weigh a dry rock, soak the rock in water and reweigh – the difference in mass is the porosity, which can be expressed as a percentage of the total mass.
Permeability:
1 Put mixed sediment in filter paper in a filter funnel and time how long water takes to pass through.
2 Attach a hollow tube to a rock using silicone sealant or similar, fill the tube with water and measure/time the rate at which the water flows into the rock.

(iii) Definitions of the terms ‘reservoir rock’ and ‘cap rock’ were well known. However, some candidates did not specify that the reservoir rocks holds oil and just referred to fluids or water and again there was confusion between the terms porosity and permeability. There were good definitions of the term ‘cap rock’ but candidates should be encouraged to include the term ‘impermeable’ and the idea of the cap rock preventing upwards migration of oil in their definitions.

(iii) There were some excellent, accurate, well-labelled diagrams showing a fault trap containing oil, but this question was not answered very well by the majority of candidates. Of those that drew a fault trap, the most common mistake was to draw horizontal beds adjacent to the fault, thus losing 1 mark as the oil could not then be drawn horizontally. Some candidates drew a horst structure with the oil trapped between two faults and were given credit for this. A number of candidates mistakenly drew an anticline trap and others made no attempt.

Teaching Tip



A simple experiment can be carried out to show that oil is less dense than water and is always held in the trap horizontally:
Quarter fill a 500cm^3 beaker with water and then pour a thin layer of cooking oil (preferably coloured with food colouring) on top. This will demonstrate that oil is less dense than water. Then tilt the beaker at an angle to show the layer of oil will always be horizontal.

(b) The advantages and disadvantages of surface water supply rather than supply from groundwater was well known with most candidates attaining both marks available. The most common advantages given were that surface water is easily accessible, easy and cheap to extract. The most common disadvantages given were that the water will be polluted / contaminated, will require treatment and there will be loss of water through evaporation.

(c) There were some very good answers to the extended question on the geological factors important in the siting of dams and reservoirs for water supplies. A significant number of candidates scored the maximum 7 marks with an impressive range of geological factors being discussed. However, weaker candidates concentrated on the permeability of the underlying rocks or the possibility of landslips into the reservoir and produced repetitive answers that were only worthy of one or two marks. Some digressed into geographical factors and dam types and lost marks. Bizarrely, a small number of candidates restricted their answers to discussing the dam itself, stating it had to be impermeable, strong, etc, and did not attain any marks, while a few mistakenly wrote about water supply from aquifers rather than dams.

2834: Palaeontology (written exam)

General Comments

The length of the paper appears to have been about right and there was no evidence that candidates were unable to complete the paper in the time allocated, although weaker candidates tended to leave the extended answer questions blank.

Generally, candidates appear to have been well prepared for this examination. However, some candidates clearly struggle with higher demand questions that ask for descriptions, explanations, interpretations or evaluations and resort to writing lists which fail to show their knowledge and understanding of the subject matter. In some cases, this appears to be an issue of poor communication skills, rather than a lack of geological knowledge.

Comments on Individual Questions

Q1 Question 1, identifying fossil groups from written descriptions and focussing on echinoids, crinoids and brachiopods, was well known by candidates and was answered well, with most candidates attaining at least 9/14.

(a) (i) The vast majority of candidates were correctly able to identify a coral, crinoid, echinoid and graptolite from their written descriptions. A minority incorrectly identified the coral as a tabulate coral, not appreciating that tabulate corals do not have a columella and dissepiments. Just answering 'coral' would have sufficed.

(ii) Most candidates, having correctly identified the echinoid in part (i), were able to draw a passable labelled diagram of one for the maximum 4 marks. However, errors included labelling the mouth and anus the wrong way round; drawing the ambulacra wider than the interambulacra; labelling pore pairs and tube feet on the interambulacra; and not labelling the view of the fossil. Candidates that drew an irregular echinoid were limited to a maximum of 3 marks as their diagram did not match the description of "a mouth and anus on opposite surfaces".

(iii) This part question asking for one similarity and one difference between a crinoid and an echinoid was surprisingly poorly answered and candidates struggled to use appropriate A2 standard terminology. Most candidates managed to get either a similarity or a difference correct, but few managed to get both correct.

(b) (i) As expected, most candidates were able to correctly label the brachial valve, the brachidium and a growth line on the diagrams of a brachiopod.

(ii) Very few candidates attained both marks for explaining how brachiopods feed using their lophophore. Responses were vague with the most common one mark answer being that brachiopods are filter feeders. Few candidates were able to give specific details about the lophophore and there was very little awareness of the presence and function of the cilia. Some candidates confused the lophophore with the siphons of a bivalve and others erroneously discussed the idea of the brachiopod sucking up and filtering sediment through it's lophophore.

Q2 This question on fossil preservation produced a range of marks but was skewed towards the top end. However, it appeared that although candidates knew the basics of fossil preservation, many were unable to give the different methods of preservation in sufficient detail to score the maximum marks available for each part question.

(a) (i) Most candidates were able to correctly match up the different types of fossil preservation to the descriptions given and thus attained the full 4 marks available.

(ii) Only the strongest candidates knew the replacement process of pyritisation in sufficient detail to gain both marks and a significant number of candidates left this part question blank. Answers not worthy of credit merely stated the sediment or water had to be rich in iron pyrites and many incorrectly cited the presence of oxygen as a requirement. Some candidates knew the environmental conditions needed to be low energy and anoxic, but very few appreciated the role of sulphur-fixing bacteria in the generation of pyrite.

(iii) This straightforward question asking for an explanation as to why aragonite does not occur in fossils older than the Cainozoic was not answered particularly well and was left blank by a number of candidates. Few candidates appreciated that aragonite is the metastable polymorph of calcium carbonate which over time recrystallises to more stable calcite. Many candidates incorrectly stated that organisms that used aragonite had not evolved until the Cainozoic or that hard shelled organisms had not evolved by that time! Many answers were completely wrong and there is a suspicion that the word Cainozoic caused confusion as some candidates did not seem to realise that this is the most recent Era in the geological time scale. Knowledge of the geological time scale is extremely important in the Palaeontology module and candidates would be well advised to ensure they have learnt it!

(b) This question asking for an explanation of how fine grained sediment; high energy conditions; and early diagenesis affect the preservation potential of an organism was answered poorly, with most candidates struggling to attain more than 3 out of 6 marks. Although, it was well known that the preservation potential would be good in fine grained sediment and poor in high energy conditions, many candidates did not give two reasons for each in their explanations and were often limited to one mark for each. There was confusion about the effect of diagenesis and it appeared this was unfamiliar to candidates as a factor in fossil preservation. Many thought incorrectly that it would reduce the preservation potential and gave explanations based on metamorphic processes. There was little appreciation that early diagenesis results in original material being preserved and less loss of features, or that early replacement of minerals will result in the fossil becoming harder and more able to withstand load pressure, or that there would be less opportunity for decay, decomposition, predation and scavenging.

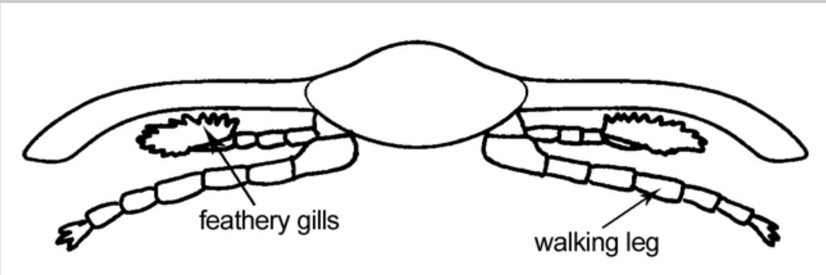
(c) The exceptional preservation of organisms in amber and tar was well known and there were many excellent responses to this part question. However, some candidates concentrated on describing the environments rather than describing the process of preservation. Weaker candidates let themselves down with poor English leading to a lack of clarity in their answers and some merely repeated the same point about anoxic conditions in both answers. It should be noted that although this was credited, there is some debate as to whether amber does actually produce completely anoxic conditions as in most cases only the hard exoskeleton or chitin and not the soft tissue are preserved by this method.

Q3 The quality of answers to question 3 on trilobite morphology, mode of life and trace fossils was variable. The question produced a wide spread of marks and proved to be a good discriminator. Again, the basic information was well known, but some candidates struggled to give sufficient detail in their answers, particularly about trilobite adaptations to different modes of life.

(a) Most candidates were able to label the position of the glabella and mouth on the triolobite diagrams. The position of the genal angle was less well known with some labelling the facial suture and others drawing a line from each side of the trilobite on either the cephalon or the pygidium and labelling the angle between them. Most candidates realised that pleurae are found on the thorax, but some labelled the pleuron in the central axis area rather than strictly correctly on the lateral margins of the thoracic segment.

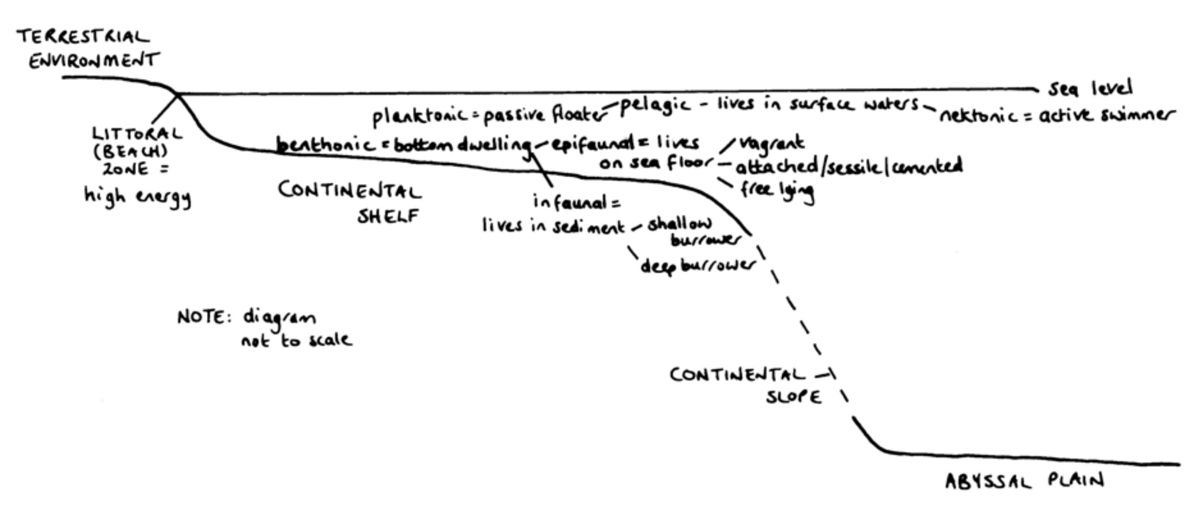
(b) The position of the gills and legs of a trilobite were poorly known and this part question asking candidates to draw their position on a thoracic segment was done very badly despite it being clearly stated in the specification that candidates should be able to describe the "nature and position of legs, gills and mouth" of a trilobite. Many candidates drew a myriad of legs on the thoracic segment and others drew the gills at the top or inside the thorax. Very few showed the jointed nature of the walking legs.

Teaching Tip



(c) The specification states that candidates should be able to "explain how trilobites show adaptive radiation to: nektonic, pelagic, benthonic and infaunal modes of life" and this has been examined in extended answer questions in the past. However this part question on trilobite adaptations to different modes of life was not answered particularly well. Most candidates struggled to get more than 3 out of the 6 marks available. Some candidates listed a number of adaptations for each mode of life but failed to explain how the adaptations enabled the trilobite to adopt the mode of life. There was confusion between nektonic and planktonic modes of life and it appeared that some candidates were unaware that infaunal means living within the sediment in a burrow. Again, these terms are listed in the specification so candidates would be well advised to know their meaning.

Teaching Tip
Marine modes of life could be illustrated using a cross section diagram:



This could be introduced early on in the module and then use of the correct technical terms could be reinforced throughout the module. If done on A3 paper, students could include a diagram of an organism with each mode of life.

(d) (i) Trilobite trace fossils were well known and this part question was answered well by most candidates. Unfortunately, a minority of candidates merely answered *Rusophycus* for trace fossil J and *Cruziana* for trace fossil K failing to appreciate that the question asked for an explanation as to how the trace fossils were formed by trilobites and not what they are called!

(ii) Most candidates suggested that the presence of trace fossils suggests soft, fine grained sediment or low energy conditions on the sea floor at their time of formation, but only a minority attained both of the marks available. There was little awareness that their presence suggest the sea floor was fit for life, i.e. aerobic or with food available, and some candidates erroneously thought that their presence indicated rapid sedimentation.

Q4 This question on mass extinctions and coral morphology was surprisingly poorly answered. Many candidates were unable to recall even simple facts such as the timing of the Cretaceous-Tertiary mass extinction event; the main groups of fossils that became extinct during the end-Permian and end-Cretaceous mass extinctions; and the evidence supporting the meteorite impact theory for the end-Cretaceous extinction. Answers were often centre dependent, which is surprising given the popular interest in mass extinctions.

(a) Only a handful of candidates gained all five marks for correctly filling in the missing words in the passage describing the end-Permian mass extinction event. Common misconceptions were that ammonites or brachiopods became extinct and that rugose corals saw a huge reduction in numbers rather than total extinction during this event. Extinction of land-dwelling organisms was even less well known, with most candidates incorrectly answering that there was a huge reduction in the numbers of mammals rather than amphibians.

(b) (i) While there were some excellent, accurate, well-labelled diagrams of a solitary rugose coral, there were also some very poor efforts. Some candidates got morphological features mixed up and others labelled morphological features that don't belong to corals (e.g. calyx).

(ii) Although this was a standard question, very few candidates could correctly state two differences between rugose and scleractinian corals. A common error was to suggest that rugose corals only existed in solitary forms.

(c) (i) The timing of the Cretaceous-Tertiary mass extinction event was poorly known with answers ranging from 4500 to 10 Ma! This is a simple fact that needs to be learnt by candidates.

(ii) Surprisingly few candidates could correctly name two marine fossil groups that became extinct at the Cretaceous-Tertiary boundary. Again this question required straightforward learning with no interpretation whatsoever. The most obvious correct answers were the Ammonites and the Belemnites, but many candidates named extant groups of organisms such as Brachiopods, Bivalves and Crinoids.

Teaching Tip

Along with the obvious "camel" mnemonic, one approach to the teaching of the geological timescale could be to get students to draw their own version of the timescale (including Eras, Periods and absolute ages) on a large sheet of paper. They could then mark on the key evolutionary and mass extinction events and draw a stratigraphic time range line and diagram of each of the fossil groups listed on the specification. This could be done as an introductory activity at the start of teaching of the Palaeontology module, which could then be referred to throughout the module when each fossil group is covered.

(iii) Unfortunately, some candidates misread this question which asked for a description of two pieces of evidence that suggest that the Cretaceous-Tertiary mass extinction event was caused by a large meteorite impact and so they gave a description of the effects of the impact which did not achieve any marks. Other answers were vague, e.g. stating there is a crater but not specifying where; or saying there is extraterrestrial rock, dust or debris from a meteorite but not explicitly naming iridium, shocked quartz crystals or tektites. There was an appreciation of the possibility of the meteorite impact triggering a tsunami, but few candidates discussed the evidence, i.e. widespread tsunami deposits of the correct age.

(iv) The quality of answers to this part question asking for another possible theory for the Cretaceous-Tertiary mass extinction was variable. Over half the candidates correctly suggested that large scale volcanic activity could have been responsible, but the global implications for climate change were poorly explained. Some candidates cited ash and dust causing a "volcanic winter", while others suggested widespread volcanism would cause global warming. However, there was little appreciation of the timescales involved, i.e. short term global cooling and longer term global warming. Few candidates could give specific details of the causes of climatic change, e.g. sulphate aerosols reflecting sunlight; erupted CO_2 being a greenhouse gas; erupted SO_2 causing acid rain, etc. Some candidates incorrectly cited volcanism in Siberia, rather than the 65Ma Deccan Traps in India, as probably being responsible. Others were clearly confused between this mass extinction event and the end-Permian event, erroneously citing changes in sea level due to the position of the continents and the existence of Pangaea at the time.

Teaching Tip
An exciting and stimulating way of teaching this topic would be to get groups of students to research the theories and evidence for the mass extinction events and present their findings to the rest of the class. This could be done in the form of verbal presentations, posters or presentations. There have also been some excellent recent TV programmes on the topic of mass extinctions.

Q5 The two extended answer questions on the morphological changes of graptolites during the Lower Palaeozoic and the morphological differences between bivalves and cephalopods produced a range of responses. At the top end there were some excellent answers which were well written and illustrated with detailed, accurate, and fully labelled diagrams.

(a) There were some excellent answers to the question asking candidates to describe and illustrate the morphological changes to graptolites during the Lower Palaeozoic. Especially impressive were some candidates' discussion and use of diagrams to show the increasing complexity of graptolite thecae over time. However, many candidates struggled to use correct morphological terminology; failed to organise their answer in a logical sequence, and produced very poor, unlabelled diagrams that were not worthy of credit. Common errors included using words such as arms rather than stipes, confusing morphological terms, getting the morphological changes the wrong way round, and not quoting the correct geological time periods again highlighting a lack of knowledge of the geological timescale by some candidates. Some answers merely consisted of a number of diagrams with arrows in between – many of these answers failed to <u>describe</u> the changes and did not achieve any credit for quality of written communication.

(b) Responses to the question asking for a description of the morphological differences (internal and external) between bivalves and cephalopods were variable in quality and it proved to be a good discriminator. The wide range of valid possible answers benefited well prepared candidates and at the top end there were some superb, well illustrated answers which gained the maximum 12 marks available. The best answers gave a point by point comparison of the differences between the two groups, but candidates that gave good separate descriptions of bivalves and cephalopods were also able to attain the maximum marks available. There were 8 marks available for diagrams which some candidates took full advantage of. Good use of diagrams for morphological questions always benefits candidates as they serve as a reminder and basis for written descriptions of the morphological features.

Weaker candidates did not know the morphology of Molluscs in sufficient detail, were unable to produce suitable labelled diagrams, and struggled to make any credit worthy comparisons between the two groups.

A significant minority of candidates confused bivalve morphology with that of brachiopods; others discussed gastropods rather than cephalopods; and a number decided to write an essay on the difference between bivalves and brachiopods rather than answer the question asked! These candidates were able to gain some credit for their discussion of bivalves if it was correct. Some candidates digressed into descriptions and comparisons of modes of life which was not asked for in the question and others penalised themselves with poor technical vocabulary and spelling.

2835: Petrology (Written Examination)

General Comments

The examination paper this session gave a full range of responses, with a large variation amongst centres. There were though many excellent scripts utilising technical terms very effectively and clearly demonstrating a good understanding of the relevant subject matter and concepts. Centres had clearly heeded advice give in previous reports and some of the traditionally more difficult concepts were well answered. In this A2 examination it is essential that answers include sufficient detail and not just general statements. This paper is synoptic on the three AS modules and it was clear that some candidates had not revised the AS material. This was especially the case with Question 4 when responses in general were poor and showed that centres and candidates may have overlooked the area of hydrothermal mineralisation and ore formation. There has been a considerable improvement in the quality and relevance of diagrams with candidates able to gain considerable credit from their effective use

Comments on Individual Questions

Q1 This question on igneous petrology led to a wide range of marks including several maximums. The marks were readily available if the specification had been covered and this question proved to be a good lead-in. Some candidates though did have problems with igneous rock geochemistry.

(a) (i) This part question proved to be reasonably well answered with candidates having a clear understanding of the use of SiO_2 in igneous rock classification.

(ii) This was generally poorly answered; many candidates simply gave lists and made no attempt to compare the various oxides. The key element here is relating the % oxides present to acid rocks.

(iii) Very few candidates achieved maximum marks for this part question. Many have a poor conception of the relationship between silica content and quartz content in igneous rocks. Only a small number recognised that silica content is measured as a total percentage in the rock or were able to link an excess in silica to quartz formation.

(b) (i) A large number of candidates are not conversant with the concept that average crystal grain size in igneous rocks is taken across the entire range of crystal sizes. Many simply incorrectly referred to the mode (most common crystal grain size), rather than the mean.

(ii) This part question was answered very well though some candidates gave a range of sizes, rather than a single figure or were out by a factor of ten.

(iii) Recognition of porphyritic texture was good and the majority of candidates were able to explain how it formed with reference to a two stage cooling process. Some candidates incorrectly referred to the texture as porphyroblastic, thus showing an inability to distinguish between igneous and metamorphic rocks. Care does though need to be taken with the correct spelling of technical terminology.

(iv) The recognition of the poikilitic (ophitic) texture was answered correctly by a pleasing number of candidates. The explanation of its formation though was often vague, with a large number of responses being a description rather than an explanation which is what was required

(c) (i) Many candidates have a poor understanding of the term ‘mafic mineral’, although reference to dark coloured was made by a significant number.

(ii) Where the concept of mafic minerals was understood, there were some good responses, however a surprising number of candidates used biotite and hornblende as examples suggesting a lack of knowledge of the essential mineralogy of the key igneous rocks.

(iii) Although a large number of candidates recognised that plagioclase feldspar composition varies from calcium rich (anorthite) at high temperatures to sodium rich (albite) at low temperatures, only rarely was there a reference to the table and the three rocks specifically. Common misconceptions included reference to the amount of plagioclase feldspar rather than the composition.

Teaching Tip:
Chemical compositions of igneous rock can be taught using graphical representations as both line graphs and bar charts. Students should be encouraged to discuss the trends of the major oxides not just silica.

Rock textures can be taught using an exercise that matches descriptions and photomicrographs. Presentations or card matching of texture and definition are useful techniques. This could be carried out not just for igneous rocks but sedimentary and metamorphic also.

Students could develop a concept map of textures, that includes diagrams, formation notes and locations of formation.

Q2 This question was generally well answered allowing a wide range of marks including several maximums. The progression from AS to A2 seems to be limited, with many of the same problems such as misuse of sediment / rock terminology and weak lithological descriptions.

(a) (i) A large number of candidates were confused between sediment and rock terminology. Marks were lost where candidates failed to understand the term clastic and therefore named the sediment type as an evaporite.

(ii) The majority of candidates showed very little use of terminology associated with energy conditions. AS type answers were in abundance with little expansion beyond the basic fact that coarse material is not transported very far because it is heavy. Responses needed to be more precise with reference to points E and G.

(b) (i) This part question was on the whole poorly answered, with textural and compositional maturity rarely defined. Only a minority of candidates were able to explain textural and compositional maturity.

(ii) On the whole this part question was well answered.

(iii) On the whole this part question was well answered, although spelling of 'alluvial fan' was occasionally incorrect. Common incorrect responses referred to the environment as fluvial.

(c) This part question was answered reasonably well by the majority of candidates where a good AS grounding was beneficial. As the sand was wind blown, the scale should have been appropriate (medium sand), with clear reference to grain shape and sorting along with hematite cement and a frosted appearance to the grains caused by attrition and abrasion.

(d) (i) The vast majority of candidates were able to name the temporary lake as a playa or ephemeral lake.

(ii) The major omission by candidates was lack of detail. A large number of candidates had a general idea of the origin of the evaporate minerals but only on rare occasions was reference made to chemical weathering and mineral solubility.

(iii) A large number of candidates were able to explain the origin of salt pseudomorphs often using clear labelled diagrams.

(e) This part question gave a good range of responses; the majority of candidates were able to identify a minimum of two of the three minerals. A common omission was biotite for mineral J, with candidates referring to the mineral simply as mica.

Q 3 There were some excellent responses to this question on metamorphic rocks including several maximums although it again showed a distinct lack of A2 awareness concerning the depth of response and the use of technical terminology.

(a) This part question led to surprisingly few candidates achieving maximum marks. Most candidates achieved one mark per factor, but failed to achieve maximum marks as answers were generally aimed at an AS level not at the depth required for A2. With reference to temperature, many candidates equated increased temperature to increasing grade and increasing crystal grain size was only referred to by a minority of candidates. A common misconception was the higher the temperature the faster the metamorphism. In terms of pressure, only rarely was reference made to pressure type, whether it is pore, directed or hydrostatic. Candidates often referred to mineral alignment in relation to pressure or increased grade due to higher pressures. Only on rare occasions were the two linked together.

(b) (i) This part question was answered correctly by the majority of candidates who were able to identify marble and (meta)quartzite respectively.

(ii) The majority of candidates made reference to the shale being polymineralic, but only the higher scoring individuals made reference to a wide variety of elements present and the relationship between new minerals and specific temperature and pressure conditions and that surface area increases the speed of a reaction, suggesting that candidates tend not to import their science learning into a geology context.

(iii) Very few candidates understood the term metamorphic zone; many confused the concept with aureoles. Index minerals were a little better understood, although again descriptions were often vague. If candidates could define an index mineral they tended to know what an isograd was; weaker candidates referred to them as areas rather than lines joining points of equal metamorphic grade.

(iv) Although a relatively straightforward part question, the responses proved to be varied, with many weird and wonderful patterns delivered. Weaker candidates lost marks by simply joining up the minerals as a dot to dot exercise.

(c) Very few candidates were able to achieve full marks for this part question. Responses were often vague and failed to refer to specific Al_2SiO_5 minerals and the specific temperature and pressure conditions under which they were formed.

(d) (i) A pleasing number of candidates were able to recognise wollastonite as the new metamorphic mineral, many though failed when trying to give the correct chemical formula.

(ii) Knowledge of metamorphic reactions has certainly improved and the vast majority of candidates were able to refer to the loss of carbon dioxide from the system as it was open.

Teaching Tip:
A good way of teaching metamorphic definitions would be to muddle up a series of definitions and link them to keywords. This could be used successfully as either a starter or plenary activity with definition domino cards or card matching.

Q 4 This question was generally poorly answered with a large number of candidates showing a limited understanding of hydrothermal mineralization and ore formation. Candidates showed a distinct lack of revision of key concepts thus leading to this question generating a low mean mark.

(a) (i) Knowledge of the main ore minerals was varied; some candidates correctly gave all four, others just one or two. The major incorrect response was malachite as a hydrothermal ore of copper.

(ii) The processes for mineral zoning were clearly not understood and many candidates confused this with the origin of the metamorphic aureole. Reference to molten lava was made rather than hydrothermal fluids. Mineral solubility was occasionally referred to but rarely linked to specific temperature conditions close to and away from the intrusion and how this related to which minerals were precipitated where.

(b) (i) The explanation of a gangue mineral and naming an example allowed most candidates to score some marks.

(ii) This part question was generally answered well with candidates able to achieve maximum marks. A symmetrical pattern was usually shown along with clear labelling of the country rock. Only more able candidates were able to label specific minerals and relate them to order of crystallization, from the vein wall towards the centre.

(c) Most candidates had some understanding of what pegmatites are, however were only able to describe them as rocks with large crystals. The actual description of how they formed seldom gained more than two marks of the three available. A firm clear description of how they formed was rare.

Teaching Tip
Growing large copper sulphate crystals in the lab takes patience as the solution needs to be regularly replenished in order to keep it saturated. This makes an excellent analogy for the growth of the exceptionally large crystals in pegmatites which grow as a result of crystallisation from a super saturated solution from the residual magma rather than millions of years of slow cooling.

5 The extended prose required gives 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)

(a) There were some good responses on magmatic differentiation even from candidates who had not done so well in the rest of the examination. There was a wide range of responses. Most candidates were able to discuss only one or two magma formation concepts usually fractional crystallization and gravity settling. Bowens Reaction Series was clearly understood and a large number of candidates was able to relate the order of mineral crystallisation to temperature but was often unable to link this to how the overall composition of the melt was affected and more than one rock type formed. Reference to assimilation, magma mixing and filter pressing tended to be centre specific. A small but significant number of candidates wrote complete responses on the classification of igneous rocks, including discussing crystal grain size and rates of cooling, missing the point of the question entirely and thus gaining zero marks.

(b) There were some excellent responses to this question proving that limestone is an accessible topic from the specification. Well prepared candidates could describe clearly the characteristic products and the processes responsible for their formation. Limestones were understood to be different to clastic rocks and many candidates were aware of the variety of different forms that existed. Clear explanations of processes of formation in terms of environmental conditions and energy conditions were given. Some candidates were unable though to describe clearly a bioclastic limestone, with many relying upon a description of ‘a rock made up of dead animals’. A clear definition of a bioclastic limestone using A2 terminology was rare.

2836: Geological Skills (Written Examination)

General Comments

The Geological Skills examination is synoptic so requires knowledge of all the other modules. Many candidates will not have sat AS modules since the previous summer session and their knowledge of topics covered in these modules was at times a problem. A good knowledge of structural geology from 2831 is vital for the sketch of a structure and the geological history of a map. The skills for this paper can be practised so teaching the skills as a topic is essential preparation for this examination. The skills listed in the specification include graphic logs, geological maps and geological histories. The quality of the sketches from the photograph was very mixed and even the help of a colour photograph did not aid the identification of the features illustrated.

A major problem seen throughout the paper is the confusion of technical terms between sedimentary, igneous and metamorphic, which given the petrology paper just a week earlier is a surprise. In part, this may be due to not reading the stem of the question where it states that it is an igneous rock, yet candidates gave answers using metamorphic terms. Some candidates missed marks by not reading all the information at the top of the page.

There was no evidence that candidates could not complete the paper in the time and there were very few questions left blank.

Comments on Individual Questions

Q1 This was a high performing question with many candidates with full marks. The general standard of geological histories continues to rise with very few lists or histories in the reverse order. Structural geology continues to be a problem for some candidates and particularly the use of technical terms.

(a) (i) A common error was to miss out the axial plane trace on the left block where it has been displaced by the tear fault, despite drawing it across the other three fault blocks. This is a basic skill common at AS so should be known by all candidates.

(ii) The dip angle was wrong in a large minority of scripts. Some put values of 35-40 degrees which would make the fold nearly symmetrical which the outcrops are not. Occasional wild estimates of 120 -160 degrees illustrate a lack of understanding.

(iii) Only the weakest candidates failed to get two marks for the description of the fold. However, a few candidates identified the fold as a syncline which is another AS basic to identify the main fold types.

Teaching Tip
Have fun with modelling clay, plasticine, playdoh, sand and blocks creating faults, joints and folds.
Get a small cardboard box (preferable cube shaped), cover it with plain paper and use marker pens to draw on structures seen on each face, to get an idea of 3D views.

(b) Most geological history answers were very good with full descriptions but a significant minority lacked detail. The mark scheme is a list but the answers expected need to have descriptive detail. A particular example of this problem was the lack of detail on the intrusions which were not identified as dykes or described as discordant, nor was it noticed that the intermediate dykes were intruded along fault lines. Few observed the horst in the centre or identified the fault in the west as a tear fault even when they had correctly displaced the fold axial plane trace for part (a). The other common omission was the tilting of the conglomerate to the NW. Surprisingly, a number of candidates confused the order of deposition of the beds giving the mudstone as the youngest even where they had correctly identified the fold as an anticline.

Q2 This was the least well done question with few candidates gaining high marks overall though many had high marks on either the metamorphic parts or on the igneous parts but rarely on both. Overall there seemed to be limited transfer of knowledge from the petrology unit.

(a) (i) There were many full mark answers here. The question needed candidates to be aware of the concentric nature of the metamorphic boundaries and to draw them reasonably accurately.

(ii) Marks were lost because the aureole was drawn but not labelled.

(b) (i) Knowledge of hornfels was very poor. A minority began to describe features of hornblende instead - referring to cleavages at 60 degrees and colour. Only the more able candidates scored the mark - usually referring to hardness, or a totally recystallised / granoblastic texture. However others referred to regional metamorphic rocks such as gneiss.

(ii) This question on spotted slate illustrated the confusion in terms by describing the spots as phenocrysts, or related to cooling rates or even as vesicles. 1 mark was often achieved, but only the better candidates gained 2 marks. Some centres correctly referred to andalusite or chiastolite but only a few used the terminology "thermal / contact metamorphism", which is surprising.

(c) (i) The xenolith was correctly identified by about 40% of candidates. The use of colour photographs allows a greater variety of features to be used. Only a few put the American term xenocryst. Many candidates identified the feature as a phenocryst (with some good error carried forward marks for part (ii)). Porphyroblasts was another answer given but when the question stated that the rock was a granite this again shows the confusion in terms. Odd answers gave mineral vein, "biotite blob", augen, pyroclasts or mica.

(ii) The use of (ecf) error carried forward ensured that good responses were awarded marks. Terms such as partial melting, stoping and assimilation were seen in the best answers.

(d) (i) Quartz was commonly given as the white mineral but it is grey on this photo and the feldspars are white. Answers given included calcite or garnet rather than igneous rock forming minerals.

(ii) The formation of a batholith was not well understood with only the most able achieving 2 marks, Reference to a plutonic setting and slow cooling was common but reference to the involvement of a continental plate at a destructive plate margin being partially melted was rare. In some cases the granite's large crystals were described rather than the conditions of formation of the batholith.

> Teaching Tip
>
> Create slide shows of lots of different features including igneous and metamorphic textures listed in the specification to encourage candidates to recognize them. Images downloaded from the web are often ideal and students are often excellent at producing these presentations as a whole class resource.
>
> Garden centres and DIY shops often sell Shap granite for ornamental stone - a hunt around can often yield a £2.50 boulder with a nice xenolith. Look for xenoliths on facing stone on shop fronts. Suppliers of kitchen work surfaces usually have broken bits of granite, some of which contain xenoliths – and they are free!

Q3 This question was synoptic on 2834 and 2833 and some candidates were not prepared for these topics. This is another question where many candidates performed very well on half the question – either fossils or coal but rarely both.

(a) (i) Fossils were not well known at all. Only a handful of scripts had totally blank boxes, but very few got 2 marks. The biggest problem was the fact that candidates had not read the stem which stated that the fossils were from the Carboniferous Coal Measures, so that they identified them as corals or graptolites. Common mistakes were identifying C as a brachiopod.

(ii) Many good answers were seen here on zone fossils with a clear understanding of slow evolution and long time range of the organisms shown. The main error was a belief that plants are good zones fossils as they were believed to (1) be restricted to the Carboniferous or (2) be good indicators of palaeoenvironment. This confusion with environmental indicators or even with preservation potential reflects a problem with applying knowledge to a new situation.

(b) (i) The coal seams were often well drawn, even by weaker students, so full marks were common. Some careless errors were made due to not reading the question carefully – such as seams not dipping west, multiple seams drawn rather than the single seam specified in the question and no labels or correct symbols.

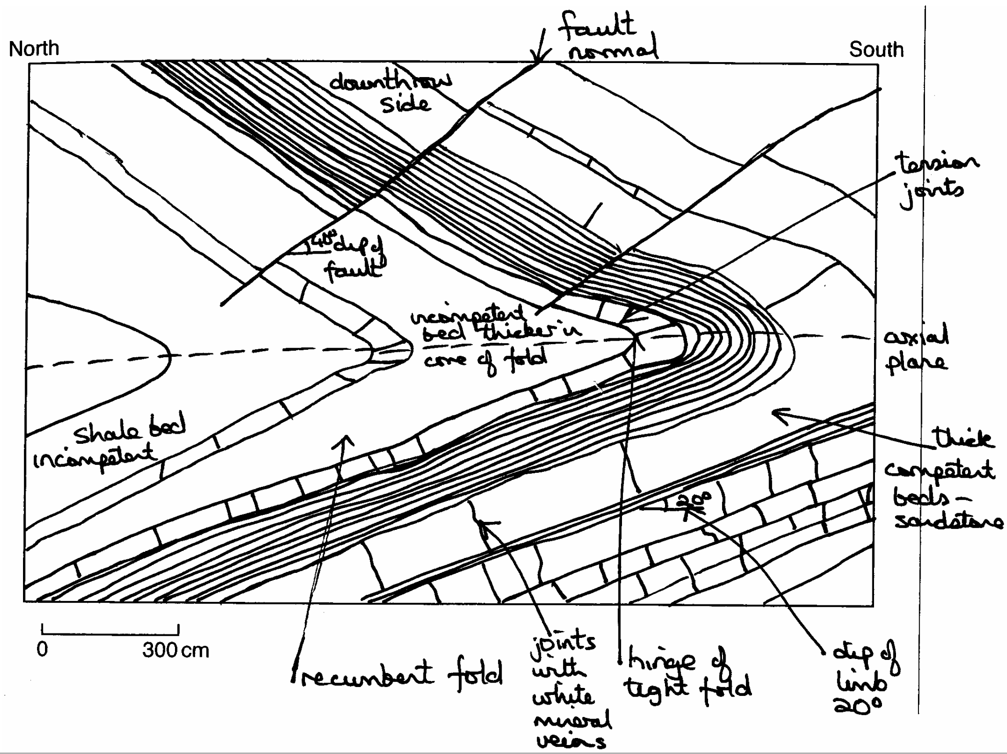
(ii) Only about a third of candidates recognised that the washout sandstone had eroded the coal, rather than being deposited on top of, or instead of the coal.

(c) A reasonable effort was made, but few candidates achieved maximum marks as the answers were often not precise enough. Some discussed problems of mining in general such as washouts or seam splitting, which are not caused by post-depositional faulting / folding. Displacement of seams by faults and flooding along fault planes were most often quoted. Imprecise answers such as 'the faulting damaged the coal' or 'folding caused the seams to disappear' did not gain marks.

Q4 The quality of sketches varied from excellent to weak. In this question the candidates were also required to describe the features and this means descriptions using technical terms. The same mark was not given for a label on the sketch and then a mention in the text.

Some of the sketches were very weak, lacking detail, drawn in pen rather than pencil and with few labels. However, artistic skills and shading are not needed and as on the example below it is not necessary to include all the detail for all beds on the sketch.

Few candidates attempted more than a few labels and many omitted the most basic features such as measuring the angle of dip of the beds and faults. When labelling a fold - recumbent fold, and terms such as crest and limb gain credit. Labels such as “white rock” or “thin rock” are vague but terms like “uneven bedding” or “laminated bed” are sufficiently detailed. Similarly, a fault has upthrow or downthrow, the angle of the fault plane and type such as normal. A fault by definition must displace the beds so the fault on the sketches had to show displacement. Vague use of technical terms such as cracks and fractures instead of joints did not gain marks



Teaching Tip
Using a photograph projected onto a whiteboard is ideal for class work with students finding as many features to label as possible and drawing over the photograph the main features for the sketch. There is a very good range of geological photographs on the internet which allows a lot of skills work.

Q5 This question was synoptic on 2835 and 2831 and was often answered very well.

(a) (i) The identification of the rock types was generally well done: sandstone was very well known and shale fairly well known, though the weaker candidates put mudstone or slate, ignoring some of the detail in the question. Greywacke was the least well known with common errors of conglomerate, breccia, glacial till.

(ii) The identification and description of the environment was variable. Many candidates associate sandstone with aeolian / desert environments but in this case it had to be water-laid given the mica content. Shale as a deep marine / low energy deposit was very well known. A few thought a lake environment was possible having ignored the graptolites. Greywacke being formed from turbidity currents was not always well known.

(b) (i) Basalt was correctly identified by most candidates though a few put dolerite and rare answers included granite and mudstone.

(ii) Cooling joints were well known by most candidates though a few opted for pillow lavas and even desiccation cracks! Some identified the feature as the Giants Causeway or Fingalls Cave without naming it.

(iii) About 95% of responses referred to rapid cooling of the basalt rather than the steady cooling of a large lava flow. The idea of contraction into hexagons was well known, but only the strongest candidates referred to cooling centres. There were some good diagrams of cooling centres but they were not always labeled so that they did not contribute to the answer. In some cases the lack of technical terms such as fracture instead of joint limited marks.

2833 / 2836: Geology (Coursework)

General Comments

Many very good examples of coursework were seen this year and it is evident that most centres are carefully examining the OCR mark scheme and then carefully planning interesting and challenging coursework for their candidates. Interesting work has been produced from a variety of topics that includes;

- Sieving mystery sediments for AS.
- Planning experiments on porosity, permeability for AS.
- Lab work using wallpaper paste at different viscosities to mimic magma, this has been done successfully for both AS and A2 work.
- Fieldwork to examine joint orientations for AS.
- Fieldwork looking at environments of deposition of a range of sedimentary rocks AS and A2.
- More complex fieldwork looking at a variety of rocks and cross cutting structures used at A2.
- Using shells to examine the amount of resistance shown to mechanical breakdown and relating this to environments of deposition for A2.

Many moderators commented that they received very helpful and interesting background information which outlined the task, or showed what answers the candidates were expected to come up with.

The issues which arose were unfortunately the same ones which have occurred over previous years. A few centres still incorrectly fill out the MS1 form with marks out of 30 rather than 60, effectively reducing candidates marks by half, as OCR use these forms to record a candidates initial coursework mark. A small but significant number of centres had addition errors when coursework, summary sheet and MS1's were compared; this then requires a form to be sent out to centres and for the centre to return this with the correct marks shown. We did experience some difficulties with a few centres this year failing to return the forms as requested, necessitating several phone calls to exams officers.

It is important that centres securely attach all of an individual candidate's work together; there were several cases this summer where there were loose sheets, where it was almost impossible to tell to whom the work belonged.

Correct cover sheets are essential e.g. 2833 cover sheets for AS and 2836 for A2.

Tip;
Put each candidate's work into a clear plastic wallet. This way weight is kept down and the cover sheet can be clearly placed at the front of each candidate's pack, with all the relevant work stored securely behind. Loose pages from field note books can be either torn out or photocopied and placed within the wallet.

Some centres like to cover all skills in one piece of work, whilst others like to use two for specific skills, whilst a small number can use up to four or five pieces of work to cover all or some of the skills. This is perfectly acceptable, but it was noticed by several moderators that the candidates who were being asked to complete several pieces for all skills were usually producing much less substantial and also much lower quality coursework, than those candidates who only had to cover each skill once! It seems to have become a case of candidate overload and does appear to disadvantage them. If several exercises are used, it is possible to cut the number of skills covered.

In a very small number of centres problems arose when multiple pieces of work were being submitted;

- Some centres wrote to the moderator saying they thought work of certain candidates was similar for different pieces and asking the moderator to choose! This cannot be done and is not the role of the moderator.
- A few centres carried marks for certain skills across two pieces of work, for example; in Skill P one piece of work might have a hypothesis whilst another had factors to vary and /or control. This also is clearly not allowable.
- Some centres had submitted work for a particular skill where the work did not achieve the mark awarded, whilst another non examined piece did meet the criteria, appearing as if the wrong piece had been recorded.

Skill P Planning

This skill is a plan so candidates should write a plan in advance. Give sufficient time and background to the task to allow meaningful research to be carried out. Encourage each candidate to come with their own problem or hypothesis to investigate. There are no mark deductions for a wrong hypothesis, if anything it can allow a candidate scope to elaborate later on as to why they were wrong, picking up many valuable marks!

The use of "I will investigate the geology of…" is rather vague. Students need to focus on predicting what they might find.

e.g. 'Can any clues be given about likely linear features in the area; what might then have caused this?'

Information on the age of rocks at a field locality could be given to candidates as could information on what rock groups to expect. This could help to focus their research on rock types.

Whenever possible try to carry out a trial run, as this will show the errors and difficulties, to make candidates think of ways to solve their problems. If the coursework is carried out as part of a residential week, then do the trial run earlier so there is time to discuss before the assessed day.

With lab work such as sieving, problems nearly always arise with leaking sieves giving scope for valuable discussion about fair testing;

- what factors should they control, why?
- what factors should they vary, why?
- what measurements should they make?
- how many measurements?
- what equipment to use?
- what are the safety issues?

By careful use of questioning, a whole range of mark descriptors can be covered!
Guidance sheets could also be issued to with descriptors, with more than one requirement.

Which are the descriptors that cause problems?

P1a/P3b; fair testing, choosing the factors to vary/control.

P1b; worryingly quite a few centres had no equipment list and a search had to be made throughout the whole work to find any reference to what was used. This happened mostly on fieldwork exercises. Use a list. That way it is there and can be credited!

P3b; what measurements are to be made and how many.

P5a; Many centres think just a line or two about the geology of an area is sufficient, but this is incorrect. Candidates have to demonstrate a suitable level of understanding, as completion of this level allows them to access 6 out of 8 marks, so a reasonable level of response is needed. Equally some centres had candidates producing in excess of 20 pages just for P5a; this is quite excessive and should be reduced. Some centres think this descriptor only needs safety; it must be done as well as the background. Some centres successfully use a preliminary study instead or in addition.

P7a; to prove that secondary sources have been used a bibliography should be included and information could then be incorporated into the candidates text, with quotes or footnotes used to clearly show they have referred and utilised these resources.

P7b; for this descriptor there has to be some justification as to why the strategy chosen will give reliable results. This is often a lot easier when a trial run has been carried out.

Skill I Implementing

Some very detailed data is being collected, both via fieldwork and laboratory work. Many centres are using useful annotations or tick sheets to show how the candidates worked in these situations, this is especially useful for fieldwork, where often they work in groups, and look at the same sites. The other advantage is that they can be very quick and easy to complete.

Moderators who received no information from centres plus no annotations on the candidates work did this year struggle, especially when the whole group had been awarded 7 marks when there where clearly great differences in the quality of the data being produced. This did happen on many occasions. The moderators did not feel that it was clear why the poorer quality work had also been awarded maximum marks. Whilst there is no compulsion for teachers to have to write on the candidates work, there are times, such as this when some communication can be beneficial and aid moderation.

Please do not send in complete field note books, as this greatly adds to the weight and cost of postage. Pages can be torn out, or photocopies sent (many centres used this option this year).

Skill A Analysis

In general the lower level descriptors are not causing too many problems for candidates, giving most candidates a good opportunity to achieve up to 4 marks. Relatively few candidates are falling into this range, those that do are often achieving similar low marks in the other descriptors.

Which are the descriptors that cause problems?

For A3a a good range of techniques are being presented, however a small number of centres are not doing any graphical techniques at all. Text alone or even photos are not sufficient to fulfil this descriptor. Suitable techniques include graphs;- bars, scatter, histogram etc; rose diagrams and sedimentary (graphic) logs.

A5a is now producing a lot of excellent work, including an increasing range of to scale maps drawn up on blank paper or even marked over photocopies of OS map sheets, field mapping using base maps, some excellent detailed and to scale graphic logs and a range of statistics, the most popular being; Spearman Rank, Chi Squared and Standard Deviation.

Teaching tip;
If rose diagrams are to used for the A3b level descriptor it can be a good idea to do a trial run in class using a different topic area, where examples on how to interpret them and make the most of the information they convey can be discussed.

As with Skill P the higher level descriptors need increasing amounts of detail. A couple of sentences will not suffice for A5b and candidates must use their findings combined with the recognised theory to access this level. A lot of candidates had been marked at this level or above when clearly only a couple of sentences had been produced. In reality this would only reach A3b, resulting in mark reductions.

For centres doing sediment sieving a detailed mathematical analysis fulfills A5a but does not achieve A5b or A7a, as it is not using geological knowledge.

For A2 the synoptic element must be included and several centres, produced entirely AS theory based work.
For A3; background knowledge from different parts of <u>one</u> module must be included, e.g. erosion and dykes are both from 2832.
For A5; different AS modules must be used e.g. Dykes and faults from 2832 and 2831.
For A7; information from parts of the AS and A2 specification must be used, e.g. Dykes and fractional crystallisation. A sedimentary log using fossils and palaeo environmental analysis of the rocks will use 2832, 2834 and 2835 if well chosen.

<u>Skill E Evaluation</u>

This is still the weakest descriptor, but there are definite signs that a lot of centres are improving and creating guidance sheets. Some candidates were using sub headings which helped to guide them to the descriptors and as a result the marks for many centres were good. However there are still a number of centres where there is little or no guidance given and candidate comments are vague about what they would improve. This only meets E5a and as the lower descriptors have not been met an award of 0 should be given.

Which are the descriptors that cause problems?

For E1a candidates should comment on the suitability of the techniques. This does not mean a moan about the weather, or the problem of lack of time.

In E1b anomalies MUST be referred to, if there were none then the candidate should say so in order to obtain the mark.

E3a needs comments on the limitations experienced.

E3b needs comments about the causes of anomalies / reasons for problems with the results.

For E7a the improvements described must also explain how this could increase the reliability of the results. For E7b candidates need to outline how significant the limitations and errors they had previously mentioned in skill E were on the overall results.

Teaching Tip;
If this skill causes problems, why not try a whole group discussion after the work has been carried out to allow students to raise issues regarding the anomalies encountered, the reasons for them, as well as looking at ways to improve the exercise. This can help make candidate's aware of issues they had experienced but had not perhaps thought relevant.

What can be done if a student is ill and misses the Fieldwork?

If this happens the main difficulty is that the student has missed the chance to collect their own data, make observations and collect measurements. They will also not have been observed in action using clinometers etc.

Ways to solve could include collecting samples of the representative rocks to take back to the centre, so the candidate could carry out their observations and measurements later.

Photo evidence can be used to enable them to carry out remote field sketching, macro observations and identification of major geological features.

To test their understanding of the use of a clinometer, sloping surfaces at the centre could be used for the candidate to demonstrate the principles behind measuring dip and strike.

If the teacher is satisfied that the candidate has demonstrated the skills relevant for Skill I a suitable mark could then be given. If it was all completed to a high level then maximum marks could be awarded.

At this stage, the candidate could be given access to the others students collected data to enable them to complete the remaining skills.

Advanced GCE Geology 3884/7884

June 2006 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	D	e	u
2831	Raw	60	44	38	32	27	22	0
	UMS	90	72	63	54	45	36	0
2832	Raw	60	46	40	34	29	24	0
	UMS	90	72	63	54	45	36	0
2833	Raw	120	93	83	73	63	53	0
	UMS	120	96	84	72	60	48	0
2834	Raw	90	67	60	53	46	40	0
	UMS	90	72	63	54	45	36	0
2835	Raw	90	56	48	40	33	26	0
	UMS	90	72	63	54	45	36	0
2836	Raw	120	89	79	69	59	49	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	17.9	37.7	59.7	77.3	91.4	100.0	1223
7884	23.6	48.6	71.3	88.8	97.1	100.0	753

1976 candidates aggregated this series

For a description of how UMS marks are calculated see;
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

Statistics are correct at the time of publication

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