OCR
RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE **A2 H487**

Advanced Subsidiary GCE **AS H087**

OCR Report to Centres

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Oxford Cambridge and RSA Examinations

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This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

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OCR REPORT TO CENTRES

Overview

General Comments

Overall, there was evidence of good geology, indicating that many candidates had been well prepared and had worked hard to understand basic principles and processes. The pattern of entry for the units was similar to the previous year though a few more candidates were entered for F795. All the units discriminated well and candidates achieved a wide range of marks. There were very few part questions that were regularly omitted and these tended to be those on topics that had not been examined before.

It is pleasing to note that Centres are making use of previous mark schemes to inform candidates of the level of precision required in answers. Candidates need to realise, however, that they cannot use a 'one answer fits all' approach to questions. It was evident in a few questions this session that the context and approach of the question had not been appreciated and a generic answer cannot gain high marks. Highlighting or underlining key words or phrases in the question can help provide focus for the answer.

The rubric for QWC questions is clearly stated in italic text next to the pencil icon, and requires a specific term spelled correctly for F791 and F794. Candidates should be aware that the QWC rubric in F792 and F795 is specific to each question and particular attention should be paid to its requirement, as it not only sets out exactly what candidates need to do for the marks, but also helps to keep the focus of the answer. While past papers can be a useful resource in preparing for examinations, candidates should be aware that it is unlikely that a learning outcome will be tested in the same way in a subsequent paper. Rote learning of previous mark schemes will not be appropriate for answering all questions on a topic. Candidates are expected to apply knowledge in different contexts – something that they do not always recognise.

Centres should continue to stress the importance of using specific geological terms in their correct context with correct, unambiguous spelling at both AS and A2. The correct use of technical terms helps discriminate between candidates. Unscientific language and using inappropriate or incorrect terms can mean that marks are not awarded. Reading all parts of a question is essential. Often a valuable clue is given in the question, such as telling candidates that the answer should be from a particular group of rocks or fossils and this can make a big difference to the marks gained. Descriptions of trends in data or graphs should indicate the broad tendency of one parameter to vary with an increase or decrease in the other. In numeric answers the appropriate units should be stated.

Geology papers have a rationale of lines allocated per question. The general rule used is two lines per mark unless part of the answer is a diagram or a single word or phrase. Candidates run the risk of wasting time and effort on a question that does not warrant it, if they are exceeding the line allocation. For most candidates, there are adequate answer lines for each question, but some candidates may use more space than that provided and continue answers on other parts of the page or paper. As noted in previous reports, it is very important for candidates to indicate clearly if their answer to a question extends beyond the boundary of the lines or space allocated for the response, and also to indicate where the rest of their answer is to be found. The initial view that examiners see is of the allocated space that follows the question, and so guidance from the candidate will ensure that any extension of their answer is found. Candidates must use the additional lined pages at the end of the question paper for their extended answers, rather than separate answer sheets or answer booklets.

If a question asks for both description and explanation, candidates should expect to be rewarded for demonstrating both skills. Many candidates answer explanatory questions poorly often describing rather than providing reasons for the explanation. A comparison needs to give a point for *both* of the rocks or fossils being compared. A list or one word answer is not sufficient for a *description*, but is for a question that just asks to *state*.

F791 Global Tectonics

General Comments

Candidates generally performed well, although relatively few scripts with marks above 50 were seen. Candidates are improving in their understanding of the new elements in the specification. However, “black smokers” has not been tested before and this topic did prove difficult for most candidates. The use of magnetic inclination also proved problematic especially linking it specifically to latitude. Diagrams were generally well drawn and labelled, although the divergent plate margin diagrams could have been clearer. Very few candidates gained very low marks, indicating well prepared candidates. There was no evidence of candidates running out of time, and encouragingly, very few candidates missed out part questions.

In addition, candidates showed a sound understanding of seismology and mid-ocean ridges. Understanding of structural features was particularly impressive.

Comments on Individual Questions

Q1 Candidates have a good general understanding of seismology, and this proved a successful opening question for many.

a)(i) Most candidates were able to provide clear and concise definitions of earthquake focus. Candidates should be encouraged to indicate that the focus is below the Earth's surface directly below the epicentre

(ii) Almost all candidates knew that the epicentre is directly above the focus. However, as this question required the correct spelling, no alternative to the spelling of epicentre was accepted

(iii) Many candidates knew the depth range as being 0 – 70 km. It is worth candidates learning the accepted ranges for earthquake depths: shallow 0- 70km, intermediate 70 – 300 km and deep 300 – 700 km

(iv) Most candidates were aware that the rocks at this depth are very hot and that the subducting plate will have partially melted. Many good candidates used terms such as rheid and ductile to describe the nature of the rocks and consequently why stress cannot build up and the rocks cannot fracture

b)(i) Candidates were expected to both describe the methods of predicting earthquakes and indicate how they worked.

- For the seismic gap theory many candidates talked vaguely about gaps in seismic activity but needed to link it to mapped historical records and the build-up of stress in the “gaps” where the fault was locked.

- Candidates had a better understanding of the use of radon gas. Many knew that radon was the main gas and could link it to the formation of micro fractures leading to an increased gas level prior to an earthquake.

Some candidates talked about predicting volcanic activity rather than earthquakes

(ii) Most candidates could give a social consequence of earthquake prediction usually discussing panic and evacuation. Others discussed the problems associated with false predictions and loss of trust. Only a few candidates mentioned that a correct prediction would actually save lives.

c)(i) Most candidates knew that the Richter scale measures the magnitude or the energy released. A few candidates still mention power or strength of the earthquake rather than energy.

(ii) Less than half the candidates were aware that the amplitude of the waves on a seismogram is linked to the energy/magnitude. Many did have a vague idea that it was linked to the size of the waves but did specifically use the term “amplitude”.

(iii) Most candidates discussed the most likely cause of fires as being ruptured gas pipelines or sparks from fallen electricity cables.

(iv) Candidates have a good knowledge of earthquake damage reduction methods. It was important in this question that the candidates not only named or described a method but also explained how it works.

Question 2

Q2 Palaeomagnetism is a topic that candidates often find difficult, especially when asked to give a detailed account using the correct technical terms. As a result, this was the most difficult question on the paper for candidates.

a)(i) Many candidates could draw at least four correct lines of magnetism while a minority were unsure. Some candidates did offset the magnetic field away from true north to magnetic north.

(ii) Many candidates were aware that convection currents in the outer core are thought to be responsible for the formation of the Earth’s magnetic field. Also many knew that it is a “self-exciting dynamo”. Candidates did not always link the magnetic field to the existence of iron (and nickel) in the liquid outer core.

(iii) Most candidates were aware that magnetism forms when igneous rocks crystallise. It was expected that candidates would discuss the alignment of minerals on cooling. Many candidates were aware of the magnetism being fixed, a “frozen compass” or that palaeomagnetism is “permanent remnant magnetism”.

(iv) Candidates found this question very difficult. Questions about inclination have not been asked in such a specific manner before, as questions have normally asked about polar wandering curves. Candidates were expected to link magnetic inclination to the latitude of formation. Candidates could then discuss the use of polar wandering curves which some did. Very few candidates discussed latitude and polar wandering. Some of the best answers involved candidates who drew simple examples of two polar wandering curves to illustrate their answers.

b) Candidates could approach this question from two directions: either by linking the same rock types across continents, or by discussing rock types that form in particular climatic zones. Most candidates mentioned the same rock types found in different continents which gained a mark, but only a few of these candidates then mentioned the outcrops of these rock types matching up across the join of the continents. Some of the best answers discussed coal or desert sandstones found in Britain that would have originally formed on or close to the equator and must have drifted north to their current location.

Q3 Candidates struggled with answering the question on black smokers, the detailed characteristics of the abyssal plain and continental shields, as well as how fold mountains form. As a result this was a low scoring question overall.

a) Most candidates knew where all four features were located on the mid-ocean ridge, although the standard of drawings was mixed. Overall the standard of cross-section drawings of plate margins could be improved. Some candidates had the volcanoes suspended above the ridge or had the volcanoes away from the ridge rather than being centred on the ridge. Also some candidates labelled the axial rift in the centre but did not draw a valley

b) Very few candidates knew much correct information about black smokers although most offered an answer. Many answers suggested they were formed by small scale volcanic eruptions at the mid-ocean ridge. This is the first time that black smokers have been assessed since they came onto the specification and it is important that all parts of the specification are covered. Black smokers occur where sea water has percolated into oceanic crust and high heat flow causes rising currents of hot fluids containing dissolved metals. The superheated water then enters the sea water and immediately precipitates metal sulphides which build up the chimney-like black smoker structures.

c)(i) Most candidates knew the location of the continental shelf and slope although one or two candidates placed one or the other on the change of slope between the two and so gained no mark.

(ii) Many candidates knew that the continental slope has a dip of 4° and has submarine canyons created by turbidity flows. However, many answers were vague and some wrote about a steep slope.

(iii) Many knew that *abyssal plain* was the answer but about half of these candidates could not spell it correctly. Very few candidates could give two correct characteristics of the abyssal plain although many could give one.
Candidates must be able to locate these key features of the ocean floor and continents and be able to give at least two of their characteristics.

d) In a similar way to the previous question, candidates rarely knew three different characteristics of continental shields. With this type of question, candidates should use technical terms where appropriate and give detailed and precise answers.

e) Candidates gave general answers on how fold mountains form but few used technical terms such as folding, uplift, reverse/thrust faulting, crustal thickening, metamorphism, batholith or volcano formation.

Q4 In the past, structural geology based questions have proved to be difficult for many candidates. However, this question was very well done with the exception of part 4(a)(ii). Candidates clearly do know the main geological structures and how they form.

a)(i) Most candidates could select the correct term and link it to a definition. The main error was in giving apparent dip instead of dip.

(ii) A question on how dip and strike are measured has not been asked before and the expectation was that candidates would know that a compass/clinometer combination was required to complete the measurement. Some candidates knew vaguely how the measurements were taken with some discussing the use of protractors. Candidates should know how to take these measurements even if under simulated field conditions in a classroom.

b)(i) Most candidates correctly identified the faults. Some gave alternative names to step faults such as, stepped, stepping, staircase.

(ii) Fewer candidates knew the types of stress that were responsible for each fault type. Candidates do need to know the type of stress responsible for folds, normal, reverse and strike-slip faults. This should then be related to the appropriate type of plate margin.

c) Many candidates were able to draw horsts and grabens. The best answers clearly showed the feature as an upthrown or downthrown block between two other blocks. Candidates were expected to label the upthrown or downthrown side and use a marker bed. Some of the better answers also used arrows to show the relative movement along the faults. Very few candidates had the structures the wrong way round.

d)(i) Most candidates knew how a competent bed would behave when folded, recognising both the formation of joints and that the bed stays the same thickness around the fold.
(ii) Most candidates named sandstone or limestone as a typical competent sedimentary rock. Some candidates suggested an igneous rock such as granite.
(iii) Fewer candidates named cleavage as a structure that forms in folded incompetent rocks. Some candidates gave large-scale structures such as a specific fold type.

e)(i) The majority of candidates were able to clearly label the location of the unconformity.
(ii) Most candidates could also describe the sequence of events. Weaker answers did not name sequence C or D or missed out erosion. When discussing why the beds are dipping it is best to say that the beds have been folded rather than say they are tilted. Some also described the unconformity as being a singular event rather than something produced by a number of events such as folding, erosion and then deposition of younger rocks.

Question 5

Q5 This whole question was answered well by almost every candidate with very high marks commonly awarded.

a) The majority of candidates plotted the points accurately. A line was not expected, although many did join the points.

b) The majority labelled Mercury or Venus as the anomalous result. Throughout the paper there was little evidence of candidates missing a question. However, a few candidates did miss this question as they probably did not read it as there are no answer lines below.

c) Almost every candidate was able to make the straightforward link between distance from the Sun and surface temperature of planets.

Question 6

Q6 This question showed that almost every candidate knew that P and S waves had shadow zones and that they provided evidence for the nature of the outer core. Most knew the correct angles. A few wrote about a general shadow zone between 103^{o} and 142^{o} instead of being specific about it being the P wave shadow zone. Most knew that S waves stop at the outer core and knew that this suggested the outer core is liquid. Most candidates backed this up by mentioning that P waves are refracted or slow down at the outer core. This meant that many candidates could gain half marks.

The better candidates also discussed the evidence for the solid inner core such as S waves being regenerated or P waves speeding up. Full marks could not be gained without stating the depth of the outer (2900 km) and inner (5100 km) cores. Candidates needed to be specific about what controlled the velocity of seismic waves such as rigidity and density

for S waves, and rigidity, incompressibility and density for P waves. Many candidates restricted the discussion to whether the rocks were rigid or not. These depths and rock properties were only given in the very best answers.

Candidates should learn the depths of the Earth layers as well as their state. They should be familiar with not only how waves move, but also the properties of the rock that control the velocity.

F792 Rocks – Processes and Products

General Comments

There were some excellent scripts and the paper proved accessible to all. Few papers were incomplete suggesting that there was not a problem with lack of time. There was evidently a wide range of ability in the cohort and full marks were seen in nearly all questions. More able candidates were able to display their knowledge and understanding by attaining good marks in all areas of the specification tested. Less able candidates were able to achieve some of the marks available in each question – notably where AO1 (recall) was being tested.

The stem or first sentence of a question or part question often has helpful information to guide a candidate towards the correct area of the specification for an answer, but it is clear that some candidates do not read this part of the question. Candidates need to be aware of the command words in the question and ensure that the answers match these. Some scripts show that candidates are underlining command words to make sure that they tailor the answer to the question set which is a good idea.

The single largest issue is the confusion between *rock* and *mineral* which can affect answers to so many questions. Candidates need to be really clear that quartz for example is a mineral and that it is found in rocks including quartzite. The second area of confusion was mixing terms across rock groups, eg porphyritic texture in igneous and porphyroblastic texture in metamorphic rocks. Furthermore, there was a general confusion so that in answers to identify the metamorphic rock, responses from granite to arkose were seen.

Comments on Individual Questions

Question 1

Q1 This proved to be an accessible question on sandstones, with almost all candidates attempting each section, making this one of the easiest questions on the paper.

a) The majority of candidates knew the definition of a rock, with basic answers describing rocks as a mixture / aggregate of minerals. Very few candidates were clear about the definition of a mineral. General or vague statements about minerals as a collection of elements or a mixture of substances illustrated confusion about these fundamental terms was evidenced in many questions throughout the paper.

b)(i) A very good response, most candidates correctly identified the feature as a sand dune, with many developing this, and identifying a barchan sand dune.

(ii) A well answered question with the majority of candidates identifying the sedimentary structure correctly.

(iii) Some very good answers with the more able candidates including all the points in the mark scheme. The question required a description, so just stating low energy and nothing else was not enough detail, while *low energy on the inside of the meander bend* is a full description.

(iv) Many correct answers showed a clear understanding of the differences between sandstones in the three environments. The calcite cement for sand 2 indicates the beach environment B, while the well sorted grains of 1mm size in sand 3 indicate the windblown sand of the dunes.

c) There was a mixed response to this question. The more able candidates were clear about the processes of compaction and cementation, and often extended the answer over the four lines on the paper by writing below and at the side. For the majority of candidates compaction was a better response but generally just referred to weight of overlying sediments and pressure. The difference between the terms *matrix* where the grains are held together by clastic material often fine sand or clay and *cement* where the grains are held together by a precipitated mineral needs to be very clear.

d) This question highlights the need to develop the skills to be able to draw diagrams accurately using an appropriate use of scale. The best diagrams also included labels to accompany the correct drawing and scale. Labels were not requested but at times helped to clarify diagrams that were drawn with a range of grain shapes and sizes. The scale needed to indicate that the grains in the conglomerate were clearly greater than 2mm in size.

e) This question on a straightforward topic had a wide range of responses. The candidates who correctly referred to the processes of saltation and traction were able to write good descriptions of these methods. If the question had asked to describe the processes of saltation and traction, answers would have been excellent but in this case the question required the extra step, of first identifying the processes for specific rocks. Many candidates incorrectly believed that sand grains were transported by suspension. A few candidates included appropriately labelled diagrams of these methods.

Question 2

Q2 There was a very mixed response to this metamorphic question making it the most difficult short answer question. Metamorphism is often found to be a challenging topic and it differentiates well between stronger and weaker candidates. Whilst many candidates attempted the metamorphic questions, a large number found the mineral questions difficult to answer with very vague statements.

a)(i) Many candidates were able to define an index mineral as a mineral that formed under specific temperature and pressure conditions. Most candidates did relate the answer to metamorphism as stated in the question above, but unfortunately some weaker candidates made reference to igneous rocks.

(ii) Very few candidates were able to successfully mark the lines correctly on the diagram, although the question was attempted by almost all candidates. A large number of candidates drew the upper limit as the start of the kyanite rather than sillimanite.

(iii) Most candidates seem to recognise that this was regional metamorphism; a number confused it with contact metamorphism, and consequently often misidentified the rocks in the next question as contact rocks.

(iv) A number of candidates who correctly identified regional metamorphism were able to identify all three rocks. The most common incorrect answer was contact metamorphic rocks. A few candidates put shale instead of slate for low grade and others included igneous rocks or minerals.

(v) The vast majority of candidates correctly identified the parent rock as shale, although there were some wide ranging answers from limestone to granite.

b) This proved to be a difficult question. Only the most able candidates recognised that these minerals had the same composition, and were able to state the formula for these polymorphs. The main difficulty was where the candidate made a statement about one of the minerals without describing its difference from the other mineral.

c)(i) Generally a well answered question, a few candidates labelled diagram D rather than E, and unfortunately a few candidates lost the mark by just writing *garnet* but not clearly identifying it with a line to the appropriate feature.

(ii) The correct textures were often successfully identified. Some candidates incorrectly stated foliated and unfoliated or flow banding. A number of candidates had problems with the correct spelling of these terms.

d)(i) This proved a problem for a number of candidates, often with very vague answers such as just using a finger nail, or steel nail. Only a few candidates successfully described how you would test these minerals for hardness as stated in the question.

(ii) Some responses to this question were very vague and many just repeated what was already written in the question, with no real clarification. There was some confusion with rock cleavage.

Question 3

Q3 This question on volcanoes was the easiest and the best answered question on the paper.

a)(i) The graph was very well done by the majority of candidates. However despite the simplicity of this question some candidates made it more difficult even using logarithmic scales. It is important that candidates realise the need for accuracy when plotting points. A few candidates tried to draw a line of best fit rather than a simple line graph as stated in the question.

(ii) The description of the relationship shown on the graph was answered well by almost all candidates. However the explanation was often omitted or made reference to the wind and its direction.

(iii) A well answered question with the vast majority of answers between 70km and 80 km. A few answers did not use the appropriate measurements of kms.

(iv) Most candidates correctly identified the feature as a lahar though with a few odd spellings. A number of candidates incorrectly identified the feature as a pyroclastic flow.

b)(i) Almost all correctly identified this as a strato volcano and very few candidates confused it with a shield volcano.

(ii) There were some interesting diagrams though many candidates did clear and well labelled diagrams. Crater was almost always identified correctly but the feeder vent was often not in the correct place or not correctly labelled. The main problem was not drawing multiple, well labelled layers of lava and ash parallel to the sides of the volcano. A number of candidates made the sides of the volcanoes very steep well above the maximum possible angle.

c) This proved to be a problematic question with the majority of candidates giving detailed descriptions of prediction methods even sometimes confusing the answers with earthquake predictions. This question is about a different part of the specification that is about long term analysis of hazards rather than short term prediction. Only the very able candidates successfully made reference to the construction of hazard maps based on the paths of historic lahar and pyroclastic flows.

Question 4

Q4 There was a mixed response to this challenging question. The stronger candidates were able to achieve high scores on this question; however the vast majority struggled particularly on magmatic differentiation.

a)(i) There were many excellent responses to this question with almost all candidates giving correct answers. This is a huge improvement on previous questions on stoping and assimilation.

(ii) Many candidates knew the contact metamorphic rocks formed from these parent rocks. Most successfully identified marble, a number confused quartzite or metaquartzite with the sedimentary rock orthoquartzite, and a number put the regional metamorphic rock slate as the answer to shale instead of the contact metamorphic rock of spotted rock. Some gave minerals as answers.

b) Most candidates were able to correctly draw and describe the subduction processes at this type of boundary, thereby achieving 3/4 of the marks. However, very few successfully then went on to make the connection with the formation of silicic magma and granite batholiths. Some of the diagrams were unclear with labels such as the subduction zone at a point rather than a zone. The thin oceanic and thicker continental crust should be drawn with realistic thicknesses. The oceanic crust does not melt to directly produce batholiths and few candidates were able to describe the rising mafic magma in turn melting the continental crust.

c)(i) Shading the area of the chilled margins on either side of the intrusion was challenging and very few candidates correctly identified the area to be shaded. Responses varied from the bottom of the mafic intrusion to the top as few candidates knew where that the rapid cooling in the chilled margins preserves the composition of the original magma.

(ii) Very few correctly identified the layered feature as cumulate and some incorrect answers used sedimentary terms such as graded bedding or cyclothems.

(iii) The majority of candidates who achieved a mark on this question did so by reference to gravity settling. A number referred to dense minerals sinking but without backing this up with mafic or actual named minerals.

(iv) The formation of silicic rocks by differentiation is a complex topic and many candidates were confused making this a challenging question. There were some candidates who gave excellent responses often adding additional detail below the lines provided. Overall the response was poor with limited understanding of the process. Confusions included making reference to silica floating to the top or rocks changing from mafic to silicic or the idea of high temperatures at the top of the intrusion.

Question 5

Q5 Candidates found the start of this question on sedimentary processes easy and accessible. However, the knowledge and understanding of glacial environments was poor with varves a particular problem. Candidates did better on the evaporite basin environment.

a) The vast majority of candidates correctly identified the four processes; nevertheless there were a few who confused the definitions of K weathering with L erosion.

b)(i) Many candidates had a poor understanding of glacial environments, both in terms of the material/sediments and processes leading to formation of features. A number of candidates were able to describe the material of boulder clay as angular and poorly sorted but failed to answer the question which asked for the formation of the boulder clay by deposition of all the material from a melting ice sheet, consequently they were unable to achieve any marks.

(ii) Varves was not well answered or understood, and very few candidates achieved both marks. A number of candidates omitted this part question. Many answers were very general and referred to material being dumped in a lake. The more able candidates were able to achieve marks with reference to finer clay sediments being deposited and silt above or that two seasonal layers were produced each year.

(iii) Some answers just quoted the question by stating that they could be found in both a fluvial and glacial environment. The stronger candidates successfully identified the role of meltwater streams.

c) Imbricate structures was a well answered part question with a number of candidates successfully achieving both marks with some excellent well labelled diagrams, with appropriate descriptions. A few candidates seemed to confuse this sedimentary structure with graded bedding and a large minority made no attempt.

d)(i) A wide variety of responses to this question that required an explanation of evaporite processes. Weaker candidates just tended to repeat what was already given in the diagram consequently often achieving 1 mark as there was little added detail. Stronger candidate were able to write about all the points in the mark scheme and achieve full marks with appropriate and detailed explanations.

(ii) The majority of candidates were able to attempt this question. A large number were able to correctly identify all evaporites but not always in the correct order. A few candidates had the whole sequence the wrong way round and a number confused the position of gypsum and halite but correctly placed the calcite and potassium salts.

e)(i) Generally attempted by almost all candidates but like the imbricate structure in (c) some candidates seemed to have no idea about this sedimentary structure. There were good detailed and well labelled diagrams and descriptions by stronger candidates which achieved full marks. Weaker candidates tended to repeat the diagram in part d) or were confused by the initial processes of salt pseudomorphs formation but understood that infilling had taken place to produce a pseudomorph.

(ii) This was successfully answered by many candidates. Common mistakes included graded bedding and flute casts.

Question 6

Q6 A number of candidates had a good basic understanding of igneous textures and were able to achieve some marks. Strong candidates were easily able to achieve full marks with very detailed and thorough answers. The most common mistake was to confuse these textures with metamorphic textures and rocks. A number of candidates missed or ignored the reference to specific igneous rocks.

· **Porphyritic** textures gave the best responses with a number of candidates identifying thetwo stages of cooling. They were able to describe the first formed, large crystals that cooled slowly at depth as phenocrysts and the ground mass that formed last, with fine (finer) crystals that cooled more rapidly and higher in the crust or at the surface. These detailed answers require knowledge of time, depth and size as well as the correct technical

term. Diagrams were mixed with some excellent, well labelled diagrams of a named igneous rock usually granite but sometimes basalt. The explanation regarding depth and crystal size needed to match the diagram and example shown. A number of candidates confused phenocrysts with porphyroblasts.

- **Flow banding** often gave weak answers with most candidates achieving a mark for recognising that there were light and dark bands. Some confused flow banding with gneissose banding or schistose foliation in metamorphic rocks with references to schist and gneiss. Others responded by writing about cumulate layers and differentiation.

- **Amygdaloidal** was better known though some candidates did not get beyond explaining vesicular texture. A number of very vague answers referred to infilling of holes by sediment rather than minerals. Diagrams needed to clearly show the infilling of vesicles with minerals and use a suitable rock example. Basalt was the most common choice though a wide range of volcanic rocks were acceptable. However, pumice does not form amygdaloidal texture as it tends to break down over the long time period in which mineralising ground waters infill vesicles.

Question 7

Q7 Limestones are a weak topic and this was therefore the most difficult question on the paper. There were a few candidates who wrote excellent answers showing good understanding and writing very detailed and relevant responses with excellent descriptions that could have achieved well beyond the 10 marks. A large number of candidates wrote very confused answers making reference to chemical and biological weathering processes rather than the types of limestones. Many answers were vague and described the general environment of formation of limestones even though this was given in the question. Diagrams were not requested but some were well used with labels and annotations contributing to the answers.

The limestone best known was the chemically formed oolitic limestone. However a minority of candidates believed that ooliths are small animals and as a result thought that oolitic limestone was a biological limestone. The mark scheme has a wide range of different options especially for the biological limestones with marks available for different fossiliferous limestones.

F794 Environmental Geology

Many candidates were very well prepared for this examination and there were some outstanding scripts demonstrating extensive knowledge and understanding of the subject. To access the highest marks, candidates need to ensure they distinguish between the command words *describe* and *explain* and between *describe* and *state*. There was no evidence that time was an issue as virtually all candidates attempted the final extended question on construction of road cuttings and embankments.

At A2 level there is a greater emphasis on application of knowledge and understanding than at AS level and novel questions that require application of knowledge and understanding to unfamiliar situations should be expected on this paper. The synoptic component of this paper continues to be a good discriminator between candidates who are well prepared and those who are less so.

Comments on Individual Questions

Question 1

Q1 Most candidates showed a good understanding of the requirements for the accumulation and production of oil and gas, but were less sure about enhanced recovery of oil using detergents and bacteriological techniques.

a)(i) The Kimmeridge Clay was well known as the main source rock for oil in the northern basin of the North Sea. Various spellings were accepted provided they were not too far different from that in the specification. Candidates could attain the mark for clay / mudstone / shale, if they correctly stated the age as Jurassic. Sandstone was the most common incorrect answer.

(ii) The technical term unconformity for the type of trap was well known. There were a few misspellings, along with some illegible answers.

(ii) The reasons why oil was trapped below the unconformity were well understood but a significant number of candidates lost marks because they wrote general answers about oil traps and did not refer to the specific geology and rock types shown on the diagram.

(iv) The majority of candidates were able to give a correct reason as to why the exploration borehole failed to locate economic quantities of oil and gas. While the presence of an unsealed fault was the most common correct answer, other allowable answers were also given.

b)(i) Most candidates understood the meaning of *production well* and *primary recovery*, but some wasted time describing the exploration stage. Some candidates could improve their answers by avoiding vague wording such as “dig a borehole” or “drill down to the oil” – technical terminology is required. Directional drilling techniques were poorly known. There was confusion between *reservoir rock* and *source rock* and some referred to the reservoir as the *reserve*.

(ii) Most answers on the reason for water injection during secondary oil recovery were correct. Some had the idea that the oil floats passively up on the water, rather than the correct idea of it being forcibly pushed up. A minority continue to erroneously attribute hydrostatic pressure to the weight of the overlying rock.

(iii) Many candidates had some knowledge of the use of detergents and bacteriological techniques in enhanced oil recovery to unstick oil from grains and lower viscosity respectively, but which method has which effect was not so clearly shown. A number of candidates were confused about the meaning of viscosity and erroneously suggested that bacteria would break down large hydrocarbon molecules making the oil more viscous. In addition, some used the terms *density* and *viscosity* as if they are interchangeable.

Question 2

Q2 Water supply is a well understood area of the specification and for the most part answers to this question were sound. Those who did not score so well did not give precise definitions when asked or did not differentiate between the command words *describe* and *explain*. Recent initiatives in the development of groundwater storage in rocks were poorly known.

a)(i) The term *aquifer* was well known, but not all gave a precise geological definition to include either the term *porosity* in relation to water storage or the term *permeability* in relation to water movement. Many candidates use the terms *porosity* and *permeability* as if they are synonymous. When asked why this limestone is a good aquifer, many lost marks because they did not refer to the limestone in the diagram. Candidates needed to show a clear understanding that the fractures (joints) would increase permeability (not porosity).

(ii) The technical term *recharge zone* for the area of the aquifer at the surface was well known with few spelling issues.

(iii) The majority were able to correctly explain the function of the recharge zone. Even those who gave the wrong answer in 2(a)(ii) often referred to the recharge zone correctly here.

(iv) A variety of answers were given to this question asking for a definition of the *hydraulic gradient*. Full answers referring to both the difference in hydrostatic pressure or hydrostatic head and the distance between the points were required for the mark. A common error was just to refer to the difference in pressure. Those who included the distance often merely referred to the difference in height without specifying what the difference was.

(v) Most got the hydraulic gradient calculation correct (0.1) but a significant number got the calculation the wrong way round (10). Hence the requirement for percentage (10%) being clearly stated if candidates chose this format for their answer. Some candidates showed clear correct working of 20/200 but arrived at an incorrect answer of 10 – use of a calculator may have avoided this mistake.

b)(i) Most candidates were able to describe the process of subsidence of an aquifer due to extraction of water but few gave a full explanation to attain the 2 marks available. Weaker answers that just referred to the cone of depression or repeated extraction of water from the question could have been improved by describing how water is extracted from the pore spaces leaving the overlying rocks unsupported.

(ii) The term *salt water encroachment* was not well known even though the mark scheme allowed for several variations for salt water and encroachment. Very few correctly described how the sea water got into the aquifer with many simply saying that it mixed with the fresh water, or percolated into the aquifer from the sea. As this mark was stretch and challenge a full explanation of how salt water is denser than fresh water and is sucked into the aquifer by capillary action due to the reduction in hydrostatic pressure caused by pumping the water out was required.

c) The advantages and disadvantages of using surface water supplies for drinking water were well known but a small number of candidates penalised themselves with very vague answers. The best answers gave geological reasons. Economic answers that abstracting surface water is cheaper, had to be qualified with a reason.

d) Recent initiatives in the development of groundwater storage in rocks were not so well known. To gain the mark candidates could have outlined the artificial recharge of aquifers with surface water for storage or the pumping of stored groundwater into rivers to maintain flow during dry periods.

Question 3

Q3 The quality of responses to this question on geothermal energy was variable and it proved to be a good discriminator.

a)(i) It is pleasing that the majority of candidates attempted to calculate and plot the two geothermal gradients for the granite areas and the sedimentary basins. The commonest errors were to start the lines at 0,0; to bend the correct lines between 0 and 1km so they went through 0,0; or to bend incorrect lines so that they went through 10,0. Not all used a ruler even though the gradients are straight lines.

(ii) As error carried forward on the graph plotting was allowed, virtually all candidates attained the mark for stating the depths at which a temperature of 100ºC would be reached in the granite areas and the sedimentary basins.

(iii) Many candidates struggled with this stretch and challenge question on the reason why the geothermal gradient is higher in granite areas. Those who recognised the source was radioactivity did not always explain where the heat came from. A common misconception was that the heat was left over from the cooling of magma and even those that answered correctly were under the erroneous impression that sedimentary rocks contain no radioactive elements.

b) Extraction of geothermal energy from hot dry rocks such as granite was well known. Virtually all candidates gained some credit for their diagrams, but only those with good understanding attained all 3 marks available. Errors to correct include: the drawing of single boreholes; u-shaped boreholes which went down into the granite and then came back up again; and boreholes that only reached into the rock above the granite. Candidates who labelled magma rather than a batholith were confused with volcanic sources. Although artificial fracturing ("fracking" crept into some answers) was well known, the reason for it (to increase permeability) was not.

c) Most candidates had a sound understanding of the advantages and disadvantages of extracting geothermal energy, but some failed to attain marks because they ignored the command word *discuss*. In particular, very few candidates who gave renewable and/or sustainable as an advantage then went on to explain what they meant. Similarly, many stated "no pollution" clearly not appreciating the waste disposal issue of toxic and/or corrosive groundwater. The economic argument, given by some as an advantage (it's cheap) and by others as a disadvantage (it's expensive), failed to score marks unless it was discussed or qualified.

Question 4

Q4 Many candidates continue to find the metallic mineral deposits section of the specification challenging. Candidates who applied their general knowledge of hydrothermal mineral deposits to the specific situation given in the question were most successful. Those with secure synoptic knowledge were able to tackle these aspects of the question with confidence.

a) This match the term to its correct description was done well by most. *Reserves* was the least well known with many confusing the definition with *cut-off grade*.

b)(i) Although most were able to correctly state the plate tectonic setting of Indonesia, not all used the prompt of the Sunda ocean trench labelled on the diagram to help. Many candidates continue to use the term *destructive plate margin* rather than *convergent plate margin* which is used in the specification.

(ii) Most of those who correctly stated the plate tectonic setting of Indonesia for (i) were able to explain that the source of the magma was melting of the subducted oceanic plate, but few used the term *partial melting* which would have been expected from AS level knowledge. Very few went on to differentiate between intrusion of magma at depth to form the granites and extrusion of lava at the surface to form the volcanic rocks.

c)(i) Those that attained the mark for their definition of the term *hydrothermal fluid* were in the minority even though the answer is really in the term. Very few included all three of hot, water and metal. Many repeated "fluid" without saying what kind of fluid, others forgot the "thermal" part and some having got the hot and water bits right then failed to include metals in solution. Questions asking for definitions of geological terms listed in the specification expect candidates to use precise wording in their answers.

(ii) It is pleasing that most candidates did make an attempt to use evidence from the map to support the hypothesis that the metallic mineral occurrences in southern Sumatra are hydrothermal in origin. Most suggested the source of the fluids were the granite intrusions but then ignored the faults on the map and gave the standard answer involving movement of the fluids along joints. Only the strongest candidates recognised that the faults shown on the map would have provided pathways for the fluids. There is still confusion between the melting point and temperature of precipitation of hydrothermal minerals, but only a small minority erroneously cited density differences as being responsible for the different areas of tin and tungsten versus gold and base metals.

d) Placer deposits were well understood but some limited their marks by failing to take account of both the command words *describe* and *explain*. Others gave repetitive answers that went through all the various sites of deposition without explaining the source of the tin. Only the strongest answers clearly distinguished between *weathering* of a pre-existing mineral vein versus *erosion* of minerals during transport, with many using the two terms as if they are synonymous. Few answers referred to the physical properties of cassiterite as being a factor. The "inside" of meander bends was often omitted.

e)(i) Although it was clear from some answers that some candidates were unfamiliar with the mineral processing technique of heap leaching, most were able to use prompts from the diagram to describe logical environmental consequences. Avoidance of the word *pollution* with no qualification would have improved some answers. Some candidates are still confused between the terms *aquifer* and *water table*. In this case, contamination of the groundwater within an aquifer is the problem, not "pollution of the water table".

(ii) Candidates struggled to correctly name and describe the environmental consequences of another mineral processing technique. Weaker answers suggested an extraction or mining method rather than a processing method.

Question 5

Q5 There were some good responses to this question on the construction of road cuttings and embankments and the stabilisation methods that can be used for them, but few gained the maximum 8 marks available. The "geological factors" were less well described than the "stabilisation methods" and not all candidates appeared to be familiar with what road cuttings and embankments are. The best answers clearly differentiated the geological factors affecting cuttings from those affecting embankments. Some candidates showed an impressive knowledge of the many stabilisation methods but weaker answers tended to list rather than describe them. There was confusion between grouting and shotcrete – in this situation shotcrete is the appropriate technique.

F795 Evolution of Life, Earth and Climate

General Comments

There were some excellent scripts and the paper proved accessible to all. Candidates were generally well prepared and had obviously worked hard on parts of the specification that were under represented in previous years. Few papers were incomplete suggesting that there was not a problem with lack of time and in fact many scripts used all of the additional pages at the end of the answer booklet. There were many examples of scripts with additional material with no indication on the question paper that there were additional parts to the answers.

Candidates need to be aware of the command words in the question and ensure that the answers match these. Some scripts show that candidates are underlining command words to make sure that they tailor the answer to the question set which is a good idea. There was a tendency to ignore the instructions following the pencil symbol for questions 6 and 7 and this could reduce marks. Where diagrams are essential, the question states this as in Q6, and full marks cannot be attained without diagrams.

The stem or first sentence of a question or part question often has helpful information to guide a candidate towards the correct area of the specification for an answer, but it is clear that some candidates do not read always this part of the question. Any question that asks for differences between two fossils needs answers that refer to *both* the fossils in order to gain marks.

Comments on Individual Questions

Question 1

Q1 Generally well answered and showing a good level of knowledge and vocabulary in relation to the four fossil groups. The recognition and labelling of morphological features was exceptionally good - a higher standard than previous sessions. Careful reading of the entire question should be encouraged as some candidates ignored the fact that the questions used the specific fossils in the drawings and the features that they show.

a)(i) Most candidates recognised the organisms with many excellent answers showing a good knowledge of phylum and group. The term *group* is used to include class or order and correct identification to the genus level was allowed though not needed. Within the Echinodermata the specification gives two classes: Crinoids and Echinoids, and candidates also need to know that echinoids are sub divided into two orders: the irregular and the regular. So that answers can be accepted at class or order or even genus level, the general term *group* is used. *Echinodermata* seemed to present the most problems and spelling of names was often poor though marks were given where the spelling was close.

(ii) Excellent knowledge of most of the features to be labelled. Spelling of *interambulacra* was sometimes varied.

(iii) Good answers gave reasons for each feature chosen and trilobite adaptations were particularly well known. Reading the question carefully would have helped some candidates, as the features had to be visible on the diagrams. Some answered in terms of features not seen, particularly the plastron on the oral surface of the echinoid. Some answers restated the information in the question by saying that this infaunal trilobite had no eyes because it was infaunal instead of giving additional information such as it was buried in mud. There was some vague use of technical terms for the features, so the spines had to be *genal* spines, the term *cephalon* had to be used rather than “head”, the shape of the echinoid *heart-shaped* and the term *petaloid ambulacra* used not “petals”.

(iv) The composition of the trilobite as chitin was generally known and the composition of the echinoid very well known. Aragonite is not appropriate for echinoids as the test developed as calcite plates.

(v) This question was answered correctly by most candidates showing a good working knowledge of the difference between regular and irregular echinoids, the most commonly stated morphological difference was symmetry and this was clearly reasoned. A few answers did not give a difference between irregular and regular echinoids but just made one statement about a morphological part, eg. a general phrase like “one has jaws and the other didn’t” so that a mark could not be awarded. Whereas an answer that states fossil B has no jaws and the regular echinoid does have jaws gained the mark. Differences in mode of life are not morphological. A common misconception is that irregular echinoids do not have spines. Spines on these echinoids are often very fine and so have small tubercles.

b)(i) Knowledge of the muscular foot was reasonably good and some candidates gave detailed descriptions of the inflation of the foot and then contraction to move the bivalve. Weaker candidates, however, rewrote the question as an answer, saying that the foot was used to dig.

(ii) Knowledge of inhalant and exhalent siphons was also reasonably good although few knew the alternative answer of siphons and gills. A few candidates confused the brachiopod lophophore with siphons.

c)(i) Most diagrams were clear and recognisable with good labels. A few diagrams were confused with bivalves and some were internal rather than external as asked in the question. The hinge lines needed to be clearly visible on both diagrams. Drawings in life position or side views could not show astrophic or strophic hinge lines and were unsuitable as answers. Labels should be of correct morphological features rather than general descriptions such as “short-hinged brachiopod” or “substrate”.

(ii) The opening and closing of brachiopods was successfully answered by many candidates showing very good, detailed knowledge. Most answers were accurate though a few had the adductor and diductor functions the wrong way round.

Question 2

Q2 Knowledge and understanding of dinosaurs was of a high standard

a)(i) Generally accurate as many candidates were able to sort the features that define saurischian and ornithischian dinosaurs. Mistakes were evenly distributed amongst the options given.

(ii) Almost all candidates were able to give an example, usually *Tyrannosaurus* or *Diplodocus* but occasionally, less well known groups were included. Abbreviations such as *T. rex* were not acceptable.

(iii) Only a few candidates failed to place this in the Triassic, many were correctly more specific. A small minority answered Jurassic.

b)(i) Some excellent knowledge of amniotic eggs with good use of technical terms but where a candidate scored a low mark it was most often due to their not giving reasons for the morphological advantages selected. Some responses were very general and referred to the move from water to land rather than clear morphological advantages. A number did not describe from what hazard/s the developing embryo might have needed a shell to protect it.

(ii) Most answers responded to the term *preservation* and wrote about anoxic conditions and rapid burial. However, this question asked about dinosaur eggs which can only be preserved on land - therefore essential in the answer.
Without reference to a terrestrial environment, answers could not gain a mark making this a poor question for many.

c) Knowledge of trace fossils was good with some very good descriptions: eg how the depth of footprints can be used to determine the weight and size of dinosaurs. Making the link between the trace fossil and the dinosaur mode of life is essential. Often the inference of mode of life failed to be linked to the trace fossil selected. Some detail was required to gain full marks eg. 'tracks' show how fast the animal moved.

d) Knowledge of exceptional preservation is good but this question required it to be tailored to dinosaurs. Answers that gave explanations of the preservation methods were needed rather than lists of the factors. Tar pits cannot preserve dinosaur skin as tar does not survive for 65 Ma or more. Similarly peat is only found in very recent deposits. Other answers referred to the Cambrian Burgess Shale which formed long before the dinosaurs had evolved. Dinosaur skin is often found in sandstones where the dinosaur was mummified and then the skin was replaced by minerals.

e)(i) Excellent answers using the correct technical terms were common.

(ii) Most candidates correctly suggested the evolutionary link of birds evolving from dinosaurs. Some candidates confused ancestors and descendants.

Question 3

Q3 Candidates found this the most difficult short answer question. There was confusion in the use of age terms younger/older which is an essential skill in this style of question. The main problem was answers that did not use the geological data shown on the diagram, but described dating in general terms.

a) Most candidates were able to correctly define half-life although a few omitted the word half. Very few candidates had a clear definition of an isotope - suggesting that there was knowledge without understanding.

b)(i) There were many accurate graphs of four half-lives from a 100% starting point, although some were untidy with curves that did not join all the points, or thick, uneven curves. The line between points needed to be a curve, as the question specified this and most answers were. Straight lines were not acceptable.

(ii) Generally excellent and where graphs were incorrect, measurements were taken for the correct answer from the candidates graph. Some candidates failed to include any units and thus lost the mark.

(iii) Answers needed to state that absolute dating is a number in millions of years. Several candidates referred to accurate or definite dates rather than a number.

c)(i) Many accurate answers though a small minority gave no units. It is essential that the units are clearly *Ma* not years.

(ii) Answers were very varied suggesting limited understanding of this topic. Not many candidates were aware of the mineral likely to contain ^{40}K that is found in an igneous minor intrusion. Glauconite cannot be found in igneous rocks.

(iii) Very good knowledge of applying dating techniques gave rise to good answers, including some who attempted to take into account the experimental error on the intrusion Y. Sadly there were some answers that stated the schists were younger than the dyke that cut them.

(iv) Good answers gave evidence such as the baked margins in the sandstone and linked it to the age of sandstone therefore being younger. Weak answers gave general statements about baked margins without giving the age relationship. Answers referring to way up structures could not gain marks.

(v) The loss of the daughter isotope argon as a gas was very well known but the explanation was often too general without giving a reason what affect a loss of argon would have on the age attributed to the rock. Few candidates wrote about the problems of obtaining adequate sample sizes or equipment inaccuracies. It is not appropriate to suggest that the margin of error is due to 'mistakes' – it seems that some candidates have a poor grasp of inherent 'errors' in measuring equipment and in half-life data. The main area of confusion was the igneous intrusions. The intrusions shown on the diagram are minor intrusions which cool relatively rapidly (months or years) so that there is no error due to differences in cooling rate. That only applies to large scale / major intrusions which take millions of years to cool. Some answers referred to metamorphism which is not part of the sequence shown on the diagram.

d) Many excellent well labelled diagrams showing included fragments made of older rock included in younger rock. The ages are important in the explanation and the explanation also required a reason such as erosion and redeposition or country rock falling into the magma for xenoliths. Many answers stated the 'law' of included fragments rather than gave an explanation. Some excellent answers included much of the detail on the diagram. Confusion between xenoliths found in batholiths and included fragments found in sedimentary rocks caused some vague answers and incorrect explanations. Derived fossils are not included fragments.

e) This was a new topic that was usually very well known, with some excellent explanations and most candidates having a good understanding of the theory. Some candidates went beyond the question stating the problems with Joly's method. Few centres had not covered this area.

f)(i) Most answers were accurate, but the most common incorrect response was zone fossils. Most were able to state the term and used the correct spelling but made up words like "biostratification" instead of *biostratigraphy* did appear. Answers of "biostratigraphic dating" suggest a lack of understanding of the difference between dating and correlation.

(ii) This question required answers that included both dating and correlation and few candidates attempted both parts of the question. The command word 'How' needed to be addressed in this question and was sometimes neglected. Some candidates used the stock responses to zone fossil attributes without involving microfossils. Conodonts and other micro fossils were often named, but rarely described, as being used to date a small time zone. Candidates knew that microfossils are important in the oil industry but rarely referred to correlation of beds.

Question 4

Q4 This question was well answered and candidates were familiar with the fossil groups drawn with high levels of identification.

a)(i) Many correct answers showed a good working knowledge of the morphology of these fossils. There were some problems with the spelling of technical terms making them very difficult to recognise. Of the three, the belemnite was least recognised and there were imaginative interpretations of the diagrams when naming distinguishing features. The identification of major septa or septa in cycles of 6 was not often given.

(ii) Many accurate answers. The most common error was naming feature 2: the dissepiments, as tabulae.

(iii) Generally this straight forward question was well answered although there was some confusion as it asked for the environment *lived* in - not *found* in. Just "marine" is inadequate at A level. There were some contradictory statements based on the requirements for reef-building corals eg. high energy deep waters. Energy whether low or high is not a palaeoenvironment nor is the climate term *tropical*.

(iv) Many answers correctly stated that fossil E, the belemnite, was nektonic but few explained why it had a wide geographical distribution. The ability to swim does imply a wide geographical distribution, but it is the fact that after death the fossils sink to the sea floor and can be found in different environments from shallow sea to deep, that is key to understanding. Mode of life of the belemnite without the explanation cannot gain the mark.

(v) Many correct descriptions using a range of correct technical terms were seen. The question uses the command word *describe* and a one word answer such as "sessile" is therefore insufficient detail. Most candidates were successful in giving both the mode of life position (benthonic epifaunal and sessile) as well as the common mode of life in terms of filter feeding.

b)(i) Almost all candidates were able to correctly identify the graptolite, many correctly added phylum and other groupings.

(ii) Graptolite morphology is generally well known with clear labels of morphological parts. The label for rhabdosome needed to bracket the whole fossil as it means the entire skeleton. The use of accurate lines connecting features to labels is essential. It appears that a minority of candidates did not see this part question as they omitted an answer.

(iii) The majority of candidates knew that this graptolite was scandent.

(iv) The evolutionary sequence was well understood with many correct answers.

c) The ideas were well understand but many candidates did not give reasons why each factor made them good zone fossils, and without this explanation marks could not be awarded. This question caused problems where answers described good zone fossils and merely referred to graptolites in passing. Zone fossils need to be in very narrow time zones and not the whole Ordovician or Silurian. There are about 40 graptolite zones in the Silurian which has a duration of about 40Ma.

Question 5

Q5 This challenging question on a less traditional part of the specification had been well-prepared by the majority of candidates.

a) There were some good definitions of both weather and climate. It is important that weather is understood to be the meteorological conditions over a short period of time and in a small area. Also important to note is that the term *weather* includes all of the factors: wind, precipitation and temperature and not simply the sun and rain. 'Climate' so often goes with the word 'change' these days, that 'climate change' was in some answers, where 'weather patterns' would have been more appropriate. Weaker answers were very general - vague impressions rather than an explanation of the difference between the terms.

The term *environmental* was incorrectly used in a number of answers, rather than *meteorological* or *atmospheric*.

b)(i) Greenhouse Earth is a familiar concept to most candidates but the lack of icecaps was not always included with the warmer temperature so that the descriptions were incomplete.

(ii) The temperature graph was understood although the quality of drawing on it was very variable. Icehouse conditions are not present when average temperatures are above 15^{o}C. The Jurassic did not have ice present. Care is needed in shading so as not to include the entire Carboniferous and all of the Permian.

(iii) Descriptions of the effect of ice sheets on global temperatures were very thorough showing good knowledge of the high albedo effect of snow and ice and reflection of solar radiation, and how positive feedback would function to produce icehouse conditions.

c)(i) There was an impressive level of knowledge displayed in remembering which orbital variation had which periodicity.

(ii) This is a complex area of the specification that candidates found very difficult to explain. There are many different ideas that relate to Milankovitch cycles and answers that used any valid ideas could be fitted in to the mark scheme. Many answers, however, were very general and did not discuss relevant ideas. Although there was knowledge of the orbital variations, there was little evidence of understanding the geological expression of these in the rocks of Dorset. Only a few managed to associate a change of temperature with a change of rock type and little further research had been attempted. Some candidates wrote about seasonal varves.

Question 6

Q6 Some excellent answers with clear and well labelled diagrams were seen. Most answers correctly used the mode of life terms and used the correct fossil types. As the diagrams were essential, full marks could not be gained without labelled diagrams with at least two labels. Many of the diagrams for all three bivalves were not good enough to earn marks, having insufficient labels, being too small to be clear, or being unrecognisable even when labelled as *Ostrea, Mytilus* or *Pecten.*
Each of the three adaptations was known by most candidates and reasons were given for most of the morphological changes. A few candidates confused bivalves with brachiopods and a few others confused the technical terms. In particular, the zigzag commissure is a *brachiopod* feature.

Epifaunal cemented

Of the three, *Ostrea* was the least well understood and often described rather generally (and incorrectly) as robust with a thick ribbed shell. The most common form described was *Ostrea* which does not have any ribs but some candidates stated that ribs were needed to survive high energy. There was a general confusion between ribs and growth lines. *Ostrea* does not live in the littoral zone so the valves do not have to be held together in order to stop drying out. The shell tends to be very irregular and not streamlined. Many *Ostrea* live in shallow waters below wave base where the energy level is not very high. Knowing that the substrate for cementation is rock is important. The word *cemented* is in the question so the answer requires more detail, followed by the reasons for this adaptation. Drawings and labels of *Ostrea* were weak.

Epifaunal attached

Mytilus was better known and better illustrated. Many assumed that because it lives in high-energy conditions it must have a thick shell - working from general assumptions. Knowledge of the byssus found in *Mytilus* and its function was good but where it exited the valves varied hugely on diagrams. There were excellent descriptions and explanations of the streamlining and colonial living and flexible attachment. Knowledge of the streamlined shape and unornamented shell with no ribs was well known, although a few diagrams showed ribs. Knowing that the substrate for byssal attachment is rock or compacted gravel is important. A few were confused with pedicle attachment in brachiopods.

Nektonic

Pecten was very well explained with thin, corrugated shells well described and explained as being light enough for swimming. Many candidates were able to explain features such as the single adductor muscle that can be contracted for flapping the valves together for movement, the 'ears' as extensions of the hinge line to direct the flow of water and the sensory eyes on the edge of the mantle to detect predators. A few candidates were confused by the corrugations/ribs as creating thick, heavy shells.

Question 7

Q7 Knowledge of both asteroid impact and volcanic activity was very good, but tailoring that knowledge to the causes of the K-T mass extinction was a challenge. The question set was not the same question that had been set previously, and did not ask for the evidence for asteroid impact or volcanic activity. Most candidates failed to act on the instruction to link descriptions with the reasons for them. The few marks that were available for the evidence of the impact did need more than simply a list that included tektites, shocked quartz and iridium. Some idea of the very large size of the impact crater (Chixulub) was appropriate. For a tsunami to have occurred, the asteroid needed to have impacted, at least partly, in the sea.

A reasonable level of detail is expected and was evident in many answers eg. in those demonstrating that the Deccan traps was a large enough event to have had global consequences by quoting the areal extent, the length of time that eruptions lasted and the great volumes of lava produced. Some candidates incorrectly identified the volcanic activity as belonging to the Siberian Traps.

Answers needed to describe how the asteroid impact and volcanic activity caused the mass extinction by giving reasons for the extinctions. Candidates who followed the instruction to link descriptions with the reasons for them did very well indeed.

Many candidates wrote an introduction including names of organisms that became extinct and the date/percentage which unfortunately was not asked for in the question.

Some candidates did not write in prose, but used a bullet pointed list which often lacked the detail required.

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