RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE **A2 H487**

Advanced Subsidiary GCE **AS H087**

Examiners' Reports

January 2011

HX87/R/11J

Oxford Cambridge and RSA Examinations

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EXAMINERS' REPORTS

Chief Examiner's Report

This January was the first occasion on which the A2 unit, F795, was offered at this time of year. Some centres had started the work in the summer after the AS examinations in order to have time to teach this longer unit. These candidates were very well prepared. The pattern of entry for the other units was similar to the previous year.

There are some common threads in the reports on individual papers. Some candidates fail to use the command words for their answers and will then lose marks. If a question asks for both description and explanation, candidates should expect to be rewarded for demonstrating both skills. Many candidates answer explanatory questions poorly, often *describing* rather than providing *reasons* for the explanation. Another area is a failure to read the question or key terms in the question, especially at A2. This is the single biggest cause of underachievement at both levels of this examination. Candidates have a tendency to write in vague or imprecise terms, often not using the appropriate technical terms or using them incorrectly. This results in some answers that are very general and not of the standard required for AS or A2. Not all questions have answer lines below, and candidates should be encouraged to read every word of the paper so that they do not miss these questions.

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

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

Teaching Tip:
It is a good idea for students to consider simple sketches to help explanations even if there are only lines for writing. Credit will be given for correctly annotated diagrams

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

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

F791 Global Tectonics

Many candidates performed well although some found certain aspects – particularly structural geology - difficult. Marks ranged from 3 to 58. There were some excellent scripts by candidates who demonstrated very good subject knowledge and were able to express themselves clearly and concisely using good technical terminology. Candidates are improving in their ability to add annotations/labels to their diagrams. Performance at the top end was excellent with a number of candidates gaining more than 50 marks out of 60. Very few candidates gained a very low mark which indicates well prepared candidates.

In addition:

- Candidates showed a sound understanding of the various aspects of seismology tested, including S and P wave velocity and earthquake mitigation. Candidates had a good understanding of the evidence for sea floor spreading.
- Structural geology remains an area of difficulty for many candidates especially fault structures. Candidates had particular difficulty in visualising fold and fault structures when drawn on a map. Candidates showed a good knowledge of the location of the main tectonic landforms/features but had difficulty describing their features in detail.
- The extended prose on earthquake prediction was very well answered with many gaining full marks. A number of candidates omitted question 1(a)(ii) and perhaps did not read it. There was, however, little evidence of candidates running out of time.

Comments on Individual Questions

Question 1

Q1 Candidates knew the location of the tectonic features but struggled with describing their detailed characteristics. This question proved to be one of the most difficult for candidates largely because answers needed detail of the characteristics.

a) (i) Generally well-answered. As the features were drawn on the map, this made the exercise relatively straightforward.

(ii) Generally well-answered, although some careless drawings extended the mountains into the ocean. A significant number of students did not respond to this question, and it is not certain whether this is because they did not know the answer or they did not see the question below the map.

(iii) A number of candidates lost marks by ignoring the reference to South America. Not many candidates gained both marks and candidates in general have a better idea where shallow earthquakes are compared to deep earthquakes.

(iv) Many answers correctly described the subduction zone, but did not distinguish between the location of shallow and deep earthquakes which meant that they could not access the second mark. A good idea was the use of simple diagrams by candidates to illustrate their answer.

> **Teaching Tip:**
> Candidates could use a blank A3 map of the world on which they draw and label all the plate tectonic features listed in the specification including the locations of shallow, intermediate and deep focus earthquakes. This makes an excellent revision aid.

b) (i–iii) Almost all answers lacked the detail needed for the mark, many concentrating on the *origin* instead of the *characteristics* of the tectonic features (continental shelf, deep-ocean trench and fold mountains). Careful reading of the question asked would have helped to focus answers – there is a tendency to write what they can remember about these features.

> **Teaching tip:**
> Before the origin of a geological feature can be determined, its characteristics must first be described. Students should be able to state at least two characteristics such as depth, width, shape of feature as well as location and activity that occurs here, for all the tectonic features. A summary table of bullet points for each feature works well or a cross section diagram with characteristics for every feature in the correct place.

(iv) Many candidates knew that continental shields were aseismic because they were in the centre of the plates away from plate boundaries.

c) (i) Most candidates could describe a seamount but were a little careless with their wording which lost marks. Candidates needed to make it clear that the feature was beneath sea level.

(ii) Most candidates could describe the abyssal plain. A common error was to state that the abyssal plain is the deepest part of the ocean even though they had just described the deep-ocean trench as the deepest area.

Question 2

Q2 Earthquakes and the structure of the Earth is a popular topic and candidates found this one of the easier questions on the paper. The majority of candidates knew about S wave velocities within the Earth and could label the Lehmann discontinuity. Candidates were less sure about locating the asthenosphere on the graph and were also unsure of how it was located by seismologists. Candidates did know a wide range of earthquake mitigation techniques although weaker candidates could not explain how they worked.

a) (i) Many candidates completed the S wave velocity successfully although some graphs lacked neatness and care. A few candidates also drew on the predicted S wave velocity in the inner core.

(ii) Approximately half the candidates located the asthenosphere. A common error was to label much of the mantle. Candidates should know that the asthenosphere is identified as the "Low Velocity Zone" and so can be identified on the seismic velocity graph as the area of reduced velocity at the top of the mantle.

(iii) Many candidates knew how the asthenosphere was located using seismic wave velocity although writing a 'change' in velocity is not enough – the seismic waves are slower. Some candidates mentioned the "Low Velocity Zone".

(iv) The location of the Lehmann discontinuity was very well known and better known than the asthenosphere.

b) (i) The graph was not always drawn accurately and many curves were not well drawn. Candidates should be encouraged to bring a ruler to the exam and use it.

(ii) Most candidates assumed that the change in density was from the mantle to the core, when it could equally be from the core to the mantle, and so ignored what the material changed from (the mantle) and described only what it changed to (the outer core). A full comparison requires the description of both the mantle and the outer

core. Candidates should be aware that it is the change in *composition* rather than the *state* that is significant in the density change at this discontinuity.
A common error was to attribute the increase in density to the change from solid to liquid, when in fact a liquid is less dense than its solid equivalent.

c) The main earthquake mitigation methods were known although the details of how the methods worked were less certain.

Common errors: to allow the building to move with the earthquake;
to stop the building toppling over;
the mass tuned damper lowers the centre of gravity.

Teaching hints:
The aim of some mitigation techniques is to prevent the building from vibrating, or to reduce the amount of building movement or to strengthen the building against the effects of movement.
This is done for example, by base isolation, tuned mass dampers and flexible steel structures respectively.

Answers should describe building techniques which are different from the norm. For example, steel girders and reinforced concrete are universally used in tall buildings but in aseismic areas additional steel cross bracing, extra reinforcement and designs that allow the building to flex are added.

A practical demonstration of base isolation - which allows the building to remain stationary while the ground moves beneath it; try putting some rock samples in an A4 photocopier paper box lid to add weight (=building), some white-board pens underneath (=rollers), and move the desk rapidly underneath everything; box stays still on its rollers while the desk moves.

Question 3

Q3 Many candidates knew about radiometric dating although many were unsure about the age of the Earth or the oldest rocks. Most candidates knew the general point about the age of the oceanic crust increasing away from the MOR although fewer discussed the symmetry. Many candidates discussed the magnetic stripes as a second piece of evidence although many were not able to explain it fully.

a) (i) Most candidates did suggest some form of radiometric dating.
No actual rocks – and certainly no fossils – survive from the origin of the Earth and so they cannot be used for dating.
Meteorites are not appropriate for use because there is no certainty that they have the same age as the Earth – until both have been dated.
Carbon dating can only be used on material no older than 50,000 years.

(ii-iii) A wide range of dates were suggested but many had correct answers for both the age of the Earth and the oldest rocks. Most used the correct units.

b) (i) Most candidates showed a general understanding of the use of the age of oceanic crust as evidence for sea floor spreading but omitted the essential idea of symmetry which proves spreading as opposed to just movement. A few candidates discussed palaeomagnetic stripes which was not relevant to this question (but ideal for b ii). Complex block diagrams are not needed.

> **Examiner hint:**
> A neat, well labelled diagram can save time writing the text. Time need not be spent in intricate shading. A few well chosen, well drawn (and well practised) lines are usually all that is needed.

(ii) In the most common answer, candidates discussed the palaeomagnetic stripes; these worked particularly well when stripes were drawn on the diagram. Not all candidates fully understood how the stripes actually form.

Some candidates also discussed sediment thickness and these were generally well explained although some candidates assumed that bed thickness and width of outcrop is the same thing.

Question 4

Q4 This was one of the most straightforward questions on the paper with some excellent answers. Candidates were able to draw the axial plane and label the trough and limb. Many though had little idea what a *nappe* is.

a) (i) Most candidates correctly drew the axial plane.

(ii) Most candidates could link the correct fold type to the diagrams.

b) (i) Most candidates recognised fold H as being isoclinal.

(ii) Knowledge of trough and limb was very good.

c) This question discriminated well between those candidates who knew what a nappe is and those who struggled to draw a recumbent fold correctly.
Common errors included displacing a monoclinal fold rather than a recumbent fold, having the displacement going the wrong way for the fold drawn or having everything too steep.

> **Teaching tip:**
> Candidates do need to be careful when drawing nappes or thrusts and do need to make sure that the dip of the fault is no greater than 30° and so should use a protractor to be certain.

Question 5

Q5 Most candidates found this the most difficult question; the fold questions proving to be a little easier than those about faults. Candidates found it difficult to recognise the structures on a map. There is overall confusion of terms between faults and folds so that identification of a fold as a horst and graben structure was seen.

a) (i) Candidates needed to use the age of the rocks to recognise the anticline; quite a few candidates recognised the dip directions only and wrote *antiform*. While antiform is a correct answer in terms of the dip arrows, the age relationships (oldest beds in the core of the fold) show that it is an *anticline*. The question did emphasise *Using all the information* which included the age relationships

(ii) Surprisingly poorly answered for an apparently straightforward question. *Syncline* was commonly given even when the anticline was correctly described in part (ii). Fault types were suggested.

(iii) Care with the drawing of the axial plane trace would make the subsequent questions easier to answer. Using a ruler to measure the width of the fold outcrop and to draw the line of the trace, would improve many answers. Many candidates offset the axial trace either side of fault 1; a small offset was allowed but needed to be less than 1 mm.

(iv–v) While some answers about the dip angle were guesses, many answers appreciated the effect of dip on the width of outcrop, although only a few candidates were able to write a clear, concise answer. This concept proves difficult for students to understand and/or remember.

b) (i–iii) It may be that candidates knew the correct answer about the dip-slip fault but it was often difficult to tell from the poorly-worded answers. Answers could not identify clearly which part of the structure was involved.

> **Examiner tip:**
> Recognising faults on a map often proves difficult for candidates. Knowing how to identify faults on both cross sections and maps is an essential skill. Using changing distances on outcrops of beds on maps to work out the downthrown and upthrown sides is an area to work on.
>
> Card sorts of fault types to match with definitions, characteristics and diagrams are very useful. Similarly card sorts of folds with definitions, characteristics and diagrams should help to reinforce the differences between these two very different structures.

c) (i) Mostly correct, candidates were allowed a range of different terms for the same fault.

(ii) Most candidates were able to work out the amount of displacement.

d) Most candidates knew *slickensides*, but there were many spelling errors, including slickenslides, slick and slides, slicken sides.

Question 6

Q6 Most candidates had a very sound knowledge of earthquake prediction methods making this one of the easiest questions for candidates. The detail of understanding of how each of the chosen techniques worked provided discrimination. Good answers were distinguished by clear, detailed answers that provided insight into how the methods work. Few answers scored less than 4 and very few candidates offered no answer.

Common errors included using P, S and L waves arrivals as precursor tremors which is a method for predicting volcanic activity, seismometers that can tell when the waves are about to arrive and confusion between liquefaction and the change in water level.

F792 Rocks – Processes and Products

It was pleasing to see that candidates were able to perform well in almost all areas of the examination paper. The majority of responses demonstrated that candidates had been well taught and showed a good level of knowledge. A recurrent theme is the need to use correct scientific terminology appropriately. The use of appropriate terms can convert a vague response into a much more focused answer that will gain more credit.

This paper will always include a range of questions about rocks, so it is essential to have a thorough understanding of the different terms used and to be able to distinguish between them clearly. Rock *groups* are igneous, sedimentary and metamorphic while rock *types* are the specific names such as *granite* or *sandstone*. The difference between a *rock* – composed of a variable range of minerals, and a *mineral* - of fixed composition, is also important.

There was no evidence that the paper could not be completed on time. The correct use of the command words explain or why or how are key to attaining the highest marks.

Comments on Individual Questions

Question 1

Candidates were generally successful in answering this question with candidates finding it one of the most straightforward. Many of the drawings were of a high standard

1 (a) Many of the diagrams to show the difference between a conglomerate and a breccia were excellent but there was some confusion with a few candidates incorrectly drawing angular fragments for conglomerate and rounded for breccia and drawings that showed grains that were not clearly rounded and angular respectively. Scale was sometimes omitted or incorrect.

(b) (i) The explanation of a sedimentary rock was not well answered with references to clasts and fragments rare. Responses often referred to weathering and erosion. Many answers referred to sediment rather than clasts.
Knowledge of matrix was poor with candidates regularly referring to cement. There was little reference to smaller particles binding larger particles together. Good answers referred to fine grains.

(ii) The majority of candidates recognised sandstone or varieties of sandstone, with incorrect responses including arkose, desert sandstone and even the occasional conglomerate when scale was not taken into account. Size was not well answered with little reference to the scale, so measurements often used the complete range for arenaceous (0.0625 –2mm) rather than the actual size drawn. Shape and sorting were generally well described but occasionally sub was omitted in the description. Vague terms like "quite sorted" were not allowed.

(c) Type of metamorphism was generally well known, although burial was sometimes incorrectly used for rock C. Pressure conditions were well known though a few candidates tried to use the exact figures in kb when the descriptive terms 'low' and 'high' were acceptable.

Teaching Tip
Thin section drawings
Thin section drawings are common on these papers and candidates should always analyse them by looking at specific features.

- *scale* in order to determine the grain size if it is sedimentary and the *crystal size* if it is igneous or metamorphic
- *grains* or *crystals* to identify the rock group as sedimentary, igneous or metamorphic
- *composition of minerals* for all rock groups and cement or matrix for sedimentary
- *grain shape* for clastic sedimentary rocks only
- *texture, foliation* and features such as *fossils* specific to one rock group.

Be clear about ***rock group*** - sedimentary, igneous or metamorphic and ***rock type*** such as sandstone or granite or schist.

(d) (i) Most candidates recognised the limestone, although incorrect responses included shale, chalk and mudstone. Descriptions were a little more varied, with good candidates referring to fossil fragments and / or a bioclastic texture. Weaker candidates described just fossils and not their state of preservation.

(ii) There were some good labelled diagrams of marble, with clear interlocking calcite crystals. Weaker candidates just repeated the diagram of the limestone in terms of both texture and content, while others showed a foliation and other new metamorphic minerals. Too many brick pattern diagrams gained no marks as the diagrams had to show random interlocking crystals.

Question 2

Many candidates were successful with this question on volcanoes – always a popular topic. However the lack of explanations reduced marks in some cases.

2 (a) (i) Generally well answered and responses included both the correct answers of Caribbean and Aleutians. Weaker candidates circled the Cascade volcanoes.

(ii) Most candidates recognised Mount Mazama as the most violent eruption but many failed to explain the answer fully, with comparative descriptions such as 'most' or 'greatest volume' or measurements e.g. Mazama produced 45 km3 compared to 13 for Katmai,

(b) (i) This was not well answered as only a small percentage of candidates were able to correctly name rhyolite. Incorrect responses included basalt, granite and diorite and even minerals such as quartz. Knowledge of the igneous classification table would have helped to give answers related to silica content and crystal grain size in a volcanic environment.

(ii) The majority of candidates were able to name two pyroclastic products but often failed to give descriptions. Only the stronger candidates gave three products with descriptions. There were some detailed references to lahars not linked to pyroclastic flows as well as lava incorrectly referred to as a pyroclastic product. Only rarely were measurements of the size of products given.

(c) (i) No problems, with the majority of candidates able to give the maximum distance within the range allowed.

(ii) Many candidates were able to describe but not explain and this does seem to be a common error. Responses for descriptions were varied with many quoting 'wind to the east' without saying which way the wind was blowing and 'thickness decreasing to the east'. Only occasionally was wind direction used as an explanation, and lateral blast even more rarely. Very few responses used energy reduction as an explanation. Weaker students did not know east from west!

(iii) Most candidates had the right idea but often failed to give specific wind directions or locations so failed to get credit. Good answers used comparisons between the two places and answered the question why?, rather than just giving a statement.

(iv) Answers were generally good although some candidates gave unrealistic distances from the volcano instead of simply stating 'close'.

(v) There were many very good answers and it was clear that candidates have a wide ranging knowledge of monitoring methods. However, the question asked not just for the method but how they are used to give warning and it was this second part that gave the problems.

- Earthquakes often lacked reference to increased activity prior to eruption with little reference to magma moving up causing the earthquakes.
- Gas composition was generally well answered though an error was using radon as an example.
- Ground level changes were well known but not often linked to magma rising upwards.
- Changing water levels was generally well described.

Incorrect responses included studying historical records as weaker candidates confused volcanic and seismic prediction methods.

(d) (i) The quality of diagrams was poor so very few candidates had diagrams worthy of 2 marks. The sides of the volcanoes/calderas slope were drawn far too steep. The lake was often omitted though this was a specific part of the description for this question. The idea of collapsing of the top of the volcano was not always known. Quality of labelling was poor.

(ii) Some good descriptions, with emptying of magma chamber and collapse regularly referred to. Violent eruption was often omitted as was water filling crater to form lake as the final stage.

Question 3

Candidates were generally successful in answering this question, finding it one of the most straightforward, so that maximum marks were obtained.

3 (a) (i) Many candidates were able to give a platy mineral although often it was just 'clay'. Incorrect responses included named rocks such as slate and shale.

(ii) A well answered question with most candidates giving water as the correct answer. Incorrect responses often referred to volatiles.

(iii) About 50% of candidates gave the incorrect response of slate instead of shale. Diagenesis is a sedimentary process and does not produce a metamorphic rock.

(iv) Some very varied responses partly due to not responding to the diagrams in the question. Many candidates were able to get 2 out of 3 marks even though they were describing a metamorphic process and cleavage formation rather than the sedimentary process shown in the diagrams. Weight of overlying material was often quoted although weaker candidates discussed compaction without mentioning the source of pressure. Mineral alignment was referred to but only the more able candidates described random arrangement before and aligned after. Water removal was often quoted but rarely reduction in porosity. Very few candidates mentioned the reduction of thickness clearly seen in the diagrams.

(b) (i) The majority of candidates named sillimanite correctly but the spellings varied enormously!

(ii) No real problems with quoting the triple point temperature and pressure conditions.

(iii) Plotting the temperature gradient proved to be a real challenge and many candidates guessed or left it blank. Other candidates had the right idea but plotted the line incorrectly on the graph.

(iv) Good candidates had no problems, but weaker ones just guessed with andalusite often quoted along with some minerals not shown on the graph Some candidates gained from the error carried forward.

(v) This was not well answered; many candidates seemed to guess and referred to igneous and metamorphic with no real reasoning. Good answers linked the graph to schist and gneiss, and temperature / pressure conditions to regional metamorphism.

(c) Fewer than 50% of candidates were able to place diagenesis in the bottom left hand corner, although there were some interesting plots from others, including around the triple point and the area for burial metamorphism.

(d) The terms and definitions were very well known with the majority of candidates achieving at least 2. The main confusions were between grade and zone, and polymorph and index mineral.

Question 4

Candidates found this a challenging question partly because of the confusion regarding the terms *rock* and *mineral*. Knowledge of the igneous classification table would have made this question much easier.

4 (a) (i) There were no problems in plotting the bar graph, although a small number of candidates plotted the diorite incorrectly.

(ii) Some surprisingly varied responses. With all three rocks being quoted, weaker candidates were unable to link lower density to the increased ability of a magma to rise in the crust.

(iii) A wide range of responses. Only the stronger candidates were able to link state to density and temperature. Others had no idea and made random guesses like crystallisation rates. Some candidates discussed the answer in relation to particle movement, which was acceptable.

(iv) This was not well answered, with only a very small number of candidates referring to pressure and an explanation of pressure as a variable was rare. Incorrect responses included temperature, inaccessibility for measurements and human error.

(b) (i) Surprisingly varied responses to a rather straightforward question if candidates knew the classification of igneous rocks. A number of candidates gave incorrect figures for mafic rocks. Also an area of concern is the use of < less than, and > more than correctly, as this led to some incorrect responses for silicic rocks.

(ii) Mineral contents were not well known and only a small number of candidates scored full marks and got all 4 correct. Candidates need to learn the essential minerals of each igneous rocks group. A number of candidates put two ticks in both the gabbro and granite columns for quartz.

(iii) No real problems as there was a wide range of possible answers. Weaker candidates failed to elaborate on coarse as a size i.e. crystal grain size. Other incorrectly gave sedimentary textural terms.

Teaching Tip
Learn the igneous classification table by creating a blank A3 template with all the headings for silica content, crystal grain size, origin and mineral composition and boxes for all the rocks. Separately, labels for the names of rocks can then be created to be put into the correct boxes. If available specimens can also be used.

(c) (i) The majority of candidates correctly gave batholith as a response; the main incorrect answer given was sill.

(ii) A challenging question that led to some very good responses from those candidates who had learned this topic. Stronger candidates were well prepared and had a clear understanding of both stoping and assimilation, could clearly link the words to the processes involved, and provided clear, well-labelled diagrams. Stoping proved to be the challenge for some candidates who clearly understood assimilation and xenoliths. A number of candidates made no response.

Question 5

Deserts are usually a popular topic but the structure of the question required precise answers that were not often given making this a harder question for many candidates.

5 (a) Some good responses, with many candidates achieving the 2 marks available. Many correctly referred to high energy and rapid deposition with the water carrying material of all sizes. Occasionally there was the incorrect use of the terms wadi and alluvial fan

(b) (i) Almost a split down the middle with 50% correct and 50% incorrect. Usually it was a 180 degree difference, e.g. G to F and not F to G. Some candidates failed to have the wind direction parallel to the line.

(ii) Some very varied responses although the ecf helped. The angle of the steeper slope continues to be an issue with many drawn at over 50 degrees. It was good to see that many candidates are learning the critical slope angle and label it on the diagram even if it is inaccurate on the diagram itself.

(iii) Stronger candidates clearly understood the process of dune migration, while others had drawn random lines in the dune structure. Some candidates left this blank, possibly failing to see the question.

(iv) Some good descriptions showing a clear understanding of the key characteristics of a desert sandstone. Many candidates knew more than three characteristics, including frosted grains. The quality of diagrams, however, was not good, with poor use of scale and shape, and little reference made to the scale bar in order to draw the correct particle size.

(c) (i) Evaporites was not a well answered question with candidates not referring to the origin of the salts. Many responses referred to evaporation of saline water to give salts. Little or no reference to chemical weathering although stronger candidates often referred to dissolving of bed rock and transport in solution.

(ii) Gypsum and calcite often given the wrong way round. Potassium often given rather than potash or potash salts. Sequences were sometimes given wrong way round. Weaker candidates just guessed and gave random minerals often with no affinity to evaporation e.g. augite, feldspar etc.

(d) Some good responses, although often one factor was omitted so candidates wrote either hot or dry, but both terms are essential for a desert climate.

Question 6

Knowledge of sedimentary structures was generally very good. The quality of diagrams was variable and they often lacked clear labels. However links for each sedimentary structure to the environments were rarely made. Surprisingly many candidates wrote about the use of sedimentary structures as way-up criteria which was not part of this question at all.

- Desiccation cracks are well known although the concept of the cracks being infilled by a younger sediment was often omitted
- Salt pseudomorphs are not well understood with both the process of formation and the material of which they are formed poorly known. Many candidates thought that they were still salt crystals rather than cubic holes left by the solution of the salt later infilled by sediment.

- Graded bedding was very well understood and the link to turbidity currents regularly used. There was some confusion with fining upward sequences by some candidates. Graded bedding is within a single bed while a fining up sequence is a series of beds.
- Ripple marks – the process of formation was well understood but the link between environment and ripple shape needed to be clear.

Question 7

Many candidates failed to read the question carefully and so wrote about processes below the surface as well as the process at the surface as asked in the question. Discussing in depth of internal processes wasted valuable time and scored no marks. A clear labelled diagram of processes above the surface helped some candidates and often acted as a plan. Many candidates failed to give thorough definitions of the key processes e.g. weathering is the break down of rocks in situ. Some answers lacked detail and were just a list of the processes. There were clear problems with differentiating between *weathering* and *erosion* and hence the methods involved in each process. There was little reference to uplift as a process.

F794 Environmental Geology

Most candidates displayed sound subject knowledge and appeared well-prepared for this examination. Some candidates, however, struggled to attain marks even on low demand questions due to a lack of clarity in their answers. Candidates need to be aware that A2 level is more demanding than AS level and simplistic answers that do not use correct geological terminology will not gain credit. In addition, some candidates were challenged by the synoptic elements of this paper, while others did not read questions carefully enough and on occasions gave responses that did not answer the question asked. There was no evidence that time was an issue, with virtually all candidates attempting the final extended question on underground coal mining.

The following points should be noted:

- Synoptic assessment – It clearly states in the specification that all the A2 units are synoptic. The synoptic assessment is designed to test candidates' understanding of the connections between different elements of the subject. It involves the explicit drawing together of knowledge, understanding and skills learned in the different parts of the GCE course. 20% of the F794 paper is synoptic. Although any synoptic question can be asked, the most obvious links with the AS level specification are geological structures and many aspects of the F792 Rocks - Processes and Products unit.
- Stretch and Challenge – 10% of the questions on the F794 paper are high level questions designed to "stretch and challenge" and differentiate between A* and A grade candidates. These may appear as whole questions or as individual mark(s) within a question.
- Quality of Written Communication – On this paper, quality of written communication is assessed by the requirement for candidates to *Use the appropriate technical terms, spelled correctly.* Once again, it was surprising that some candidates did not make more of an effort to be neat and legible on the specific questions that tested this skill.

Comments on Individual Questions

Q1 Most candidates showed a good understanding of the geological requirements for spring and groundwater supplies but many lost marks as they struggled with the hydraulic gradient calculation and did not give full explanations where required.

a) The majority of candidates were able to give a correct definition of the term *water table* but some lost marks due to simplistic descriptions such as the *level of water in a rock.* Other errors included stating the water table is the boundary between permeable and impermeable rocks or between soluble and insoluble rocks.

b) (i) The reasons why there was a spring at location A were well known, but many candidates did not attain maximum marks because they did not give a full explanation. Although the fact that metamorphic rocks are impermeable was well known, few cited that the spring is at the boundary between permeable and impermeable rocks and thus lost a mark. About half of the candidates gained a synoptic mark for recognising that the spring was at an unconformity, but few explained that springs occur where the water table intersects the land surface. A small minority mistakenly wrote about the spring at the top of the shale lens.

(ii) Although the majority of candidates could correctly draw the position of the water table that fed the spring at A, some did not draw the shape accurately enough to attain the mark. A common mistake was that it did not intersect the land surface accurately at A. Others did not read the question properly and drew the likely shape of the water table above the shale lens, while some drew it cutting through the impermeable shale.

c) This question asking candidates to draw a fully labelled thin section diagram of the sandstone to explain why it produced groundwater suitable for drinking proved to be a good discriminator. While there were some excellent, fully labelled diagrams with good explanations of the process of filtration of the water, others were very poor. Many candidates did not put any relevant labels on their diagram and had obviously forgotten the correct terminology for describing the texture of a sandstone. Common errors were labelling matrix or cement between the grains which would reduce the porosity and permeability and no scale or an incorrect scale. By definition, a sandstone should have a grain size between 2 and 0.0625 mm. In addition, a significant number drew a standard labelled diagram of a porous and permeable sandstone but did not apply it to the specific question of why it produced groundwater that is suitable for drinking, thus losing a mark

(d) (i) The vast majority of candidates were able to correctly name and spell the aquifer as unconfined or perched. There were a few misspellings such as 'pearched' and others erroneously identified it as being a confined aquifer or an artesian basin.

(ii) Many candidates struggled with this straightforward question asking what would happen if the well cut through the shale lens. A number confused the situation with an artesian well and some answers suffered from a lack of clarity due to poor use of grammar with suggestions that the water would go "into" the shale or the well would dry up but not specifying why.

(e) (i) Most candidates correctly determined the amount of draw down between points C and D, but there were a number of omissions, while others misread the scale and arrived at an answer of 14 metres - double the correct one.

(ii) Candidates were less confident about calculating the hydraulic gradient between the two points and many had not learnt the formula: the difference in hydrostatic head between two points divided by the distance between them. A correct answer stated as a decimal, fraction or ratio was acceptable.

(iii) Many candidates struggled with this high demand question asking for an explanation as to how the hydraulic gradient related to the shape of the water table. Few were able to go beyond the simple idea, for one mark, that a cone of depression forms. For the second mark candidates needed to discuss the reduction in pressure in the vicinity of the well or the idea that the water flows in response to pressure differences between the two points. Unfortunately, a common misconception appeared to be that hydraulic gradient was reduced rather than increased around the well.

Q2 The requirements for the formation and accumulation of oil and gas were well known areas of the specification, but some candidates penalised themselves by not applying their knowledge to answering the actual questions asked. Some candidates were less sure of the new part of the specification covering underground gas storage in rocks.

a) (i) This straightforward question asking candidates to shade and label an area on the map where economic quantities of offshore oil and gas have been found around Britain was not done particularly well. Although many candidates shaded an offshore area correctly, very few labelled the area oil, gas or both. This was unfortunate, as it was then impossible for the examiners to know if the candidate understood which type of petroleum would be present in their chosen area – oil and/or gas in the northern basin of the North Sea and gas only in the southern basin of the North Sea or in Morecambe Bay / off the coast of Kinsale Head in the Irish Sea. Candidates must ensure they follow the question rubric correctly.

(ii) The likely structure of the Ekofisk anticline oil trap was well understood by most candidates and there were many excellent, accurate, fully labelled diagrams that attained the maximum three marks with ease. Common errors were not including the Kimmeridge Clay source rock at the bottom; not showing both the chalk reservoir rock and the clay cap rock as an anticline; and failing to draw the oil (and gas) *horizontally* at the top of the reservoir rock.

(iii) The requirements for the formation of oil in a source rock were well known but many candidates lost marks because they did not read the question carefully enough. Instead of describing the process of oil formation they wrote an answer to a different question and described the environment of deposition of the source rock. In addition, some candidates did not use any technical terminology in their answers: merely stating that plankton is changed into oil by the effects of heat and pressure is not worthy of a mark at A2 level. The best answers described the maturation process by which plankton is converted to kerogen and hydrocarbons during burial and compaction over millions of years. Others correctly referred to the process requiring temperatures of 50 to 200°C (the oil window) and the involvement of anaerobic bacteria.

(iv) Most candidates knew migration was the process by which the oil moved from the Kimmeridge Clay to the chalk reservoir rock and there were no issues with spelling of this term.

b) Most candidates were very aware of the environmental problems that might result from offshore extraction of oil and gas but, again, many let themselves down with very simplistic answers that did not *describe* the problem. Just stating that an oil spill or leak may occur, or that pollution may occur was not enough. To attain the mark, candidates needed to describe a specific problem, e.g. an oil spill, *and link it* to the environmental problem it would cause, e.g. damage to marine ecosystems caused by toxins in the oil, oiling of birds, etc. Some of the more memorable incorrect responses included: "Oil could pollute the surrounding seawater making it dangerous to drink"; "Sea bed subsidence may cause changes in the tides"; and "Disturbing plate boundaries may trigger earthquakes"!

c) (i) Some candidates found this question on underground gas storage in rocks very demanding. Only the strongest candidates gained all three marks by correctly naming and describing a suitable facility such as a depleted oil and gas reservoir, a salt cavern or an aquifer. Weaker candidates let themselves down with poor English and were unable to give a correct and coherent description. Common errors included mixing up the different types of storage facility, using the term salt *dome* rather than salt *cavern* and not using the term *depleted* when referring to old

oil and gas reservoirs. The worst answers suggested "Putting the gas in barrels and storing them in abandoned quarries" or "Storing the gas in canisters underground" and there appeared to be some confusion with landfill waste disposal and underground storage of nuclear waste.

(ii) Most candidates were able to suggest a safety problem that could result from the underground storage of gas, with fires and explosions being the most commonly cited correct problems. Just stating it could leak was not sufficient for the mark. Furthermore, a significant minority had no idea and suggested it could pollute groundwater supplies or it would be dangerous to plants and animals. Incorrect spelling was also an issue with suggestions that it could cause "subsistence" rather than subsidence.

Q3 While there were some very good responses to this question on the formation of ore deposits in mafic igneous intrusions, as expected, some candidates found the stretch and challenge parts of the question very difficult.

a) (i) Virtually all candidates correctly plotted the scatter graph of density against melting point for the minerals given in the table. Using crosses instead of dots is a better technique for plotting points and any lines on the graph were ignored. However, a small number made careless errors plotting points and lost a mark.

(ii) This question asking for an explanation as to how the data about mineral density and melting point related to the formation of economic metallic mineral deposits in mafic igneous intrusions was not answered very well. Some candidates did not appreciate that they needed to discuss the formation of ore deposits by gravity settling and a significant number were confused with the formation of hydrothermal ore deposits in silicic intrusions. Others simply discussed the patterns shown in the table and on their graph without relating them to the formation of ore deposits. Of those who did correctly discuss the formation of magnetite and chromite deposits by gravity settling, few attained all three marks available. The misspelling of *cumulate* layer continues to be a problem, often quoted as "cumulative" or "accumulate".

(iii) As expected for this stretch and challenge question, very few candidates achieved all three marks for suggesting a relationship between mineral composition, density and melting point. The most common correct answer given for one mark was that the denser minerals have higher melting points. Only the most able candidates were able to discuss the differences between oxide / ore minerals and silicate / gangue minerals with any confidence and many just repeated the information given in the table.

b) Geophysical exploration techniques were well known with only a handful of candidates choosing an incorrect technique such as a seismic survey or a geochemical survey. However, in common with other questions asking for descriptions or explanations, some candidates penalised themselves with poor spelling and grammar that made their answers unclear. At A2 level just stating the use of a magnetic survey with a magnetometer (often spelt incorrectly) or a gravity survey with a gravimeter is insufficient detail for two marks. Others did not use correct terminology such as the presence of magnetite would result in a *positive anomaly*. A small number were confused between gravity and magnetic surveys.

Q4 This question on tunnelling and geological materials proved to be a good discriminator. Well-prepared candidates scored highly, while others struggled to attain marks and gave basic answers that lacked correct geological terminology.

a) (i) While there were many general answers stating that both geophysical and borehole information were needed to give a complete picture of the underlying geology prior to the construction of the Channel Tunnel, sadly a large number of candidates penalised themselves on this question by not stating the specific information that would be provided by each technique.

(ii) Most candidates were able to attain some credit for explaining why the Chalk Marl was considered to be an ideal tunnelling material. The fact that it is impermeable, soft, yet competent was well understood. However, some candidates lost marks because they did not use their geological knowledge to *explain* why it was easy to tunnel through or didn't allow leakage of water.

(iii) The vast majority of candidates correctly stated that the major fold structure shown in the cross section diagram was a syncline. Only a minority thought it was an anticline. One stated it was "The White Cliffs of Dover", while another "The Bushveld Complex"!

(iv) Candidates were less sure of the advantage that the fold structure gave to the route of the tunnel and those that said it followed the shape of the fold often did not use the correct technical term i.e. that it was able to follow the *dip* and stay in rock type.

(v) The problems faults could cause were well known, but some answers did not include geological reasons. Simply stating the faults would cause the tunnel to collapse or flood was not sufficient. In addition, answers that suggested there would be different rock types on either side of the faults were not given credit as it could be seen clearly on the cross section diagram that the tunnel stayed in the Chalk Marl. Probably a case of repeating learnt information without applying it to the actual geological situation in the question.

(vi) This question asking for a description of the process of grouting and an explanation of its purpose was not answered as well as expected. Although there were some excellent responses that achieved the maximum three marks with ease, this proved to be yet another example of many candidates failing to use correct geological terminology to describe a fairly simple concept. Many candidates confused grouting with shotcrete or lining and few were aware that *liquid cement* is pumped into holes drilled into rock. Furthermore, to gain the other marks, the candidates had to show a clear understanding that the cement fills pore spaces and joints, reduces the permeability and increases the strength *of the rock* rather than the walls of the tunnel.

b) It was clear that many candidates were familiar with the issues surrounding the development of coastal super-quarries such as that at Glensanda. There were many good responses that focused mainly on the economic advantages and environmental disadvantages of coastal super-quarries. However, economic and environmental arguments had to be qualified with specific details to attain the marks.

c) Candidates who were familiar with geological materials and their uses scored the full 3/3 on this 'match the geological material with its most likely product' question. However, it was surprising that a small minority of candidates gained no credit at all on this low demand question.

Q5 There were some excellent, well-illustrated answers to the extended question on the geological problems that can make underground coal mining difficult and uneconomic. It was encouraging that there were very few no responses and virtually all candidates gained some credit for their answers.

However, few candidates attained the maximum mark because many answers only covered a limited range of problems – usually faults, seam splitting, washouts and folds / steep dips. Weaker candidates lost marks because they failed to notice the word *geological* and wasted time discussing socio-economic and technical factors instead of concentrating on geological factors.

The standard of diagrams was variable. While there were some excellent, accurate diagrams complete with detailed annotations that were a credit to these candidates, others were so poor as to be worthless. In some cases, the diagrams merely repeated what was written in the text so did not add anything to the answer.
Key points to note include:

- The problems of rocks of different hardness and thin / variable thickness and deep coal seams making mining difficult and uneconomic were well understood by the majority of candidates, but many kept repeating these two problems in different contexts.
- Washouts – most candidates were aware that these result from river channel erosion, but few achieved the second mark because they implied it occurred after the coal formed rather than when the vegetation / peat was forming on the delta top.
- Seam splitting – the problem of coal seams splitting into thinner, unworkable seams was well known, but few achieved the second mark available for explaining that it occurs due to differential rates of subsidence during the delta formation. In addition, seam splitting diagrams were often inaccurate and showed seams rising upwards – clearly impossible.
- Faults – generally done well but many candidates did not use good terminology when referring to displacement of rocks, e.g. a fault could "misplace the material"!
- Very few candidates discussed problems such as the presence of methane / toxic / flammable / explosive gases; permeable rocks / position of water table causing flooding or high pumping costs; or the rank / carbon content of the coal being too low to be economic to mine – all of which were worthy of marks.

F795 Evolution of Life, Earth and Climate

This was a small entry which consisted of a cohort with many high achieving candidates. The overall mean mark attained was therefore high. The majority of candidates displayed sound subject knowledge and were very well prepared for this examination. There was no evidence that time was an issue with virtually all candidates attempting the extended questions on mass extinctions and corals.

The quality of diagrams and the ability for the candidates to label them accurately has improved, supported by publication of helpful recent texts. Very few candidates did not annotate diagrams properly.

The synoptic assessment was embedded into the questions. This is designed to test the candidates' understanding and enable them to make links between the AS and A2 content. This sometimes corresponded to the stretch and challenge component, for example question 2(e), which differentiated well. The most obvious links for synoptic topics revolves around the ideas of sedimentary environments and deposition, from F792 Rocks – Processes and Products.

Comments on Individual Questions

Q1 Most candidates showed a good understanding of the classification elements and understanding of echinoid functional morphology in this question with many candidates gaining nearly full marks.

a) (i) The majority of the candidates were competent at recognising fossil groups from their description.

(ii) Most candidates were able to draw and label the gastropod. Many were excellent - both well drawn and with 6 or more correct labels. Almost 90% of candidates gained full marks for this part question, despite the content representing a minor fossil group.

(iii) Candidates were mostly able to describe the mode of life for fossil B. The most common answer described B as sessile and attached to the substrate by a holdfast. Error carried forward was taken into account for this question.

(iv) Almost all candidates stated D as planktonic.

b) (i) This part question provided better differentiation between the candidates. Part 1 was sometimes wrongly labelled as the mouth or peristome. For part 2 there was some general confusion between the ambulacra and interambulacra by some candidates.

(ii) This was generally well done. Most candidates were skilled at being able to identify the morphological parts as an expanded part of the fossil echinoid E. Common mistakes included the tube feet being wrongly labelled as a spine and pore pairs a tubercle, both gaining no marks.

(iii) Due to the term *tube foot* this attracted a much stronger locomotion importance than it probably warranted. There were some good descriptions of the water vascular system and the use of tube feet for respiration and the concept of many tube feet providing a large surface area for respiration.

(iv) This part question discriminated relatively well, although there were lots of answers that described the use of rotating spines for movement of echinoids and the jaws for feeding.

Q2 This question differentiated relatively well, with the majority of candidates gaining 13 out of the maximum 19. Very few candidates gained maximum marks. The subject matter in part (a) was least well known, being a new addition for this specification.

a) (i) As candidates were provided with two lines and the instruction *describe,* the mark was not given for a one word answer. Around one third of candidates did not access this mark.

(ii) Most candidates gained one out of the two marks here. Most were confident about the composition of the ostracod, but less secure about the conodont. Incorrect answers included; calcium unqualified, some type of protein and organic.

(iii) As a minor part of the specification, it was pleasing to see that many candidates were able to state that the conodont is a tooth from a soft bodied creature. Some even used the term 'hagfish' in their answer. A minority who did not know what it was guessed that they were spines to help or a hook attaching an animal to the substrate.

(iv) There were some very general answers for this question, stating they were simply already extinct. This fossil belonged to an animal that was extinct at the P-T event, and excellent candidates used this terminology to good effect.

b) (i) Belemnites were mostly well drawn and labelled, with some diagrams including soft parts. The minority of diagrams that were less clear had drawn the phragmocone in the incorrect position. Some omitted the labels 'guard' and 'phragmocone' from their diagram, but including other valid labels such as the pro-ostracum. As the instruction was to label the guard and phragmocone, this gained no marks.

(ii) Most candidates described the mode of life of belemnites very clearly.

(iii) Most understood that the guard was made of calcite and harder than the rest of the organism.

c) Almost all candidates could recall the difference between body fossils and trace fossils. Many gave good examples for each.

d) The descriptions of pyritisation generally demonstrated a much wider appreciation of the processes involved, with many correctly describing bisulfate as part of the process. There were a few weak answers which simply described this as replacement by pyrite, which gained no marks.

e) This question was one of the stretch and challenge questions on this paper. As such it did differentiate very well, with many candidates gaining only two of the possible four marks. Some candidates spent time describing burial or erosion and weathering, instead of diagenesis, the synoptic topic. As such they were distracted by scavengers, decay and some simply described exceptional preservation of fossils, rather than answering the question. Understanding was mostly limited to fine grains providing good detail. Few candidates were able to describe the effects of early diagenesis.

Q3 This question was well answered by the majority of candidates, with the spread of mark spanning 5 to 19 marks overall. Part (a) was more accessible than parts (b) and (c). There were some general problems with some candidates transposing brachiopods and bivalves which is a common error.

a) (i) The morphology of brachiopods was well remembered, with the exception of the more difficult question relating to dentition.

(ii) Adaptations to soft substrates were not always fully explained. There were two marks for each section, requiring a description and explanation. Two descriptions did not fully answer the question set. The high energy adaptations were better described and explained.

b) (i) The question asked about the internal morphology, yet some candidates only drew the standard razor shell in a burrow complete with siphons and a foot. Some produced drawings with more rounded bivalves possessing a shallow pallial line - clearly shallow burrowers. There was a general uncertainty about the position of the adductor muscle scars and the ligament. Incorrect answers included the labelling of a pedicle or with soft parts only.

(ii) Questions with two parts and two marks should be answered in detail; many candidates tended to give rather incomplete answers that were more general, such as 'siphons were used to feed and respire', thus demonstrating a lack of understanding of the processes required. Some incorrect answers included the lophophore as arms or as a description of the siphons.

(iii) The adaptations required were often stated as a list, without the required description or explanation. Some incorrectly stated that the siphons were used to dig the burrow.

c) (i) Some candidates completed this question very well, with full descriptions of the position of the symmetry of each fossil. Others used a diagram to help explain the differences. Some merely reported whether they were equivalve or not, or that bivalves were symmetric and brachiopods asymmetric. Some used incorrect terminology such as the axial plane or discussed five-fold symmetry.

(ii) Many candidates could describe how shells were opened in both bivalves and brachiopods. There was, however, some evidence that candidates were regurgitating information as a lot of answers also discussed in detail how to close the shell which was not asked for in the question. Another incorrect answer stated that all bivalves were monomyarian and brachiopods were not.

Q4 The graph-plotting was generally accessible by all, but most of part (b) was answered less well by candidates.

a) (i) Graph-plotting was for the most part accurate and the axes were labelled correctly. Sometimes the points were not well emphasised, and it was difficult to see the plotted points when the line of best fit was added.

(ii) Candidates mainly gained this mark, as an error carried forward from plotting was allowed. A few candidates did not attempt the plotting and left this question as no response.

(iii) The changes in gradient were explained reasonably well by most candidates. One candidate described Milankovitch cycles as a reason.

b) (i) Some candidates had not read the question carefully and answered a question about coral and not coal, proving that it had to be in the tropics. This question related more to the formation of coal rather than the palaeolatitude.

(ii) Desert sandstones and evaporites were commonly used as evidence of arid conditions. Most completed this part question wel,l but incorrect answers centred on less arid conditions needed for coal and corals and even a description of red/orange desert limestone.

(iii) Candidates found it difficult to explain why it is believed that the UK moved north rather than the climate cooled. The transition of palaeoclimate does not in iitself require movement.

Q5 This new subject matter has been well absorbed by candidates with many good and detailed responses throughout.

a) (i) Most candidates could answer this part question correctly, a few mistakenly transposing the answers.

(ii) There were many good descriptions of the mode of life of *Diplodocus*. Most discussed the flexible neck or the peg-like teeth in their answers. These were as well described as many other more traditional areas of the specification. Incorrect answers suggested that *Diplodocus* could fly!

(iii) There were detailed descriptions of the hip bones and pelvis in particular. Again, some candidates transposed the answers.

b) (i) There were many excellent answers showing an advanced understanding of the importance of the amniotic egg. Again, the question was expecting linked descriptions and explanations, not just a list of features.

(ii) Many candidates simply stated *Triassic* as an answer, thus gaining no marks. It was required that the answer had to be specific; 251ma or the *beginning* of the Triassic. Incorrect answers included the Ordovician, Jurassic or Cretaceous.

c) There were many sound answers detailing with the formation of coprolites or footprints. Some candidates neglected to give any information about the environment at all. Coccoliths were discussed incorrectly as fossil dung by one candidate.

Q6 This long answer was very often very well written, with many candidates gaining full marks. Most candidates were able to describe the correct extinction event, not confusing it with the Permo-Triassic boundary. There were high level descriptions of the processes involved in climate changes fuelled by volcanism or impact of a meteorite. The geological evidence was carefully linked to the answers and the answers were rarely presented as a list of facts.

Some candidates discussed flood basalts rather than the meteorite impact triggering the tsunamis and one candidate discussed the Siberian Traps rather than the Deccan Traps.

Q7 This question asked for labelled diagrams and as such could not achieve full marks without them. Most diagrams were recognisable and most candidates discussed the correct corals as a comparison. There were many answers that accurately compared the age ranges and structures of the two coral groups.

There was a tendency to discuss in some detail the environment of modern corals and a possible symbiotic relationship between the coral and zooxanthellae, wasting space and precious time in the examination. Less clear answers included all corals, giving Scleractinian corals equal exposure though they were not asked for at all.

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