GCE EXAMINERS' REPORTS

GCE (LEGACY)
GEOLOGY
AS/Advanced

SUMMER 2018

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GEOLOGY

General Certificate of Education (Legacy)

Summer 2018

Advanced Subsidiary/Advanced

GL1: FOUNDATION GEOLOGY

GL1

Mark range for paper 0 to 58 out of 60, Mean mark 37.02

Question 1 mark range 2 to 15 out of 15. Mean 10.80. Facility Factor 0.72

This was the most accessible question on the paper and many candidates scored well on all sections.
The majority of candidates correctly stated the name of the oldest rock and the trend of the igneous body but all of the rock types were given as answers and a number of candidates gave NE-SW for the trend instead of NW-SE.
The graph in part (b) was completed successfully by the vast majority of candidates and most were able to explain the reason for the variation in crystal size. Weaker candidates simply described the crystal size variation and did not relate to cooling rates.
Mineral E was correctly identified as orthoclase feldspar by the majority, with quartz and plagioclase feldspar being the most common incorrect responses.
Most candidates were able to explain how the texture in Figure 1d formed but weaker candidates repeated their answers to (b)(ii) and did not refer to the order or temperature of crystallisation.
(b)(iv) was a very good discriminator but only the most able candidates scored full marks here. Many weaker candidates simply agreed that it was a dyke, or disagreed stating it was a sill. Good candidates discounted it being a lava flow due to having two baked margins and not a pluton because of the size and shape of igneous body A. Only a few candidates correctly stated that it could be a sill or a vertical dyke.

Question 2 mark range 2 to 15 out of 15. Mean 9.38. Facility Factor 0.63

Most candidates gained credit on (a) citing the included fragments of shale and the age order of the fossils. Very few candidates referred to horizontal/undeformed strata on top of deformed or folded/faulted strata.
Table 2a was completed correctly by most candidates but the symmetry of folds was the main incorrect response. It is disappointing to see that many candidates are not aware of limb length being the criterion for symmetry or asymmetry.
The majority of candidates identified the fault as normal and gave a valid reason to support their answer.
Table 2b generated a wide range of numerical answers, many of which were incorrect. Candidates were poor at using the scale given to measure the two displacements. Clearly a number of candidates did not know what and where to measure to and from on Figure 2.
The type of tectonic stress was correctly identified as tensional in the majority of responses.
Section (d) resulted in a wide variety in the quality of responses. Weak candidates ignored the word energy and just described the characteristics of the rocks and some only referred to limestone and shale, ignoring the breccia. The more able linked the rock types and depositional environments to the changing energy conditions.

Question 3 mark range 1 to 15 out of 16. Mean 8.62. Facility Factor 0.57

This question proved to be the most demanding on the paper. It was surprising to see how many candidates were unable to state the meaning of relative age which was supposedly an easy starter.
The majority of candidates were able to give the relative age of the gabbro in Figure 3 but a number of candidates stated it was 60 Ma.
Many candidates were unable to state all three of the correct periods that make up the Mesozoic Era. Many seemed to be random guesses.
Table 3 was completed correctly by many, but a significant number made careless errors by giving 0% for the parent isotope and 100% for the daughter isotope.
Half-life was defined correctly by the majority of candidates but the calculation of the absolute age of the schist was answered incorrectly by many as they didn't realise that 12.5% parent atoms equalled 3 half-lives. Many thought it was 4 half-lives.
Part (iv) was answered very poorly, many candidates not actually stating whether location Q would be older or younger than P. Many thought that the gabbro would introduce more daughter or parent atoms. Very few mentioned that daughter atoms would be lost until the rock cooled below 300°C or blocking temperature. The better candidates referred to the clock being re-set but often failed to qualify this.
The use of carbon 14 seems poorly understood by many candidates and the answers only occasionally had any evaluation in them. Many did not refer to the other rock types in Figure 3. The best responses referred to the age limit of 60,000 years and could only be used if carbon was present.

Question 4 mark range 0 to 14 out of 14. Mean 8.38. Facility Factor 0.60

The graph in Figure 4a was correctly read by the majority of candidates. Most correctly identified the temperature of 200°C but a number gave the pressure reading on the left instead of the depth value on the right.
Inserting the labels onto Figure 4a was generally well done but it was disappointing to see so many responses with one of the labels in the dark grey area on the left.
Most candidates scored 1 or 2 marks on (a) (iii) with the most common incorrect response being temperature which was referred to in the actual question.
Mineral X and mineral Y were correctly identified by many but virtually every other mineral on the data sheet appeared in responses.
The common parent rock in (b) (ii) also elicited a wide range of responses that included granite, basalt, limestone and sandstone. Many candidates did correctly identify shale as the most likely.
Response to the differences in texture between Figure 4b and 4c were rather variable and weaker candidates used inappropriate igneous or sedimentary terminology. Foliated and non-foliated was the most common response, followed by coarser and finer crystal sizes. Less common was granoblastic and porphyroblastic.
Linking the rocks in Figure 4b and 4c to the graph in Figure 4a produced a range of answers which often seemed to be allocated randomly. Only about half of the candidates correctly identified Figure 4b as N and Figure 4c as L.
Part (v) elicited some very weak and generalised responses with little or no reference to an actual plate tectonic setting. Vague reference to mountain building was a common theme but few linked it to continental collision zones, regional metamorphism and recrystallization.

Principle Examiner

GEOLOGY

General Certificate of Education (Legacy)

Summer 2018

Advanced Subsidiary/Advanced

GL2A: INVESTIGATIVE GEOLOGY

1. (a) The majority of candidates had no difficulty correctly identifying Specimen A as being porous, well sorted and having been the product of aeolian processes. The most common error was stating that the specimen was coarse grained.

   (b) Most candidates were able to justify their choices of quartz and haematite but some weaker candidates suggested garnet as their second mineral.

   (c) This proved to be the most difficult question on the paper with south-west proving to be the most common response from the candidates.

2. (a) This question produced a wide range in the quality of responses. A minority of candidates drew an external view that was able to be awarded some credit and most candidates were able to correctly name 2 hard parts. Weaker candidates often used names associated with other fossil groups such as pygidium.

   (b) The most common incorrect answer was brachiopod but a surprisingly high number of candidates were able to correctly identify specimen B as a bivalve but were then unable to give a correct reason for their identification.

   (c) The majority of candidates were able to discuss marine and aeolian environments with the more able candidates also able to integrate the map evidence into their responses.

3. (a) This proved to be a very accessible question with credit awarded to candidates who incorrectly identified the igneous body.

   (b) There were a number of high quality responses to this question with candidates discussing stoping at length.

4. (a) Most candidates had no difficulty with this section but a number of candidates correctly recognised the rock as oolitic limestone but then suggested the mineral was quartz.

   (b) This question produced some excellent diagrams with the majority of candidates scoring full marks.

   (c) Orthoquartzite was the most common incorrect answer but most candidates were able to correctly select marble.

5. (a) This proved to be a very accessible question, with nearly all candidates gaining the mark.

(b) This proved to be a good discriminator with weaker candidates being able to correctly identify the faults but then not being able to give a credit worthy piece of evidence to support their identification.

(c) This proved to be a very challenging question for the candidates with only a minority of candidates scoring full marks.

(d) Most candidates were able to correctly insert the missing rock units but the correct placing of the faults proved to be more challenging. Most candidates were able to deduce the relative ages of the faults correctly.

6. (a) The majority of candidates were able to correctly name the rock and give a suitable piece of evidence.

(b) Most candidates scored both marks but some candidates surprisingly selected both deep tidal marine and shallow marine.

7. The standard of cross-section drawing across most centres was very good although there were some centres whose candidates struggled. The most common errors were failing to show cross-cutting relationships above the ground surface and a failure to use the pre-drawn F/E boundary to the east of fault F1.

8. There was a very pleasing variety of field work locations chosen by candidates, the majority of whom were able to produce good diagrams that included clear annotation as to how their chosen structure related to the way up of the sedimentary sequence.

Principle Moderator

GEOLOGY

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GL2B: INVESTIGATIVE GEOLOGY

Specific points are made in the Moderators' Report to each centre but some general points can be made.

Administration

Ten centres submitted candidates for moderation. Mostly the work was well organised and easy to follow thanks to the detailed annotation. There continues to be the occasional example of marks that have not been doubled before submission through the EMI system.

Suitability of tasks

A variety of tasks were seen which mostly demonstrated skills which equated with those required in GL2a. The better investigations included the demonstration of basic field skills such as rock identification and description of textures, identification of field structures using dip and strike/field sketches, sedimentary logging and fossil identification. The data collected was then manipulated and presented in cartographical or graphical form. Some excellent field investigations were seen which were well-suited to the assessment framework. It is good to see geological field skills being demonstrated with a high degree of competence. Occasionally centres used Field Study Centres in order to carry out their fieldwork. In the majority of cases this proved to be a successful venture.
A mixture of tasks was undertaken, with a rough break down being investigations into; interpretation of sedimentary environments (sedimentary logs, fossils and rock description), mapping exercises (leading to drawing up of geological sections and history), structural analysis (faulting and folding styles related to compression or tension or to specific orogenies), nature and relative age of igneous intrusions, geological history of an area involving both sedimentary environments and structural history.
Unsuccessful tasks were mostly those that attempted to cover too many locations and lacked focus. e. g. 'To investigate the Geology of Pembrokeshire'. Centres are to be congratulated once more on the variety of opportunities given to candidates in areas of outstanding geology such as, Isle of Arran , Alderley Edge, Ogmore, Black Mountain, Nappa Scar (Yorkshire Dales), Cow Green (Northumberland), Mumbles Head (Swansea), Lulworth Cove, Broad Haven (Pembrokeshire).

Planning

Some plans tended to be fairly simple with no details for example as to how to measure clast roundness, sorting etc or identify rocks and fossils. Planning is required to be specific and related to the chosen fieldwork site. It is not sufficient to write- 'I will carefully observe and identify the rock types and will describe the rocks in detail'.
'I will observe minerals and explain where they come from.'
'Sketches and measurements will be taken'.
There were some examples of large amounts of 'cut and paste' background material.
More thought should be given at the planning stage as to whether the data being collected in the

field is suitable for processing and analysis e.g. by the use of histograms, cross-sections, logs, rose diagrams maps and geological histories. A number of centres made preliminary visits to sites in order to allow some forward planning by candidates, which resulted in better planning marks.

Field Notes

It is important to see a variety of data collection including; field sketches, rock descriptions, measurements of dip and strike and tabulated measurements in the field notes. Opportunities for the collection of tabulated field data such as dip and strike, clast size, fossil orientation were sometimes missed. A minority of field notes were untidy and unclear with poor field sketches. Some field sketches lacked detail and did not include grid references, orientation or scale. Some candidates sketched geomorphological features rather than looking at the rocks in detail then stepping back to make a generalised sketch with the knowledge of what is present. Centres sometimes did not ensure candidates had enough time at the investigation site to collect appropriate and sufficient data. Observations such as rock identification, grain size, sorting, direction of cross- bedding, clast roundness/orientation, field sketches, dip and strike measurements should normally be part of every investigation where appropriate.

Report (Analysis and Evaluation)

There was a tendency for candidates to repeat observations made in the field notebook in the report. Repeating field notes in locality sequence is not a good way to structure the report. It is more advantageous for candidates to concentrate their efforts on the analysis and evaluation. The conclusions should link up the important evidence from relevant sites rather than describing each site again in sequence. Candidates must process data such as clast orientation, sedimentary logs or dip and strike measurements which have been collected in the field. There should be evidence for graphical or numerical techniques e.g. a rose diagram for trends, sedimentary log, field map, cross-section, calculation of crustal shortening, histogram of clast size/roundness. In a minority of cases it was difficult to distinguish between field data and secondary data or individual work and collective work. Candidates made good use of their IT skills. Evaluation was still the weakest skill. Evaluation should refer to the data gathering process. Reference to weather and the lack of time are not acceptable.

Assessment

The assessments were accurate in most cases. There were two main reasons why scaling was applied;

- reliable rank order but marks generous. Sometimes maximum marks were awarded where candidates had clearly not demonstrated evidence of reaching the highest category and in some extreme cases there was no evidence present at all.
- unsuitable task were undertaken which did not give candidates the opportunity to demonstrate the higher level skills e.g. processing of data yet were still awarded high marks.

GL2b coursework finishes with this assessment and the WJEC specification has been replaced by a new reformed WJEC Eduqas GCE A level Geology specification for awarding in 2019. In future non-exam practical assessments will then be in the form of a Practical Endorsement, details of which can be found on the Eduqas website (http://www.eduqas.co.uk/qualifications/geology/as-a-level/index.html) or from David Evans, Subject Officer for Geology.

Principle moderator

GEOLOGY

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GL3: GEOLOGY AND THE HUMAN ENVIRONMENT

Section A

General comments

Both questions in Section A proved to be equally accessible to all students with the marks comparable. Most candidates opted for Question 3 as their option essay.

Question 1.

This question was generally done well though not all candidates were able to make use of all the data in the two questions that tested analysis.

(a) (i) This was generally answered well with many candidates able to make two valid descriptions of the distribution. A few candidates failed to gain full marks by not using numerical data to support their answer; e.g. the dimensions of the zones.

(ii) Many candidates were able to gain marks for linking an earthquake or volcanic trigger to the generation of a tsunami, sometimes even citing sector collapse or other mass movement. A few candidates considered that the earthquakes caused the volcanic events, possibly misinterpreting the events of Mt St Helen's. The coastal location of the town was mostly realised but fewer candidates mentioned the confining and possible funnelling effect of the bay. Some failed to appreciate the significance of the scale of the tilting (mm km^{-1}) and suggested the greater tilt towards the north would mean a tsunami flowing towards the town.

(b) (i) This was generally done well although a number of scripts, where inaccurate measurement resulted in a tilt outside the acceptable range, were seen; some well out. Even the direction of tilt was sometimes inaccurate.

(ii) This was generally well answered with the radial nature and asymmetry of the tilt from the centre of the caldera often given, sometimes supported by numerical data.

(c) This question required students to analyse all the data to consider the risk of an eruption. Whilst earthquake and the active volcanoes were often mentioned, the ground deformation (tilt) and its link to the possible infilling of a large magma chamber indicated by the zones of epicentres, was not. Few considered the possibility of an eruption on a large scale and suggested the possible collapse of the caldera, as the shape of the coast indicates may have happened previously.

Question 2.

This question was generally accessible to most with parts (aii) and (c) causing candidates the most problems.

*(a) (i) Many candidates were able to collect the data from **Figure 2a**, correctly substitute it into the equation and calculate the velocity. Some candidates interpreted 'height of water table in boreholes' as the depth of water in the boreholes. These were given a mark for a correct calculation using their data so as not to carry the error through.*

*(ii) Some candidates did not answer the question set. A comparative statement on a texture that was different to **Figure 2b** was required. An answer that stated e.g. – 'Grain shape – angular grains interlock better than round grains' (rather than '**more angular** grain shape') required the examiner to interpret that the candidate realised that **Figure 2b** has sub-rounded grains' and full credit could not be given. Some answers cited only differences in porosity and permeability rather than textural differences (size, shape and sorting) although degree of cementation and packing were credited.*

(b) (i) There were 2 marks awarded for a description and 2 marks for the explanation. Whilst the descriptions were generally well done with candidates using numerical data from the graph, full marks were only awarded if the pumping AND recovery parts of the graph were described. Similarly for the explanation. A mark was awarded for an explanation relating to pumping rates v recharge during pumping AND recovery with further details then credited e.g. cone of exhaustion, reasons for the changes in the rate of pumping/recovery.

(ii) This was moderately well attempted although some candidates failed to consider the 'regional' trend and concentrated more on local borehole variations.

(c) Often answers to this question were vague and it discriminated well. The reduction in water from pores was not always related to 'pore pressure' and its removal related to changes in packing or grain distortion, resulting from pressure from the rock above, bringing about a reduction in volume. Weaker students were unsure of the scale of the effect and implied that the reduction in the water table would leave a large void into which the ground above would collapse.

<u>Section B</u>

General comments

Candidates response to this section were generally favourable. Question 3 was by far the most popular choice although a few candidates opted for Questions 4 and 5.

Question 3.

(a) Examiners saw examples of each of the four options available though few case study examples were given or annotated diagrams provided, to support the scripts.

- *Slope angle and direction: Examiners interpreted this as the slope and direction of the land surface or the dip of the beds where these were related to the topography. Only the more able candidates suggested a figure for a natural*

stable slope angle (~35 degrees) and even fewer suggested this varied with lithology. Many suggested that steeper slopes were more unstable and vice-versa. Friction and cohesion were mentioned but weaker candidates often gave inaccurate statements about the forces involved. E.g. "gravity is greater on steeper slopes" or "you can affect the slope by changing the amount of gravity"

- *Lithology: The differences between mass movements in shale, clay, sandstone and limestone were stated but fewer candidates mentioned crystalline rocks or rock structures (cleavage, bedding, joints etc).*
- *Weathering: All types of weathering were cited but not always appropriately linked to the risk of mass movement in the case of chemical weathering. Weaker candidates confused processes of erosion and transport with weathering (abrasion, attrition, saltation, traction etc).*
- *Groundwater/rainfall changes: The effect of pore pressure was rarely stated with most candidates linking water to lubrication. There is a general erroneous acceptance that an increase in the **weight** on a slope by the addition of soil water (or anything) will **itself** cause slopes to fail.*

(b) This was generally well answered with clear knowledge of a range of stability techniques. Too often these were given in the form of a list with little reference to appropriate case studies. The Vaiont Dam and Aberfan disasters were sometimes cited although not always appropriate to the answer. For example, various stability methods were attributed to both case studies which were incorrect and for which little credit could be given. It was as though candidates felt they had to give examples and these were the only two they knew. A few excellent annotated diagrams were given to support the scripts.

Question 4.

(a) The few candidates who opted for this question usually concentrated on coal and responses were generally poor. Ground subsidence, flooding and the stability of underground mines were often mentioned at the exclusion of all else.

(b) This section was generally answered better with candidates feeling more comfortable with the topic. Reference was made to case studies especially the Wheal Jane acid mine drainage incident which was generally well documented.

Question 5.

(a) Most candidates that attempted this question were able to suggest appropriate examples of soft and hard engineering solutions with groynes, seawalls, and beach replenishment schemes most popular. Many answers were very general, however, and lacked suitable detail with the best marks being awarded to those who gave appropriate case studies.

(b) (i) The hazard of underground cavern formation and the subsequent reservoir leakage and/or dam collapse was adequately explained. Faulting mainly related to fault rejuvenation and the subsequent effect on the dam structure though few considered the possible effect of water leakage along the fault zone.

(ii) Whilst the problems of building on ancient landfill sites were identified in terms of subsidence and groundwater issues, surprisingly the effect of methane gas was not always specifically stated. Examples were rarely given. Some candidates suggested that houses might try to obtain their water supply directly from the leachate polluted groundwater in the landfill.

(iii) Fewer candidates attempted this option. Answers were generally vague with references to sinking in soft lake sediments being the main problem. The possible effect of the liquefaction of sediments during an earthquake was not considered and few case studies were seen.

Principle Moderator

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GL4: INTERPRETING THE GEOLOGICAL RECORD

Questions certainly discriminated between candidates with a wide range of marks seen. Higher scoring candidates gave sophisticated lines of argument for the critical evaluation parts of questions. Candidates seemed to cope better with Section B this year, bringing their synoptic skills together. Disappointingly there were a number of errors involving inaccurate measurements by candidates.

The GL4 scripts were traditionally marked by examiners in hard copy, handwriting legibility was sometimes a limiting factor for some candidates. Many candidates are still not able to clearly express themselves or to communicate effectively to the examiner, and the usual spelling errors were seen.

SECTION A:

Q.1

The question focussed on in depth knowledge and understanding of weathering processes and application of this to a photograph of an exposure of igneous rock. The majority of candidates used the data to good effect. Candidates scored well on most parts of this question, and many full marks were seen, demonstrating very good levels of responding to the range of data given and showing very good knowledge and understanding.

(a) The majority of candidates were able to name granite in part (i). Candidates found part (ii) more challenging, struggling to name clay minerals and iron oxide minerals as the weathering products. In part (iii) candidates were able to fully describe hydrolysis and oxidation, sometimes without getting the correct answers in part (ii). Part (iv) was an unusual take on Bowen's Reaction Series, looking at weathering resistance instead of cooling order, and candidates gave some very thorough answers. Weaker answers usually missed a second process. Some candidates chose incorrectly to focus on hardness.

(b) Surprisingly many candidates struggled to accurately measure the sizes (within tolerance) of the blocks Y and Z in part (i), although shape was not an issue for candidates. Many candidates who correctly used rectangular and rounded terms however had some difficulties subsequently in part (ii) by incorrectly linking "rounded shape" to transport history, and "block Z having travelled down a river for longer". The strongest candidates were able to link to density of jointing in the photograph and the chemical weathering being more severe in the corners where the surface area allowed greater reaction to occur to leave a rounded core.

Q.2

The question focussed on metamorphism and the traditional graph of the stability fields of three silicate minerals. Many candidates were inaccurate in their graph reading skills, with some incorrectly looking at the kyanite/sillimanite boundary instead of the andalusite/sillimanite boundary. In addition, some candidates wrote answers in the wrong boxes, some giving temperatures for the mineral names, and some only looked at point X rather than the whole of pathway 1.

(a) (i) The majority of candidates correctly stated regional metamorphism. Part (ii) was more of a challenge to candidates. Little credit was gained for listing heat and pressure conditions because the rock cycle and plate tectonic settings responsible for the conditions were required. The higher scoring candidates linked burial and increasing depth to the increase in metamorphic grade resulting from continental collision and orogenic processes; and uplift and erosion to the decrease in metamorphic grade resulting from crustal shortening. A number of candidates did incorrectly refer to melting as part of a metamorphic process.

(b) (i) The majority of candidates were correctly able to describe the mineralogy (no sillimanite) and texture (no schistose texture) and explain that it was due to contact metamorphism. Part (ii) was more variable in the range of answers, with few candidates discussing that the sillimanite had formed earlier along the pathway, and that the recrystallisation was too slow for complete change to the more stable andalusite to occur.

Q.3

This question examined deformation by completing a block diagram. As seen in previous examination series many candidates often found difficulty in working in 3D. The question then continued into a way-up structure and, as usual many candidates found the critical evaluation part most difficult.

(a) The majority of candidates were able draw and label the axis and axial plane trace. In addition the majority of candidates correctly drew the outcrop pattern of the volcanic ash deposit.

(b) The fault characteristics table was completed well, although some candidates did not measure the throw accurately. Part (ii) was usually well answered with candidates noting the difference in throw of the dyke and the volcanic ash deposit.

(c) Many candidates incorrectly focussed on bombs linking to volcanic history and not linking to the sedimentary structure presented. The best responses linked to the bomb deforming the underlying sediment (now on the east) giving the correct way up to the west.

(d) This was the most challenging part of the question. Candidates linked the way up structure to the youngest beds being in the centre so correctly determining that it was an overturned syncline. Plunge was well understood, with majority agreeing the plunge to the north as the antiform closed to the north. As in previous examinations some candidates incorrectly noted that fold symmetry is due to the angles the beds make at the land surface, when it is the relative limb length which determines symmetry. In this instance there was no evidence for the relative limb length so the correct response was that it could not be concluded from evidence given.

Q.4

Q4 examined igneous rock processes at hot spots, their impact on past climates, and a link to the past life part of the specification.

(a) The majority of students gained credit for (i) African plate. Some surprising incorrect responses gave plates not on the figure (e.g. Eurasian plate and even Australian plate). Part (ii) was well answered generally with candidates describing the linear track and age relationship. The best responses in part (iii) linked the rising hot rock, locally melting the surrounding mantle and the melt of the lithosphere/mantle/peridotite yielding basalt. Many candidates gave impressive answers referring to decompression melting and a lack of contamination of the melt.

(b) Calculating the eruption rate was challenging for many candidates and shows why the instruction to "show your working" is important. Candidates needed to multiply the duration 2 (million years) by the rate 0.04 (cubic kilometres per year), to give 2,000,000 x 0.04 = 80,000. Many incorrect responses of 0.08 and 40,000 were seen. Part (ii) was generally well answered with candidates linking the larger volume of magma over a shorter period of time, and greater rate of eruption for the Deccan traps.

(c) This question was typically very well answered and candidates demonstrated good knowledge of mass extinction causes due to volcanism, detailing cooling volcanic winters due to dust in the atmosphere and longer term global warming due to carbon dioxide and methane hydrate release. There were some poor phrasings by candidates who discussed that mass extinction was due to lava touching species and the usual confusion of P-T and K-Pg dating for the Deccan traps.

Section B:

The 1:25,000 solid geology map extract of Telford was clearly reproduced, accompanied by an enlarged box, and generalised geological column. The maps are "real data", which means that they can include information which cannot be touched on in an approximately 1 hour segment of the exam. This really tested the skills of interpreting the data by candidates. The use of a box highlighted areas to candidates quickly.

Q.5

This question covered aspects linking to relative ages. This question was intended to allow candidates to become familiar with the map and was generally well done.

(a) The majority of candidates gained full credit for comparing relationships between events. Unusually some candidates chose completely different events to compare from those listed

(b) The majority of candidates were able to correctly explain the fault control of the ridge and link this to rock resistance. In part (ii) the underlying impermeable rocks and valley shape were the most common correct responses.

Q.6

The question examined the contacts between rocks on the map section and developed into environments of deposition with a link to past life at the close of the question.

(a) The majority of candidates were able to correctly discuss the granophyre age being younger than the Precambrian tuff using data from Figure 6a. Fewer candidates were able to discuss the discordant boundary (describing the evidence that supported the statement) with many merely restating that the granophyre had intruded the tuff.

(b) The majority of candidates were able to complete the table correctly. In part (ii) the higher scoring candidates gave fulsome detail on age relationships, the lack of baked margins, and granophyre pebbles in the quartzite, leading them to conclude an unconformity in (iii).

(c) The majority of candidates correctly named ripple marks in (i). The environment in (ii) was less well understood, but the better candidates linked shallow water, with wave domination giving a bi-directional current to form the ripples and higher energy evidenced from the pebbles in the conglomerate. In part (iii) it was evident that some candidates incorrectly thought that the Wrekin Quartzite Formation was metamorphic, despite the information in Table 6, which limited their marks. The best answers discussed a wide range of reasons, most common answers were soft bodied life in the Cambrian, diagenesis and weathering, predators and scavengers, and the fossil record bias. Many candidates linked well from (ii) into (iii) with the high energy environment potentially sweeping away any remains before preservation could occur.

Q.7

The gravity profile proved a good test for candidates.

(i) Many candidates simply calculated a mean of 2.41 and 2.46. Some unusual answers showed that some candidates didn't understand what they were doing as they gave a result outside of either figure. The better answers used the proportions with the sandstone.

(ii) The majority of candidates were able to show a reduction across the Cluddley Fault, an increase over the Wrekin fault and the highest values over the Precambrian rocks towards Y.

(iii) As in previous years candidates struggled to explain their answer. Use of the data could have improved their responses.

Q.8

This question developed some synoptic links to the 'Geology and the Human Environment' concepts, developing environmental issues from recent coal extraction.

(a) (i) The majority of candidates were within the range of 1.9cm -2.0cm for the minimum thickness of rock removed and correctly used the scale to calculate the thickness of 19-20m at the open cast site. Some candidates gave answers in the region of nearly 1km which the photograph of the site did not corroborate. Part (ii) was well attempted with candidates correctly identifying faulting and coal seam splitting most frequently.

(b) The question aimed to get candidates to discuss how the environmental issues had been partly managed with reference to Figure 8. Many candidates gave long lists of environmental issues, but points needed to be developed to gain full credit. Some answers involved regurgitation of general information on coal mining (deep mining) and the associated problems (tunnel structures and collapse) without linking to the data which referred to an open cast site. The best answers detailed the stored deposits and banks being retained to restore the environment post-mining whilst minimising visual impact and noise during mining. Water treatment facilities to minimise the amount of pollution created, and habitat loss were the most common thread of discussion.

Team Leader

GEOLOGY

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GL5: GEOLOGICAL THEMES

Thematic Unit 1 Quaternary Geology

Question 1

(a) (i) The majority of candidates were able to recognise the direction of flow of the turbidity current with only a small minority confusing the depth shown on the submarine contours for height measurements.

(ii) This question was answered well with most candidates able to offer an explanation of the causes of this turbidity flow.

(iii) Most candidates were able to measure the distance between the two points marked on the map. However a surprisingly common error was made in calculating the number of minutes between the two cables breaking.

(b) (i) Most candidates were able to recognize differences between the two sedimentary logs. However a significant number simply repeated an observation or gave the converse of their first description thus failing to gain credit.

(ii) This question proved to be a good discriminator with a minority of candidates giving an explanation related closely to the physical processes that create turbidite deposits.

(c) Few candidates achieved full marks for this question. Many were able to make a statement about the link between flow energy and grain size. However linking this to a turbidity flow was less frequently successful.

Question 2

Few candidates attempted this question. The best answers made detailed reference to modern reef environments, such as Andros Island, with a detailed evaluation of how the different sediments are the result of both geochemical and physical processes.

Question 3

A popular essay choice with some very good descriptions of the wide range of fossils that can be used to reconstruct Quaternary climates. The better candidates were able to describe oxygen isotope evidence from foram shells as well as pollen and mammoth evidence. Weaker candidates gave a far more generic description of fossils as palaeoenvironmental indicators or used examples of fossils, such as sabre-toothed tigers, not found in the British fossil record. Many candidates showed a good understanding of the strength and weaknesses of carbon dating.

Question 4

Any candidates who had prepared carefully for the exam were able to attempt this question. Most candidates were able to explain the link between the underlying geology and the landscape above. However, often the evaluation was not strong with little discussion of the role of glaciation in shaping pre-existing landforms. Only the best candidates were able to write the essay in a way that created a logical flow through the ideas being discussed.

Thematic Unit 2 Geology of Natural Resources

Question 1

(a) Most candidates were able to answer this question well. It was pleasing to see how many had quantified the size of the intrusion accurately. Some candidates gave some imaginative descriptions of the shape of the intrusion.

(b) (i) Many candidates were unable to rearrange the equation given and as a result gave a concentration significantly less than the average crustal concentration. It was clear that few candidates use checking strategies for numerical questions.

(ii) Most candidates were able to recognise the significance of magma segregation/fractional crystallisation with some good, detailed explanations of the processes involved.

(iii) This question proved challenging to answer with only the better candidates able to explain a cyclic process that could deposit multiple layers of chromite.

(c) This was a generally well answered question with the best candidates able to give a well-reasoned suggestion for remediating the problem identified.

(d) Most candidates were able to identify the key geophysical methods, although a minority did consider mapping to be a geophysical technique. The majority were able to relate those techniques to the properties of the minerals in the Bushveld Complex.

Question 2

This was a popular choice of essay. The best answers related the understanding of geophysical prospecting with the properties of non-metalliferous resources. However there were many instances of rehashed material to give a very generic response often discussing ore minerals and geochemical prospecting techniques. The answers to the section on hydrocarbon resources were generally of higher quality.

Question 3

Only a minority of candidates attempted this question with a wide range of quality of response seen. Weaker candidates gave simple descriptions of the formation of several resources. The best responses established the role of water as an agent either of concentration of resources or removal of non-valuable materials.

Question 4

Many candidates found this question accessible, with some very good evaluations of the role of thermal alteration. Weaker answers generally involved too much of the essay describing hydrocarbon traps rather than considering all the factors that might influence the formation of

economic deposits of hydrocarbons and coals. The best answers clearly compared and contrasted oil/gas and coal resources.

Thematic Unit 3 Geological Evolution of Britain

Question 1

a) i) The vast number of candidates answered this well and recognised the difference in plunge directions of the two fold axes.

ii) Most candidates identified the orogeny correctly as Variscan. However, the need for clarity in the explanation must be reiterated here; the exact trend, age of rocks affected and precise location needs to be stated to achieve full marks.

b) i) The vast majority of candidates scored well on this question with the better candidates quantifying sea level changes rather than providing qualitative responses. Best practice is achieved by candidates working from the bottom of the sequence upwards i.e. in a younging direction.

ii) Most candidates achieved at least one mark here. However, the precise link between the mechanism and resulting change in sea level was not always explicit.

c) i) This was well answered with most candidates being able to use the descriptions of the stratigraphic surfaces to correctly annotate Figure 1b.

ii) Very mixed responses were received with the better candidates using data from the description in Figure 1b to support their deduction in non-marine sequences overlying eroded marine sediments.

Question 2

This proved to be a relatively popular question with candidates. In general candidates showed a good superficial knowledge of how fossils can be used to differentiate between terrestrial, shallow and deep marine environments. However, it was rare for students to give substantive details on how a particular fossil group may be diagnostic of a particular environment- the classic example here would be a coral reef life assemblage. It was pleasing to note that many candidates were aware of the problems invoking the principle of uniformitarianism for certain fossil groups and the issues resulting from biased fossil preservation and post-mortem transportation.

Question 3

This proved to be the least popular question with candidates. Better candidates made explicit reference to the changing latitude and changing climate of the British Isles from the Devonian to Permian and backed this up with both supporting sedimentological and palaeontological evidence. The use of well-documented exemplar field case studies enriched their responses considerably. Surprisingly, candidates were not strong at evaluating the role of palaeomagnetic evidence for the changing latitude of the British Isles despite this being a relatively common question in past examination papers.

Question 4

This also proved to be a relatively popular question with candidates. Weaker candidates presented a chronological account of the Caledonian orogeny rather than documenting the geological legacy of this event in comparison to the Variscan and Alpine orogenies. Better candidates made reference to the severity of all aspects of the structural, metamorphic and igneous history of these orogenic events. Some outstanding candidates noted that many of the more recent earth movements were indeed controlled by the Caledonian structural fabric and that Caledonian rocks form the basement to post Carboniferous successions.

Thematic Unit 4 Geology of the Lithosphere

Question 1

a) The vast majority of candidates answered this well and within tolerance of the expected range of values. The calculation of mean increase in rock strength per km in the brittle zone also posed no particular problems.

b) i) This questioned differentiated well but caused no significant issues to candidates.
ii) This simple calculation of dividing by 100 proved more difficult and many candidates did not attempt the question or determine a correct value.

c) i) Better candidates here quantified their answers in terms of a range of depth values or made discrete reference to the fault or boundary between the crust and mantle. Such an approach avoided ambiguity and is strongly advocated.
ii) Surprisingly many candidates failed to achieve full marks here as they either neglected to use the data provided (thrust fault) or to fully discuss the plate tectonic setting of the area (continental-continental convergent plate boundary). Too many candidates gave rather simplistic explanations involving friction and pressure build up instead of using A2 concepts of elastic strain and fracture point.

d) iii) Responses here were very mixed but the bulk of the candidates failed to recognise the significance that strong brittle rocks, rather than weak ductile rocks, fracture to produce earthquakes. The fact that Figure 1c has two zones of brittle deformation which matches the two zones of earthquake foci described in (c)(i) was missed.

Question 2

This proved to be a popular question with many candidates. In general candidates showed a good knowledge of the layering displayed by the oceanic crust (sediments/pillow lavas/sheeted dykes/gabbro). However, very few incorporated this into explicitly answering the question which asked for the seismic structure of the oceanic crust i.e. layers 1, 2 and 3. With respect to the importance of ocean drilling, good candidates were able to evaluate the importance of programs like IODP in providing direct evidence of the composition of the ocean crust in conjunction with proxy evidence including xenoliths, ophiolites and seismology.

Question 3

This also proved to be a popular question with many candidates. Many candidates supplemented their answers with a well-annotated cross section across an ocean-continent margin, which is to be encouraged. Candidates' knowledge of ocean basin heat flow was generally very good but this was rarely linked to lithospheric thickness and the change in the position of the 1300^{o}C isotherm. Very little attempt was made to discuss the role of isotopes and crustal age in influencing heat flow in continental areas. Good candidates were able to evaluate the importance of heat flow measurements in supporting plate tectonic theory by linking high heat flow to plate boundaries and convection drag. Excellent candidates noted that hot spots enable plate motions to be calculated but are themselves not linked to plate tectonic processes.

Question 4

This proved to be the least popular of the three essays. In general candidates showed very good knowledge of the age distribution of rocks in ocean basins and the causative link to seafloor spreading. It was very rare for candidates to recognise where this pattern may be upset e.g. hot spot trails. Most candidates neglected to discuss the more variable age distribution of rocks in the continents caused by much more variable geological processes. The role of accretion and the aging of crust into continental interiors yet alone the various factors that can disrupt this pattern were rarely addressed.

Principle Examiners

GEOLOGY

General Certificate of Education (Legacy)

Summer 2018

Advanced Subsidiary/Advanced

GL6: GEOLOGICAL INVESTIGATIONS

Administration

The administration and moderation of the coursework samples ran smoothly once again this year. The Principal Moderator is very grateful for the efficient organisation and punctuality of the majority of centres. Only a small number of centres submitted materials after the May 15th deadline.

Standards

The standard of coursework marking in this final year has been the most consistent ever and indicates that the vast majority of teachers fully engaged with the assessment objectives and were able to award marks appropriately to their students' investigations.

Principle moderator

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