GCE EXAMINERS' REPORTS

GEOLOGY
AS/Advanced

SUMMER 2013

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GEOLOGY

General Certificate of Education

Summer 2013

Advanced Subsidiary/Advanced

GL1

Principal Examiner: Ian G. Kenyon

The GL1 examination was designed to test a wide range of skills including the interpretation of graphs, diagrams, maps, geological cross sections and photographs. The paper covered many areas of the specification content and included both straightforward and more complex ideas, making it accessible to a wide ability range. Question 1 proved to be the highest scoring of the four questions. Other questions proved to be quite testing in places.

Q.1 (a) A very accessible question based on a graph showing the geological histories of trilobites and graptolites. Candidates scored well here if they studied the data carefully and followed the instructions in the questions. In part (ii) a number of candidates described the geological history of trilobites instead of graptolites as stipulated in the question. Others ignored the graph and gave an outline of how the graptolites evolved in terms of changes to their stipes and thecae. The characteristics of graptolites that made them good zone fossils were well understood by the majority of candidates.

(b) Over half of the candidates correctly identified **Figure 1b** as being either the pygidium or thorax of trilobites and the majority successfully used the data sheet to identify iron pyrite. The process of petrification or pyritisation was clearly understood by many candidates and the process was well explained in most cases. Carbonisation was the most common incorrect answer and the other area where marks were lost involved omitting reference to the original hard parts being dissolved away. Death assemblage was well understood by many, but all too often candidates failed to use the evidence from **Figure 1b** their evaluation. Many candidates failed to recognise that a death assemblage had undergone transport/erosion/sorting before being fossilised.

Q.2 (a) A surprising number of candidates did not recognise that gneiss was the only metamorphic rock shown on the cross section in **Figure 2**. Every other rock type on **Figure 2** was offered and some candidates suggested examples that did not appear in the figure, e.g. granite, spotted rock, gabbro, slate and metaquartzite! Part (ii) worked well and many candidates scored 2 or 3 marks here. The most common 'lost mark' was confusing the strike directions.

(b) It was pleasing to see that many candidates recognised the fault as being a thrust fault but many failed to give two reasons in support of their conclusion. Reverse fault was also a valid answer and full marks could still be gained if supported by two pieces of evidence. Part (ii) was misinterpreted by many candidates and they tried to answer it by using information solely from **Figure 2**. Most ignored '**in the field**' in the question and only a relatively small number of candidates referred to fault breccia, slickensides, drag folds and fault scarps. Credit was given to valid descriptions using information drawn from **Figure 2**.

(c) This question was a good discriminator and produced a wide range of responses. It was disappointing to see many candidates describing the structure adequately but failing to recognise it as an unconformity.

(d) Most candidates managed to score at least half marks here by recognising that the dolerite was the youngest rock on **Figure 2** as it cut through the older folded rocks and conglomerate above the unconformity. The principle of cross cutting relationships was also cited. Many candidates lost marks by misinterpreting the gneiss as being the youngest due to the law of superposition. Many failed to recognise the significance of the foliation in the gneiss or the fact that the base of the gneiss was a faulted boundary. The more able candidates realised that the gneiss had to be older as it was the only one that had been regionally metamorphosed and it must have been brought up from much lower down by the thrust fault.

Q.3 (a) It was disappointing to see a significant number of candidates unable to accurately plot the position of a mid-ocean ridge and ocean trench on **Figure 3a**. Some candidates plotted ridges in the position of trenches and trenches in the position of ridges. Symbols were often plotted parallel to line A–B–C or actually on the continental area of South America. Part (ii) was generally well answered but very few candidates recognised the ages produced a symmetrical pattern about the ridge.

(b) Very few candidates were able to score full marks on part (i) using the data from **Figure 3b**. Most realised the calculation involved dividing 700 kilometres by 30 million years (scoring 1 mark) but the majority were unable to do the arithmetic to arrive at an answer of 2.3 cm per year. Answers varied from 0.0000023 cm per year to 230,000,000 cm per year. Part (ii) was generally well answered with most candidates recognising a change in rate at 30 million years on Figure 3b. Many failed to read the graph carefully and incorrectly stated that the rate had increased rather than decreased over the last 30 million years. Part (iii) produced some very disappointing responses and only a minority of candidates showed secure knowledge of radiometric dating techniques. Carbon-14 dating was often given as an answer and worryingly a significant number stated that the age of the ocean floor could be worked out by looking at bands of normal and reversed polarity and palaeomagnetism.

(c) The formation of andesitic magma was generally well understood by many candidates and the more able gave details of water being released from the subducting slab as being the mechanism responsible for the partial melting of the mantle wedge above. Weaker candidates failed to refer to *partial* melting and confused this with convection currents at mid-ocean ridges.

Q.4 (a) Answers describing the pattern of joints in **Figure 4a** were very disappointing. Few candidates referred to the number of joint sets or their distribution. Marks were mainly gained for identifying vertical and horizontal joints that intersected at 90° to each other. Very few candidates could suggest a valid reason to explain the formation of the joints in **Figure 4a**. Most candidates seemed to think that freeze-thaw action produced the joints. The majority of candidates correctly suggested freeze-thaw as being the process responsible for the loose blocks in **Figure 4a** and most described the process very well.

(b) The majority of candidates correctly identified quartz using the data sheet, but many other minerals were suggested, including olivine and garnet. The size, shape and sorting information required in part (ii) generated a wide range of responses. Many candidates failed to quote any size values for the particles and simply stated ‘coarse’ or ‘medium’ grained. Many candidates failed to give a range of particle sizes. It appears that a number of candidates misread the scale bar as 1.0mm instead of 10mm. Many candidates incorrectly stated that the grains were very well sorted and very well rounded. The grains clearly ranged in size from 1mm or less to10mm. The grains were clearly angular. The photograph was taken at the foot of a granite outcrop and the grains had moved no more than a few metres from their bedrock source. Students failed to make use of the data sheet in part (iii) and link the differences in mineral content to their physical properties. Many responses concentrated on one idea - either hardness/cleavage or susceptibility to hydrolysis – rather than two. Part (iv) proved to be a good discriminator with the more able candidates suggesting an alternative (fluvial) origin for the sediment shown in **Figure 4b**. More able candidates recognised that Aeolian processes would have produced more rounded, better sorted and much finer grains. Weak candidates simply agreed with statement or had little understanding of the term ‘*aeolian’*.

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General Certificate of Education

Summer 2013

Advanced Subsidiary/Advanced

GL2a

Principal Moderator: David Evans

The paper tested the range of skills and techniques covered in Unit GL1 of the specification. It had to be, like GL2b, centre-marked with moderation by the WJEC team.

A meeting, whose personnel included the moderators, took place the day after the paper was timetabled. The mark scheme proposed by the Principal Moderator was reviewed against some students' scripts and a definitive version was then published for download by centres from the WJEC website. Guidance in its application was available, as in the previous year, via e-mail to the Principal Moderator. A marked and annotated exemplar script was also published to demonstrate the mechanics of marking.

The scheme suggested expected, acceptable and unacceptable responses. It stated that alternative answers could be credited. The e-mails and the moderation process indicated that this did occur. Feedback from centres and moderation of sample scripts suggested that the application of the mark scheme by teachers was successful. A very small number of teachers failed to annotate scripts as requested on the cover of the mark scheme and issues such as this are discussed in their centre reports, which are available for download on results day.

The demands made by the paper on candidates were designed to be broadly comparable with papers from previous years, being an integrated test using maps, photographs and specimens. Extra information is also given so that some questions test candidates' data response skills. There is usually broad coverage of GL1 content but there is no fixed length of questions

Q.1 Most candidates noted the crystalline and porphyritic features of specimen A and drew them appropriately. The most common errors involved drawing grains rather than crystals, an incorrect scale or poorly shaped phenocrysts. Part (b) was well answered with most candidates referring to the large, discordant nature of Rock Unit A and its coarse groundmass. A few candidates commented on the porphyritic nature of specimen A rather than focussing their ideas on the groundmass as the question demanded. The majority of candidates correctly referred to the mineralogy of specimen A, in particular the presence of quartz, as a reason for A not being gabbro. Part (c) was answered well with only a few errors, most noticeably concerning "eruption at the Earth's surface", presumably because the rock is now exposed at the surface on map A.

Q.2 The majority of candidates gained all 4 marks for the fossil drawing, with the most common errors being inaccurate shape (despite the wide range of shapes permitted) or drawing it too small for the scale supplied. Most candidates correctly recognised that there were two valves of unequal sizes, thereby indicating the fossil to be a brachiopod.

Q.3 Part (a) proved to be straightforward with the majority recognising that specimen C was an oolitic limestone, typically of grain size 1 mm, which could be identified by its reaction with hydrochloric acid. A few candidates did not explicitly give the result of the test with acid and so lost a mark. Figure 3 was used accurately but a number of candidates did not gain the crystal size mark, stating that "they are greater than 2 mm" which was not precise enough. In question 3(b) the majority of candidates correctly noted that the marble, being a metamorphic rock, would have formed in this locality by contact metamorphism, hence demonstrating that Rock Unit D was a heat source and therefore igneous.
In part (c) most candidates noted that the outcrop pattern of Rock Unit D made it concordant and hence possibly a sill. Fewer recognised the structures in Rock Unit D as pillow structures and fewer still noted that the contact metamorphism had occurred on one side of the igneous body only, making D a lava flow. Despite many candidates correctly noting the three aspects above, some still concluded this structure to be a sill rather than a lava flow.

Q.4 (a) Many candidates plotted the APT of the antiform correctly but failed to find the APT of the synform in Rock Unit F, the middle bed of the outcrop pattern. Most candidates put the APT in Rock Unit B, equidistant between the two dip symbols rather than in the centre bed. In part (b) very few candidates used the spot heights to calculate the throw as 125 m, based on the displacement of Rock Unit G. Question 4(c) proved to be the most difficult part of the paper with only the best candidates referring to the fact that F2 has displaced Rock Unit G, but that F1 is overlain by G. This makes F1 older than G but F2 younger than G, and hence demonstrates that F1 is older than F2. Common mistakes included attempting to use F3 as an indicator of relative age, or to state that because F2 is not overlain by G, then F2 must be younger than G. The latter could of course have come about by G having been simply eroded off the area above F2, which is of no help in solving this relative dating question. Question 4(d) was competently completed with the majority of answers showing a dyke of the correct width, trending to the North-East, passing beneath Rock Unit G and displaced by fault F3. The most common error was for it not to be displaced by fault F3. In part (e) most candidates noted that mineral specimen H did scratch with a steel pin. For two additional marks in part (i) students needed to refer to a test which was a useful property for diagnosis. Such properties are referred to with a * on the mineral data sheet, hence the property of density is necessary for the two marks. The description and result of another test/observation such as colour, lustre or acid reaction gained only one additional mark. Specimen H was correctly identified as barite by perhaps only half of the candidates, with a wide range of other answers seen. A few samples also contained calcite and full credit was given in these cases for tests or observations which lead to this identification.

Q.5 The cross-section proved to be an excellent discriminator with a wide range in the quality of responses. The most common errors included "missing" the synform below the unconformity close to Y and failure to demonstrate the cross-cutting relationships of the base of G or the discordant nature of fault F2 above the ground surface. The inability to join the pre-drawn "base of B" to the base of B forming the other limb of the antiform was often seen.

Q.6 The structure of this question meant that many excellent responses were seen. The best answers gave equal attention to both the origin of features and how they can be used for determining the way up. There were some very clear annotated diagrams and well written text. The range of answers using fieldwork was impressive and contained detail of many sedimentary structures including flute casts, graded bedding, desiccation cracks and current bedding. There were also detailed answers referring to pillow structures (photograph 2) and current bedding (photograph 3). No marks could be related to way-up features which were not relevant to the photographs if one of the photograph boxes had been ticked. A few answers were very superficial, gaining little more than one mark for naming a relevant structure. A significant minority of candidates scored no marks because they did not attempt the question.

GEOLOGY

General Certificate of Education

Summer 2013

Advanced Subsidiary/Advanced

GL2b

Principal Moderator: Alan Seago

It is pleasing to report that in general centres are taking note of comments made in previous years' individual centre reports so that there is a continuing improvement in the suitability of tasks being undertaken and the quality of candidates' work. However there is quite a turnover of centres with some submitting work one year and not the next and new centres submitting work for the first time, so all are reminded that moderators' comments should be considered before embarking on work to be submitted next year.

Centres should be aware of the required context of the investigation at all times as described in the specifications.

Centres are to be congratulated on:

- the standard of work produced by the candidates
- the opportunities given to candidates to study geology in such suitable areas
- and in most cases the accuracy of the assessment.

The enthusiasm for geology and expertise of the teaching staff in centres is obvious from the quality and effort put into coursework submissions.

There were one or two examples of errors in administration but nothing of any great significance this year. Centres are urged to ensure that coursework samples arrive with the moderator by 15 May. WJEC should be informed in the event of any unforeseen circumstances which may lead to a delay.

Most good investigations include the demonstration of basic field skills such as rock identification and textures, identification of field structures using dip and strike/field sketches, sedimentary logging and fossil identification. The data collected is then manipulated and presented in cartographical or graphical form. Some excellent field investigations are now being seen which are well suited to the assessment framework. It is good to see geological field skills being demonstrated with a high degree of competence.

In some cases there was no risk assessment although the number of instances decreased. It was pleasing to see the extensive use of the Planning Tracking sheet. **Some thought has to be given at the planning stage as to whether the data being collected 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 are now making preliminary visits to sites in order to allow some forward planning by candidates, which often results in better Planning marks. Some candidates devoted insufficient time to the retrieval and evaluation of relevant material from different sources. **Evaluation remains the weakest skill.**
Some field notes consisted entirely of tables of data and it would be an improvement to see a variety of data collection, including field sketches and rock descriptions etc. In other cases,

opportunities for the collection of basic field data have been missed. A minority of field notes were untidy and unclear with poor field sketches. Centres should ensure that candidates have 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, where appropriate, be part of every investigation.** There is no need for candidates to repeat observations made in the field notebook within a report unless it contributes significantly to the analysis. It is more advantageous for candidates to concentrate their efforts on the analysis and evaluation. Candidates must process data such as clast orientation, sedimentary logs or dip and strike measurements which have been collected in the field. In a minority of cases it was difficult to distinguish between field data and secondary data or individual work and collective work. Centres and candidates should ensure that the nature of the work is clearly identified for moderation. Candidates are making good use of their IT skills.

A number of centres are using Field Study Centres in order to carry out their fieldwork. In the majority of cases this proves to be a successful venture. However, centres should be aware that in some cases the field study centre may not be familiar with relevant assessment criteria and teachers should make sure that the field study centre knows exactly what is required for the field investigation in terms of the specification.

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)
- analysis of fossil assemblages
- structural analysis (faulting and folding styles related to compression or tension or to specific orogenies)
- crustal extension related to dyke intrusion
- nature and relative age of igneous intrusions
- geological history of an area involving both sedimentary environments and structural history

Centres are to be congratulated on the variety of opportunities given to candidates in areas of outstanding geology such as Isle of Arran, Anglesey, Amroth, Ogmore, Styal Mill, Mumbles, Black Mountain, Anglesey, Halkyn Mountain, Barry, Portishead, Harlech Dome, Bridgnorth, Clee Hill, High Force. Other centres made good use of suitable local geological locations.

GEOLOGY

General Certificate of Education

Summer 2013

Advanced Subsidiary/Advanced

GL3

Principal Examiner: Pete Loader

Section A

General

Section A discriminated well with both questions based on previously unseen data. Question 1 was slightly better answered than Question 2 with the latter based on topical data associated with the *fracking* process. Whilst this term is not directly to be found in the specification, the questions relate to the spirit of Key Ideas 2 and 4 in line with the philosophy of this and other WJEC geology papers. AO2 of the Assessment Objectives suggests that candidates should be able to "apply scientific knowledge and processes to unfamiliar situations including those related to issues."

Q.1 (a) (i) This was usually answered well though some were not able to use the scale or read the data accurately.

(ii) Few found it difficult to identify two pieces of evidence.

(b) (i) Some excellent explanations relating to solubility and hydrostatic pressure were given by the more able candidates. However, many candidates failed to appreciate that the gas was dissolved into the water and was associated with the hot springs which introduced the gas into the bottom of the lower lake.

(ii) The effect of the landslide disturbing the lake bottom to release the gas was mentioned by most but little further explanation was given as to how this resulted in gas being released at the surface. More able candidates referred to pressure release and gas expanding as it came out of solution.

(iii) This was generally well answered and clearly students had studied the Lake Nyos disaster as a case study. However, many did not refer to the "properties" of carbon dioxide or made vague statements such as "it is poisonous to humans and can kill" for which little credit was given.

(c) This question asked candidates to review the evidence and evaluate the risk of collapse of the natural dam. Reference to erosion, the permeability of the lower unit and jointing were usually identified though few mentioned the shallow dip downhill of the upper unit. Poor development of ideas was often an obstacle to candidates obtaining full marks for their explanations.

Q.2 (a) (i) It was surprising how many candidates failed to give a satisfactory or accurate definition of the term *porosity*. This had nothing to do with the *fracking* process and is a major element in this specification. Porosity and permeability were often confused in this and part (ii). Those who referred to the percentage of pore space between the grains or compared with the volume of solids were given full credit as were those who communicated this in terms of a formula. Weaker definitions simply made reference to the "pore spaces within a rock".

(ii) This also proved to be surprisingly difficult for some despite evidence from the textual data. Reference to size of pore spaces was often cited but their degree of connectivity and permeability was often absent. Some suggested that the shale had less pore space despite the specific reference to 'both rocks having similar porosities' in the question stem.

(b) Whilst knowledge of the process of *fracking* is not required in this specification, this question was purely data response and it discriminated well with an encouraging number obtaining full marks. However, despite the data given and the direction of the previous questions, many failed to realise that shale is fractured by the forcible injection of water and that the sand is there to keep the fractures open and increase porosity and permeability.

(c) (i) The basis of this question was the link between earthquakes (KI 2) and engineering activity (KI 4). Few had difficulty coping with this. The specification refers to stress release in controlling earthquakes. Better answers referred to pore pressure from the fracking process "unlocking" the stresses in the rock to create a minor tremor or reducing friction along fault planes. Vague explanations citing the vibrations from the drilling process itself or explosions of the gas underground gained little credit.

(ii) This question asked candidates to "describe and explain". Too often they successfully described without further development or explanation of the lower energies involved. Weaker candidates thought that significant structural damage, or even total collapse, might be caused.

Section B

General

Question 4 was the most popular with over 50% of candidates opting for this essay, closely followed by question 3. The marks awarded covered the whole range. Question 5 was very rarely attempted and accounted for less than 3% of the scripts.

Q.3 This was generally well done and many excellent answers were seen gaining high marks, although this essay was not as accessible as question 4.

(a) This part was directly from the specification and has been set previously. However, too often candidates wrote in generalities and few case studies were referenced, other than by the more able candidates. There was an overall implication that *earthquakes are predictable (*as in the weather) and that a typical benefit would be in evacuation *before* the event! Some candidates concentrated solely on the social benefits or economic limitations and few gained full marks with the result that the mean score for this question was slightly lower than that for question 4. The better scripts gave a range of benefits and limitations, backed up with case studies, within a general discussion of our current inability to accurately predict earthquakes but a need for protection and strategies to cope with their inevitable effects in earthquake-prone areas.

(b) This was answered better than part (a) and some excellent essays, using case studies, gained full marks for this section. Although not directly mentioned in the specification, many responses involved engineered solutions and hazard management with some excellent diagrams of earthquake-proof building design and hazard mapping. Few candidates mentioned "attempts to control stress release along faults" as stated in the specification though some that did also suggested that this was currently an effective way in which some faults are controlled. The effect of currently using water (or bombs) to reduce stress along faults is fanciful and, though possibly linked to sound principles and observations, not practical.

Q.4 This was the most popular question and better answered than the other essays.

(a) Whilst the question was very specific about the hazards associated with **lava flows** some took this to mean any hazards remotely related to volcanoes. Thus pyroclastic flows, volcanic gases, blasts, ash etc, were all ignored by examiners unless a link was also made to lava related case studies. Candidates must be made aware that credit cannot be given for responses that do not answer the question. Where the answers were applied directly to lava flows, only the better scripts gave an indication of temperatures of the flows (other than to say they are hot) and little was made of the effect of temperature on viscosity and how this changes as the lava flows and cools. Likewise, speed of flow was mentioned as affecting the risk by only the more able candidates. As usual, a number of candidates tied themselves in knots by mixing up terms (viscous and non-viscous, silicic and mafic) when explaining the relationships. Where candidates had these correct they inevitably scored well when they were related to the potential risks.

(b) This section also produced some very good essays when based on appropriate case study materials. A whole range of predictive techniques were identified and appropriately used together with the methods used to minimise the risks from a variety of volcanic hazards. However, only the more able candidates were able to discuss the extent to which the technique might be effective. Weaker candidates erroneously claimed that a range of techniques had been used to predict eruptions; the eruption of Eldfell (Heimaey) in 1973 was considered to have been predicted by everything from gravity, EMD, thermal and COSPEC surveys.

Q.5 This was undertaken by very few candidates from a limited number of centres.

(a) This was done well when accompanied by appropriate annotated diagrams. Some discussion with teachers suggested that candidates were possibly put off by the terms “friction angle” and “disconformities”. Friction angle is the term used in the specification (KI4) but “disconformity” is not. This should have read “discontinuities” (of which a disconformity is one example). This was regrettable but candidates were not adversely affected and maximum credit was available to those who confined their answer to either friction angle or discontinuities.

(b) Following a data response question set in the May 2011 GL3 paper, a variety of monitoring techniques were presented. This was particularly effective when supported by annotated diagrams. The examiners also accepted discussion of the monitoring of volcanic slopes (e.g. Mount St Helen’s) as appropriate in answering this question.

GEOLOGY

General Certificate of Education

Summer 2013

Advanced

GL4

Team Leader: Jo Conway

As last year, the GL4 scripts were marked on-line. Centres are reminded of the importance of following instructions regarding the use of black ink and not writing outside designated areas in order to ensure that all responses can be clearly seen and read by examiners. Illegible handwriting was a problem for some candidates. A number of excellent scripts were seen but many candidates had difficulty expressing themselves clearly in questions where an extended explanation and/or evaluation were required.

SECTION A:

Q.1 The question focussed on sediments and included a wide range of data (map, sieve frequency plots, table and colour photograph) which candidates used to good effect.

Candidates scored well on most parts of this question, demonstrating very good data response skills and good knowledge and understanding.

(a) The majority of candidates got part (i) correct but some found this difficult. Some decided to compare sediments A and B though this was not required. In some cases there were issues with scale e.g. candidates describing 8mm grains as boulders! In part (ii) many did not **account** for the difference and weaker candidates simply repeated their answer to part (i).

(b) Only the stronger candidates focussed on the composition and linked to the map to give reasons.

(c) In part (i) the majority of candidates were able to deduce the composition of the mass lost, but many did not specify the amount. In part (ii) the majority looked at the map to work out "where the calcium carbonate was from" and "how had it got there". A small number of candidates incorrectly described gravity transport over 2.5km.

(d) The use of a colour photograph aided candidates with the evaluative final part of the question. As in previous years candidates were required to give evidence for their evaluative comments.

Q.2 The question focussed on trilobites and the increasing diversity of life through time. Figure 2b is similar to that used in GL1 May 2013 and this question is a good illustration of the increased demand at A2 as well as the use of data at different levels.

(a) Surprisingly many candidates found it difficult draw the graph from the text given in Table 2. The most common error was the failure to continue the graph into the Permian.

(b) The majority of candidates gained full marks for part (i) and had little difficulty in detailing how different trilobite A was to the others.

(c) This part of the question was similar to the dinosaur question from last year and required candidates to explain the evidence rather than just describing the evidence. Some excellent detailed responses were seen. Weaker candidates were confused in relation to mode of life.

(d) Some excellent responses linking to the specification were seen although some candidates appeared to randomly place an arrow in part (ii). Part (iii) was a good discriminator. Examiners were expecting the majority of candidates to talk of the ending of Snowball Earth but this was not often seen. Candidates who described detailed and specific changes in the environment scored well while those who omitted detail and stated generically that “the environment changed” did not.

Q.3 This question examined the end-Cretaceous mass extinction event. Candidates tackled the question well and produced some extremely knowledgeable answers.

(a) Part (i) was well done with many encouraging descriptive responses detailing the iridium distribution of the graph but parts (ii) and (iii) were more challenging. Part (ii) focussed on the correlation shown by the iridium and soot graphs. The phrase “positive correlation” was quite rarely used by candidates. In part (iii) many candidates were let down by poor phrasing of their answers, with some rehashing their descriptive responses for part (ii) for which there was no credit. The best answers for part (iii) linked to a causal factor.

(b) Part (i) elicited some very good responses. The weaker candidates incorrectly linked the spherical shape to erosion.

(c) This part of the question linked specifically to the K-T boundary. Candidates demonstrated excellent detailed knowledge most commonly about the Deccan flood basalts and the specific environmental changes which it triggered to cause the mass extinction.

Q.4 This question examined the rock deformation and structural element of the specification with links to igneous and metamorphic processes. As in previous years candidates found this a challenging question. This was again examined by means of a block diagram with a range of other data.

(a) The majority of candidates gained full marks for completing the outcrop of the pluton in part (i) although some failed to do so as a result of inaccurate drawing. Part (ii) was more challenging and candidates often failed to spot the cross cutting relationship of the dyke with the pluton as they had not read the Quarry A description of the dyke containing xenoliths of gabbro.

(b) Many candidates found this question challenging. In part (i) many candidates did explain themselves particularly well. In part (ii) many candidates described the difference rather than accounting for it.

(c) Some excellent responses were seen but weaker candidates gave purely descriptive answers. There was some confusion between igneous cooling and metamorphic processes.

(d) This was a real challenge for most candidates. In part (i) the majority of candidates peaked the calcium-rich in the core (middle) of the graph. Part (ii) required an understanding of why the graph should be this way. Poor grammar meant candidates did not make clear the link between core and early/first formed (or rim later formed). Responses detailing the temperature dropping too fast for equilibrium to be maintained were rare.

Section B:

The 1:25,000 solid and drift map extract of Usk-Cwmbran was clearly reproduced, accompanied by a cross section. The maps are “real data”, which means that they can be littered with a wealth of information which cannot be touched on in an approximately 1 hour segment of the exam.

Q.5 This question intends to get candidates familiar with the map and was generally well done.

(a) This was generally well answered though weaker candidates struggled with descriptive phrases.

(b) A straightforward question which was well answered.

(c) Candidates were asked to draw on the bedding planes of the Wenlock Limestone and the water table and resultant spring. Some candidates were obviously looking at the wrong line of section – X-Y rather than P-Q. The majority of candidates drew the bed dipping towards P in part (i) but found part (ii) much more challenging.

Q. 6 This question was based on the structural features on the geological map with a small section of the map reproduced in sketch form. It was the least well answered question on the paper.

(a) It was disappointing that many candidates found part (i) extremely challenging. Many confused their answers to synform and syncline and the plunge proved very difficult for some. Only the stronger candidates gained credit in part (ii).

(b) Despite the relevant source material being emboldened in each part of the question, candidates frequently used a different source and gained little credit. Part (i) was quite poorly done with many candidates looking at the cross section rather than the geological map. In part (ii) candidates were pointed to the geological column and those who used the cross section lost marks. In part (iii) some candidates looked at the wrong fault and answers were often vague. If candidates had looked at Figure 6 the offset of the anticline would have given easy credit. In part (iv) some candidates confused orientation and direction and poor grammar skills often lost credit. The best candidates agreed slickensides could give orientation (e.g. N-S) but that direction (e.g. S) could only be worked out from the rough/smooth feel. The most common correct responses focussed on the last movement only being recorded.

(c) The last part proved the most challenging and many candidates missed the folding and simply compared the faults.

Q.7 Candidates performed well on this question and the use of colour improved the photograph.

(a) It was very disappointing that many candidates failed to use the scale of the hammer and converted from cm to m for the answer. Many incorrect responses of 200m were seen.

(b) This part of the question proved a very good assessment link to field skills. It was left unattempted by a significant number of candidates. Candidates need to be reminded that arrow heads need to point directly to the relevant feature.

(c) Candidates are by now familiar with drawing together all strands in the last part of a question and some excellent answers were seen which covered all the suggested points with assessment of their implications. The question was a good discriminator. A surprising number of candidates confused the terms permeable and impermeable and contradicted their answers e.g. “not suitable because rock is permeable”.

Q.8 Candidates performed well on this question and examiners saw the whole mark range being used. Candidates should be reminded to look at the mark allocation for each question in order to apportion time sensibly.

(a) There were some very good accounts of the evidence from the geological map evaluating the likelihood of the factor.

(b) A number of candidates did not focus on the geological choice of this particular site as a reservoir. The best answers linked to the map and named faults rather than being generic. In part (ii) the majority of candidates were able to use the map to give detailed geological factors for the limit of the size of this particular reservoir. Candidates often lost marks for being too generic and not looking at this particular site.

GEOLOGY

General Certificate of Education

Summer 2013

Advanced

GL5

Principal Examiner: Elliott Hughes

Unit 1 - Quaternary

Q.1 (a) (i) Generally well answered, with most candidates choosing the Scottish granite and the marine shell fragments. Some candidates however only mentioned one piece of evidence.

(ii) Again, generally a well answered question, with the most common answer being glacial striations. Many candidates however did not explain the process and so did not gain two marks. A wide range of answers were acceptable here and some candidates gave excellent answers on other possible evidence e.g. drumlins.

(b) (i) This question was not particularly well answered with a substantial number of candidates confusing the head deposits with the till deposits and giving answers that related to glacial deposits and not periglacial. The significance of the ice wedges was one of the most common responses to be awarded full marks. Very few candidates mentioned local debris as evidence for periglacial deposits.

(ii) Better answered than (b)(i) but some candidates lost out because they just noted the features of the deposit and not how these features provided evidence for the formational processes. The most popular correct answers explained the significance of the texture of the till.

(c) (i) Generally well answered. Most correct answers chose the platform (raised beach) although many convinced with their description of the conglomerate. A few candidates discussed the greywacke as if it was Tertiary in age.

(ii) Generally a well answered question with most candidates scoring at least one mark for the drowned valley or submerged forest. Many candidates did not gain the second mark because of an inadequate explanation.

(d) Although most candidates scored marks in this question there were also many confused answers. The most common problem was that candidates just mentioned the feature and did not discuss how this provided evidence of climatic fluctuations or indeed mention the climate at all.

Q.2 (a) This question was generally well answered. Most candidates were able to draw a reasonable cross-section of a modern reef. There were a significant number of excellent diagrams. Textures were well covered.

(b) Few candidates convincingly evaluated the statement. The high scoring candidates tended to give very good accounts of the processes involved in the formation of oolitic limestones.

Q.3 This was the most popular question.

(a) Many candidates focussed too much on pollen to the detriment of the rest of the question.

(i) Good candidates were able to describe and explain pollen diagrams but weaker candidates often did not refer to them at all.

(ii) In comparison, the discussion of vertebrates was generally much less extensive with few candidates mentioning an incomplete terrestrial record. Some incorrectly focussed on non-vertebrate species (beetles were quite popular.)

(b) Evaluation was generally better for this question than the other two essays and most candidates were aware of the limited coverage of the method given. However, most accounts were quite limited and basic with few candidates discussing problems of contamination or mentioning that ^{14}C dating is more useful for the more complete marine record than for the terrestrial record.

Q.4 (a) Well answered and enabled many candidates to display a wide range of knowledge relating to landforms and geology. The candidates who included diagrams and provided field examples scored most highly on this part question.

(b) Was poorly answered with many candidates just writing in general about human activity and not really addressing the question or even attempting to evaluate. The better candidates focussed on glacial and periglacial deposits and how they can mask the underlying geology.

Unit 2 - Natural Resources

Q.1 (a) (i) Most candidates scored full marks on this but a few did not make quantitative reference to the size.

(ii) Reasonably well answered. Most candidates made the association with volcanic rocks that potentially provided heat and fluids. A few candidates incorrectly stated that the water was provided by the till or by melting glaciers. Those who suggested that this probably formed at a subduction zone scored well. Some made convincing arguments as to the possible part played by fracturing in the creation of the ore body.

(b) (i) Most candidates got the fact that this was due to the ore body being covered by an impermeable till.

(ii) Not particularly well answered with few candidates gaining full marks. The main reasons for losing marks were either the failure to explain the chosen method properly or the lack of significant evaluation of the method. Some candidates did not read the question properly and talked about geochemical methods or drilling boreholes. The latter would have been acceptable if the answer had then gone on to discuss downhole geophysical logging.

(c) (i) and (ii) Most candidates gave acceptable answers, but some were a little too superficial such as: (i) “a big hole is created which is an eyesore” (ii) “this could be filled in or flooded and used for recreation”. (The latter hardly being an obvious choice for an area that had been mined for sulphides.)

Section B

Q.2. This was the least popular question and, as might be expected, a wide range of resources were discussed, with the most popular being residual deposits, evaporites, banded iron formations and placer deposits. The better candidates also included examples. Diagrams were generally very sparse and of variable quality. Evaluation was relatively poor, which prevented some candidates with excellent descriptions from scoring the highest marks.

Q.3 A reasonably popular question.

(a) This part of the question was generally better answered. Diagrams were generally good and well utilised, but the accounts given frequently omitted or gave scant attention to significant parts of what might be expected such as the supply of organic material exceeding the decay and the cyclic nature of sequences with repeated subsidence.

(b) This section frequently resulted in much superficial discussion of CO_2 build-up and its effects on the climate. The better answers focussed on the nature of the traps which might mean they were good or poor reservoirs for CO_2. Some candidates attempted evaluation, which was generally rather poor. Relatively few mentioned that this is quite an energy hungry process. Virtually no one noted that if CO_2 is put into a reservoir it would be very difficult, if not impossible, to re-open the oil well in future if technology improved.

Q.4 This was far and away the most popular question. Many candidates focussed too much on the trapping and accumulation of oil to the detriment of discussing its formation. A significant number of candidates claimed that oil and gas are formed (exclusively) from algae. The migration of oil was also commonly neglected. It would have been nice to see more diagrams in the discussion of oil formation (e.g., the ‘oil window’ curve diagram) and a fuller exposition of the various stages that organic material goes through en route to oil and gas formation. A small minority of candidates also discussed the formation of coal in some detail. The better candidates included examples of oil shales, locations of traps of the type under discussion and also mentioned specific geological time periods when the deposition of black shales occurred. Evaluation was generally better for this question than for the other two, with most candidates stating that all factors must occur for there to be an economic oil reservoir.

Unit 3 – Evolution of Britain

Q.1 (a) (i) No significant problems. Most candidates got these correct.

(b) (i) This proved to be particularly challenging. The question asked for a description and was intended to test a candidate's ability to describe some unfamiliar visual data. All that was expected here was that there appeared to be no pattern and that the beds were random, discontinuous or disjointed. A majority of candidates however chose to give an origin to the structures (which it was hoped would be the answer to (c)(iii). Thus flame structures and load casts were common responses, and were credited so long as the answer included a description.

(ii) Well answered with most candidates gaining the allotted mark.

(c) (i) Very well answered although some candidates did not properly justify their answer. Corals plus reference to the Law of Uniformitarianism was by far the most common accepted response.

(ii) This elicited some excellent responses. Most candidates scored well with a majority justifying a lack of fossils. There were some very concise, convincing answers which explained the regular nature of the beds and / or the presence of flute casts suggesting the base of the continental slope.

(iii) As mentioned with regards to (b)(i) this question did not work out as intended. It was hoped that candidates would correlate the random structures with deposition on a slope. There was a minority that cited slump structures and thus deposition on a slope. However, by far the most common accepted answers cited unidirectional current bedding as evidence of deposition on a slope.

(d) Most candidates scored at least two marks by giving corals and uniformitarianism as evidence for a warm climate. Far fewer candidates mentioned that palaeomagnetic evidence could help resolve the latitude issue.

Q2. A reasonably popular question that was generally well, but not spectacularly, answered.

(i) The evidence was described well but the evaluation was of quite limited extent. More could have been made of the application of the principles of uniformitarianism. A surprisingly regular omission here was mention of coal measures. Many discussed limestone and associated fossils but then went straight onto red beds.

(ii) Many candidates focussed too much on the evidence from sedimentary rocks and fossils and quite neglected the evidence from palaeomagnetism. Evaluation was usually poor or non-existent. There was rarely reference to the various assumptions that are made in relation to palaeomagnetism, such as undisturbed rocks and a dipolar field.

Q.3 This question was the least popular but there were some excellent responses.

(a) Some candidates focussed too much on a relatively small part of the BTIP where they had presumably gone on fieldwork. This meant that the described "range" of rocks and structures was somewhat limited although some allowance was made for depth versus breadth. There were some excellent answers which covered most, if not all, of the ranges.

(b) The relationship with a spreading regime was well described. A significant number of candidates stated that a way of determining that this was a constructive plate tectonic setting was because the basalts were uncontaminated with continental crust. Very few commented that most (over 90%) of the lavas from the BTIP contain a signature of crustal contamination. There were a few excellent responses noting that the cause of the volcanism was the start-up of the Iceland plume and that that extension alone (i.e. opening of the North Atlantic) would not generate the volume of melt observed in the North Atlantic igneous province. The excess heat (and therefore more decompression melting) of a plume is required.

Q.4 This was quite a popular choice and was generally well answered. The main problem with candidates' answers was a lack of breadth in their discussion of the features with too much focus on one particular feature. Very few mentioned the difference in metamorphic grade between the Highlands of Scotland, the Lake District and Wales although some discussed, to varying degrees, Barrow's Zones. Many quoted all of the major Caledonian faults but their plate tectonic setting was usually ignored and only the Moine Thrust was regularly covered satisfactorily. Generally the evaluation was reasonable. However, only a relatively small number noted that granites indicate deep crustal melting and that the high grade metamorphism provided evidence for this.

Unit 4 – Lithosphere

Q.1 (a) Generally very well answered.

(b) This proved to be surprisingly difficult. Most gained the two marks but a significant number of candidates were very careless with their drawings. The angle of incidence had to be equal (as far as the eye could judge) to the angle of reflection.

(c) Generally quite poorly answered. Many chose to describe rather than explain. The most common mistakes were not mentioning the increase in velocity on going from the crust to the mantle and failing to specifically note that the path from the Moho to the station also involves refraction. Relatively few mentioned that there was an increase in rigidity in the mantle.

(d) This was very pleasing with the vast majority of candidates being persuaded to show their full working. However, there is still a significant minority who obtained the correct answer in (ii) but did not **fully** show how they had arrived at it.

(e) Generally not particularly well answered with all four options being popular for a variety of sometimes quite implausible reasons. Answer B is clearly wrong since the thickness of normal ocean crust is 6-7km. Thickened continental crust from continent-continent collision is also likely to be incorrect as is the heterogeneous crustal structure. Also the magmatism of D does not easily correlate with the data provided. Most responses that obtained the full marks arrived at their conclusion by a process of elimination.

Q.2 This question was not popular and was generally poorly answered.

(a) Much better answered than (b) with many candidates correctly writing about the various types of faults and the better candidates giving examples of locations where such faults do, or might occur. Some better candidates made reference to, and drew, stress / strain curves here or in the second part of the question.

(b) Generally very poorly answered with some candidates focussing solely on compressional features and not mentioning tensional features at all.

Q.3 This was the most popular question and was generally well answered. Responses to part (a) were usually much better than those for part (b). Candidates exhibited several fundamental misconceptions. Many candidates had difficulty correctly describing the nature of the gabbro in ophiolites. There are typically two types of gabbro in an ophiolite. There is a lower region of layered gabbro that represents piles of crystal cumulates (olivine mostly) that have fractioned out of the MOR magma chambers (i.e. they do not represent liquid compositions). This is overlain by massive (isotropic) gabbro that has no layering and represents the residual magma. K-Ar dating is no longer used since it is easily affected by (sub-solidus) hydrothermal alteration - so resetting the K-Ar clock – resulting in spuriously young ages. Ar-Ar (or better still) U-Pb zircon(or baddeleyite) are more resistant to alteration and will give a better indication of the true magmatic age. Mantle plumes are not ordinarily responsible for MOR volcanism – the key mechanism of melt generation in these regions is decompression melting of upwelling mantle of ambient temperature (1320-1370°C).

Q.4 This was a popular question but there were far too many candidates who saw the words "J. Tuzo Wilson cycle" and took this as an invitation to write an essay on this topic.

(a) Some candidates gave excellent detailed accounts with examples of the variation in the age of continental crust across a continent, accompanied by good diagrams, although many had difficulty discussing growth by accretion and preferred superposition.

(b) Most candidates were let down by relatively poor evaluation, in that there was too much tendency to just give an account of the complete Wilson Cycle with no attempt made to try and relate to the variation in crustal ages across a continent. Again there was an issue of dating methodology, K-Ar is not used at all for dating such old rocks(in fact it is rarely used at all these days apart from very young and completely unaltered rocks). The most reliable method for dating Archaean and Proterozoic rocks is U-Pb zircon (or baddeleyite) dating.

GEOLOGY

General Certificate of Education

Summer 2013

Advanced

GL6

Principal Moderator: Ian G. Kenyon

Administration

The administration and moderation of the coursework samples ran very smoothly 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 15 deadline.

Packaging Coursework

When packing the coursework samples please try to reduce bulk and weight as far as possible. A4 hardback ringbinders should not be used. It is helpful (and cheaper for centres) to use slim plastic folders that can be packed efficiently. The use of large and heavy field notebooks containing only a few pages of assessed material is to be discouraged. Please consider detaching the relevant pages of field notes and inserting them in the front of the report with a paper clip. Alternatively photocopy the relevant pages and include in the front of the report. All materials for moderation should be included in just **one modest sized package**.

Please note that the coursework samples for GL6 and GL2b should not be sent together in the same package as they are moderated by different examiners. If centres are unsure about the address for despatch, they should contact WJEC for clarification.

Fieldwork and Laboratory based Investigations

Please note that the requirements for GL6 are a minimum of two investigations. The assessment must be a minimum of 50% field based work. Therefore three possible combinations are available. Field 50%, Lab 50%, Field 75%, Lab 25% or Field 100%. Please state clearly on the GLF1 form whether Lab (L) or Field (F) is being assessed. It is not appropriate to write F/L.

GLF 1 Forms

The F1 form should list **all** candidates and their marks from the centre, not just those selected as a sample for moderation. It is helpful to mark with an asterisk on the left hand side those which make up the sample.

F2 Forms – The Tracking/Planning Sheet

A completed F2 form should be included for each investigation undertaken, i.e. two for each candidate in the sample. This is used primarily to assess the planning of the investigation.

The quality of the planning sheets varied from exceptional, exhaustive and comprehensive to inadequate, over-brief and quite vague. The best marks for planning were achieved where students carried out a pilot study to test their planning, then modified the original plan in light of this. A small number of centres were a little over-generous in awarding marks for planning. It is not possible to score full marks on this section when candidates have failed to make any predictions about possible outcomes and anticipated sources of error.

These sheets can be enlarged to A3 where space is insufficient. Additional planning information can be included at the beginning of the written report under a clear ‘planning (F2) continued’ heading.

Students should be encouraged to plan in detail and should be discouraged from using simplistic bullet point statements on the planning sheet.

F3 Forms

A completed F3 form should be submitted for each candidate in the sample. Please make full use of the opportunity to comment on the work of individual candidates on the F3 form. Ideally 4 ‘post-it’ notes should be placed within the work to identify where and why the marks have been awarded. A few centres still fail to comply with this request and possibly disadvantage their candidates as a result.

Please ensure that the updated F3 form, which has the candidate declaration on the reverse, is downloaded from the WJEC website. This must be signed by the candidate and teacher to confirm the authenticity of the work being submitted. It was pleasing to see that nearly all centres complied with this administrative task this year.

Downloads from WJEC

Copies of the forms F1, F2 and F3 can be downloaded directly from the WJEC website www.wjec.co.uk by following the GCE/AS subjects and then Geology links from their home page.

Implementation

In order to provide evidence for implementation, it is vital that the appropriate field and laboratory notes are included with the report.

A small number of centres failed to include the laboratory notes this year.

It should also be noted that laboratory work must yield some raw data that could not be collected in the field. Bringing back rock samples then describing them as in a ‘traditional’ practical is not really in the spirit of the assessment.

Good examples of lab work included:
Making thin sections of rock samples followed by microscope analysis
Sieving sediments and calculating sorting, skewness and kurtosis
Establishing composition of sediment samples using point counts
Testing rock samples for resistance to abrasion, impact and polishing
Modelling rock deformation using plasticine and mars bars
Simulating mass movements and tsunami generation in a wave tank
Porosity and permeability of rocks related to their utilization potential
Testing the resistance of various mollusc shells to abrasion/attrition and linking to preservation potential

The overall quality and quantity of the lab and field notes were a little disappointing again this year and could easily be improved upon. Field sketches were particularly poor. Ideally each field location should have a six-figure grid reference. If sites are close together, then the same reference should be given with “12 metres west of site 4”. It was pleasing to note some very accurate fieldwork locations were given by a number of centres using GPS devices this year. This approach is to be commended and encouraged.

All field sketches should have grid reference, scale, compass orientation and detailed annotations. Simplistic labelling of sketches should be discouraged.

Information from secondary sources such as bed ages or detailed palaeogeographies should not appear in the field notes. Photographs are also inappropriate in the field notes. The field notes should be used to interpret the photographs in the report. Field notes should consist of detailed observations, measurements and records made individually by each candidate. Identical notes obviously dictated in the field are to be strongly discouraged.

It is strongly recommended to practise field sketching from photographs or slides prior to fieldwork being carried out. The field and lab notes provide the basis for the report and should be considered the most important part of the investigation.

Analysis

This involves some synthesis and interpretation of the primary data collected in the lab or field. There must be some development from the field or lab notes, rather than simply copying out the same information in a neater form.

The use of photographs is to be strongly encouraged but these should be used selectively and integrated within the text. Transparent overlays or outline diagrams adjacent to photographs may be used to highlight important features or they could be annotated digitally. Grid reference, compass orientation and scale should be included as a matter of course.

Please discourage the indiscriminate use of photographs, which lack location and annotations. Only include photographs, which are directly relevant to the investigation. As a general guide no more than 8 to 10 photographs should be included. Less than half the candidates included photographs this year and the majority were poorly annotated.

Statistical analysis is recommended if it is appropriate to the data collected. Excellent investigations on sedimentary environments included work on sorting, skewness and kurtosis. Particle size and shape was assessed using Zinng’s, Krumbein’s and Cailleux’s indices. Spearman’s Rank, Chi Square and Vector analysis were also used by some centres. Point counts were used to assess the mineralogical composition of rock and sediment samples.

Spreadsheets were used by a number of centres, but not always to the best effect. Printouts of cumulative frequency graphs, Zinng diagrams and histograms were rarely annotated to show evidence of thorough analysis and interpretation.

Evaluation

Evaluation must be included as a separate section within the report. It is an opportunity for candidates to reflect objectively on the work they have carried out. The quality of evaluations varied from sophisticated and thorough to simplistic and inappropriate. It may be worthwhile suggesting that candidates break up the evaluation into a number of distinct components:

Evaluating the planning sheet they completed. How appropriate were the techniques and methods they selected? This may refer to methods of sampling, sample size and sample number.

What problems or limitations were encountered during implementation? This could involve reference to confusion between true and apparent dip or problems between the base map geology and actual rock outcrops.

An outline of the way in which the investigation could be improved, given more time and/or resources and with the benefit of hindsight.

An overview of the investigation based on the likely reliability/validity of the data collected in the available time frame. Which part(s) of the investigation(s) yielded the most/least reliable data and why? Are the conclusions made concrete, tentative or partial? How do these findings compare with published work on the same area/topic. How do they compare with the results/conclusions of students from last year? How could the work be developed further, with perhaps reference to the outline planning of extension work.

Evaluation is not a list of excuses. Naïve and simplistic statements regarding lack of time, bad weather and lack of familiarity with equipment do not form the basis of a mature evaluation. As a rough guide one side of A4 word-processed text is a probable minimum length for a high scoring evaluation.

The Report

It is now **expected** that candidates make use of IT and finish reports to a professional standard. It was encouraging to see so many doing so this year and only a few hand-written reports were submitted.

As a rough guide, the optimum length for each report should be around 2000 words, excluding maps, diagrams, photographs, graphic logs and statistics. Quality rather than quantity is to be encouraged. The reports should be concise, relevant and clearly focused. Please dissuade students from including large amounts of photocopied material from secondary sources.

The report should be based on the primary data collected in the lab or field and there should be some cross-referencing between the two. Safety considerations should be briefly acknowledged and students should be encouraged to be aware of the importance of the need for conservation of geological sites. The report might include the following sections, though they may be subsumed under a smaller number of headings:

Contents Page
Location Map
Introduction
Aims/Hypotheses
Safety Aspects
Methods of Data Collection
Data Presentation
Data Analysis
Statistical Analysis
Graphs/Printouts **with** Annotations
Photographs **with** Annotations
Conclusions
Evaluation
Bibliography
Acknowledgements

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