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GEOLOGY

265 students presented for the 1998 Higher School Certificate Geology examination. This was a small increase on the candidature for 1997.

The examination afforded students the opportunity to demonstrate a wide range of communication, and interpretive and analytical skills, as well as geological knowledge. As in previous years, the quality of the responses varied considerably. The most able students produced excellent responses, demonstrating a high level of achievement in all the outcomes examined. At the weaker end of the candidature, a few students showed little engagement with the subject, while the majority showed a knowledge of the course content but had difficulty in interpreting new data and in applying geological reasoning to new situations.

All but the weakest students attempted to produce extended answers when these were required, but many used valuable answer space and time to repeat information given in the question. While the standard of drawing was slightly better than in previous years, a significant number of candidates appeared to have little understanding of the relevance and application of scale and direction.

Over 65% of candidates attempted Elective Questions 33 or 34 and the quality of the responses in these electives was very varied. This was particularly significant in Elective 33 — Igneous Rocks, which appeared to have been attempted by a number of students who had not studied the elective. Only a small number of students attempted each of the other electives. As in past years, elective responses often failed to reflect the depth of study expected.

Marking Scheme

SECTION I — CORE

Part A — 15 multiple choice questions which were machine-marked.

Part B — 10 questions, three marks each.

Part C — 6 questions, five marks each.

The questions in Part B and C were marked using a marking scheme developed by a group of markers and trialed over a significant range of papers.

SECTION II — ELECTIVES

All electives were marked using marking schemes developed by one group of markers and trialed over a high proportion of the answers of students attempting the elective. Procedures were carried out to monitor parity between standards in responses across electives. This was followed by comparing the results of students doing each elective with the core results for the same group.

SECTION I — CORE

Part A: Multiple Choice

The table below gives the percentages of the candidature selecting each response. Examination of these statistics indicates that most students performed well in this section of the paper. Correct answers are marked with an asterisk.

Question	A	B	C	D	% Correct
1	4.98	4.60	1.53	88.89*	88.89
2	4.60	27.97*	30.65	36.78	27.97
3	11.11	67.43*	15.33	6.13	67.43
4	5.36	90.04*	3.45	1.15	90.04
5	8.81	6.51	37.93	46.74*	46.74
6	42.53*	35.63	9.96	11.88	42.53
7	3.07	4.21	6.51	86.21*	86.21
8	27.59	14.94	39.46*	17.62	39.46
9	21.07*	65.52	7.28	5.75	21.07
10	5.36	47.51*	42.15	4.98	47.51
11	11.11	13.03	18.39	57.09*	57.09
12	29.12	16.09	47.51*	7.28	47.51
13	0.38	12.64	8.43	78.54*	78.54
14	4.21	9.20	72.41*	13.79	72.41
15	9.96	1.92	3.45	84.29*	84.29

Part B

Question 16

Most students answered this question well. The majority were able to give three pieces of evidence, but some answers lacked the detailed description asked for in the question.

Question 17

(a) Many students were able to state that ocean basins are younger than continents. The better answers described the relationship between constructive and destructive plate margins and sediment distribution.

(b) This part of the question was generally well answered, although some responses were very generalised, referring to ‘ooze’ or ‘dead plants and animals’. The better answers included foraminifera shells or wind-blown volcanic dust.

(c) Many students had difficulty with this question. Some confusion was evident as to the relevance of radiometric dating, with C^{14} dating being a common incorrect answer. The better answers referred to radiometric or by palaeomagnetic dating of basalts beneath the sediment, correlating these with the sediment immediately above, and dating the fossils found within the sediments or by palaeomagnetic dating of the sediment column.

Question 18

(a) This question was generally well answered, but some students had difficulty in describing divergence.

(b) Many students did not explain the significance of Australia's location relative to plate boundaries.

(c) The majority of students described the process of divergence and made no reference to the relationship between the divergent and convergent boundaries.

Question 19

(a) This question was poorly answered, with many students failing to give a clear definition of isostasy.

(b) While most students provided labelled diagrams, the quality was often poor. The inclusion of normal faults was a common error.

(c) Most candidates were able to identify a relevant igneous rock but very few could name a suitable regional metamorphic rock.

Question 20

(a) Most students were able to give one use for basalt, but many had difficulty in finding a second. Some students gave uses for coal instead of basalt.

(b) Most candidates gave a suitable environmental reason. The question on the economic reason was answered reasonably well, but some related price fluctuations for basalt to world markets.

(c) Some students suggested non-environmentally acceptable uses for the abandoned pit, eg dumping of toxic waste.

Question 21

(a) This question was poorly answered. Candidates did not seem to understand the processes involved in the formation of a hydrothermal deposit.

(b) This was generally well answered, but some students confused minerals and metals.

Question 22

Many students appeared to have difficulty in coping with all the written and diagrammatic information provided in the question. There was evidence of misreading of dates; 1935, 1955, 1995, time spans and the housing symbols.

(a) Many students had little understanding of geological hazards, with many referring to cyclone damage.

(b) This was well done. Many students named landslides as the most likely geological hazard and the better responses referred to increased runoff, reduced infiltration or decreased soil stability during heavy rainfall.

Question 23

(a) A minority of students labelled the transform faults correctly, with many marking entire fracture zones. Almost all students correctly shaded the rift valley, recognised point R as being the same age as point X and indicated that the ocean floor at P is moving south.

(b) Both parts of this question were well answered.

Question 24

(a) Most students were able to answer the question in relation to gold but few understood how pyrite weathers.

(b) This part was well answered.

(c) All answers to this part were good.

Question 25

(a) Most students recognised the importance of pressure but not of heat. The majority were able to state the tectonic environment of formation.

(b) This question was answered well.

(c) About half the candidates were unable to name a suitable fault type correctly. Even when correct fault names were given, some students used incorrect arrow directions on the diagram.

Part C

Question 26

(a) Most students were able to draw and label the surface profile, although there were some who did not attempt to draw the diagram to horizontal scale. Many had difficulty in deriving an appropriate vertical scale for their diagram. Internal structures such as lithosphere and asthenosphere were often omitted or incorrectly labelled. The sources of the two magma types were generally well described.

(b) Many students answered this question incorrectly, even though they had recognised the hot spot. It appeared that these students could not use compass directions. Students generally used the correct data and procedures for calculating the rate of movement, but values were often expressed in kilometres per year rather than centimetres per year.

Question 27

(a) This question was answered very well.

(b) The quality of diagrams varied considerably. Most students correctly represented the internal structure of the volcano but many did not show the correct shape or slope. Several had slopes as steep as 65o and, for some, this contradicted written information. Most students did not relate either the steepness of the cone or the internal layering to the chemical composition of the magma.

(c) Most students correctly named a mountain range. The majority named an igneous rock characteristic of the mountain range but fewer were able to name a relevant metamorphic rock.

Question 28

(a) The students answered this question well. The open-ended nature of the question led them to suggest a wide variety of responses. Geological, environmental and social problems were all given as responses.

(b) The first part was answered very well, with the better responses referring to more complete extraction of the coal, the shallow depth of the coal seam and improved technology. The second part was poorly answered. The better responses referred to a

high water table flooding of the site or to problems caused by the dyke. In the third part students recognised a variety of environmental problems but some of the answers were too brief, referring, for example, simply to ‘pollution’, ‘dust’ or ‘noise’.

Question 29

(a) This question was poorly answered, with few students giving more than a comment on grainsize for each rock.

(b) This question was moderately well done, with most students naming at least one mineral present in andesite, but only about 20% were able to name two. Some students, however, showed little or no knowledge of earth materials, listing sedimentary rocks such as sandstone and shale as being in andesites.

(c) This was quite well answered, with most students referring to magmatic or volcanic processes. The better students also related the andesitic composition of the rock to partial melting, subduction or other processes linked to plate tectonics.

Question 30

(a) Generally, the conditions and processes necessary to change swamp vegetation into coal were well understood but many failed to relate this to ‘high grade coal’.

(b) Many students did not distinguish between the types of organisms. A number used the word ‘organism’ without understanding its meaning; for example, they stated ‘coal is made from plants and organisms’.

(c) Many answers were too general and did not describe a specific environment. Terms such as ‘ocean’, ‘living things’ and ‘aqueous’ were given rather than specific statements such as ‘shallow marine basins’, ‘deltas’ or ‘abundant marine micro-organisms’. Some students interpreted this question as meaning the formation of the actual oil and gas field, but their descriptions of source rock, reservoir rock, cap rock and trap were poor.

Question 31

(a) This was generally well done. The majority of students knew the method to use, but some gave the answer in centimetres per year. Some were imprecise with measurements of depth and/or time.

(b) Very few students gave the correct time for the end of the Matuyama reversed epoch. Most gave the time at which the reversal began. The second part was well answered, although some students rounded off the figure to 600 instead of recording a more precise measurement.

(c) This was reasonably well answered in terms of evidence of the Olduvai event’s not being recorded in Core 3 due to lack of sedimentation or absence of magnetic minerals. Many students, however, were not aware that sediments have a magnetic signature. Some students attributed the lack of magnetic response to lack of volcanic activity.

(d) The term ‘Mammoth’ confused some candidates but the approximate age for the event was handled well; the second part of the question, however, was poorly answered. Students could not clearly express the concept that the other cores (2-5) had not penetrated deeply enough to intersect sediments of the approximate age of the Mammoth event. Many assumed that the cores showed the full depth of the sediment present.

SECTION II — ELECTIVES

The table below shows the approximate percentage of the candidature attempting each of the electives.

Question 32 — Contemporary Sedimentary Processes	17%
Question 33 — Igneous Rocks	43%
Question 34 — Economic Geology	24%
Question 35 — Regional Geology	11%
Question 36 — Palaeontology	5%

Question 32 — Contemporary Sedimentary Processes

In general, the quality of answers to this elective was poor and showed little understanding of:

- map scales
- weathering of the source rock
- relationship between specific sites and grain size and shape
- composition of sediment in terms of rocks, mineral, organic material.

Answers tended to be general rather than specific.

(a) (ii) Maps were drawn quite well, but scales were often inappropriate.

(iii) Students did not understand the idea of ‘distance of the source’ area(s) from the area studied. Good answers referred to aspects such as catchment size, bank erosion adjacent to the river, stormwater drains from local streets. Parts (2) and (3) were poorly answered, as students did not appear to understand the meaning of the word ‘source’. Often textural terms such as ‘sand’ and ‘pebbles’ were used rather than rock types, while the terms ‘weathering’ and ‘erosion’ were confused.

(iv) Answers were often non-descriptive and lacked depth. Some used contradictory terms, eg ‘angular’ and ‘round’ with no qualification or expansion to show meaning.

(v) The textural changes were generally well done but, again, students had little idea of compositional changes.

(vi) Detail was lacking, with processes such as abrasion being mentioned but not developed. Again students confused the terms ‘weathering’ and ‘erosion’.

(vii) The majority of students knew what the transporting medium was but some thought it was the sediment. Most appeared to have been involved in a practical fieldwork task measuring the energy of the transporting medium. The idea of measuring time taken over a set distance was well understood, but the descriptions lacked detail, with very few students referring to the calculation or formula used. Few students referred to the methodology in terms of variables and repetition.

Most of the diagrams of sedimentary structures were poor and bore little resemblance to what could be achieved in nature. For example, ripple marks were curved like breaking waves showing unsupported sediment on the crests, and current beds were often near vertical straight lines that suddenly reversed mid-bed.

(b) This question was well answered, although some students failed to refer to the transporting medium.

(c) This process type question was generally well done and students showed good understanding of graph reading techniques.

In part (vi) the majority showed little understanding of ‘scouring’.

(d) Some students became confused and tried to explain how the past is the key to the present. Many listed sedimentary structures seen in the ancient environment but made no connection with the modern environment.

Question 33 — Igneous Rocks

(a) (i) This part was quite poorly answered, with a high proportion of candidates failing to identify one or both minerals. Many could identify a property that might help to identify the minerals, but many struggled to match diagnostic property to the correct mineral. ‘Hornblende’ was commonly confused with ‘augite’. Some students provided mineral group names rather than specific mineral names.

(ii) This question was well answered. Most students could correctly name the texture illustrated from the diagram.

(iii) Most students correctly described the texture in detail. Some, however, incorrectly stated the order of formation of the phenocrysts and groundmass. The majority showed an understanding of the relationship between grain size and cooling rates.

(iv) All three possible responses were commonly provided for this rock classification. The correct answer, (intermediate) was the most common. Due to incorrect identification of minerals in (a) (i), many students classified the rock as being ‘mafic’. The second part of the question, asking for support for the classification, was inadequately answered by the majority of candidates. For example, many students based their answers on the presence of one mineral rather than on the mineral assemblage or on the presence or absence of quartz and/or augite or olivine.

(v) This question was generally well answered. Most candidates could identify two oxides and extract information from the table. Many, however, had difficulty in stating whether the nominated oxides were present in concentrations which were too low or too high for the rock in the diagram. Many students incorrectly referred to the Silica content of 46.62% as being high.

(vi) This question was generally poorly answered. Many candidates showed a lack of understanding of the formation of mineral zoning. Many confused zoning with reaction rims of alteration processes. A number also believed that zoning caused one mineral to change into another. Students who provided a correct answer, however, demonstrated a sound knowledge of zoning.

(vii) This part was relatively well answered. Some tectonic settings provided were, however, very broad, and should have been more specific.

(b) (i) In general, this question was quite well answered, with some candidates providing excellent answers. Most students showed at least some knowledge of processes involved in magmatic differentiation.

(ii) Many candidates equated ‘coarse grained’ with ‘first formed’ rather than with ‘slow cooling’. Many used simplified terms rather than more accepted textural terms, eg ‘large’ rather than ‘coarse’, even ‘grained’ rather than ‘equigranular’, etc. Many candidates linked coarse crystals with ‘room to grow’ rather than ‘slow cooling’. The majority made at least a basic link between texture and cooling history.

(iii) A number of students recognised that a chilled margin represents the composition of the parent magma, but few explained why. Few candidates adequately explained how the geologist would ascertain compositional information from the chilled margin. For example, many used terms such as ‘look at’, ‘study’ and ‘examine’ rather than ‘sample and analyse/assay’ or ‘make thin sections and study the mineralogy’.

(iv) Few students correctly named two economic minerals. Many could nominate only one — usually chromite or magnetite. A number provided names of elements rather than minerals, eg copper, nickel etc.

(v) This question was well answered. Many candidates could provide at least two or three ultramafic minerals, and some could name four. A number of candidates provided simplified answers by naming mineral groups (eg plagioclase, amphibole, pyroxenes) without providing specific mineral names.

(c) This question was relatively poorly answered. Many candidates found it difficult to interpret information from the graph correctly. A number of students confused the depth of magma formation with the depth of intrusion. Several students reproduced Bowen’s Reaction Series without applying it to the question. The mineralogy component of the question was quite well answered, with most students providing all or part of an assemblage of minerals typical of granite.

Question 34 — Economic Geology

(a) This question was generally well answered.

(i) Some candidates failed to read the fort intensity scale correctly and interpreted the lines as being topographic contours.

(ii) Most candidates realised that granite and basalt were involved in the mineralisation, but many failed to realise the significance of the contact between these two rocks.

(iii) F3 was widely nominated as the correct response. Most candidates recognised that the deposits were found at the 300 fort contour but many failed to link this reading with the basalt/granite contact. Many candidates provided an appropriate technique to confirm the presence of fortunium. Some, however, simply (and correctly) repeated the details of the fortuning technique from the question.

(iv) This question was generally well answered. Strong candidates correctly identified the northern and north-western regions and explained that this was where the granite would most likely be found.

(v) Most candidates were able to describe an exploration technique which they had studied.

(b) (i) Almost all candidates could name a deposit and list the materials extracted from it.

(ii) This section was generally very well answered.

(iii) Students had difficulty in selecting appropriate factors necessary for the materials to be extracted. Part 2 was well answered, but students needed to be specific in their answers. Many appeared to be quoting general responses from the Core.

(iv) Most students were able to sequence and explain the extraction procedures well. In (2) some candidates failed to select appropriate features of the deposit and answers were sometimes too general.

(c) (i) Almost all of the candidates could nominate a second deposit and list the ores or materials extracted from it. Many failed to provide sufficient details on their cross-section. Common errors included no reference to direction, scale, mineralisation type, structures or country rock. Most candidates answered (3) well. In (4) many candidates had little idea of the meaning of the terms 'indicated' and 'proved' reserves. The problem was exacerbated by the fact that many deposits do not publish reserves under these categories. (5) was generally well answered; some candidates, however, provided insufficient detail, limiting their answers to those expected from Core work.

(ii) Only a small number of candidates attempted this question, and it was obvious that some had not studied a specific engineering project. All candidates could name an engineering project. (2) was extremely poorly answered, with almost no attempt being made to include any geological or topographic information. Since no features were included in the answers to (2), questions (3) and (4) were also very poorly answered. Those who made some attempt to answer the questions did not appear to have any relevant information at their disposal. In (5) those who described environmental considerations did not state how these considerations had affected the project, but rather how the project had influenced the environment. Those who attempted to discuss the exploration and testing methods could provide little relevant information.

Question 35 — Regional Geology

Nearly all students had studied the Sydney Basin, though some confused their study region with adjoining regions. There were some good answers, but many students provided only brief answers that lacked the detail necessary at the elective level.

(a) (i) Nearly all students correctly named an adjoining region.

(ii) This question was poorly answered. Few students described differences in tectonic setting, with most confining their answers to differences in age.

(iii) This question was well done, with the better answers including diagrams of the boundary.

(iv) Most students could state the age relationship between the two regions but few made any attempt to indicate how the age relationships were determined. A few students referred to methods such as using fossils or radiometric dating, but none used field relationships.

(b) (i) Most students correctly named an igneous unit and stated where it was located.

(ii) Some students correctly described the source of the material in the unit but others merely described the material.

(iii) There were some very good diagrams of basalt columns but those of other structures were usually poor.

(c) (i) Approximately 50% of the students named a sedimentary unit, while many of the others simply named a rock such as sandstone or shale.

(ii) Very few students adequately described the source of the sediment making up the unit.

(iii) Very few good diagrams of appropriate sedimentary structures were produced.

(d) (i) Most students chose to write about scenic features, such as the Blowhole at Kiama, the Three Sisters and the Blue Mountains. Two students chose coal as an example of a major economic deposit.

(ii) This question was well answered.

(iii) Most students had some idea of how their chosen feature was formed, but only a few provided detailed answers.

(e) Most of the answers to this question were very general and did not refer to specific information. Examples of the type of inadequate answers given included ‘Field trips showed us where different rocks occurred’. The few good answers included details such as the nature of specific stratigraphic distributions or structural patterns seen on maps or aerial photographs, or referred to specific rock types or structures examined in the field and indicated how these fitted into the overall geology of the region.

(f) Students had difficulty in interpreting what was required in this question. Very few were able to explain how the rock type influenced the topography of the selected area or to indicate that other factors were of greater importance in relation to the landforms they had chosen. Most students merely described a specific landform.

(g) There were some good answers to this question, with diagrams and explanations of the Hunter Thrust Fault being the most common. Some students were confused by the variety of structures within the region, labelling structures such as the unconformity as the Lapstone Monocline. Labelling of some diagrams was sparse. Students need to realise that more is required than just a name. Better answers included, where appropriate, reference to scale, direction and relative movement, as well as labelling of rock units and ages. Few students appeared to consider the scales of the two map areas.

(h) Students had difficulty with this question and appeared to have little understanding of the sequence in which geological information about an area is collected. Many repeated the same processes for each part of the question or wrote one answer to cover both questions.

(i) Some realised the role of reconnaissance-type procedures, such as the use of satellite images and aerial photography but they were unable to explain the use made of these procedures. The majority of those who attempted the question wrote about collecting samples and drilling.

(ii) The answers in this part were slightly better, with most students referring to at least one suitable procedure. Many included reference to specific geochemical and geophysical techniques and to drilling programs, although the question did not necessarily require as much detail.

Question 36 — Palaeontology

Only a small number of candidates chose this elective.

(a) This question was generally well answered.

(b) (i) Most students recognised the shape of the graph as showing mass extinctions.

(ii) This question was generally well answered, with 'climatic changes' and 'meteorite impacts' being the most common responses.

(iii) Many students read the graph incorrectly and suggested that the number of species has decreased with time. The better answers referred to the increase in the number of species over a period of time or to the boundaries of the eras being marked by extinctions.

(iv) This question was quite well answered with graptolites, trilobites, ammonites and dinosaurs being the most commonly chosen groups.

(c) (i) and (ii) Some students could not name any two people other than John Phillips and Charles Darwin who had made a significant contribution to palaeontology. Where students were able to name scientists such as Lyell, Cuvier and Smith, they usually still had difficulty in describing the contribution made by such scientists.

(d) (i) This part was well answered.

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

(iii) A high proportion of students could state one reason why the fossil record is very incomplete but only a few gave two reasons. Some statements, such as 'unfavourable conditions' or 'were destroyed' were too brief or too general.

(iv) Few students could answer this question. Some produced general statements such as 'lack of evidence' but only two students realised the importance of morphological detail and soft parts in classification.

(e) (i) Questions 1 and 2 were well answered, although some students did not know the difference between 'marine' and 'aqueous'. The majority were confused about the usefulness of ammonites in stratigraphic correlation, usually because they did not recognise the importance of variations between the different ammonites.

(ii) Most answers were too general and included statements such as 'shells got rounder and thicker' or 'became more complex'. The better answers referred to changes in suture patterns and coiling.

(iii) Good answers referred to increased strength and agility.

(iv) About 50% of students produced a possible reason to explain why the ammonite might have developed a different shape to the others.

(f) (i) While the trilobite diagrams were quite good, few students correctly labelled all the features required.

(ii) and (iii) These questions were well answered.

(g) Most students chose to answer parts (ii) or (iii).

(i) None of those who attempted this question were able to discuss how palaeontological principles could be used in the debate about when Aboriginal Australians came to the continent.

(ii) Students correctly described the changes in the horse through time. Although they indicated an understanding of the term palaeoecology, however, they had difficulty in relating the changes in the horse to its palaeoecology. Few students were able to suggest any other evidence which could be used to interpret palaeoecology.

(iii) Some students were confused by the symbols used in the diagram. The majority, however, showed a good understanding of the term ‘index fossil’. Answers on the use of microfossils in oil exploration were generally poor.

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