GCE

Geology

Advanced GCE **A2 7884**

Advanced Subsidiary GCE **AS 3884**

Combined Mark Schemes And Report on the Units

June 2005

3884/7884/MS/R/05

Oxford Cambridge and RSA Examinations

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Advanced GCE Geology (7884)

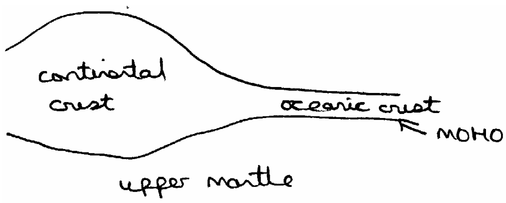
Advanced Subsidiary GCE Geology (3884)

MARK SCHEMES FOR THE UNITS

REPORT ON THE UNITS

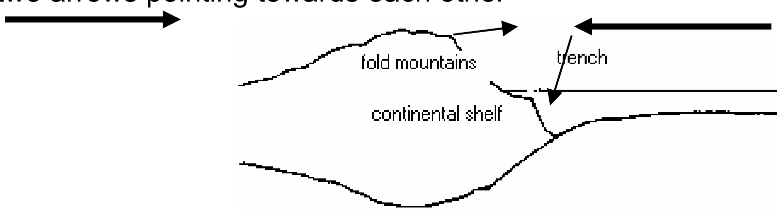
Mark Scheme 2831
June 2005

Question	Expected answers	Marks
1 (a)(i)	A crust / lithosphere B mantle C <u>outer</u> core D <u>inner</u> core 4 or 3 correct = 3, 2 correct = 2, 1 correct =1	3
(ii)	at boundary between B and C	1
(b)	upper mantle at base	1
	oceanic crust as thin layer either continuous just above Moho or next to continent/if continuous and no continental crust then must have correct thickness	1
	continental crust as thick layer deepest below highest point/if continuous and no oceanic crust then must have correct thickness	1
	Moho as line below crust	1



Question	Expected answers	Marks
(c)(i)	outer core is liquid has convection currents moving iron / creates magnetic field at depth of 2900 - approx 5000 km/2900 mantle – outer core/approx 5000 outer – inner core very dense 9 - 12 composition is <u>iron nickel</u> 15 – 20% mass/11% +/- 2% volume	any 2
(ii)	asthenosphere is rheid / plastic/has convection currents 100 - 250 km depth/below the lithosphere in the mantle acts as a low velocity zone (for P and S waves) partial melting/5% liquid/5% molten made of peridotite/ultrabasic	any 2
(d)(i)	3 - 8 km/2 – 5 miles/10,000 – 27,000 feet	1
(ii)	peridotite / ultrabasic rocks brought up come from (upper) mantle to surface kimberlite pipes/xenoliths diamonds mean very high pressure and temperatures	any 2
(e)	stoney / silicate meteorites match mantle composition metallic / iron-nickel meteorites match core composition different types of meteorite have correct densities for mantle and core Carbonaceous chondrites represent whole Earth composition Broken fragments of planet (but must link to the question)	any 2
		17

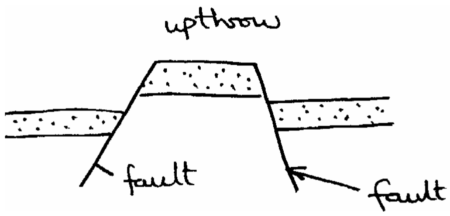
Question	**Expected answers**	**Marks**
2(a)(i)	pillow (lava)	1
(ii)	dyke	1
(iii)	C on MOR - no sediment / area of youngest rocks - no time for sediment to form	1
	A furthest away from MOR - time for sediment to form	1
	OR max 1 for statement of position C on ridge and A away from ridge	
	OR max 1 if time taken given as the explanation for A and C	
(b)	<u>magnetic</u> field flips AW North and South poles change over Chandler Wobble / field dies down and then builds up again in opposite direction iron (magnetic) particles are aligned parallel to the Earths magnetic field when rock <u>cools</u> iron particles are 'frozen' in place	any 3
(c)	trench at top of subducting plate	1
	fold mountains at highest point	1
	continental shelf on flat area just below sea level	1
	two arrows pointing towards each other	1



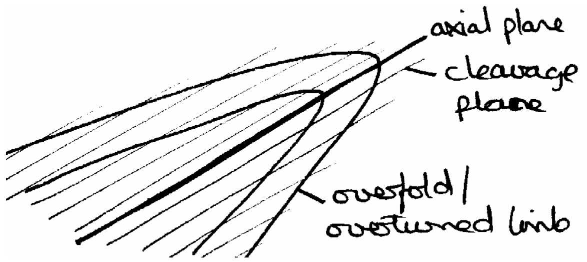
Question	**Expected answers**	**Marks**
(d)(i)	high above fold mountains	1
	low above the trench	1
(ii)	low above trench <u>cold</u> water / very <u>deep</u>/cold sinking convection currents	1
	high above volcanoes / magma rising to surface/intrusions within fold mountains	1
(e)(i)	mantle plume / magma rising from mantle source of magma at fixed point AW plate moving above fixed point / magma source area of volcanic activity in the centre of a plate / away from plate margin	any 2
(ii)	**rate** of movement by looking at <u>age</u> of rocks and <u>distance</u> from hot spots	1
	direction of movement is shown by the line of youngest to oldest/towards the oldest/away from youngest	1

19

Question	**Expected answers**	**Marks**
3(a) (i)	reverse	1
(ii)	on right hand side	1
(iii)	70° +/- 5°	1
(b)(i)	fault breccia	1
	fragments of rock broken by movement of faults/cataclasis	1
(ii)	slickensides	1
	it (scratches) forms parallel to the direction of movement of faults / due to (irregular) fault surfaces moving against each other	1
(c)(i)	two faults	1
	block upthrown in centre as horst	1



Question	**Expected answers**	**Marks**
(ii)	overfold - overturned limb	1
	cleavage planes parallel to axial plane	1



Question	**Expected answers**	**Marks**
(d)(i)	tension / tectonic/extension	1
(ii)	Contraction (shrinking) of magma	
	cooling around centres	
	forms hexagonal / polygonal (columns)	any 2
		14

4	**Deep sea trench**		
	origin	friction between plates	1
		earthquakes at top of subducting plate	1
		subduction of oceanic plate	1
		Benioff zone	1
		plate moves in jerks / sticks - sudden movement	1
	depth	shallow + medium / deep	1
		increasing depth away from the trench	1
	max 3 if no depth		
			max 4
	Transform fault		
	origin	movement along fault	1
		due to different rates of spreading	1
		on sections between MOR	1
	depth	shallow only	1
	max 2 if no depth		
			max 3
	Continental shield		
	aseismic / no earthquakes / very rare earthquakes		1
	because in the centre of the plate / away from plate margins		1
			max 2
	diagram of Benioff zone		1
	diagram of MOR and transform fault		1
		if any of the three sections is missing max mark is 7	
			8

2 marks	Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.
1 mark	There are shortcomings in the structure of the answer, however, the candidate is able to communicate knowledge and ideas adequately, a limited range of specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.
0 marks	There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.
	max 2

Mark Scheme 2832
June 2005

Question	Expected answers		Marks
1 (a) (i)	A and E		1
(ii)	A is vesicular texture		1
	E is glassy		1
	If general point not specific A and E max 1		
(iii)	Large crystals / Phenocrysts labelled		
	Fine grained groundmass labelled		
	Scale	Diagram max = 2	Any 2
	Two stages cooling		
	Large crystals form first (at depth)		
	Followed by faster cooling of groundmass (nearer or at surface)		Any 2
			Max 3
	Mark diagram as text		
(b) (i)	C and F		1
(ii)	C has a slatey cleavage		1
	F has a sugary texture		1
	If general point not specific C and F max 1		
(c) (i)	B and D		1
(ii)	B shows bedding / fragmental		1
	D contains fossils / is bedded / fragmental		1
	If general point not specific B and D max 1		
	If only bedding given twice max 1		
	If only fragmental given twice max 1		
(d) (i)	Process by which sediment becomes rock		1
(ii)	Weight of overlying sediment / hydrostatic pressure / load pressure) / compression		
	Squeezes fluids from pore spaces		
	Porosity reduced / no pore space		Any 2
	Close packing of grains		
(iii)	Fluids pass through pore spaces		
	Carry minerals in solution		
	Minerals precipitate in pore spaces / crystallise out / deposited in pore spaces		
	Porosity reduced		
	Pressure welding		Any 2
			17

Question	Expected answers	Marks	
2 (a) (i)	Degree to which particles are the same size Spread of grain size around a mean Measure of variation of grain size Well sorted = all same size Poorly sorted = wide range of grain sizes Diagram can act as text	Any 2	
(ii)	$\frac{3.2 - 0.3}{2}$ $\frac{3.2 - 0.2}{2}$	1	
	= 1.45 1.5 Allow e.c.f. I mark for correct reading from graph into equation 2 marks for correct answer only in range above	1	
(iii)	Poorly sorted Allow e.c.f.	1	
(b)(i)	G = Well sorted	1	
	H = Poorly sorted	1	
(ii)	G = Rounded / Well rounded	1	
	H = Angular / Subangular	1	
(iii)	**Shape** Grains start off / no transport = angular More transport sharp edges go / particles become more rounded **Size** By attrition / abrasion / collisions Longer / more transportation smaller the grains	Any 3	
(c)	Rounded fragments drawn	1	
	scale or label	1	
(d)	5 Break down of rocks due to different expansion and contraction rates 2 Hydration		
	7 Reaction of minerals with carbonic acid produced by the solution of carbon dioxide in water	6	=4
	4 Frost shattering	4-5	=3
	6 When minerals combine with oxygen. A red-brown weathering crust develops on iron-containing rocks	2-3	=2
	1 Hydrolysis	1	=1
			18

Question	Expected answers	Marks
3 (a) (i)	Altered / changed area of (country) rock / baked	1
	By heat from intrusion / by contact metamorphism	1
(ii)	in the north the edge of the intrusion is dipping at a shallow angle in the south the dip of the granite is steep (diagram OK) general statement of width depends on shape of intrusion max = 1 general statement of width depends on dip max = 1 eroded more in north / topography shows slope more jointing / fractured in north	Any 2
(iii)	J = Metaquartzite / Quartzite	1
	K = Marble	1
	L = Hornfels	1
	M = Spotted rock / spotted slate / Andalusite slate	1
(iv)	No mineral alignment Heat only Lack of pressure Some minerals are equidimensional / lack of platy minerals If state contact metamorphism then max 1 equivalent to heat only and no pressure	Any 2
(b (i)	Discordant = cuts the beds	1
(ii)	On / close to contact point with country rock (not in country rocks)	1
(iii)	Chilled margin	1
(iv)	Edges of intrusion crystals are small / fine due to rapid cooling	1
	As move into intrusion crystals become larger due to slower cooling / insulation	1
	ALT fine at edge and coarse in centre	1
	Rapid cooling at edge and slow in centre	1
		15

4 (a)	**Changes in ground level**	1
	Detailed measurements using tiltmeters / accurate surveying / laser surveying / aerial photographs / satellites	1
	As magma rises towards surface / magma moves in cone	1
	Ground rises / swells cone	1
	Suitable diagrams	1
		Max 3
	Historical pattern of activity	1
	Where eruptions can be dated by radiometric dating or historic records	1
	Time between eruptions can be determined	1
	Can allow a rough prediction but only general time in years / inexact process	1
	Identifies potential risk areas	1
		Max 3
	Using seismometers / seismogram	1
	Precursor earthquake tremors / harmonic tremor / earthquake swarm	1
	As magma moves into pipe / vent the liquid vibrates	1
	This causes many small scale earthquakes <3 on Richter Scale	1
		Max 3
	Changes in gas composition	1
	As outgassing / exsolving begins as pressure is released	1
	Gas amount changes,	1
	Increase in SO_2 / CO_2	1
	increase in hot springs,/ geysirs	1
		Max 3
	Thermal imaging	1
	Remote sensing / satellite data	1
	Increase in heat measurements / readings over time	1

Any 3
Max 3 for each method

8

2 marks	Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.
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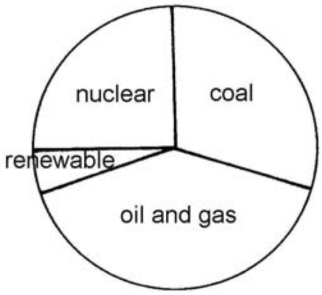
0 marks	There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.

Mark Scheme 2833
June 2005

Question 1	Expected Answers	Marks
(a) (i)	4 correct labelled segments 	1
(ii)	70%	1
(iii)	take millions of years / accept thousands / a very long time to form fossil fuels are burnt / destroyed when used / products are lost as gases (to the atmosphere) / can only be used once / can't be renewed within human lifespan / it is a finite resource (accept alternative wording)	any 1
(b) (i)	peat → lignite → bituminous coal → anthracite lignite / brown coal; anthracite	 1 1
(ii)	the percentage of carbon in the coal / the position of the coal in the coal series / the maturity of the coal / the amount of energy produced when burnt / the calorific value	1
(c) (i)	suitable diagram(s) to distinguish the two types; exposed – coal bearing strata outcrops at surface; concealed – coal bearing strata under younger cover max 2 if only indicate exposed is at surface and concealed at depth (mark labels as text)	1 1 1
(ii)	overburden is removed / stripping ratio of less than 20:1 is economic / maximum depth 200m sides of open cut must not be too steep / bucket or dragline excavator used / restoration /reclamation of site after mining / max 1 for coal is extracted / quarried at surface (and hole filled in) (accept alternative wording)	any 2
(iii)	noise / dust / visual impact during mining operation deforestation / disruption to habitats / ecosystems / wildlife pollution of soil / pollution of surface water / large holes in the ground / disruption of water table / pollution of groundwater	any 1

Question 1	Expected Answers	**Marks**
(d)	regrading/recontouring slopes to lower angle / use of retaining wall / use of berm ledges to reduce risk of rock falls/slides/slumping / gabion boxes filled with rocks as toe support / drainage to reduce pore fluid pressure / wire netting to reduce possibility of rock falls / rock bolts to pin loose rock to solid rock behind shotcrete – spraying liquid cement on cutting sides vegetation / geotextiles to bind soil / intercept water	any 1 + 1 (description must match named strategy)
(e) (i)	Cornwall / Devon / South West England / Cornubian granites / Weardale / Northern England / Caledonian granites / Eastern Highlands granites; OR East Yorkshire / Lincolnshire Basin / Cheshire Basin / Wessex Basin / Southampton / Bath / Worcester Basin / Northern Ireland Basin	any 1 (description must match named area)
(ii)	hot dry rock / granites have high heat flow due to high content of heat producing radioactive elements / rock is artificially fractured / cold water pumped down and water heated as it passes through; OR geothermal aquifer / sedimentary basins with higher than normal geothermal gradient / low enthalpy system / hot water pumped up and passed through heat exchanger / hot water is used for space heating, greenhouses, etc. max 1 if general discussion of geothermal energy not linked to named area	any 2 OR any 2
(iii)	production areas are geographically restricted / possibility of dangerous volcanic eruptions / pipes corrode / pipes blocked by precipitated salts / each well only viable for a few years / takes time for rocks to reheat/ may trigger earthquakes / hot dry rock method in Cornwall has been abandoned as uneconomic / small / local scale accept expensive if qualified with discussion	any 1 Total: 18

Question 2	Expected Answers	**Marks**
(a) (i)	at base of intrusion immediately above bottom chilled margin – horizontal shading with maximum thickness of 1cm	**1**
(ii)	iron ore minerals/magnetite are dense / heavy iron ore minerals/magnetite are high temperature / crystallise early	**any 1**
(iii)	magnetite	1
(b)	magnetic survey; proton magnetometer used / detects variations/anomalies in Earth's magnetic field / iron/magnetic minerals give positive anomaly OR gravity survey; gravimeter used / results plotted on a map / lines joining points of equal gravitational field strength / iron minerals give positive gravity anomaly / iron minerals have higher density (than surrounding rock) OR electrical resistivity; two probes/electrodes are put in ground / electric current is passed between them / iron minerals have a lower resistance / higher conductivity (than surrounding rock)	any 1 + 1 **(description must match named technique)**
(c) (i)	horizontal shading in lateritic top soil / subsoil	1
(ii)	bauxite / gibbsite / diaspore / boehmite	1
(iii)	(extreme) chemical weathering / hydrolysis; requires hot and humid / tropical / equatorial climate; soluble elements / ions / minerals removed in solution; leaves insoluble residue of aluminium (oxides and hydroxides)	any 2
(iv)	joints increase permeability / allow water into rock; water is required for hydrolysis/chemical reactions; joints increase surface area available for chemical weathering	any 2
(v)	limestone / granite / acid rock / feldspar-rich rock	1
		Total: 12

Question 3	Expected Answers	Marks
(a) (i)	(730,000,000 / 365 x 200,000 =) 10 years +/- 0.2 years	**1**
(ii)	exploration may find more oil; technology may improve allowing extraction of more oil from reservoir / improved secondary recovery methods /extraction of oil from deeper water; use of unconventional / heavy / shale oil; smaller oil fields become economic as oil prices rise	any 2
(b) (i)	well rounded, well sorted grains; large pore spaces between grains holding oil; high permeability / good interconnections between pores / indication of oil flow; little or no cement / matrix; suitable grain size / scale – grains 0.5 – 2 mm size	any 2
(ii)	pressure is insufficient to maintain oil flow to surface / oil is viscous / high surface tension causes oil to stick to grains / porosity / permeability / cementation of reservoir rock varies	any 1
(iii)	water is pumped into rock (below oil) / maintains pressure / forces oil up borehole(s) to surface; OR gas/carbon dioxide is injected into rock (above oil) / maintains pressure / forces oil up borehole(s) to surface; OR use of steam / detergents / chemicals / surfactants / bacteria / to reduce surface tension / viscosity of oil	any 1 + 1 (description must match method)
(c)	springs form at junction between permeable and impermeable rocks;	**1**
	springs form at intersection of water table and topographic surface / groundwater flows out at surface;	1
	rain water percolates down to water table / groundwater collects in porous / permeable rocks / aquifers;	1
	groundwater flows in response to pressure / water flows down hydraulic gradient / springs require high hydrostatic pressure	1 max 3 for general description
	descriptions of the sites where springs form: at contact between permeable and impermeable sedimentary rocks (lithology); at igneous intrusions (lithology); at faults; at unconformities	1 + 1 (diagram and detailed description) for each site
	must describe, not list; diagram or detailed description of each site mark diagrams as text (1 for spring and water table in correct position; 1 for correct rock situation)	total max 7 (max 5 if no diagrams) **Total: 15**

Mark Scheme 2834
June 2005

Question	Expected answers	Marks
1 (a) (i)	Anterior groove – fossil B, top indentation Anus – centre of fossil A / rear of fossil B Tubercle – circular structures fossil A Petaloid ambulacra – petal structures on fossil B 1 mark per label	Max 4
(ii)	One complete plate with central tubercle on Fossil A / One complete plate adjacent to petaloid ambulacra on fossil B	1
(iii)	<u>Tube feet</u> Extension allows feeding / Respiratory function / attachment / movement / secrete mucus	1
	<u>Plastron</u> Digging tool for making burrows / area of attachment for large spines	1
(b) (i)	mamelon / spine boss / tubercle	1
(ii)	Soft tissue (muscle) decays / disarticulate due to wave action	1
(c) (i)	1 – 4 points correct = 1 5 – 8 points correct = 2 9 – 12 points correct = 3	Max 3
(ii)	Results show two distinct groupings; Representing two separate species; Description of length v width relationship; Reason given, eg growth or avp	Max 2
(d)	High energy / rocky shore / littoral zone / benthonic environment	1
		15

Question	Expected answers	Marks
2(a) (i)	Diagram showing formation;	1
	Burial of fossil in sediment; Dissolution of fossil; infilling of void; Moulds – show exterior or interior of shells; Casts – show exterior or interior of shells; Fracturing along weakness to reveal mould / cast	Any 3
	No diagrams = maximum of 3	
(ii)	Length of time buried prior to diagenesis; Size of particles / fine grained = better preservation ora; High energy level during deposition results in breakage ora; Nature of replacement material; Post depositional alteration by groundwater / heat / pressure; Possesses hard parts	Any 2
(iii)	aragonite	1
(iv)	Silica dissolved in groundwater; Percolation through rocks; Fills voids in fossil / directly replaces fossil material	Any 2
(b)(i)	Lagerstatten deposit / obrution / catastrophic slide; Fine grained sediment allows fine detail; Anoxic / anaerobic conditions / no bacterial decay; Lack of scavengers; Early diagenesis and replacement of fossil material / clay replacement	Any 2
(ii)	<u>Resin</u> produced by extinct pine trees (Pinus succinifera); Sticky during day / harden at night; Flow down trunks covering insects / trapping insects; Lumps washed into sediments to be preserved	Any 2
(c)(i)	Traces left by an organisms; not the organism itself; Evidence of behaviour of organisms; May show evidence of structures not usually preserved	Any 2
(ii)	1 mark = diagram 1 mark = what it tells us about the organism (as pairs)	1 1
		17

Question	Expected answers			Marks
3(a)(i)	**Fossil**	**Phylum**	**Group**	
	C	Arthropoda/Arthropod	Trilobita/Trilobite	
	D	Echinodermata/Ecghinoderm	Crinoidea/Crinoid	
	E	Mollusca/Mollusc	Belemnite/Coleoid/Cephalopoda	
	F	Mollusca/Mollusc	Gastropoda/gastropod	
				Max 4
(ii)	1 = glabella			1
	2 = arm / pinnule / brachia			1
	3 = basal / calyx			1
	4 = guard			1
(iii)	Any two suitable labels			2
(iv)	To the left / helical / dextral / spiral in a vertical plane			1
(v)	Fossil D / Crinoid			1
(b)	Fossil benthonic / bottom aerobic; Soft sediment as fossil has large surface area; Dark environment as fossil was blind; Possibly lived in soft sediment			Any 3
(c)	Fossils made of calcium carbonate / calcite / aragonite; Break into small fragments or fine sediment; Form part of fine particles that make up limestone; May be dissolved and redeposited elsewhere forming limestone			Any 2
				17

Question	Expected answers	Marks
4(a)(i)	J = bivalve / bivalvia	1
	K = graptolite	1
(ii)	Lived in open conditions; Coarse sediment breaks up fossil; High energy breaks up fossil; Delicate skelton; Only preserved in fine sediment	Any 2
(b)(i)	<u>Derived fossil</u> Fossil deposited in original sediment and formed into rock; Fossil eroded out of old rock; deposited into new sediments and formed into rock	Any 2
	Death assemblage Fossils die and accumulate on sea floor; Fossils moved to another location; prior to being encased in sediment	Any 2
(c)(i)	<u>High energy environment</u> Fossil X	1
(ii)	Strophic / straight	1
(iii)	Suitable diagram	1
	One mark for each label Pedicle / pedicle valve / pedicle foramen / brachial valve / substrate	Max 2
(d)	Suitable diagram	1
	Described differences in symmetry; Described differences in dentition; Articulation common in brachiopods, rare in bivalves; Differences in muscle scars Each point must be a comparison between bivalves and brachipods A other valid comparisons R comparison of soft parts	Any 3
		16

5(a)	**Establish absolute ages**	
	Isotopes are unstable and emit radioactive particles	1
	Half of the parent element has formed daughter elements	1
	Detail of half life graph	1
	Explanation of how half lives are calculated using graph	1
	Measurement of daughter and parent isotopes needed / ratio found	1
	Date given in millions of years	1
	K – Ar method	1
	Detail (K^{40} decays to Ar^{40} / half life is 11,900 -12,000 Ma)	1
	U – Pb method	1
	Detail (U^{238} decays to Pb^{206} / half life is 4500 Ma or **U^{235} decays to Pb^{207} / half life 710 Ma)**	1
	Date radioactive minerals in rocks	1
	Example of minerals containing radioactive elements eg mica, sphene	1
		Max 7
	Problems of radiometric dating	
	Whole rock dating / overprinting problems	1
	Glauconite in sedimentary rocks	1
	Problems due to loss of gases by weathering eg Argon	1
	Metamorphism resets geological clock	1
	Dating sedimentary rocks dates the fragments not the formation	1
	Don't know the accuracy of radiometric techniques / mass spectometer	1
	Initial amounts of isotope difficult to determine	1
	Comments on margin of error for methods	1
		Max 7
		Max **11**

5(b)

Ammonoids evolved in Lower Devonian	1
Evolved from Nautiloids / Orthocone nautiloids (Clymeniids / Anarcestids)	1
Goniatites in Palaeozoic	1
Angular sutures	1
Little ornament / growth lines only eg Goniatites sp	
Suitable diagram with labels	Max 2
Ceratites in Triassic	1
Extinct at end of Triassic	1
Smooth saddles and toothed lobes	1
Suitable diagram with labels	Max 2
Ammonites in Jurassic and Cretaceous	1
Extinct at end of Cretaceous	1
Frilly saddles and lobes /complex sutures	1
Move from involute to evolute forms	1
Large number of species – showing adaptive radiation	1
Gradual uncoiling at end of Cretaceous eg Hamites / heteromorphs	1
Some completely uncoiled	1
Exploitation of different habitat eg bottom dwelling rather than water column	1
Change in position of siphuncle /eccentric siphuncle	1
Increase in diversity of ornament	1
Increase in types of coiling	1
Suitable diagram with labels	Max 2
Gradual folding of septa makes animals stronger	1
Enables animal to support higher pressure of water	1
Possible exploitation of deeper habitats / different habitats	1

Alt - Where each morphological feature is described as a change eg change in suture line, identify points from existing markscheme, but where there are lists with no times max = 1
Eg goniatites to ceratites to ammonites = 1 mark
Simple to complex suture lines = 1 mark

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0 marks	There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.

quality of written communication max 2

Question total 25

Mark Scheme 2835
June 2005

Question	Expected Answers	Marks
1 (a)	A = Cone sheet	1
	B = Ring dyke	1
	C = Transgressive sill	1
	D = Laccolith	1
(b) (i)	Contact / Thermal	1
(ii)	Chilled margin / (chilled by) contact with (cold) country rock	1
	Rocks cooled quickly / Less time for nucleation centres / *less time for crystals to form*	1
(iii)	Olivine crystallises first / *link to Bowens Reaction Series* At high temperatures Sinks to base Gravity settling / *Fractional Crystallisation / Magmatic Segregation* Reference to density of mineral	any 3
(c)	E = Plagioclase feldspar / *Anorthite* F = Augite / Pyroxene G = Olivine	1 1 1
(d) (i)	Gabbro	1
(ii)	Peridotite / Picrite / Dunite	1
(e) (i)	*24%* +/- 3%	1
(ii)	Less pressure at 200m than 1000m Gas comes out of solution when pressure drops / Exsolves / Exsolution **Gas expands / greater volume at lower pressure / lower depth**	any 2
(iii)	(Pore) fluids flow through vesicles Precipitation / *crystallisation* of new minerals in the vesicle / *minerals coming out of solution* Examples such as quartz, calcite, amethyst, zeolites	any 2 Total: 20

2 (a) (i)	***Compressive in from sides, 2 correct***	1
(ii)	85km +/- 5km	1
(iii)	**In root zone below marked area**	1
(iv)	**Increased temperature *(with depth)*** Presence of water	1
(v)	Acid / viscous magma **Relatively low temperature** Magmas generated too deep to reach surface / crust *is* thick *(in this area)* Cools / crystallises / *solidifies* before reaching surface Discussion of hydrous granite solidus curve Volatiles emerge as magma rises aiding crystallisation	***any 2***
(vi)	Granite / Granodiorite / Diorite / Any other named *coarse grained* acidic or acidic-intermediate rock	1
(b)	Thrust / reverse fault Synform /syncline Antiform / anticline Nappe Recumbent Overfold Isoclinal Any other correctly named fold	any 2
(c) (i)	**H = (garnet) schist / gneiss** J = marble	1 1
(ii)	Rock H Parent Rock: mudstone / clay / shale / pelite /slate /phyllite / volcanic ash / *granite* Conditions: medium / high grade / medium T and P / high T and P / regional met Rock J Parent rock: limestone Conditions: regional / contact / thermal *Alternative if likely conditions described FOR parent NOT product* *Rock H* *Low energy / deep water* *Rock J* *Tropical / Warm / Saturated in $CaCO_3$ / Well Oxygenated / Marine / Clear / Lack clastic input ANY 2 POINTS REQUIRED FOR MARK*	1 1 1 1 *1* ***1*** (Total: 15)

3 (a) (i)	**K = conglomerate** L = chalk / fine grained limestone / *Micrite* M = oolite/oolitic limestone	1 1 1
(ii)	Mechanical	1
(iii)	**Allow ecf** **Low energy / *calm*** Water saturated in $CaCO_3$ No clastic input / *clear* Marine Presence of planktonic organisms that secrete a calcareous skeleton / *coccoliths* Warm / tropical conditions with strong evaporation	any 2
(iv)	Allow ecf Moderate / high energy Water saturated in $CaCO_3$ Marine Tidal action Shallow water / above wave base Warm water If sandstone given as M, allow all above except water saturated in $CaCO_3$	any 2
(b)	**Rock L** Allow ecf *Use* — *Reason* ***Chemical industry*** — ***Often very pure / rich in $CaCO_3$*** ***Cement*** — ***Rich in $CaCO_3$ / easily crushed*** ***Pharmaceuticals*** — ***Often very pure*** ***Agriculture*** — ***Rich in $CaCO_3$***	*1 for use* *1 for appropriate reason*
	Rock M **Allow ecf** *Use* — *Reason* *Building stone* — *Attractive / easy to cut / easily quarried / strength for building* *Cement* — *Rich in $CaCO_3$ / easily crushed* *Aggregate* — *Strength / easily quarried*	*1 for use* *1 for appropriate reason*
(c)	**Evaporation** Loss of water greater than inflow/water volume decreases **Replenishment of water / repeated cycles** Dissolved salts *(held in solution)* */ brine* Minerals are *precipitated* Deposited in sequence > Most soluble Bittern salts / K salts, halite, (anhydrite), gypsum, dolomite, calcite > Least soluble **Any three minerals in correct sequence** Least soluble first, most soluble last *Zechstein type deposit diagram / column or* *Saucer shaped cross section with concentric deposits* Max 2 if no diagram N.B. Accept dolomite NOT dolerite	any 4 Total: 16

4 (a) (i)	Graded bedding	1
	Turbidite / turbidity flow / *submarine avalanche* (Rapidly) decreasing energy Close to continental slope / abyssal plain boundary **Heavier / coarser / larger particles deposited first**	any 2
(ii)	River bed / sea bed Turbulent water / eddy **Scours / erodes bed** Asymmetric in cross section Tear / heel shaped in plan view Sediment infills erosional hollow Max 2 if no diagram / *incorrect diagram*	any 3
(iii)	**Wet sediment compressed** Mud/clay rich lower bed Upper bed heavier/denser/sand(stone) Load sinks into bed below Flame structure intrudes upwards Max 2 if no diagram	any 3
(b) (i)	Composition: Immature Reason : Polymineralic / composed of rock fragments Need reason for mark	1
	Texturally : Immature Reason : Poorly sorted / angular Need reason for mark	1
(ii)	Greywacke / turbidite / wacke	1
(c)	high energy at base / lower energy towards top / energy decreases upwards bouma sequence repeated due to repeated turbidite events rapid deposition high energy deposits coarse / low energy deposits fine / size of particles related to energy	any 2 Total: 14

5a

Acidic volcanoes	
Shape :	
Steep sided (dome)	1
	Max 1
Eruption Type :	
High volatile content	1
Highly siliceous lavas / >66% SiO_2	1
Acidic lava / Rhyolitic / pyroclastics	1
Very viscous	1
Very explosive / i*nfrequent*	1
Associated with nuée ardente / *Pelean type eruption*	1
Diagram	1
	Max 5
	Max 6 for acidic
Intermediate volcanoes	
Shape:	
Steep sided cones	1
	Max 1
Eruption type :	
Lavas are less siliceous / 66 - 52% SiO_2	1
Intermediate lava / Andesitic composition / composite cones / alternating lava and pyroclastics	1
Viscous lava	1
Intermittently violently explosive	1
Up to Krakatoan scale eruptions	1
Diagram	1
	Max 5
	Max 6 for intermediate
Basic volcanoes	
Shape:	
Wide base and shallow sides / shield	1
	Max 1
Eruption type:	
Lava of basic composition (rich in Fe/Mg minerals) / basaltic	1
Lavas have low silica content / 52 - 45% SiO_2	1
Fluid / Non viscous lava	1
Effusive / non-explosive eruptions / *frequent eruptions*	1
Hawaiian type (eg Mauna Loa)	1
Occurring as fissure eruptions	1
Forming plateaux / *flood* basalts	1
If submarine give pillow lavas	1
Diagram	1
	Max5
	Max 6 for basic
	[Total 12]

Question	Expected Answers

5. (b)

Sandstones

Quartz main rock forming mineral in parent	1
New rock is a quartzite / metaquartzite	1
Quartz recrystallizes / interlocking / sutured / fused grain boundaries	1
If pure no changes to mineralogy	1
Granoblastic texture / sugary texture / saccharoidal texture	1
Loss of texture / structure from parent rock / bedding / sedimentary Structures / Ghosting/destruction of fossils	1
Loss of porosity	1
Impurities give new minerals	1
e.g. clay minerals form new silicate minerals	1
Diagram	1
	Max. = 5

Shales

Clay minerals (plus quartz) are main rock forming mineral in parent	1
Initially clay minerals recrystallise to micas	1
Some elements e.g. carbon / mica may concentrate to give spots	1
New rock is spotted (rock)	1
Relict structures preserved	*1*
Further heat causes new minerals to appear	1
Chiastolite / andalusite are the new minerals	1
Minerals form porphyroblasts (with random orientation)	1
Further heat causes total recrystallisation	1
New rock is hornfels	1
Granoblastic texture	1
New minerals include garnet / cordierite / sillamanite	1
Texture showing zoning around intrusion / High grade close to intrusion, low grade further away	1
List of rock changes only	*Max 1*
Diagram showing correct sequence of zoning	1
	Max = 7

[Total : 11]

Quality of Written Communication

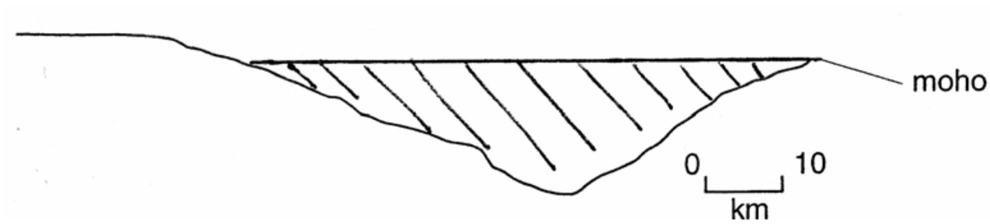
2 marks Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.

1 mark There are shortcomings in the structure of the answer, however, the candidate is able to communicate knowledge and ideas adequately, a limited range of specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.

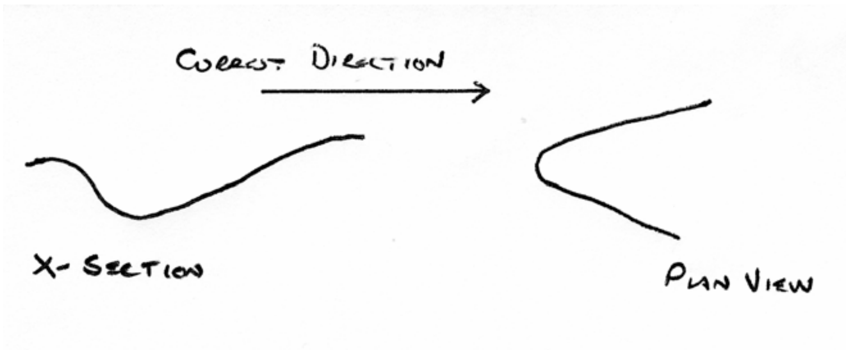
0 marks There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar, which makes the candidate's meaning uncertain.

[quality of written communication max 2]

[Total: 25]

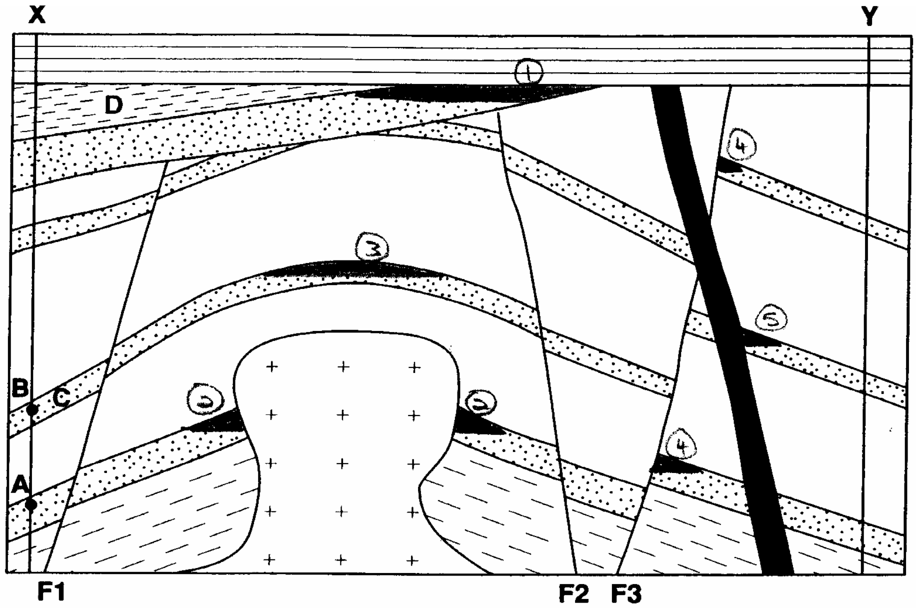


2 (a) (iii)



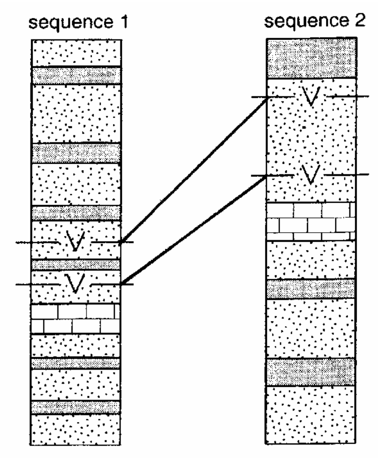
4 (a) (ii)

Mark Scheme 2836
June 2005

Question	Expected Answers	Marks
1(a) (i)	 (must be within sandstone) (trap must be shown and name given for 1) 1. beneath unconformity; unconformity trap 2. adjacent to salt dome; salt dome trap 3. above salt dome; anticlinal trap *4. at fault line; fault trap* *5. next to dyke; lithological trap*	any 2
	ALT if 2 correct traps shown but no names max 1 *if 2 correct traps labelled but not accurately marked max 1*	
1(a) (ii)	oil can move / migrate upwards along fault flows through sandstone / seep through pores in sandstone	any 1
1(b)	**bed D** non-marine deltaic / lagoonal / *swamp* / lacustrine / terrestrial *I flood plain of river*	1
	mudstone marine / medium depth */ continental shelf*	1
	general statement of one is marine and the other not max 1	
1(c)	deposition of salt (in arid environment); deposition of shale, followed by alternating sandstone and mudstone; density contrast causes low density salt to rise; formation of salt dome; causes folding – <u>anticline</u>; faulting by **F1, F2**, [or **F3**;after deposition of sand and clay D] horst between **F1** and **F2** / graben between **F3** and **F2** / **F3** is reverse fault intrusion of dolerite <u>dyke</u> [or after deposition of sandstone and clay]; uplift / erosion, (angular) unconformity; deposition of sandstone and clay D; tilting / uplift / erosion, (angular) unconformity; deposition of clay	any 8
	lists max 4 *wrong way round max 4*	
	QWC	1
		Total: 14

Question	Expected Answers	Marks
2 (a) (i)	[need some detail for each point to gain a mark]	
	glacial deposits on both continents line up both continents near pole when deposits laid down.	Any 1
	mudstones and siltstones laid down in similar depositional environment	1
	freshwater fish fossils on both continents but fish could not have crossed wide ocean.	1
	metamorphic rocks / fold axes continue across the continents	1
	Similar shapes of coastlines; continents were once joined / continents have split apart	1 Max 3
2 (a) (ii)	(500 or 550 km = 50 000 000 cm divided by 40 000 000 years) answer 1.25 or 1.38 allow in range 1.2 – 1.4 (cm per year)	1
2 (a) (iii)	Transform	1
2 (b)	[GLACIAL TILL DESERT DUNE SANDSTONE] **Diagram 2** boulder clay: angular, poorly sorted, coarse grained, suitable scale >2mm sandstone: well rounded, well sorted, fine grained, suitable scale <2mm	2
	Description 2 Explanation 2 angular fragments vs. rounded fragments - no attrition in glacier / fragments do not collide [ora]	2
	poor sorting vs. good sorting / texturally immature vs mature - all fragments carried at same speed in glacier / carried equally easily / deposited at same time [ora]	2
	coarse grained vs. fine grained - no attrition in glacier / fragments do not collide [ora] max 4 for text if no diagram	2 6 max
	general comparative comment for explanation max 1 1 for describing each point on diagram 1 for explaining each point in text to max OR if detailed labelled diagrams with scales max 4	

2(c) (i)



BOTH ash bands correlated 1

No other beds to be correlated

2(c) (ii) sequence 1= 10+ / -2 (metres), sequence 2= 22+ / -2 (metres) 1

2(c) (iii) Greater rate of deposition in sequence 2;ora
Sandstone deposited more rapidly than mudstone
Greater rate of subsidence in sequence 2;ora
Mudstone in sequence 1 compacts more than sandstone (in sequence 2);
(More) erosion in sequence 1 any 2

2(d) (i) Carboniferous 1

2(d) (ii) Mudstone (containing goniatites) 1

2(d) (iii) goniatites are good zone fossils / crinoids are poor
goniatites evolved rapidly / short time range; crinoids evolved slowly / long time range
goniatites geographically widespread / crinoids restricted
goniatites independent of environment / pelagic / nektonic //crinoids benthonic shallow sea any 2

Total: 19

Question	Expected Answers	Marks
3(a) (i)	downthrow to S / upthrow to N;	1
	dip-slip / E-W trending / vertical	1
3(a) (ii)	DRAWN CORRECTLY (reasonable angle) AND LABELLED: <u>synclinal structure</u>; symmetrical / limbs dipping approx. 30 degrees sandstone -shale – sandstone max 1 if no labels or key	max 2
3(b) (i)	graptolites / graptoloids / hemichordata	1
3(b) (ii)	theca / stipe / sicula / nema / rhabdosome	any 2
3(b) (iii)	in shale but not in metamorphic aureole	1
3(b) (iv)	fossil D is younger than fossil C (AW) / C has evolved into D ora / *C and D found in rocks of different ages*	1
3ci	metals / elements from country rock / late stage cooling of granite / residual magma; hydrothermal fluids / hot water; metals / elements dissolved / leached / elements carried in solution; fluids move along fractures / joints; fluids cool down and minerals crystallise / precipitate	any 3
3cii	GALENA: dense (>7) ; metallic lustre ; black / grey streak ; grey colour; cubic cleavage / cubic crystals / hardness 3	5 or 6 correct = 3
	SPHALERITE: resinous / adamantine lustre ; brown / yellow streak ; (dark) brown colour ; hardness 4	3 or 4 correct = 2 1 or 2 correct = 1
	FLUORITE glassy / vitreous lustre ; cubic / diamond-shaped / tetrahedral crystals ; 4 directions of cleavage / hardness 4 / blue / purple colour (blue John)	max 3
	but credit maximum of two points for each mineral **must be first two**	
		Total: 15

Question	Expected Answers	Marks
4(a)	(drawn and as labels on sketch:) antiform / anticline; nappe; minor folds / Z or S folds / parasitic folds / slumping limbs / hinge / core / crest; measured dips; axial plane; arrows to show compression light coloured beds sandstone / limestone and darker beds shale / mudstone joints reverse fault; (reverse / thrust) fault plane fault drag quantification of (thrust) fault, eg. dip of fault plane, amount of throw; small faults to the left of main thrust; laminated / thinly bedded sedimentary rocks; competent and incompetent beds with variation of thicknesses appropriate scale; sketch of high quality	any 5
4(b)	**recrystallisation / metamorphism of shale / mudstone to form slate;** **low grade (metamorphism) / low temperature and pressure** **slate in chlorite / biotite zone; (or phyllite)** **foliation is slatey cleavage;** **slatey cleavage due to alignment of platey minerals / alignment of mica / chlorite; (or phyllitic / crenulation cleavage**	any 2
	schist from slate **medium grade; / medium temperature and pressure** **schist in garnet / kyanite zone;** **foliation is schistosity;** **micas curve around porphyroblasts;**	any 2
	gneiss from schist **high grade; / high temperature and pressure** **gneiss in kyanite / sillimanite zone;** **foliation is (gneissose) banding;** **separation of minerals into bands / felsic minerals in pale bands and ferromagnesian minerals in dark bands**	any 2
	max 5 if no foliation mentioned correct index mineral sequence matched to grade max 1	max 6
	QWC	1
		Total: 12

Report on the Units
June 2005

Chief Examiner's Report Geology

General Comments

The examinations this summer performed well with no problems and a good range of marks achieved on all the units. There has been a further improvement in the coursework as teachers become expert at applying the criteria to a range of fieldwork and laboratory work.

It is interesting to note that over the last four years we have seen a consistent pattern of performance for specific topics for each unit. Clearly some topics are disliked by either candidates and/or teachers so that questions on these topics generate weaker answers. Examples include structural geology for 2831, metamorphism for 2832 and mineral deposits for 2833. This is often centre based with strong answers from some centres and consistently weak answers from others on these topics. Some questions may show common misconceptions which are highlighted in the reports on the examination. An example of this is radon as a volcanic gas emitted and used as a precursor of volcanic activity when it should be carbon dioxide or sulphur dioxide. This was raised in the Examiners report for Rock Cycle Processes and Products (2832) from June 2004 yet when this was set in June 2005 the same incorrect response was common.

A continuing concern is the exhaustion factor that is clearly seen by AS candidates who have to take the three units in a single session. The effect on the Environmental Geology (2833) is clear as candidates are more likely to omit part questions. 2833/01 is usually the third unit to be taught for AS level and it is clear that some Centres are struggling to cover the specification in sufficient detail. As this examination is worth 20% of the total and the other two AS level modules are 30% each, then 2/3rds of the teaching time allocated to each of the other two modules should be reserved for the teaching of 2833/01. If the total teaching time is 29 weeks then this unit could be allocated seven weeks where 2831 and 2832 have eleven weeks each, though coursework arrangements are varied.

The examination papers for each unit will cover the entire content of the specification over a number of years. So even the minor topics will come up at some time and it is noticeable that when some of these topics come up they be omitted or poorly answered – often on a centre basis. An example this year was in the Environmental Geology (2833) when the part question on the formation of bauxite as a residual mineral deposit was not known by a large number of candidates.

There are some standard examination techniques that would improve candidates marks

- Reading the question carefully, as it may ask for two separate points in the answer such as describe and explain……. , or it asks for **three** features and some answers will have two and others four, which could be contradictory, but the marks can only be awarded for three features.
- All units regularly ask candidates to do fully labelled diagrams, but it is common to see diagrams with no labels which therefore cannot gain full marks; or if the label lines are vague, ending in mid-air, candidates may again miss out on marks. Similarly if a scale is requested it is likely that there is a specific mark for it.
- Using technical terms instead of generalisations is essential, and correct spelling of these terms should be strongly encouraged.
- The last question may have only one side available for the answer and this will be adequate for concise answers to gain full marks. Where candidates wish to include more detail or if diagrams are large then extra sheets of paper should be requested.

2831:Global Tectonics and Geological Structures

General Comments

The level of difficulty was appropriate and there were no obvious problems with candidates running out of time.

The overall quality of the papers this year seemed to be very varied. The paper marks ranged from 5 to 59 out of the maximum 60 marks with a good spread between the two extremes.

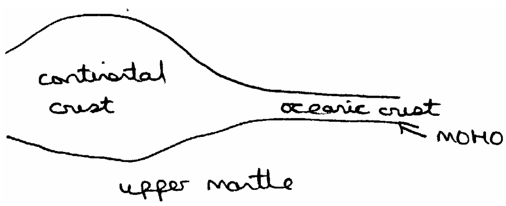
Again the question on structural geology was less well done than the others and this has been a common problem over a number of years. Perhaps it is the necessity to know a large number of structures and the technical terms, which candidates find difficult to learn. It is clear that by learning this section of the specification a number of candidates could make a major improvement to their marks.

Comments on Individual Questions

Q 1) This was generally a high scoring question on the well-known topic of earth structure.

a) There were very few problems with part i) and the majority of candidates knew the position of the Gutenberg Discontinuity.

b) Diagrams of the crust were very variable. The most common mistakes were to draw the Moho as a zone or as a line below the upper mantle. The continental crust frequently lacked a mass below sea level – ending as a straight line. Some candidates repeated the diagram given in the question but, given the scale, it was very difficult to show the Moho. The question asked only for relative depths so that there was a high degree of flexibility.



> **Teaching Tip**
>
> The idea of the Moho at variable depths can be shown practically using rocks on foam rubber sheets. It will be clear that the large rocks cause the foam to be pushed down further in the same way that the Moho is deepest below the mountains.

c) Knowledge of both the outer core and the asthenosphere was generally good.

> **Teaching Tip**
> A useful practical suggestion when teaching about partial melting of the asthenosphere is to use **chocolate chip cookies**. These solid biscuits will have about 5% partial melting as a small amount of heat melts the chocolate leaving the rest of the biscuit intact. The problem may be controlling the biscuit supply!

d) i) The maximum depth of deep mines was not well known. (Some candidates had mines at 1000km rather than the 3.5 km of the worlds deepest mine in South Africa!) The mark scheme was generous but could not help the more extreme answers which ignored the effect of the geothermal gradient! Some candidates went to the opposite extreme with maximum depths of 500m.
ii) Many candidates lost marks here because they gave answers that were very generalised rather than giving details of rocks that were derived from the mantle, such as peridotite, which may be brought up in xenoliths or nodules in volcanic rocks.

e) As in d ii), many candidates failed to give details of the evidence. Some students thought that the composition of the layers of meteorites were the same as that of the earth ie meteorites having an outer layer of peridotite and an iron core. This was then compared to the structure of the earth. It was often all or nothing, with some students being very vague whilst others gave excellent detailed answers. There was a general tendency to describe meteorites rather than answering the question which required an explanation.

Meteorites and the evidence we can obtain from them can be set as an extended prose questions and students need to know them in sufficient detail:
stoney / silicate meteorites match the mantle composition
metallic / iron-nickel meteorites match the core composition
carbonaceous chondrites represent the whole Earth composition.
Different types of meteorite have the correct densities for the mantle and core.

Q 2) This was also a high scoring question, with many candidates showing a wide ranging knowledge of global tectonics.

a) Knowledge of pillow lavas and sheeted dykes was very good and very few candidates failed to score marks here.
Part iii) caused some problems where candidates failed to realise that the igneous rocks were the same in each section and simply referred to different depositional environments eg continental shelf and abyssal plain but with no reference to the MOR.

b) This sub question caused many difficulties and proved to be a good discriminator. Many candidates clearly knew in detail about palaeomagnetism but some could not give the details of how magnetism was preserved in iron-rich igneous rocks. Most candidates, however, gained a mark for stating that the magnetic poles reverse or switch round.

Teaching Tip

Ideas for teaching magnetic reversals in a visual way include continuing the biscuit theme by using chocolate fingers in dark and white chocolate to show the pattern of magnetic stripes.
An interesting alternative is to have a series of six bar magnets hidden in a box and to have students passing a compass over the box to identify the pattern of reversals.
For the kinaesthetic learner the use of the whole class in black and white paper hats or holding sheets of paper each being added in to the centre of the MOR in pairs is another alternative.
Perhaps then the theory concept of how the palaemagnetism stays in the rock will be clear memorised!

c) Virtually no candidates failed to score marks on the main diagram! Only the location of the continental shelf was erroneous on a few scripts or students only gave one direction of plate movement.

Students should remember to draw **both** direction arrows for plate movement. Students should also be more **precise** with the labels – they must end at the feature to be labelled and not in mid air.

d) Sketching and explaining the heat flow anomalies caused problems for most candidates. Many had high heat flow over the trench. This then led to difficulties in answering part ii). Very few candidates scored both marks here, the main error being the lack of reasons for the negative anomaly at the trench.

- The high heat flow links to the rising magma and volcanic activity within the fold mountains caused by the partial melting of the subducting oceanic crust.
- The low heat flow is due to a combination of cold sinking convection currents and the deep trench full of relatively cold water.

e) i) Hotspots are not as well known, with many candidates failing to explain them in terms of a fixed source of rising magma from the mantle. Descriptions of the Hawaiian islands were very commonly given as examples. Many did though link hotspots to mantle plumes. (ii) Determining the rate of plate movement was far better known than the direction. Many candidates referred simply to the chain of the Hawaiian Islands as indicating the direction of movement but with no reference to their age. A diagram showing the Hawaiian island chain, age and direction of movement worked well for some candidates.

Q 3) This question produced by far the widest range of marks as again structural geology proved the most difficult question for candidates.

a) Most candidates knew the type of fault and the location of the footwall. A surprisingly high percentage of candidates, however, could not give a correct dip measurement. Many measured from the vertical rather than the horizontal.

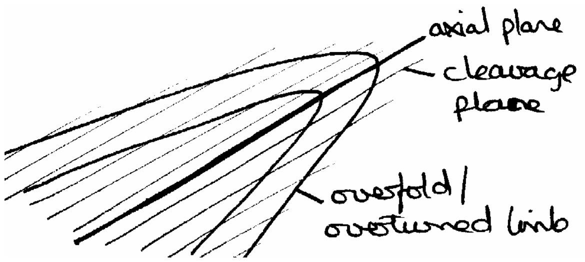
b) Knowledge of the terms fault breccia and slickenside were reasonably well known (despite numerous misspellings of slickenside!). Explanations were often weaker – a common error being to describe fault breccia as rocks being broken rocks but without reference to movement of the fault. Slickensides were better understood but still many candidates did not link the formation to movement along the fault plane.

c) i) The diagram of a horst caused many problems. Many diagrams were of rift valleys or grabens rather than the horst. Diagrams were generally poor with confusion over the upthrows. In (ii) the majority of candidates could draw an overfold, although some had drawn recumbent folds instead.

The drawing of cleavage planes was much weaker, and many candidates drew bedding planes parallel to the outline of the fold instead of cleavage planes running parallel to the fold axis.

Teaching Tips

Using match sticks or spaghetti or pencils on top of an OHP to illustrate the platey clay minerals can work well. They are started in a random arrangement and then pressure is applied using rulers so that they line up perpendicular to the pressure.



d) i) Tension joints were quite well known as a topic. Knowledge of columnar jointing in (ii) was variable – candidates could either describe exactly how they formed or had little idea especially about the contraction/shrinkage.

Q 4) There were some very good answers to this question, which again proved to be a good discriminator. Some very able candidates wrote detailed descriptions of the nature of deep sea trenches, transform faults and continental shields, but with virtually no reference to the origin or depth of earthquakes.

Knowledge of earthquakes at subduction zones and deep sea trenches was generally very well known. Many candidates included labelled diagrams.

Knowledge of transform faults was more variable. Most knew that shallow focus earthquakes were associated with them, but described the origin as plate movements rather than fault movements.

Very few candidates knew of the lack of earthquake activity at continental shields or knew what these features were. This aspect often prevented candidates from achieving full marks for this question. Generally, knowledge of continental shields was a problem – there is very little for candidates to learn but the fact that they are generally aseismic is important.

Only a few scripts were left totally blank, and about 5-10% gained full marks.

2832: The Rock Cycle - Processes and Products

General Comments

This session's examination paper gave a full range of results, with a wide variation between centres, some of which had a large proportion of very well prepared and able candidates, whilst others had many candidates with little grasp of the content or use of technical and 'AS' level vocabulary. There were some centres that showed a wide range of results amongst even a few candidates. Some had prepared well, but others appeared not to have learnt the essential factual content needed for success in Geology.

Comments on Individual Questions

Question 1

This question led to a wide range of marks, with a small proportion gaining none, and over 3% gaining the maximum. It was generally well answered. The marks were readily available to candidates who had learnt the material in the specification; they were able to recognise the terms commonly used to describe the rock types.

1 **(a)** (i) Most candidates correctly identified the two igneous samples A and E. The most frequent mistake was in thinking that sugary texture was igneous, leading to the incorrect choice of sample F.

(ii)The reasons required were simply the information given in the table. There was no need to try to justify the selection by saying why other samples had been rejected or to try to name the rock. 'A is vesicular, E is glassy' was sufficient.

(iii) Porphyritic texture was sometimes mixed up with vesicular texture and the wrong diagram was drawn. The origin of the texture was well understood by most candidates who could generally explain it satisfactorily though some drew sedimentary rocks. This is a very common examination question.

(b) (i) Most correctly identified the two metamorphic samples C and F. The most frequent mistake was in thinking that glassy texture was metamorphic, leading to the incorrect choice of sample E.

(ii) Again, there was no need to give any reasons other than the information provided in the table. Some candidates did not always link the reasons to the specific samples. The link was needed to gain full marks.

(c) (i) More candidates correctly identified the two sedimentary samples than the two igneous or metamorphic ones. Almost all of them could recognise the characteristics of sedimentary rocks. Or, as one candidate put it 'rock D has fossils present, which is a big give away'.

(ii) The great majority of candidates did well in this part of the question and linked their reasons to specific samples. From this evidence, sedimentary rock descriptions seem to be better known than those of igneous and metamorphic rocks.

(d) (i) Lithification was well known. Where there was confusion it usually involved liquefaction and sometimes lithosphere. Not everyone knew that it was sediment that became rock and there was the occasional ‘turning into rock’ without mentioning the sediment.

(ii) Describing the process of compaction presented some difficulty. Some candidates left this and part (iii) blank and seemed a bit unsure about what to write. Where the pressure came from was often a mystery. A simple reference to the weight of overlying sediment would have been adequate. Where candidates did begin their answer in this way it was more likely to be followed by one or two other correct points that followed logically, such as reduction in porosity, close packing of grains etc.

(iii) If anything, cementation was rather worse. Many thought that it was caused by heat and /or pressure, or it might have been due to infilling the pore space with finer material like clay. Cement was sometimes confused with matrix. The ones who really came unstuck used phrases like ‘glued together’. Fluids carrying minerals in solution pass through pore spaces. These minerals precipitate in the pore spaces as cement.

Teaching Tip

To demonstrate that compaction and cementation can lithify sand grains, producing ‘sandstone’, can be done practically

Materials needed: syringe with the nozzle cut off and the inside smeared with Vaseline; sand grains (damp); plaster of Paris powder.

Put some of the damp sand grains into the syringe. Block the open end (e.g. with your finger) and press hard on the plunger (compaction). Carefully push the compacted sand out onto a sheet of paper and describe what has happened.
Next use a mix of five parts damp sand and one part plaster of Paris powder. (The plaster of Paris will form a cement). Compact and push out as before. Allow it to dry.

Which of the two samples appears to have been lithified? Describe what happened to this sample.

Question 2

All candidates scored at least some marks on this question. This is a popular topic that was generally very well answered, with a high average mark and some maximum marks.

2 **(a)** (i) Most candidates gained their marks by giving descriptions of what a well sorted and a poorly sorted sediment would be like and this was enough to gain both marks. Relatively few could actually define the term itself. A minority of candidates thought that sorting involved shape as well as size and this invalidated their definitions. Sorting is not the same as a measure of the actual grain size.

(ii) Most candidates correctly worked out the coefficient of sorting. If readings from the graph were correct but the calculation of the coefficient was wrong, one mark was still awarded.

(iii) To avoid the possibility of a double penalty, candidates could gain the mark here by using the term that corresponded with the coefficient they had calculated for part (ii). Again this was successfully answered by most.

(b) (i) Well answered by virtually everyone

(ii) Some tried to shorten the odds by giving a range of descriptions. This approach doesn't usually work and it is much better for candidates to give the answer they think is best, rather than try to give a range of terms, some of which will probably be incorrect and hence give contradictory answers which cannot gain marks. However, the majority answered successfully.

(iii) Generally well answered. Some thought that angular fragments were caused by short transport, rather than their remaining angular as a result of a lack of transport. Others described the type or mode of transport (wind, ice etc) rather than the degree. Attrition and abrasion were terms quite often used to explain changes in size, but some resorted to 'bumping' and 'banging into', which lacks the degree of precision required at this level.

(c) Labels and scales were provided by almost everyone. Some of the drawings were either hastily done or revealed a lack of knowledge of the term conglomerate. Some of them illustrated angular or sub angular clasts or had scales that made the clasts less than 2mm in size.

(d) Even candidates who didn't do too well in the rest of the question generally managed to get some marks here. Exfoliation was occasionally thought to be a process where 'new minerals grow in rock spaces forcing rock apart' rather than 'breakdown of rocks due to different expansion and contraction rates'. A few candidates wasted some time by writing out terms and definitions when all they were asked to do was to write down the correct numbers from the list.

Teaching Tip
A useful way for candidates to become familiar with cumulative frequency curves and sorting coefficients, as well as grain size descriptions, is for them to carry out an experiment to analyse the grain size distribution of a range of sands, by using a sieve stack and a balance. This is a common coursework experiment but could be done quickly as class practical to illustrate the techniques.

Two sands from contrasting depositional environments, or even a builders merchant (soft sand used for mortar and sharp sand used for floor screeds work well!) can be used to show contrasts in sorting. 100g of sand is sufficient for each experiment and the different grain size fractions are caught in the sieves, weighed and the cumulative totals plotted as cumulative frequency curves, like the one in question 2. Coefficients can then be calculated and the sorting described.

Question 3

This question proved to be the most difficult on the paper, with many candidates having minimal or patchy knowledge of metamorphism. Over 2% of candidates were unable to gain any marks. Very few gained the maximum.

3 (a) (i) Many candidates gave a definition that did not answer the question, for example 'a metamorphic aureole is an area around an intrusion which has been metamorphosed'. This kind of 'definition' just repeats

the terms in the question without defining them. Some mistakenly referred to pressure as well as heating in their definitions.

(ii) A minority gained marks for this question. Only rarely was it realised that the sides of the intrusion might be dipping more steeply to the south than they were to the north. Some suggested that the difference was due to the fact that heat rises, suggesting that they may have interpreted the map as a section. Several suggested it might be due to the rock types responding differently to heat, even though the same rock occurred in both the narrow and the wide parts of the aureole. Creative guesswork was a very frequent response.

(iii) Metaquartzite and marble were quite well known overall. Knowledge of hornfels and spotted rock varied according to centre. Blanks and wild guesses were also in evidence. Some of this basic factual information appeared to be poorly learnt.

(iv) There was occasional confusion between foliation and exfoliation, but this part question was well answered overall, although some candidates did not realise that lack of pressure was the key issue.

(b) (i)The idea of discordant rocks cutting across the beds was effectively communicated by many, although some did not get their ideas across concisely or clearly, using negative attributes in their definitions, such as ‘ does not follow the bedding’.

(ii) Candidates usually got this correct. The main mistakes were by those who shaded the baked zone, probably because they had not read the question carefully enough, and those who did not shade all of the chilled margin.

(iii) Most candidates correctly named the area as the chilled margin, but there was a noticeable minority of ‘cooled margins’ that did not gain the mark.

(iv) Some candidates gave a general account of how rates of cooling affect crystal grain size. This only took them half way, since the question asked for an account of the variation within the intrusion. The most successful responses linked the rate of cooling to crystal sizes at the edge and in the centre of the intrusion. Some answers were quite long. Some misinterpreted the question and gave grain sizes in the aureole rather than the intrusion.

Teaching Tip

The “Ten Word Challenge”
Students are challenged to write a definition of a geological term in ten words (or so)

- without using a dictionary
- without using the words in the term
- giving a full and complete explanation
- in good English

A metamorphic aureole *comprises the rocks around an igneous intrusion altered by heat* .

Question 4

This question on predicting volcanic activity was well answered by many candidates, but it did discriminate well. Written communication was usually clear. Candidates appeared not to have run out of time and several answers were quite long.

Some candidates included diagrams which tended to reveal understanding that was not clear in the written part of their work. Diagrams often had something to commend them and were usually worth including though the angle of the sides of these volcanoes was often very steep!

The full range of prediction methods was used and these were well described by the best candidates. Scientific terms were more in evidence in some essays than others, and knowledge of these terms helped candidates from particular centres to gain credit. The mark scheme had a very wide range of possible answers but many methods were not written about, and some candidates just referred to one or two.

Relatively few centres had candidates who referred to harmonic tremors for instance and this was valuable to those who did know when describing the use of seismograms. At the other end of the scale some candidates had vague ideas about gas emissions, but used terms inaccurately, referring to sulphur as a gas. Better candidates were able to describe how the observations were made, for instance thermal imaging using remote sensing by satellite and why the observations demonstrated that volcanic activity was imminent.

Some common misunderstandings involved references to seismic gap theory, radon gas and gas emissions being the result of increased pressure. One unique suggestion was to look out for ‘geologists who are running very fast away from the site’!

2833/01 Economic and Environmental Geology

General Comments

The length of the paper appears to have been right. There was no evidence that candidates were unable to complete the paper within the allotted time and all attempted the final extended 7 mark question. However, in common with the last two years, as 2833/01 was the third module taken it is possible the performance of some candidates suffered because they were tired.

The overall performance of candidates was satisfactory and all questions achieved a wide range of marks. Question 1 on energy resources, coal and geothermal energy was generally answered well. There were also some very good responses to question 3 on oil and to the extended question on springs. Question 2 on mineral deposits, once again, was the most poorly answered as it appeared that some candidates had no knowledge of this area and left many blanks. It is increasingly clear that some topics, especially mineral deposits, are answered poorly for each examination session and these areas of the specification need careful targeting. The examination papers are designed to cover every aspect of the specification over a time scale of a few years and consequently all areas of the specification will have questions on them at some time.

The following points should also be noted:

- Poor spelling is becoming an increasing issue especially in questions that ask for a specific named mineral, rock or term. In question 1 (b) (i) (the coal series) and questions 2 (a) (iii) and (c) (ii) (ore mineral names) a significant number of candidates lost marks because their spelling was so poor it really wasn't clear whether or not they knew the correct names. Candidates should be encouraged to learn the correct spelling of key geological words and terms.
- The drawing and labelling of diagrams is a key skill in Geology, and candidates should be encouraged to practise this skill at every opportunity. In general, the quality of diagrams was better than in previous years, but candidates still lost marks due to inaccuracies and poor labelling, particularly in the extended question 3 (c) on springs.

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Comments on Individual Questions

Q 1) This question was often well done with some candidates achieving full marks.

(a) (i) The vast majority of candidates were able to draw the pie chart correctly. However, a small number penalised themselves by not using a protractor, not drawing the segments accurately, or forgetting to label them.

(ii) Again most candidates realised that coal, oil and gas are fossil fuels and were able to calculate the percentage of fossil fuels correctly. However, some made the error of including nuclear energy as a fossil fuel and a small number made careless mistakes in their calculation.

(iii) The definition of a non-renewable energy resource as being a finite resource that can only be used once and will not reform within a human lifespan was well known, and most candidates gained the mark. A few candidates misread the question and defined a renewable energy resource.

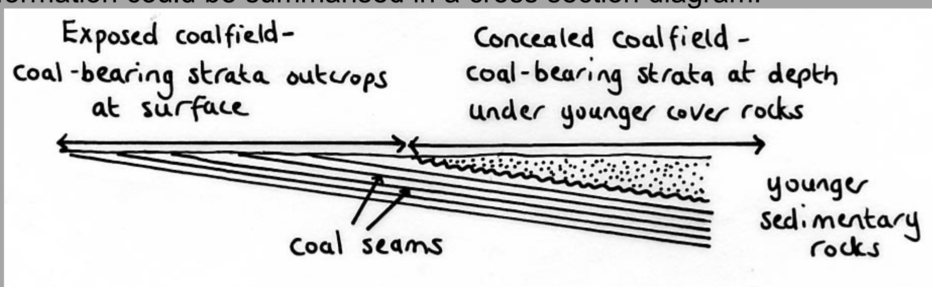
(b) (i) The coal series of increasing rank was well known, with most candidates scoring at least one mark. However, poor spelling let a significant number of candidates down, and in some cases it was not clear whether or not they really knew the two missing names. If one or two letters were incorrect, e.g. "anthresite" rather than anthracite, and it was clear the candidate knew the name they were awarded the mark, but spellings such as "ligmatite" instead of lignite and "andresite" or, more worrying, "andesite" instead of anthracite were not accepted. Candidates should be encouraged to learn the correct spelling of key geological words and terms.

(ii) More than half the candidates were able to define the term rank as being the carbon content of the coal. Answers that referred to the amount of energy produced when burnt (the calorific value) or the maturity of the coal depending on its depth of burial were also credited. However, some candidates said it was putting coal 'in order of quality' or 'ranking from top to bottom' without any further explanation. A few candidates referred to the "grade" of the coal, highlighting confusion with mineral deposits terminology.

(c) (i) The diagram(s) to show the difference between an exposed and a concealed coalfield were poorly done with only the strongest candidates attaining all three marks. Most candidates merely indicated that an exposed coal field is where the coal outcrops at the surface and a concealed coalfield is where the coal is at depth. However, this is not strictly correct as in an exposed coalfield the individual seams do not have to out crop, it is the "coal-bearing strata" that needs to be at the surface. Some candidates drew one coal seam starting off at the surface and dipping downwards, which was awarded a maximum of 1 mark. Others forgot to label which of their diagrams was which and hence could not be awarded any marks.

Teaching Tip

An exposed coalfield is one in which the coal-bearing strata (usually of Carboniferous age in the British Isles) out crops at the surface.
A concealed coalfield is one in which the coal-bearing strata is below younger cover rocks (usually Mesozoic rocks in the British Isles).
This information could be summarised in a cross section diagram:



(ii) What should have been a straight forward question describing opencast coal mining was surprisingly poorly answered. Most candidates were able to achieve one mark by stating that opencast mining was "digging coal out at the surface" and involved the use of "heavy machinery", but descriptions were vague and did not use technical terminology. Only the strongest candidates made reference to removing the top soil/overburden and even fewer discussed the use of dragline or bucket excavators, or replacing/restoring the overburden after the coal has been extracted.

(iii) This part question asking for one environmental problem associated with opencast mining was very well answered with the vast majority of candidates scoring the mark. Most answers focused on the negative visual impact; the noise and dust during the mining operation; or the disruption to habitats, ecosystems and wildlife. A few candidates discussed pollution of surface/river water or groundwater supplies. However, the small number of candidates who described unsightly spoil heaps did not appreciate that in opencast mining the overburden is usually replaced and this is really an environmental issue for underground mining.

(d) Slope stability techniques were well known, with most candidates achieving at least one of the two marks available. Popular responses included the use of rock bolts, profile modification, retaining walls, wire meshing, vegetation and drainage. A number of candidates referred to the use of shotcrete, but unfortunately some of them confused this technique with grouting.

Teaching Tip
Main techniques for stabilising a slope:

Profile/slope modification – Regrading/recontouring slopes to lower angles increases stability and prevents slumping. In strong, competent rocks vertical cuttings are possible, but for incompetent rocks such as clay the cutting angle must be less than 10°. Berm ledges, which are level steps (~5m wide, 10m high) cut into the slopes, can also be used to increase stability. Cut and fill techniques can be used to reduce the slope angle.

Support – A concrete retaining wall can be employed. Gabion boxes (wire mesh boxes filled with rocks) can be placed as lateral toe support at the bottom of the slope.

Rock bolts – Steel wires are glued/cemented into the rock face and tensioned in order to pin loose blocks of rock to the sound rock behind. Only useful for competent rocks.

Shotcrete – Liquid cement is sprayed onto the surface of the slope to increase strength, reduce permeability, and protect against weathering.

Wire meshing – To prevent rock falls.

Vegetation/Geotextiles – Fix soil, intercept water, and prevent erosion and slumping.

Drainage - Pore fluid pressure is critical in providing weight and lubrication, thus promoting slips, etc. Drains, relief wells, pipes and tunnels, etc., can be constructed to reduce the pore fluid pressure.

(e) This part question was poorly answered and, other than their knowledge gleaned from GCSE Science or Geography, it was clear that some candidates had no knowledge of geothermal energy. Unfortunately, a significant minority wrote about wind power instead.

(i) Many candidates were unable to name an area in the British Isles where geothermal energy has the potential to be exploited. The most common acceptable responses were South West England (Cornwall and Devon) and the Southampton area. Scotland and South Wales (confusion with coalfields?) were often given as incorrect answers.

(ii) Very few candidates achieved both marks for this question as their descriptions of how geothermal energy would be exploited in their named area was usually just a general response about hot ground water/steam being used to drive turbines to generate electricity. Better answers focussed on the potential hot dry rock method for the Cornubian granites and discussed their high heat flow, artificial fracturing of the rock, and pumping cold water down boreholes to be heated as it passed through the rock.

(iii) Most candidates found this part question straightforward and were able to give a correct disadvantage of exploiting geothermal energy. Responses citing geographical limitations and the fact each well has only a limited lifespan due to the rocks cooling down were the most common correct answers. A number stated geothermal energy would be expensive but were only awarded the mark if they qualified this with some discussion such as the high set up costs.

Q 2 In common with last year, the mineral deposits question was the least well answered of the three questions. Answers suggest that some candidates still have conceptual difficulties with the various theories of formation of metallic mineral deposits.

(a) (i) Most candidates appreciated that an iron ore deposit formed by gravity settling would be concentrated at the bottom of the igneous intrusion but some shaded in the fine grained basic rock which represented the lower chilled margin rather than shading horizontally just above it in the rest of the intrusion.

(ii) The great majority of candidates correctly cited high density, although many just used the term "heavy", as the property of the iron minerals that allowed them to be concentrated in the ore deposit. A smaller number equally correctly stated that the iron minerals are high temperature or crystallise early in the cooling history of the magma.

(iii) Many candidates gave magnetite as their answer but a significant number incorrectly stated haematite, pyrite or iron oxide, which is not a mineral name. Once again, poor spelling let some candidates down and answers such as "magmatite" were not accepted.

(b) Geophysical exploration techniques were well known, with most candidates describing either a magnetic or gravity survey for the full two marks. However, a number stated the iron ore would produce an anomaly, but did not say it would be positive. There were some excellent descriptions of electrical resistivity surveys too. Weaker candidates started by naming a gravity survey and then described magnetism or vice versa. A small number described a seismic survey not appreciating that this is not a technique used for metals' exploration. Even fewer mistakenly described drilling for the ore deposit or using a geochemical survey.

(c) (i) Most candidates were able to shade in correctly either the lateritic top soil or subsoil to show where the aluminium ore deposit would be concentrated and thus scored the mark for this part question.

(ii) Bauxite was well known as the main ore mineral of aluminium, but again some candidates penalised themselves with poor spelling and others simply stated aluminium oxide.

(iii) The most common error was confusing the process of concentration from residual deposits with secondary enrichment, with many candidates suggesting that the aluminium would be taken into solution and precipitated just below the water table. Only a minority of candidates recognised that the aluminium ore represents the insoluble residue left when all the other soluble elements have been removed in solution. A few gained at least one mark for stating that the process involved (extreme) <u>chemical</u> weathering or that it took place in hot, wet, tropical climates.

(iv) This part question asking about the significance of jointing in the development of residual ore deposits was also done rather poorly, with few candidates achieving even one of the two marks available. Many talked about the aluminium ore "falling into the joints". Most of those that gained one mark discussed the idea of jointing increasing permeability or allowing fluid flow through the rock, even though many used rather imprecise terminology. Only a handful of candidates appreciated that jointing increases the surface area available for chemical attack or that water is required for the reactions, such as hydrolysis, that take place during chemical weathering.

(v) Even though the rest of this part question was done poorly, many candidates were able correctly to state that residual ore deposits of aluminium form in limestone or granite.

Q 3 There were some very good responses to the first part of the question on oil, and a large number of candidates gained full marks for this. Although there were some good answers to the extended question on springs, this part of the question was less well done and only the strongest candidates gained the full 7 marks.

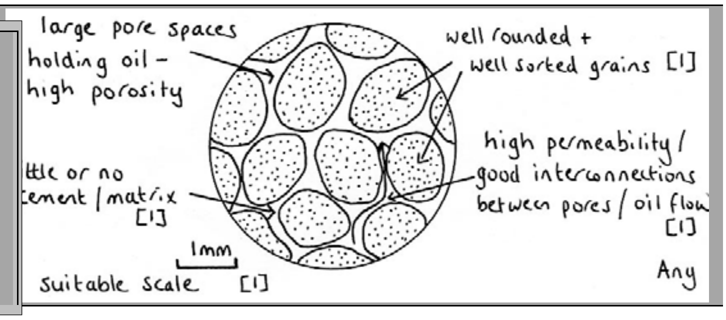
(a) (i) Most candidates worked the oil reserves calculation correctly. This was very pleasing as in the past candidates have tended to struggle with calculations.

(ii) For what should have been easy marks this part question was done rather badly and candidates that achieved both marks were in the minority. The most commonly made points were that more exploration or improved secondary recovery techniques could increase the reserves of oil and gas around the British Isles. Other acceptable answers suggested the use of unconventional / heavy / shale oil, the idea of small oil fields becoming economic as oil prices rise, and one or two suggested that the reserve calculations could be wrong! Unfortunately, a significant number of candidates suggested that new oil and gas deposits would form, appearing not to appreciate the long time scale involved.

(b) (i) There were some excellent, accurate, well-labelled thin section diagrams showing the characteristics of a good reservoir rock for oil. The grains were sometimes erroneously labelled as pores and there was confusion between porosity (spaces between the grains holding the oil) and permeability (good interconnections between the pores allowing the oil to flow). Very few candidates included a scale.

Teaching Tip

The drawing of thin section diagrams of rocks, particularly to illustrate texture , will be asked for on this paper and also in units 2832, 2835 and 2836. Such diagrams should be done in pencil; they should be accurate, fully labelled/annotated, and, if appropriate, they should have a scale.



(ii) This part question was well answered with most candidates, citing loss of pressure as the reason why typically 80% of the oil is left in the reservoir rock after primary recovery. Others gave the high viscosity of oil as the reason.

(iii) Secondary recovery methods were well known. The most common correct answers were the injection of water (below) or the injection of gas (above) the oil to maintain the pressure. However, a significant number of candidates did not attain the second mark as they conveyed an idea of the oil passively floating upwards rather than the idea of it being forced or driven upwards by the injection of water or gas.

(c) There were some very good, well-illustrated answers to the extended question on the geological conditions leading to the formation of springs as a result of lithology, faults and unconformities. Most candidates gained a mark for stating that springs form where the water table intersects the topographic surface, but their formation at the contact between permeable and impermeable beds was less well known.

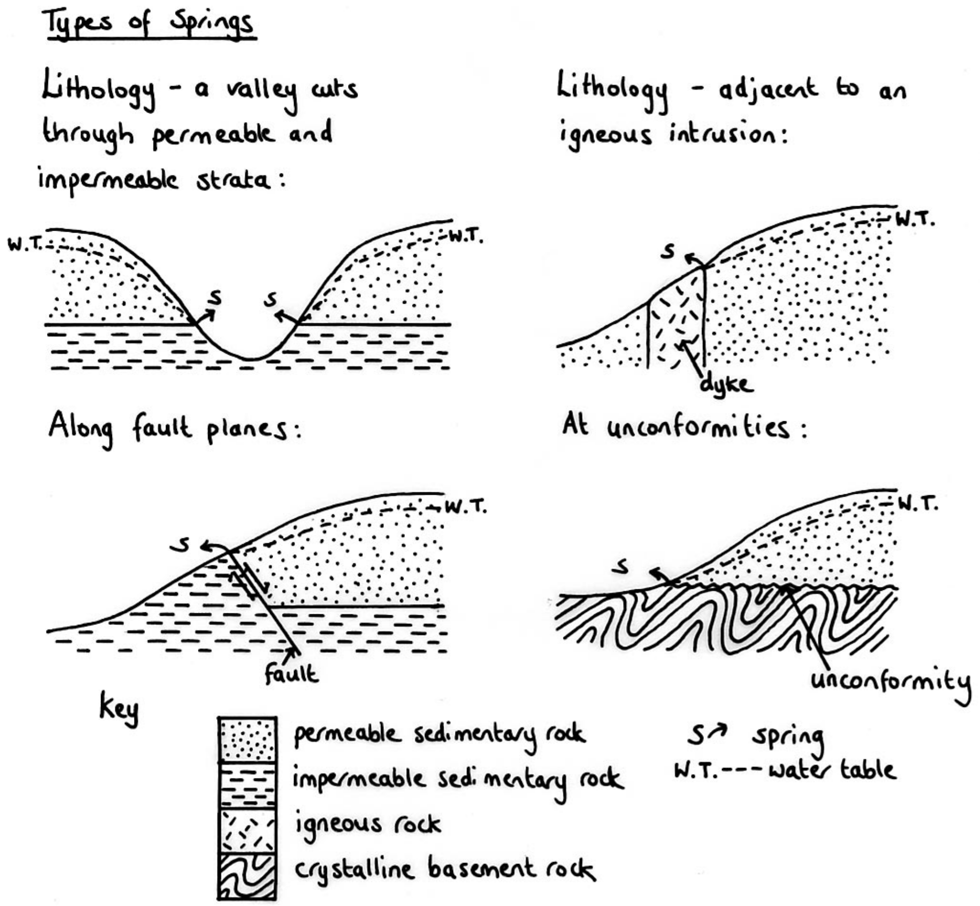
Lithology was best known, with many candidates attaining marks for describing and drawing cross section diagrams showing permeable rocks overlying impermeable rocks in a valley, with the water table and position of the spring correctly labelled. Unfortunately, a significant minority drew impermeable beds overlying permeable beds and there seemed to be some confusion with confined aquifers.

Only the strongest candidates realised that faults could result in the juxtaposition of permeable and impermeable rocks and, hence, produce springs. There were many vague comments such as, “the water table is pushed up to the surface by the fault” or “the fault blocks the path of the water”.

There was little awareness that springs can form at unconformities if the underlying rocks are impermeable and the overlying rocks are permeable. Many diagrams of unconformities were simply a repeat of the lithology diagram or were the wrong way round with impermeable beds overlying permeable beds. Written descriptions were also poor with suggestions such as “the unconformity would erode the top off the aquifer and release the water” or similar.

Teaching Tip

The geological conditions leading to the formation of springs can be summarised using a series of cross section diagrams:



2834: Palaeontology (Written Examination)

General Comments

Overall, the paper is of appropriate difficulty for the A2 candidates. It is obvious that candidates were well prepared for this subject: recall of complex morphology and classification was much improved.

As usual, the quality of the diagrams produced by the candidates was variable, and both good practice and poor practice was often centre specific. Some candidates drew excellent diagrams but did not label them at all. Other common problems with diagrams involved the positioning of arrows where they did not reach the morphological features in question.

Comments on Individual Questions

Question 1

1) (a) (i) Most candidates were able to label the tubercle, anterior groove and petaloid ambulacra. The position of the anus was always correctly identified on the regular echinoid but was often incorrectly placed in the centre of the petals of the irregular specimen.

(ii) A surprising proportion shaded in *all* the interambulacral plates or the ambulacral areas showing either uncertainty or a disregard of the bold type in the question.

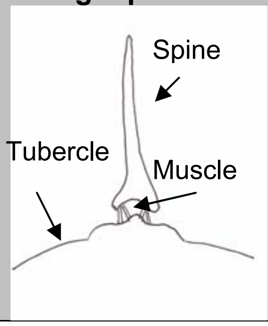
(iii) Most candidates knew some of the functions of tube feet and there were many detailed descriptions of this feature. Very few candidates recognised the term *plastron* and a common error was to associate it with the water vascular system.

(b) (i) Most candidates named tubercle for this part of the question, more occasionally boss or mamelon was given, usually by higher level candidates. Some answers were too general for the mark, e.g. test or interambulacra was given here.

> **Teaching Tip**
> Few candidates were aware that, in irregular echinoids, the area occupied by the plastron houses modified short spines for digging burrows. The structure and function of such adaptations should be stressed <u>together</u> when teaching.
>
> For example the short spines on the plastron are to enable digging burrows in soft sediment. Other features should also be stressed: for example, the ambulacra house the pore pairs which allow tube <u>feet</u> to extend for respiration or movement / attachment. This is easy to remember as the stem 'ambulacra' comes from the latin word meaning to walk, and the tube feet allow this attachment / walking to occur.

(ii) This provided good differentiation with the good candidates showing an advanced knowledge of the morphology of echinoids. No marks were given for intuitive answers such as "the spines were delicate" or "composed of organic material".

Teaching Tip



Candidates should be aware that spines are attached for movement and for defence. Few candidates are aware that the spines rotate, as they are attached to the test via muscles. I t is the muscles that is soft tissue that decays on death, a reason why the spines are usually found disarticulated.

Students should learn the accompanying diagram to aid their understanding.

(c) (i) Most candidates were able to plot these results accurately on the graph. It should be emphasised to candidates that plotting points (or drawing diagrams for that matter) with wide nibbed pens and then attempting to alter the results by crossing them out with more pen will not result in full marks. Clear pencil points in circles or with crosses were generally appropriate.

(ii) Most candidates described the two groupings successfully and some pointed out the vague negative correlation between length and thickness of spines. Very few were able, or tried, to suggest a realistic explanation. Remember that questions with 'Describe and Explain' in the rubric require both parts to be answered for full marks.

(iii) Candidates should be prepared to give specific answers at this level and towards the end of each question. They should not expect marks for trivial responses such as "marine" and should note that it is a regular echinoid that is referred to. Many failed to pay sufficient attention to this. Some candidates thought that regular echinoids were planktonic.

Question 2

2) **(a)** (i) The diagrams produced varied from excellent labelled explanatory figures to expressionistic artwork capable of no scientific interpretation. Throughout this paper there were very poor quality figures drawn. Drawing is an examinable skill in geology and should be practised.
There were basic misunderstandings of the term cast and mould as ever: no candidates appreciated how an internal mould could be created. Many associated moulds only with pressing a fossil into the surface of the sediment and some described the use of plaster or plasticene to try to explain their formation. The dissolution of the original material was often incorrectly described as breakdown, crumbling or erosion.

(ii) Poorer candidates interpreted this question as if it was asking for the conditions of exceptional preservation. The fact this question is on the next page failed to alert these candidates. Good candidates described the energy of the environment and size of particle and explained in detail how the two things were interrelated.

Teaching Tip
Students appear unaware that simple things such as increased sediment size and energy of the environment can adversely affect the preservation of organisms. As a rule high energy and a large sediment size = poor preservation. This should be stressed when teaching environments.

(iii) A good number of candidates simply stated calcium carbonate as a response, without the appreciation, or perhaps knowledge, of aragonite. Other responses included chitin, keratin, protein, albite and augite.

(iii) It was clear that this was poorly understood by many candidates. Most candidates simply restated the information given in the question, saying original material was replaced by silica. In this way few these candidates achieved full marks. Better answers described the replacement of other minerals and the source of the silica and the fact that it had to be mobilised to get to its destination.

(b) (i) This was well answered and understood by the majority of candidates. This is obviously a topic that fires candidates' imaginations, and they had been well prepared for this topic overall. Many described detailed mechanisms for preservation within the Burgess Shale.

(ii) Most candidates lost some marks here due to careless answers or repetition of the same point, such as entrapment of the insect. "Sap" is not a precise enough term at this level and it should be recognised that amber is the eventual product after lithification – not what is leaking out of those ancient pines.

(c) (i) Trace fossils were well described and many good examples were given by candidates. Many related the traces to behaviour of the organism.

(ii) Diagrams were generally over simplistic, unrecognisable and unlabelled with no scales. The explanations tended to describe modes of life rather than specific information about the organisms as asked. To say that a burrow showed an infaunal mode of life is self evident and not of A2 standard. The best responses described number and shape of legs of trilobites in relation to a crawling trace or made some link between spacing of prints and speed of travel of an organism.

Question 3

3) **(a)** (i) Most candidates recognised the group of the four fossils, the belemnite being most commonly misidentified as a coral. Fewer candidates had been prepared with the phylum of these groups often giving the class e.g. Cephalopoda.

Teaching Tip

Classification is often a neglected topic by some centres. The examples studied in A level Geology all belong to the Animal Kingdom. A simplified classification is given below. Those relevant to the question are underlined.

COMMON NAME	PHYLUM	CLASS	SUBCLASS	ORDER
Trilobite	Arthropoda	Trilobita	-	-
Brachiopod	Brachiopoda	-	-	-
Coral	Cnidaria	Anthozoa	Rugosa Tabulata Scleractinia	-
Echinoid Crinoid	Echinodermata	Echinoidea Crinoidea	-	-
Graptolite	Hemichordata	Graptolinithina		Graptoloidea Dendroidea
Molluscs	Mollusca	Cephalapoda	Ammonoidea	Goniatites Ceratites Ammonites
			Nautiloidea Coleoidea (belemnite)	
Molluscs	Mollusca	Bivalvia Gastropoda		

(ii) These morphological features were well known, the belemnite guard giving most problems. Some incorrect alternatives given by candidates were phragmocone or plastrocone. This is not surprising however as it is only a small part of the specification.

(iii) The morphology of the gastropod was surprisingly well known. Some candidates lost marks by not labelling accurately; e.g. a whorl requires a bracket rather than a line.

(iv) Descriptions of coiling of gastropods were not well understood, many candidates using evolute in desperation (or other parallel terms) to describe ammonioids.

(v) Most correctly identified the crinoid as sessile.

(b) This part was generally poorly answered. Candidates failed to grasp the difference between the environment asked for and the mode of life which they wanted to answer questions on. Dark relates to the environment, burrowing does not. Some simply gave detailed descriptions of the adaptations of the organism and did not mention environment at all.

(c) This question was very poorly answered indeed. Less than half of candidates made the connection between the calcium carbonate laid down as skeletal matter and the construction of limestone. There were many incorrect assumptions about oolitic limestone. Some discussed alternative minerals as a basis for the limestone, obviously incorrectly.

Question 4

4) (a) (i) Most candidates recognised these fossil fragments.

(ii) Many knew that the graptolites were fragile but few made the connection between their environment and their likelihood of preservation. Some recognised that scleroprotein would be consumed by bacteria and scavengers in oxygenated waters - a high level idea.

(b) There were surprisingly few clear statements defining a derived fossil, although many were familiar with the term. In contrast, most candidates were reduced to vague guesses when attempting to define a death assemblage. Some confused the terms life and death assemblage.

(c) (i) This was well answered; candidates were well prepared on the adaptations for high energy conditions.

(ii) The term strophic was used infrequently by candidates, even ‘straight’ proved troublesome. Candidates should be aware that reproducing material contained in the question will never attract marks e.g. the most common response was ‘long’.

(iii) Once again the quality of the diagrams was poor, many were unrecognisable as brachiopods and some were labelled with ‘byssal threads’ to confirm the confusion. The valves have to be clearly differentiated and the organism portrayed in a recognisable position for their mode of life. Some erroneously labelled the pedicle valve as the brachial valve, despite labelling the pedicle opening.

(d) Diagrams had to be labelled as Bivalve and Brachiopod to qualify for a mark. Most candidates were well aware of the differences in symmetry of the organisms. Only a few were sure of the symmetry variations in bivalves. Many drew attention to the differences in muscle scars and dentition to good effect.

Question 5

5) (a) Candidates either knew this topic, gaining moderate marks or had no idea about the subject matter, despite being a large part of the specification. This question was generally poorly answered, with few candidates able to show a convincing understanding of the principles of radiometric dating. Most candidates were able to give a definition of half-life. Many understood that a closed system was essential and that metamorphism and the variety of ‘clasts’ in a sediment produced problematic results. Very few were able to explain the significance of glauconite or to give examples of radioactive minerals from igneous rocks and the common elements involved in radioactive decay. A disturbing proportion wasted valuable time in describing carbon dating, relating it to dating of archaeological remains. Many of the responses were shorter than the 24-line first page: there was generally a lack of detail in the answers of most candidates.

5) **(b)** This question was very poorly answered, most students filling the space given, but gaining few marks. The most common error was to describe the changes apparent between Nautiloids and Ammonoids which was not asked in the question. This appeared to be the result of lack of knowledge of the evolution of ammonoids, or a lack of appreciation of the classification system, rather than a misreading of the question. A lot of inappropriate responses therefore included changes in the position of the siphuncle and the directions of the septal necks. The simple evolution of the suture lines was appreciated, although very few could place the groups in the correct periods. Many candidates had understood that the increase in shell strength would result in a greater variety of exploitable niches as a response to competition, and there were many good examples given. Diagrams were reasonable in this question (often correctly labelling saddles and lobes) although many did not illustrate the evolutionary trends asked for. Few candidates talked about heteromorphs, and few linked morphological changes to reasons and so did not fully answer the question.

The quality of written communication was generally of a good standard though spelling of technical terms is an issue.

2835: PETROLOGY (Written Examination)

General Comments

The examination paper this session gave a full range of responses, with a large variation amongst centres. There were though many excellent scripts utilising technical terms very effectively and demonstrating a clear understanding of the relevant subject matter and concepts. In this A2 examination it is essential that answers include sufficient detail and not just general statements. This paper is synoptic on the three AS modules and it was clear that some candidates had not revised the AS material.

Comments on Individual Questions

Q 1) This question on igneous intrusions led to a wide range of marks, including several at maximum: the marks were readily available if the specification had been covered. It proved to be a good lead-in question.

(a) This part question was reasonably well answered although in places was a bit hit and miss: very few candidates achieved maximum marks. There seemed to be a considerable number of candidates who had forgotten that basic intrusions form the AS specification essential for this synoptic paper. Two major errors were candidates mixing up the ring dykes and cone-sheets and not being specific in terms of the sill failing to include the term transgressive for stepping across beds.

(b) (i) The majority of candidates were able to recognise that the type of metamorphism affecting the sandstone was thermal or contact.

(ii) The origin of the fine grained basic rock was well known although some weaker candidates described the origin of a baked margin rather than a chilled margin.

(iii) This part question led to some excellent responses, where candidates often wrote in concise and accurate terms with a strong reliance on technical terminology. Many showed a clear understanding of magmatic differentiation and its interrelationship with Bowens Reaction Series. Candidates should be taught that the olivine sinks in the magma as a result of it being more ‘dense’ rather than being ‘heavier.

(c) Higher grade candidates had a clear understanding of the physical characteristics of the three unknown minerals and were able to identify them. Weaker candidates tended to guess and arbitrarily put in three minerals. Plagioclase feldspar was occasionally described only as feldspar and this is not specific enough at this level. There is still confusion between mineral group names and specific minerals. Pyroxene and augite were often given as examples of two minerals when in fact augite is an example of a pyroxene! Olivine was the one mineral that was most frequently identified.

Teaching Tip:
The easiest way to learn the physical properties of mineral is to examine the mineral in a practical laboratory session. Candidates should be encouraged to carry out all the physical tests and know the key characteristics that separate one mineral from another. For remembering the detail, fact flash cards or loop description cards provide a series of questions leading to the correct answer.

(d) Very few candidates have a clear understanding of the essential mineralogy of the igneous rocks on the specification and as a result were unable to answer this part question correctly. Many candidates failed to see that both rocks were coarse grained and as such even if the mineralogy was known the incorrect rock was given. Granite was often mistakenly given instead of gabbro.

(e) (i) The majority of candidates had few problems calculating the percentage difference in the lava depths. The candidates that got this part question incorrect were looking too deeply for an answer.

(ii) The explanation given for this percentage variation was not well done and there were some very weak responses, with only the more able candidates achieving maximum marks. Some candidates referred to increased pressure with depth although only occasionally was reference made to gases changing to liquids under pressure and the reversal if pressure is reversed. Only the more able candidates referred to exsolving or exsolution.

(iii) The origin of an amygdaloidal texture was not well known. Candidates often referred to infilled vesicles without any reference to the origin of the solution, subsequent precipitation and crystallisation. A surprisingly large number of candidates referred incorrectly to the vesicles being infilled by sediment.

Q 2 This question was generally well answered providing a wide range of marks including several at maximum.

(a) (i) The majority of candidates were able to show the direction of plate movement with the aid of arrows, although a few weaker candidates drew only one arrow or showed one plate being subducted in relation to the other. These candidates identified this as a continental-continental collision.

(ii) The majority of candidates had few problems calculating the maximum depth of the crust. Those candidates that got this part question incorrect often failed to use the scale provided.

(iii) This part question proved to be a real discriminator and only the more able candidates were able to relate depth to partial melting. On numerous occasions this area shaded was within the crust when it should have been deep within the root zone.

(iv) The origin of the partially melted material was not well known, many candidates referring to 'pressure created by collision' and failing to make any reference to increased temperature with depth.

(v) This part question proved to be particularly difficult with only the better candidates achieving maximum marks. Magma generation at depth was well known as was solidification before reaching the surface. No reference was made by any candidates to the hydrous granite solidus curve or volatiles emerging as the magma rose. Incorrect responses often referred to the magma cooling before reaching the surface, which failed to refer to crystallization or solidification.

(b) This part question was straightforward but proved to be an obstacle to many candidates. Far too many named general structures related to tectonics without commenting on specific geological structures such as antiform, recumbent folds and reverse fault. There were many incorrect references to fold mountains and plate margins.

(c) The majority of candidates were able to recognise the two rock types and their conditions of formation. Some weaker candidates incorrectly called rock J a metaquartzite, although this was not penalised twice as the "error carried forward" allowed candidates to gain the explanation marks. In terms of formation some weaker candidates referred generally too 'heat' or 'high heat', with no specific mention of temperature. This is not acceptable at this level

Q 3 There were some excellent responses to this question on sedimentary rocks, including several at the maximum, although it proved to be the most challenging question on the paper for most candidates.

(a) (i) This part question led to surprisingly few candidates achieving maximum marks. Conglomerate was rarely recognised despite clear reference in the description to large rounded clasts. Chalk was the most frequently identified rock with some candidates referring to micrite which the mark scheme allowed. Oolitic limestone was often misidentified as sandstone with candidates clearly failing to recognise the positive reaction with dilute hydrochloric acid. A large number of candidates described both the latter two rocks as limestone without any specific reference to type - which is required at this level. The specification clearly lists the types of limestone that candidates are required to know.

(ii) The origin of the conglomerate caused few problems, with the majority of candidates correctly identifying a mechanical origin.

(iii), (iv) Most candidates were able to describe the conditions of formation of the chalk and oolitic limestone. Tropical conditions were frequently referred to although water depth did occasionally prove to be a problem to a few. Origins of ooliths is clearly not well understood and only the more able candidates made reference to sand grains acting as a nucleus, being rolled along the sea-bed and getting coated in calcium carbonate. Error carried forward was allowed for both rocks.

(b) This part question led to the poorest responses with candidates clearly not expecting economic uses of rocks in this examination. It should be highlighted that economic uses does form an integral part of the specification for the module and recall of 2833 is a prerequisite. Over 60% of candidates stated that an economic use for chalk was for writing on blackboards. When candidates did correctly identify a use all too often the reason did not match the use. With reference to the oolitic limestone, candidates simply stated 'building' as a use without being specific in terms of building stone

(c) There were some excellent responses to this question on how evaporates form in barred basins. Top candidates were able to explain the significance of salt solubility, order of crystallization and replenishment, as well as crystallization and precipitation, were often accompanied by some first class diagrams. Weaker candidates confused barred basins with sabkha type deposits

Q 4 This question was generally poorly answered with a large number of candidates showing a limited understanding of the environmental processes associated with turbidite deposition. Candidates often failed to take note of the scale, and referred to the graphic log as showing a transgressive and regressive sequence This question generated the smallest number of maximum scores.

(a) (i) There was some confusion over the sedimentary structure present. Able candidates recognised the graded bedding while others simply described the sequence as one 'that fined upwards' and subsequently then went on to incorrectly describe a fluvial origin. It should be stressed that a graded bed is one bed, while a fining upward sequence is more than one bed. The better candidates when recognising graded bedding were then able to explain its origin in terms of energy and its relationship to grain size, although there were few direct references to turbidity flows and the significance of the continental slope - abyssal plain boundary.
(ii) The origin and recognition of flute casts is clearly not well understood, and the responses to this part question were very much centre based. There was a real tendency to account for their origin as impacts made by sticks and stones on the sea bed. These account for a different erosional structure known as a tool mark. One whole centre accounted for the origin of flute marks as an organic process. There was also a tendency to use imprecise and inaccurate terminology; only rarely was the term scour or eddy used. Surprisingly some candidates were unable to define the term cast. Some other centres' candidates by contrast produced excellent responses with well labelled and executed diagrams.
(iii) The origin of load casts is clearly not well understood, and responses were again very much centre based. Many candidates confused the concepts of density, solidity and plasticity of sediment. The quality of diagrams varied, with some excellent sequences showing sinking and the formation of flame structures. Few candidates recognised load casts as being post-depositional.

(b) (i) There was a common tendency in this part question to use imprecise terminology such as fairly mature, quite mature, not very mature, very young and quite old. Candidates should be encouraged to use the correct terminology such as immature, moderately mature, mature and super mature. Many candidates failed to achieve maximum marks because they did not refer to texture and composition when explaining why the sediment was immature.
(ii) The more able candidates named the rock as a greywacke, others simply described it as a sandstone which would have been adequate for 'AS' but a more specific identification is required at A2.

(c) A surprisingly small number of candidates achieved maximum marks for this part question. Some candidates simply failed to describe the graphic log in terms of grain size and its relationship to energy levels. Only the more able candidates referred to how energy changed up the sequence and related this to a bouma sequence.

Teaching Tip:
Sedimentary environments are topics that can be used for group presentations. Small groups of students are given a specific environment such as glacial or beach. They plan, research and present their findings to their peers in the form of a power-point presentation, including a handout. General group understanding is monitored through an open group discussion at the end of the presentations.

Q 5 The long answers give candidates an opportunity to provide detailed answers with diagrams and explanations. The organisation of the answers needs to be logical and structured in order to obtain the marks for the Quality of Written Communication (QWC)

1) **(a)** There were some good responses here even from candidates who had not done so well in the remainder of the paper. The major omission was to discuss acid and basic volcanoes only, with no reference to those of an intermediate origin. The quality of diagrams was again poor with a distinct lack of appropriate labels and scales. For example, shield volcano diagrams rarely had a correct base width, height (including above and below sea level) or slope angle. Acid volcanoes will have steep sides but drawings of near vertical sides are not realistic or accurate. Intermediate composite volcanoes will have sides at an angle of perhaps 45° while basic are at an angle of less than 10°.

Some candidates confused quartz and silica content, a concept that is commonly examined and should be clearly understood. Incorrect terminology was again prevalent, with the terms sticky, thin and runny being used. Candidates should be made aware that these are not correct terms and should not be used at A or AS level. Some weaker candidates confused acid and basic magmas / lavas in terms of describing viscosity and subsequent type of eruption.

(b) There were some excellent responses to this question proving that metamorphism is an accessible topic from the specification. Well-prepared candidates could clearly describe the processes and products involved, including rock types, textures and new mineral growth. There were some good-labelled diagrams showing textural changes in a sandstone, and maps showing zoning caused by an argillaceous country rock.

The most predictable error was that weaker candidates described the regional metamorphic products of an argillaceous rock rather than those resulting from thermal metamorphism. This obviously led to numerous marks being lost. Foliation and fabric were often described as characteristic features, again illustrating lack of clear understanding as they form as a result of strong directed pressure.

Some candidates, who correctly recognised the sequence of rocks formed, occasionally lost marks when they did not show clear knowledge and understanding of the subject matter, and failed to give the detail and technical terms required.

2836/01: Geological Skills

General Comments

The Geological Skills examination requires knowledge of all the other modules. Many candidates will not have sat AS modules since the previous summer session and their recall may be rather sketchy in comparison to the A2 modules. 2836 does not have any separate content but the skills do need practise and centres should teach these as a separate topic in preparation for this examination. The skills listed in the specification include graphic logs, geological maps and geological histories, and this requires a good knowledge of structural geology from 2831.

The quality of the sketches made from the photograph was again poor and this is a skill that can be much improved by classroom exercise using photographs or real examples in the field. Colour photographs will be used in the future. The quality of other diagrams was high and individual candidates could do excellent sketches from memory in question 2. This inconsistency is seen in other parts of the paper and may reflect a lack of revision: candidates should revise all other modules, as this paper is entirely synoptic.

There was no evidence that candidates could not complete the paper in the time available, and there were few questions left blank. However a number of candidates were not reading the questions carefully so that they did not always answer fully - eg "draw **and** label" or "describe the fault **and** the movement".

Comments on Individual Questions

Question 1

This question included the geological history of an area and was generally well answered, giving the highest average score on the paper. However, this was not a map but a cross section and a few candidates found this confusing. Whenever this style of question on oil traps has been set as part of 2833/01 candidates usually perform well, showing a solid knowledge of oil traps. This synoptic paper has therefore repeated this approach, but many candidates appeared to have forgotten the basics on oil traps.

1) (a)(i) The only possible reservoir rock for the oil is the sandstone so all the oil traps had to be drawn within these beds. Many candidates had the oil in other beds but, as they are impermeable mudstone or clay, this is impossible. The oil in the traps should ideally be drawn as a horizontal line and each trap needed to be named as anticlinal trap or salt dome trap etc. Answers were often inaccurate and unlabelled yet this should have been a straight forward question to start the paper.

(ii) The idea of oil migrating up the dip and across the fault line because the permeable sandstone is continuous was better known, but a minority of candidates described the oil moving down.

(b) There were many correct answers using the fossil content to distinguish between the depositional environments of terrestrial and marine. However a number of candidates attempted to explain the differences using energy levels; but as both these rocks were laid down in low energy conditions there is no difference. The presence of brachiopods means that the water depth would not be deep.

(c) Most geological history answers were very good with full descriptions and few lists. Knowledge of salt domes was poor and some candidates confused the salt dome with igneous intrusions. It was rare for candidates to appreciate that the salt must have been laid down first.

A few candidates omitted the detail eg stating folding occurred but not describing the folding as an anticline or stating faults formed without any detail such as F1 and F2 being both normal and form a horst. In order to have the marks for the unconformities there has to be erosion and some candidates omitted reference to this process.

Question 2

Most candidates had the right idea but few provided sufficient detail in the answer to gain full marks. This question was synoptic on 2831, 2835 and 2834, and so included material that would have been taught a year before and which may not have been revised as well as the A2 content.

(a)(i) This led to simple, general statements even though the question asked candidates to describe fully the features. Stating there are fossil fish does no more than reword the question, while an answer that says that the fossil fish are freshwater so could not cross the ocean gains a mark.

(ii) The answers for the calculation of the rate of spreading were often a factor of 10 out but ranged from 1.25×10^{-8} cm per year to about 80,000 cm year.

(iii) Most candidates could identify the transform fault, though the terms *strike, slip* and *constructive* were also used incorrectly.

(b) Some excellent answers, with high-quality and detailed drawings, made this a high scoring part question. A few candidates did excellent drawings but without any labels or a scale. Only the most able candidates gave the explanation of why the grain shape and size changed. General statements about “long transport” without a clear indication of how this affects grain size, was a problem.

(c) (i) The correlation was very poorly done with the majority of candidates using lithostratigraphy and not chronostratigraphy. Just the two volcanic ash bands needed to be joined.

(ii) The measurement provided few problems.

(iii) The reasons why the ash bands were different thicknesses apart in the sequences is due to erosion or varying amounts of deposition, but a common answer was to refer to the distance from the volcano. No thickness was shown for the ash bands but the answers often tried to explain volcanic processes in terms of different ash thicknesses.

(d) This part question on zone fossils was often answered very well, but where candidates had not made the connection with zone fossils the answers were poor and showed a lack of knowledge of the limited uses of crinoids.

Question 3

This question was again synoptic on 2831, 2834, 2833 and 2835 and some candidates answered very fully though rarely on all the sections.

(a)(i) The fault was often identified as a tear fault even though the axial plane trace has not been displaced. This is one of the basic methods of distinguishing between faults with vertical and horizontal displacement.

(ii) The sketch cross section was usually well drawn but not always labelled. A few candidates drew an anticline - or drew a syncline and labelled it as an anticline. There are many ways of teaching basic structures but the phrase “antis out and sin is in” can become a slogan to in class to help remember the dip arrow directions for anticlines and synclines.

(b) Graptolites were generally very well known, with many candidates gaining full marks on this part question. The word ‘septa’ instead of ‘stipe’ appeared on a few papers.

(c) (i) The hydrothermal processes that produced the mineral veins were usually known but did not always have sufficient detail in their description to gain full marks. A number of candidates wrote that the minerals were formed by evaporation causing the minerals to precipitate out of solution. A small minority of candidates confused this process with magmatic differentiation or pegmatites.

(ii) This part question was poorly answered. The word diagnostic was clearly a problem, with many candidates describing mineral properties such as white streak for fluorite, which is not diagnostic. The real test of diagnostic properties is – ‘can the mineral be uniquely identified from the description?’ eg SG of 7 and a shiny, metallic grey colour could only be galena, out of the minerals listed in the specification. Some candidates wrote a long list of properties, but the question asked for two, so only the first two were marked. Some candidates used rock description terms of crystalline or fragments while some were general or confused eg “shiny and hard” or “melanocratic and metallic”.

Teaching Tip

Learning the correct terms and descriptions for the minerals and rocks in the specification in 2835 can be done visually, with specimens or photos and cards with diagnostic descriptions to match, and quick tests to match card and specimen or photo. Without specimens a card with the mineral name can be matched to properties. This method also works well with fossil identification and labels.

There are computer learning games available that allow you to enter your own data into a game format such as How to be a Millionaire or Blockbusters.

Question 4

This was the worst answered question largely because the photograph sketch was poor with few labels, and regional metamorphism is a topic that is not well known.
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(a) Most of the sketches were very rudimentary – some were in pen rather than pencil. However full marks could be achieved by good labelling. Few candidates attempted more than a few labels and omitted the most basic features such as measuring the angle of dip of the beds and giving a scale in centimetres. When labelling a fold then, as well as the name, terms such as *crest* and *limb* gain credit. Labels such as "white rock" or "thin rock" are vague, but terms like *uneven bedding* or *laminated bed* are sufficiently detailed. Similarly a fault has *upthrow* or *downthrow*, the fault plane an *angle* and a *type* such as reverse.
A few candidates identified the structure as gneissose banding which was not possible given the scale and the fact that the question stated the rocks were sedimentary.

Teaching Tip

Use of a photograph projected onto a whiteboard is ideal for class work, with students finding as many features to label as possible and drawing over the photograph the main features for the sketch. There is a very good range of geological photographs on the internet to allow practise of skills work for this question.

(b) This question on regional metamorphism was poorly answered by many candidates, though a minority obtained full marks very concisely by making the link between the index minerals and the rock types produced. The most common error was to ignore the actual question, which specified regional metamorphism, and write about contact metamorphism or even Bowens Reaction Series.

There are some misconceptions regarding index minerals and rocks which suggests that candidates are confused about this essential difference; eg "sillimanite is the highest grade rock" or "sillimanite was deposited first then…". A further misconception occurs with the term foliation shown by the statement "there is no foliation but it has banding". It is not clear how much is lack of revision and how much is misconception. Certainly, regional metamorphism is a topic that candidates find difficult on 2835 as well.

2833 / 2836: Geology (Coursework)

General Comments

This year there was again a sign that most centres are now confident with the interpretation of the mark descriptors. Many centres now make useful comments in the margins to explain how and where the marks have been awarded.

There is a common pattern to the types of work set for coursework. For AS there is an emphasis on laboratory based exercises, with sieving of sediments being the most favoured, followed by experiments on porosity and permeability. A growing number of centres are now using igneous investigations with chemicals such as Salol for rates of cooling, or even wall paper paste to simulate viscosity and speed of flow. Some centres though are beginning to arrange good AS fieldwork, although there is an issue with having to leave it quite late in the year to be able to cover sufficient detail in class to help with the theoretical part of the fieldwork.

For A2 coursework, centres are predominately using fieldwork at a wide range of locations. Increasingly some are now using foreign sites, such as Santorini and Cyprus and showing some very detailed forward planning. A few centres appear to go on tours with local guides and a word of warning here - often the work for skill A can appear to be virtually identical across all the candidates as well as being predominately descriptive instead of analytical. However, there are a lot of sites used in Cornwall and elsewhere in the south west. In the north the Isle of Arran is one of the most popular destinations, followed by inland sites in North Yorkshire, Derbyshire and the Lake District.

On major problem which had not occurred before was a great number of clerical and arithmetical errors. Most moderators had at least one centre where paperwork had to be returned for checking or confirmation.

The problems fell into the following categories;

- Marks incorrectly copied across from the coursework cover sheet onto the coursework summary sheet / MS1
- Marks on the MS1 not doubled to be out of 60.
- Incorrect addition of totals, often leading to confusion as to what the marks were for candidates not included in the sample.
- Some marks not being included, due to students handing in work late.
- Marks awarded for certain skills without any evidence being submitted.

A lot of these problems were probably directly connected with late handing in of coursework. It is very important to note that the date for final submission of coursework to the moderator is published well in advance and that this **must** be adhered to. Therefore, centres must ensure that they set deadlines that are realistic so as to be able to mark the work and dispatch it to the moderator in time to meet this external deadline. Centres are also advised to check additions and be very careful over all form filling.

Skill P: Planning

Most centres are now getting some good clear planning sections, with a lot of detailed questions posed. Detailed hypotheses, although not compulsory, can be a really good way to investigate the issue proposed.

Teaching tip;

Using subtitles in this section can help candidates show that they have covered all of the vital sections in order to gain maximum marks. For example;

- Aim
- Hypothesis
- Fair Test / Variables to be controlled or varied
- Equipment list
- Features to be measured/recorded
- Background information and safety.

Candidates from a small number of centres are still making absolutely no reference to how to set up a fair test. These exact words do not have to be used, but candidates should mention why they will keep certain things constant and what they are going to vary. For example, some centres have candidates discussing sampling techniques and how they will collect a representative data set. If none of this has been mentioned then P3a has not been achieved, which means that the candidate cannot progress beyond level 1, and so no more that 2 marks can be awarded. If level 3 has been achieved three marks are awarded this. Four marks can be given if it has been achieved well and then further marks can be awarded if the relevant higher descriptors are covered.

Both descriptors need to be covered in order for a mark to be given at each level. For example, if P5b is done but P5a is incomplete - as safety is missing, for example - then only 4 marks can be given.

A few centres are using preliminary experimental work in a good context for part of P5a, giving candidates a chance to re assess their plan in light of the earlier investigation. This is also good for allowing access to P7b. However it should be noted that just a couple of sentences for P5a background or P7a is NOT sufficient. For P5a the scientific background needs to be developed, and detail is needed. This must be sufficient to get the candidate up to 5 or 6 marks out of 8, so **good quality detail** is needed, and this cannot be achieved in just a couple of sentences. For P7a, references need to be given to prove the use of secondary sources - or a bibliography could be added.

Skill I: Implementing

Some very detailed data is being collected, both via fieldwork and laboratory work. Often, very useful annotations or tick sheets are included to show how the candidates worked in these situations. This is especially useful for fieldwork, where students often work in groups and look at the same sites.

There is no need to send in complete field note books, as this greatly adds to the weight and cost of postage. Individual pages can be torn out or photocopies sent.

Skill A: Analysing

In general the lower level descriptors are not causing too many problems for candidates.

For A3a a good range of techniques are being presented, however a very small number of centres are doing none of these. Text alone or even photos are not sufficient to fulfil this descriptor.
Suitable techniques include the following:

Graphs - bar, scatter, histogram
Rose Diagrams
Sedimentary (graphic) logs.

A5a is now producing a lot of excellent work, including lovely scaled maps drawn up on blank paper, field mapping using base maps and a range of statistics, the most popular being; Spearman Rank, Chi Squared and Standard Deviation.

Teaching tip;

Going to Arran?
A good way to achieve skill A5a is to get candidates to produce a scale map of the Sannox Dykes area, where two dykes cross cut Devonian sedimentary rocks, followed by faulting. The fault can be plotted to the north and then the other features can be plotted on relatively with proportional thicknesses.

Studying Joints in Cornwall?
Joint directions could be plotted onto rose diagrams and successful statistical analysis could then be carried out. Some centres use Standard Deviation, others Spearman Rank on different orientations of joints.

As with Skill P, the higher level descriptors do need increasing amounts of detail. Just a couple of sentences will not suffice for A5b.

For A2 the synoptic element must be included:
For level 3 - background from different parts of one module must be included, e.g. erosion and dykes are both from 2832.
For level 5 – different AS modules must be used e.g. Dykes and faults from 2832 and 2831.
For level 7 - information from parts of the AS and A2 specification must be used, e.g. Dykes and fractional crystallisation. A sedimentary log using fossils and palaeo -environmental analysis of the rocks will use 2832, 2834 and 2835 if well chosen.

Skill E: Evaluating Evidence and Procedures

This is still very much the weakest performing skill area. Marks from a particular centre tend either to be very good - where the centre has maybe given candidates some guidance sheets, for example showing key questions to answer - or very poor, where only brief statements are made, often about the weather and possible improvements. Rather frequently, it seems, little or no guidance has been given here.

In E1b anomalies MUST be referred to. If there are none then the candidate should say so to obtain the mark.

For E7a besides any improvements described there must also be an explanation of how they might increase the reliability of the results. For E7b candidates need to outline how significant the limitations and errors they had previously mentioned in skill E were on the overall results.

Teaching Tip; Mystery Sediments exercise

For sieving most sieve stacks leak! Therefore there is a chance that the candidates lost some sediment and so providing a valuable opportunity to comment on the suitability of the techniques (E1a), the chance of anomalous results creeping in (E1b), as well as comments on the reasons for the errors (E3b) and the limitations of the sieves (E3a).

Candidates should be able to suggest how they would improve this (E5a) and go into some detail to explain how this would increase reliability (E7a). Evaluating how serious the problems were on their results (E5b) could be illustrated by the candidates having knowing the environment the sediments were deposited in **before** they write this section. If this information is given then the candidates can finish by stating how serious an effect the overall errors/ problems experienced had on their final conclusion, by analysising how many sediments they got correct, and by looking at how far out they were with the wrong decisions.

> For example, a sand dune deposit identified as a glacial outwash would constitute major uncertainty for the overall reliability of the conclusions drawn. Whereas the same sediment identified as having a beach origin would contribute a smaller error to the interpretation (E7b).

What can be done if a student is ill and misses the fieldwork?

If this happens the main difficulty is that the student has missed the chance to collect data, make observations and collect measurements. Also there will not have been the opportunity for the teacher to observe the student in action, using clinometers etc.

There are various ways to solve this. Samples of the representative rocks can be collected to be taken back to base, so the student can carry out observations and measurements later, when well.

Photo evidence can be used to enable remote field sketching, macro observations and identification of major geological features.

To test understanding of the use of a clinometer, sloping surfaces back at the centre could be used for the candidate to demonstrate the principles behind measuring dip and strike.

If the member of staff is then satisfied that the candidate has demonstrated the skills relevant for Skill I a suitable mark can then be given. If it was all completed to a high level then maximum marks could be awarded.

At this stage, the candidate could be given access to the others students' collected data to enable them to complete the remaining skills.

Advanced Subsidiary GCE Geology 3884
& Advanced GCE Geology 7884
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2831	Raw	60	42	36	31	26	21	0
	UMS	90	72	63	54	45	36	0
2832	Raw	60	47	41	36	31	26	0
	UMS	90	72	63	54	45	36	0
2833	Raw	120	89	78	67	57	47	0
	UMS	120	96	84	72	60	48	0
2834	Raw	90	62	55	48	41	35	0
	UMS	90	72	63	54	45	36	0
2835	Raw	90	65	57	49	41	33	0
	UMS	90	72	63	54	45	36	0
2836	Raw	120	88	78	68	58	48	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3884	300	240	210	180	150	120	0
7884	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3884	19.5	39.6	60.2	78.9	90.3	100	1142
7884	22.5	46.7	67.1	86.6	97.2	100	753

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