GCE MARKING SCHEME

SUMMER 2018

GCE (LEGACY)
GEOLOGY - GL5 (OPTION 4)
1215/04

INTRODUCTION

This marking scheme was used by WJEC for the 2018 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE GEOLOGY - GL5 (LEGACY)

OPTION 4

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SECTION A

1. (a)

maximum strength (MPa)	246-250 (1)
depth to brittle-ductile transition boundary (km)	12.5-12.9 (1)
mean increase in rock strength per km in the brittle zone ($MPakm^{-1}$) ecf candidates values above	19-20 (1)

[3]

(b) (i) brittle-ductile boundary positioned at < 250 MPa and < 12.5 km (1)
linear brittle region and curved ductile region (1) [2]

(ii) 10^{-15} s^{-1} (1) [1]

(c) (i)

Lesser Himalaya	• found in (mainly) lower crust or exemplar values; 20-50 km or "in the crust below the fault" (1)
Higher Himalaya	• found throughout the crust or exemplar values; 0-50 km or "in crust above and below the fault" (1)
Tethyan Himalaya	• found in upper crust **and** (uppermost) mantle or exemplar values; 5-25 km and 70-100 km (1)

[3]

(ii) Any three from:
thrust (reverse) faulting (1)
compressive stress (1)
destructive/convergent plate boundary (1)
continent-continent collision (1)
between Indian and Eurasian plates (1)
(compressive) stress exceeds fracture point (1)
elastic strain energy released as seismic energy (1)
rocks are brittle (1)
(max 3 marks) [3]

(iii) Location = Tethyan Himalaya (1R)
faulting can only occur when rocks are brittle/strong (1)
in Tethyan Himalaya rocks brittle/strong in upper crust as per Figure 1c (1)
in Tethyan Himalaya rocks also brittle/strong in mantle as per Figure 1c (1)
in Higher Himalaya rocks brittle/strong in all the crust contra Figure 1c (1)
in Lesser Himalaya rocks brittle/strong in the lower crust contra Figure 1c (1)
(1R + 2 marks) [3]

[15 marks]

SECTION B

2. (a) Describe and explain the layered seismic structure of the oceanic crust.

(b) Evaluate the significance of ocean drilling in providing evidence for the composition of the oceanic crust and upper mantle. [25]

(a) Layer 1: 0-1 km thick, thickening away from the ridges. Low seismic velocities comprising various (un)consolidated fine-grained sediments including turbidites, clays and oozes. Deposition under low energy conditions. Poorly consolidated thus low rigidity hence low seismic velocities.
Layer 2: more variable in thickness 1-2.5 km. Variable but faster seismic velocities. May contain two or more sublayers. Mafic (basaltic) igneous volcanic rocks dominate with possible pillow lava structures or brecciated lavas. Dykes may be present. Formed during submarine eruptions. Lava generated by de-compressional partial melting of mantle peridotite. Brecciated/weathered nature results in relatively low velocities for mafic rocks.
Layer 3: main component of oceanic crust (4-6 km thick) and represents its plutonic foundation. Highest, relatively constant seismic velocities. May have two sublayers. Mafic igneous plutonic rocks (gabbro) dominate with dykes in upper section. Moho (seismic) defines its base. Intrusives generated by de-compressional partial melting of mantle peridotite: dolerite forms tabular dykes in tensional faults/joints, gabbro forms in magma chambers. Layered gabbros form cumulate textures as a result of fractional crystallisation.

(b) Layer 1 especially (but also 2) extensively sampled by drilling hence composition very well understood. Layer 3 penetrated only in a few boreholes (and mantle not at all) so composition not well understood. Need additional data from laboratory experiments and obducted ophiolites. Discussion of results of Joides Resolution 360. 'Outcrop' of mantle and plutonic mafic rocks on seafloor.

[25 marks]

3. (a) Describe and explain the variations in surface heat flow measurements across the Earth's surface.

(b) Evaluate the importance of surface heat flow measurements to support the theory of plate tectonics. [25]

(a) Surface heat flow depends on thermal conductivity and geothermal gradient- hence give clues to subsurface temperature. Description/graph of surface heat flow across a typical spreading ocean-continent margin. Definition of 1300^{o}C isotherm and hence thermal structure of lithosphere flow across a typical spreading ocean-continent margin. At oceanic ridges and continental rift valleys high heat flow due to thinned lithosphere and associated volcanic and hydrothermal activity. Over abyssal plains heat flow reduces as lithosphere cools and becomes thicker. At trenches lowest values of heat flow as lithosphere is oldest and hence 'lost' most heat energy. In orogenic mountain belts/island arcs high heat flow as magmatic activity brings heat to the surface together with relatively high amounts of radioactive isotopes. In cratons/shields lower heat flow (but still higher than the oceanic lithosphere mean) due to older continental rocks but still containing long half-life radioisotopes. High heat flow over mantle plumes.

(b) High heat flow measurements correlates well with CPB (oceanic & continental). Supports model of convection- one of a number of driving forces for plate tectonics. Decreasing heat flow across oceans correlates well with idea of sideways moving, cooling plate becoming denser as it does so. High heat flow measurements also delineate DPB which are related to igneous activity associated with subduction and high radioactive isotope concentrations in magmas. High heat flow measurements associated with 'hot spots' not necessarily linked to plate tectonics. Also high heat flow may also be related to hydrothermal activity removed from plate boundaries e.g. hot springs at Bath etc. Heat flow measurements when combined with other remote sensing techniques support the theory of plate tectonics.

[25 marks]

4. ‘*The distribution of ages of rocks in oceanic and continental lithosphere is predictable*’.

Evaluate this statement with respect to the way in which oceanic and continental lithosphere is created. [25]

Oceanic lithosphere: formed by decompressional partial melting of mantle peridotite at spreading centres. New material added in ridge areas. Sea floor spreading results in older material further from ridge with oldest at trenches. Age range 0-200Ma. Highly predictable but age distribution may be confused by transform faults and hot spots.

Continental distribution: formed by more varied processes e.g. accretion, magmatic activity and obduction. Accretion of new material at destructive plate margins leads to a general younging of rocks towards continental margins e.g. north America. Accretion of microcontinents leads to ‘islands’ of older rocks surrounded by younger e.g. Africa.
Age range 0-4.4Byrs – shields and cratons
Younging trend commonly disrupted by various other processes e.g. rifting and volcanic activity and modern sedimentation severly disrupt any simple age distribution patterns. Age increases with depth unlike in ocean lithosphere.

[25 marks]