

Geology 12

June 2003 Provincial Examination

ANSWER KEY / SCORING GUIDE

- Topics:**
1. Earth Materials
 2. Time and Fossil Record
 3. Internal Structures and Processes
 4. Surficial Processes
 5. Comparative Planetology

Part A: Multiple Choice

Q	K	C	S	CO	PLO	Q	K	C	S	CO	PLO
1.	B	U	1	1	B1	29.	B	K	1	3	K1
2.	A	K	1	1	A5	30.	D	U	1	3	K2
3.	B	U	1	1	A6	31.	D	K	1	3	K3
4.	C	H	1	1	A4, 5; D1	32.	A	U	1	3	K5, 6, 7
5.	B	U	1	1	A5; D1, 2	33.	D	U	1	3	K4
6.	D	U	1	1	A7	34.	C	U	1	3	L1
7.	A	H	1	1	E1, 2; D2; C3, 4	35.	C	H	1	3	L4
8.	B	U	1	1	B2, 3; C4	36.	C	U	1	3	L4
9.	C	U	1	1	C2, 3, 4	37.	A	U	1	3	L2, 5
10.	B	K	1	1	C8	38.	C	U	1	3	M1
11.	C	U	1	1	D2, 3, 4	39.	D	U	1	3	N1
12.	B	U	1	1	E1, 2, 3	40.	A	H	1	3	O3
13.	A	U	1	1	D2, 3	41.	A	U	1	3	O6
14.	D	H	1	1	F4, 7	42.	D	H	1	3	O7
15.	A	U	1	1	C6, 7	43.	D	U	1	3	O4
16.	A	U	1	1	C6, 7	44.	D	U	1	3	O8
17.	A	U	1	1	C6, 7	45.	A	U	1	4	Q4
18.	A	K	1	2	G2	46.	A	K	1	4	P2
19.	A	H	1	2	G3	47.	D	U	1	4	P3
20.	A	H	1	2	G4	48.	D	U	1	4	S2
21.	C	U	1	2	H2	49.	C	K	1	4	R1, 2
22.	A	U	1	2	H3	50.	C	H	1	4	R2, 1
23.	C	U	1	2	H4	51.	B	U	1	4	Q4
24.	D	U	1	2	I1, 2	52.	C	U	1	4	R1
25.	B	U	1	2	I1	53.	C	U	1	5	T1
26.	C	K	1	2	J5	54.	C	U	1	5	T2
27.	C	U	1	2	J2	55.	A	K	1	5	T3
28.	C	U	1	2	J3						

Multiple Choice = 55 marks

Part B: Written Response

Q	B	C	T	S	PLO
1.	1	U	1	2	B2, 3; C5; P2, 3
2.	2	U	1	2	C1; E4
3.	3	U	1	3	D4
4.	4	H	1	7	F8; D3; E1, 2, 6; F3, 6
5.	5	U	3	3	G5
6.	6	H	3	3	H1
7.	7	U	3	3	J1
8.	8	U	4	2	P5
9.	9	U	4	3	Q1
10.	10	U	4	3	S4
11.	11	H	3	3	K1, 2, 3, 6, 7
12.	12	H	3	5	L2, 3, 5
13.	13	H	3	4	O5, 6, 9, 10
14.	14	U	5	2	T1

Written Response = 45 marks

Multiple Choice = 55 (55 questions)

Written Response = 45 (14 questions)

EXAMINATION TOTAL = 100 marks

LEGEND:

Q = Question Number

B = Score Box Number

PLO = Prescribed Learning Outcome

K = Keyed Response

S = Score

C = Cognitive Level

T = Topic

PART B: WRITTEN RESPONSE

Value: 45 marks

Suggested Time: 55 minutes

INSTRUCTIONS: Answer each question in the space provided. You may not need to use all of the space given.

REFERENCE DATA BOOKLET

For question 1, refer to the table below, and the following in the Data Booklet.

page x: Bowen's Reaction Series

page xii: Properties of Common and Important Minerals

Minerals present	Mineral content of granite	Mineral content of stream sand
potassium feldspar	60%	18%
quartz	30%	80%
biotite	10%	2%

1. An area of British Columbia that is entirely composed of granite is drained by a single, fast-moving stream. With reference to chemical and physical properties, describe **two** factors which could be used to explain why the mineral content of the stream sand has become so different from the mineral content of the granite. **(2 marks)**

Any **two** for **2** marks:

Hardness: Quartz, the harder mineral, has become enriched in the sediment because it is better at resisting weathering and erosion, whereas the other two minerals have been worn and washed away.

Cleavage: Quartz has no cleavage and thus is more resistant to weathering and erosion. Feldspar has two cleavages and biotite has one excellent cleavage.

Mineral stability: According to Bowen's Reaction Series, quartz has more stability than the other two minerals and has thus become enriched in the sediment.

**REFERENCE
DATA BOOKLET**

For question 2, refer to the following in the Data Booklet.

page i: Geological Map

2. A geologist has observed that the crystals in igneous rock unit **S** are much smaller at points **X** and **Y** than they are at a point half way between **X** and **Y**. Explain why the crystals are smaller at **X** and **Y** than in the middle of the unit. **(2 marks)**

Igneous rock unit S would have been intruded as a magma. The magma in contact with the country rock would have lost heat and cooled much more quickly than the magma in the middle. The faster a magma cools, the smaller the crystals will be.

} ← **2 marks**

Note: chilled margins is worth 1 mark only

**REFERENCE
DATA BOOKLET**

For question 3, refer to the following in the Data Booklet.

page i: Geological Map

page vi: Photograph 10

3. Sedimentary structures are very useful to geologists because they can give clues about the environment where the sedimentary rock they occur in was deposited. The sedimentary structure shown in Photograph 10 was found in the sandstone **T** shown on the geological map.

- a) Identify the sedimentary structure. **(1 mark)**

Ripple marks ← **1 mark**

- b) Describe how the sedimentary structure would have formed. **(1 mark)**

Moving water, usually shallow, or moving air ← **1 mark**

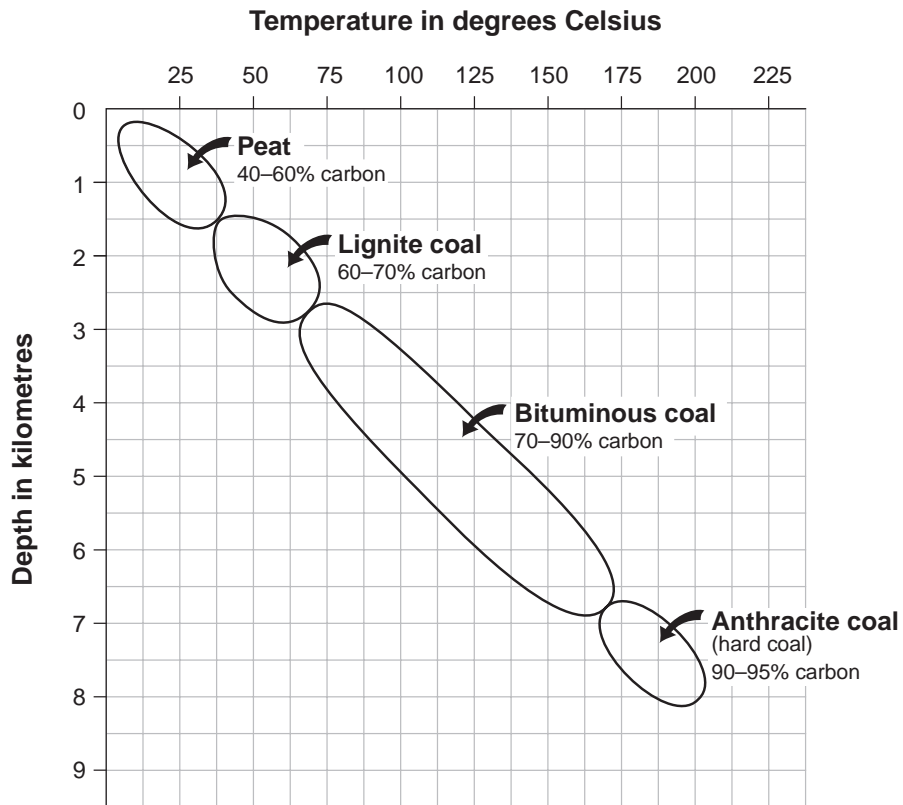
- c) Name an environment where the sedimentary structure could have formed. **(1 mark)**

There are many possible answers – anywhere there is sand and moving air or water, for example:

- **bottom of a stream**
- **shallow marine, even deep marine if there are currents**
- **intertidal zone – beach**
- **desert sand dunes**

} ← any **one** for **1 mark**

Use the following graph which shows relationships between temperature, depth, and types of coal, to answer question 4.



4. a) Describe a type of environment where a potential coal deposit could accumulate on the earth's surface and the type of material that would accumulate to eventually become coal. (2 marks)

Type of environment: **usually a swamp, marsh or delta where there is abundant plant growth and decomposition.** ← 1 mark

Type of material: **plant material, vegetation** ← 1 mark

organic ← ½ mark

previously living material ← ½ mark

- b) According to the graph, at what temperature and depth would lignite change to bituminous coal? (1 mark)

Temperature: **approximately > 62° C** ← ½ mark
< 75° C

Depth: **2.3 – 3.5 km** ← ½ mark
> 2.5 km
< 3 km

c) Choose **one** type of coal and describe a use for it.

(1 mark)

Any **one** for **1 mark**:

Peat: used for heating, power generation, soil enhancer, absorbent for liquids

Lignite: used for heating, power generation, source for organic chemicals

Bituminous: used for heating, power generation, source for organic chemicals, coking in steel manufacture

Anthracite: heating, power generation

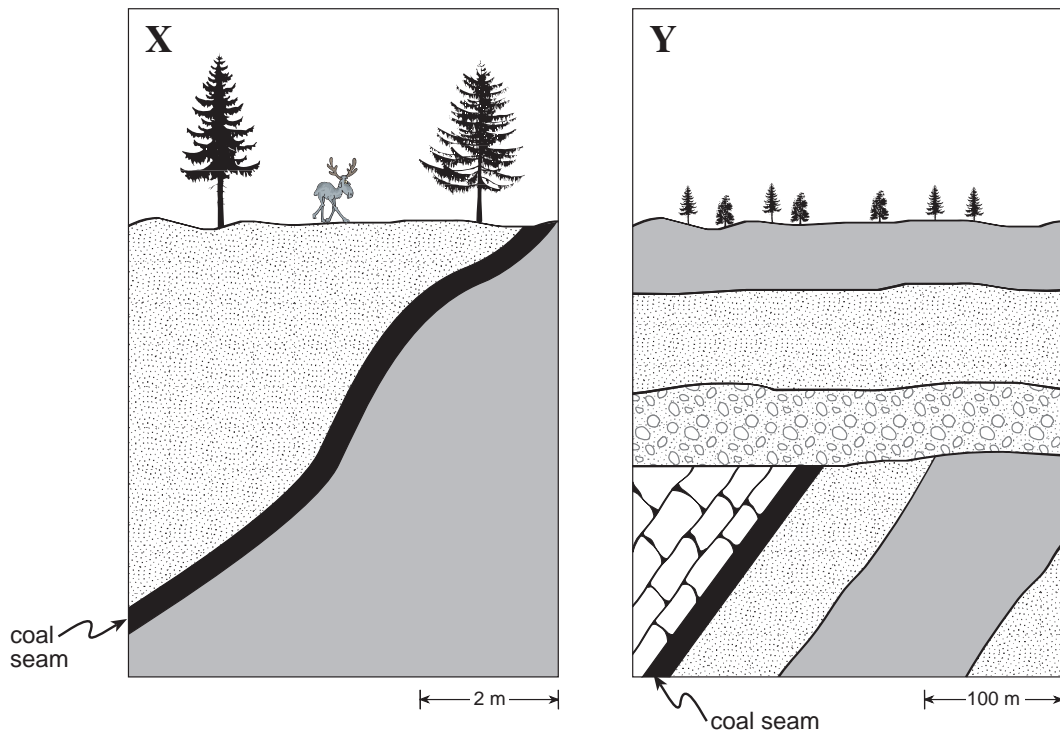
d) Why is anthracite (hard coal) often found in association with slate rather than shale or mudstone?

(1 mark)

Anthracite (hard coal) forms at the highest temperature and pressure of all the coals and is in fact metamorphic. At this temperature and pressure, the sedimentary rock shale or mudstone will have been metamorphosed to slate because of the higher temperature and pressure.

} ← 1 mark

Use the following cross section diagrams of coal deposits to answer question 4e).
 Note the different scales of the cross sections.



e) The two coal deposits X and Y were discovered in British Columbia, however neither of them will be mined at this time.

i) Describe **any** geological or economic reason why deposit X will not be mined. (1 mark)

Any one for 1 mark:

- The coal seam is too thin (about 50 cm) and would be too difficult to extract using machinery.
- The coal seam is too thin and too much rock would have to be removed for every ton of coal obtained.
- The price of coal is too low to make it worthwhile mining this deposit.
- Dip of the seam makes it too deep.
- Environmental reason connected to economical or geological reasons.

ii) Describe a different geological or economic reason why deposit Y will not be mined.

(1 mark)

Any one for 1 mark:

- The coal seam is too deep. It would be difficult to extract the coal using cheaper open pit methods.
- The coal seam is too deep and too much rock would have to be removed for every ton of coal obtained.
- The price of coal is too low to make it worthwhile mining this deposit.
- Dip of the seam makes it too deep.
- Any other good geological or economic reason.

5. Photograph 6 shows sandstones and siltstones in a cliff section. Using the information visible in the photograph, name and describe (in order from youngest to oldest) **three** geological processes that have been important in the development of the rock sequence in the cliff section.

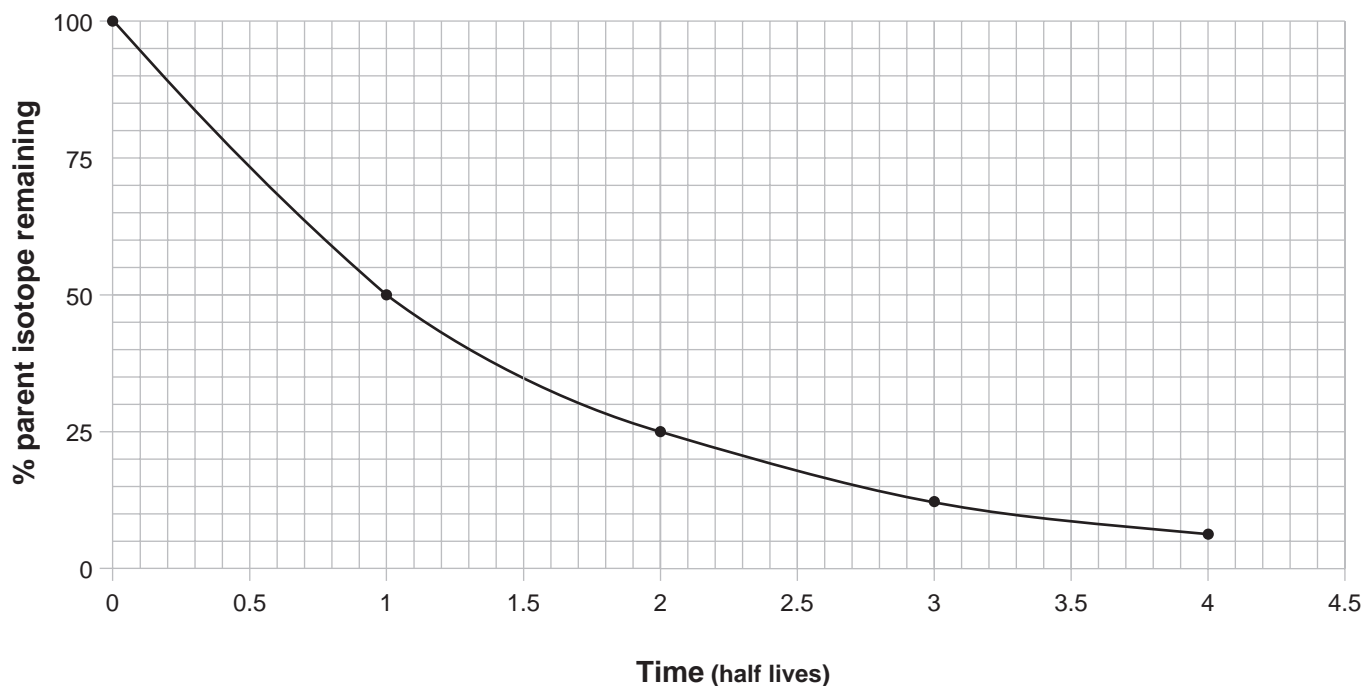
(3 marks)

<i>Youngest</i>	Process 3	<ul style="list-style-type: none">• weathering of structure• erosion of structure	1 mark
	Process 2	<ul style="list-style-type: none">• folding of sedimentary layers• uplift of sedimentary layers	1 mark
<i>Oldest</i>	Process 1	<ul style="list-style-type: none">• deposition of sand• lithification of sediments	1 mark

Note: Part marks if out of order (deduct **1 mark**)

6. a) In the space below, draw a graph to show how the amount of parent isotope changes over **four half-lives** of radioactive decay. **(2 marks)**

Radioactive Decay Graph



2 marks for graph

Note: deduct $\frac{1}{2}$ **mark** each for mistakes: – not a smooth curve
– 4 points not in correct spots
– started curve at 0, 100

b) A rock sample is analyzed and found to contain only 20% of the original parent isotope. According to the graph you produced in part a), how much time has elapsed since the rock's formation if the half-life of the isotope is 1 million years? **(1 mark)**

2.2–2.4 million years ← 1 mark

Note: was marked based on student's graph

7. The formation of a fossil from a living organism is a relatively rare event.

a) Describe **two** reasons why this is so.

(2 marks)

Any **two** for **2 marks**:

- **The organism must be buried rapidly by fine material before it decomposes.**
- **The organism must have hard parts that can fossilize.**
- **The organism could be scavenged before burial.**
- **The organism has to be in an appropriate environment (e.g. amber, freezing, tar ponds, low oxygen, anaerobic.)**

b) Once a fossil has formed, it is also unlikely to be found. Give **one** reason why this is so.

(1 mark)

Any **one** for **1 mark**:

- **Many fossil bearing rocks are still under water.**
- **Many fossil bearing rocks have been eroded away.**
- **Geologic processes may have destroyed the fossil.**
- **Fossil may be buried under many layers.**

**REFERENCE
DATA BOOKLET**

For question 8, refer to the following in the Data Booklet.

page vi: Photograph 9

8. Photograph 9 shows some perforated pipes used to drain water. Give **two** geological reasons why draining water may reduce the likelihood of a landslide.

(2 marks)

Any **two** for **2 marks**:

- **reduces the load of water on the hillside**
- **reduces pore pressure between particles and thus increases friction**
- **increases friction, especially with slippery clay minerals**

9. A fast-moving stream carrying sediment enters a lake. Describe what physically happens to each part of the sediment load within the next 10 minutes after the sediments enter the lake. (3 marks)

The *bed load* will stop moving first. ← 1 mark

The *suspended load* will gradually settle out of the water. ← 1 mark

The *dissolved load* will remain in solution. ← 1 mark

10. Human activities can affect the quality and quantity of groundwater.

a) Describe **one** way in which human activities can reduce the quality of groundwater. (1 mark)

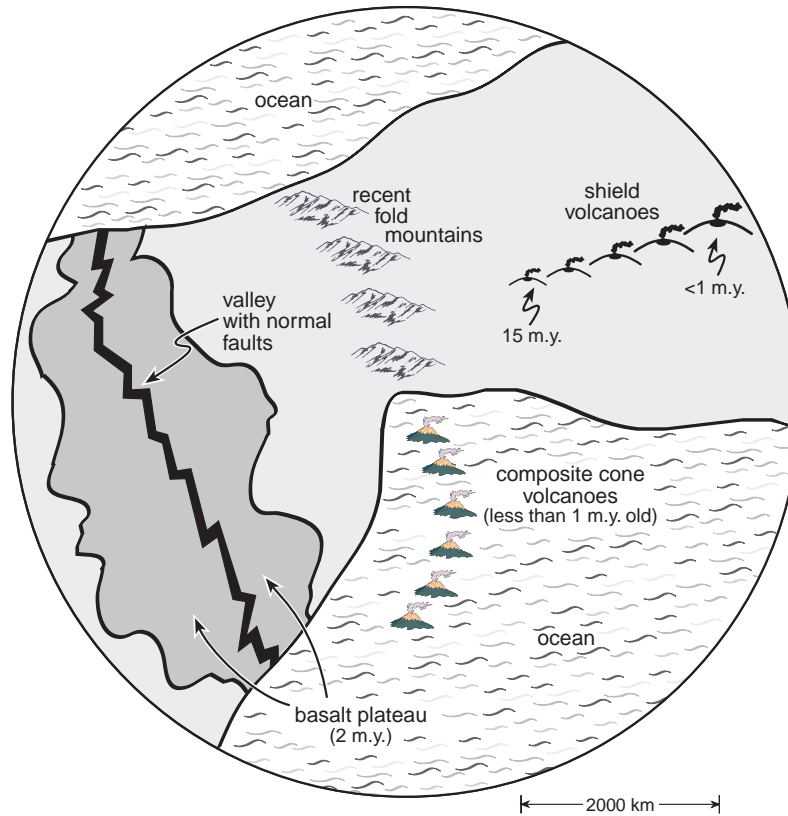
Either **one** for **1 mark**:

- **Waste from many sources (landfills, industry, farms, etc.) can leach into groundwater and contaminate it.**
- **Excessive withdrawal may lead to saltwater intrusion.**

b) Describe **two** ways in which human activities can reduce the quantity of groundwater. (2 marks)

- **Excessive withdrawal (by urbanization or agriculture or industry) may cause the water table to be lowered.** ← 1 mark
- **Urbanization may lead to a reduction in recharge by covering recharge zones.** ← 1 mark

Use the figure below of a map of a newly discovered planet to answer question 11.



11. The map shown above is of a newly discovered planet in a distant solar system. The surface features were plotted by a space probe sent to study the planet. Features on the map suggest that the planet has been affected by plate tectonics. List **three** features, and describe how each indicates that plate tectonics has occurred. **(3 marks)**

Any **three** features and descriptions for **3 marks**:

Feature: **fold mountains**

Description: **indicates possible collision boundaries**

Feature: **island arc volcanoes (composite cone volcanoes)**

Description: **indicates oceanic plate subduction**

Feature: **chain of shield volcanoes**

Description: **indicates probable hotspot under moving plate**

Feature: **rift valley**

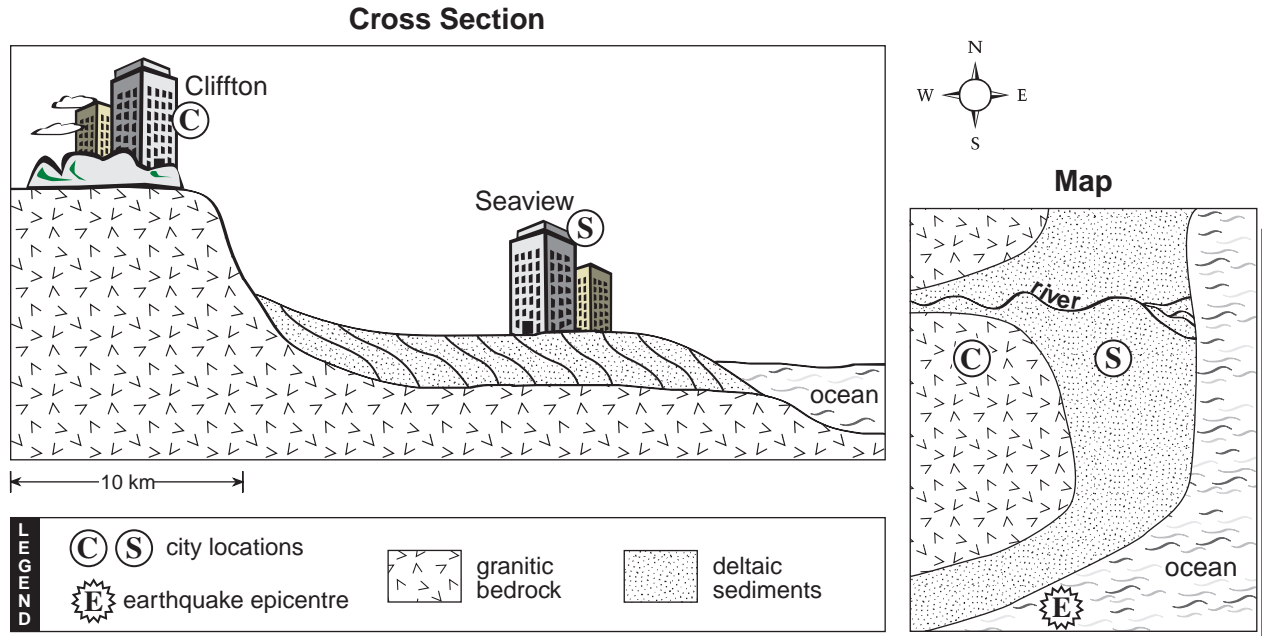
Description: **indicates possible continental rift zone**

Feature: **basalt flow**

Description: **indicates sub-surface molten layer – mechanism for plate tectonics**

Note: Marks awarded for correct descriptions, not the feature name.

Use the figures below of a cross section and map of two towns, Clifton and Seaview, to answer question 12.



12. a) The figures above show two towns of similar age and building construction standards. A magnitude 7.4 earthquake strikes south of Clifton and Seaview as shown on the map. How will the intensity of shaking in Seaview differ from that in Clifton? (1 mark)

The intensities will vary. The town of Seaview will experience greater shaking. ← 1 mark

b) Explain your reasons for a). (1 mark)

The town of Clifton is built on bedrock. Seaview is built on deltaic sediments which will cause more shaking to occur. } ← 1 mark

c) In addition to structural damage caused by the initial shaking, list and describe **two** other potential earthquake hazards for Seaview. **(2 marks)**

Any **two** hazards and descriptions for **2 marks**: ($\frac{1}{2}$ **mark** for hazard names, $\frac{1}{2}$ **mark** for descriptions)

Hazard: **flooding**
Description: **caused by change in elevations around the river**

Hazard: **liquefaction**
Description: **water seeping into unconsolidated sediments amplifies the shaking effect on structures**

Hazard: **landslide damage**
Description: **from the edge of the cliff wall collapsing**

Hazard: **tsunami, seismic sea wave**
Description: **caused by plate shifting under the ocean**

Hazard: **landslide damage**
Description: **deltaic sediments slide into the ocean**

d) Pick **one** hazard and describe specifically what the people of Seaview could do to prepare themselves in order to minimize the potential damage caused by the earthquake. **(1 mark)**

Any **one** feature and description for **1 mark**: (mark awarded for description)

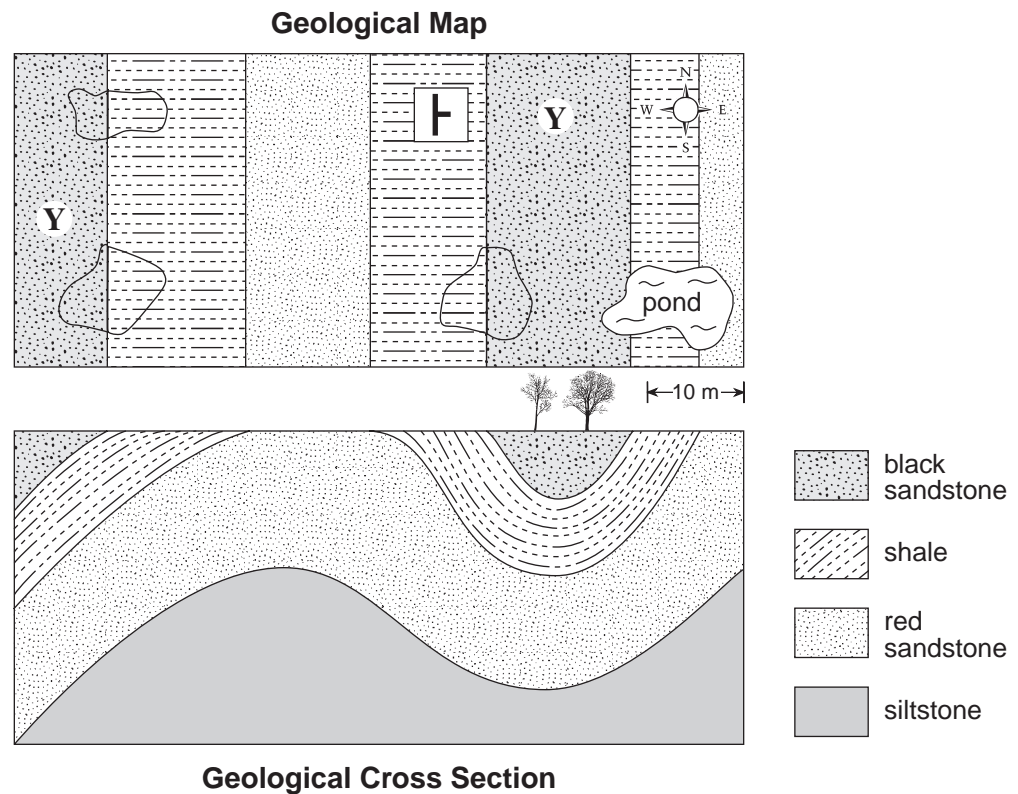
Hazard: **flooding**
Preparation: **levees along the river to stop flooding**

Hazard: **building structure**
Preparation: **use better structural support for building foundations**

Hazard: **landslide**
Preparation: **install rock bolts, walls, fencing or mesh. Remove overburden, lower slope to minimize the effects of a landslide.**

Hazard: **tsunami**
Preparation: **have a warning system, and corresponding action plan**

Use the following partial map and completed cross section of sedimentary rock layers to answer question 13.



13. a) Using information from the cross section, complete the geological map. **(2 marks)**

See geological map above.

Mark breakdown: $\frac{1}{2}$ mark for accurate contacts

$\frac{1}{2}$ mark for layer labelling

1 mark for basic straight lines in approximately the right place

b) Place the correct strike and dip symbol in the box shown on the geological map. **(1 mark)**

1 mark for a correct placement of the strike and dip symbol.

c) Place a Y on the youngest rock unit of the geological map. **(1 mark)**

1 mark for a correct placement of Y.

14. Classified as an inner planet, Mercury shares some characteristics with both Venus and Earth, including density and composition. List and describe **two** features which make Mercury **different** from Venus and Earth. (2 marks)

Any **two** features and descriptions for **2 marks**:

Feature	Description
1. Atmosphere	<ul style="list-style-type: none"> • Mercury doesn't have one.
2. Cratering	<ul style="list-style-type: none"> • Mercury is severely cratered. • Earth has geologic processes that have hidden or eroded most craters.
3. Orbital distance	<ul style="list-style-type: none"> • Mercury is much closer to the sun than Earth or Venus
4. Moisture	<ul style="list-style-type: none"> • It is virtually non-existent on Mercury. There is speculation there may be frozen water (ice) in craters at north and south poles.
5. Period of revolution	<ul style="list-style-type: none"> • Mercury's orbital period is 1/4 that of Earth and less than 1/2 the orbital period of Venus.
6. Temperature differences/extremes	<ul style="list-style-type: none"> • Venus has an average surface temperature of about 475° C. Earth approximately 22° C. Mercury approximately +350° C to -170° C.
7. Equatorial radius	<ul style="list-style-type: none"> • Mercury is smaller, Venus and Earth are similar and larger.
8. Volcanics	<ul style="list-style-type: none"> • There are volcanoes on Earth and Venus, but not on Mercury.
9. Mass	<ul style="list-style-type: none"> • Mercury is less massive, Venus and Earth are similar and larger.
10. Orbital shape	<ul style="list-style-type: none"> • Mercury's orbit is more circular than Venus and Earth's.

END OF KEY