

# Geology 12

June 1999 Provincial Examination

## ANSWER KEY / SCORING GUIDE

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- 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	T	PLO	Q	K	C	T	PLO
1.	B	K	1	B1	29.	B	U	3	K3
2.	A	U	1	B3, 2	30.	C	U	3	K6
3.	D	H	1	F3	31.	D	H	3	K1, 7
4.	D	U	1	B2, 3	32.	B	H	3	K2, 7
5.	B	U	1	C4	33.	C	H	3	K3, 7
6.	D	H	1	C3	34.	B	U	3	L2, 3
7.	B	U	1	C6, 7	35.	A	U	3	L6
8.	A	U	1	C8	36.	C	U	3	L5
9.	A	U	1	D4	37.	A	K	3	L1
10.	C	U	1	D3	38.	A	U	3	M1
11.	A	K	1	E6	39.	A	K	3	N3
12.	D	U	1	E1	40.	C	U	3	O6
13.	D	U	1	E4	41.	B	H	3	O9
14.	C	U	1	F4	42.	B	U	3	O3
15.	B	H	1	F2	43.	C	U	3	O2
16.	C	U	1	F7	44.	A	U	3	O4
17.	D	U	1	F8	45.	D	K	4	P2
18.	B	K	2	G1	46.	A	U	4	P4
19.	A	K	2	G2	47.	C	U	4	Q3
20.	B	U	2	G2	48.	D	U	4	Q4
21.	A	H	2	G4	49.	D	U	4	R1
22.	D	H	2	H2	50.	D	U	4	R2
23.	B	U	2	I1	51.	B	U	4	S1
24.	A	U	2	J2	52.	D	U	4	S2
25.	D	U	2	J3	53.	C	H	5	T3
26.	C	U	2	J4	54.	A	K	5	T3
27.	C	H	2	J6	55.	C	U	5	T2
28.	B	U	2	J7, I1					

**Multiple Choice = 55 marks**

**Part B: Written Response**

<b>Q</b>	<b>B</b>	<b>C</b>	<b>T</b>	<b>S</b>	<b>PLO</b>
1.	1	U	1	3	A1, 2
2.	2	H	1	4	F1, 6
3.	3	U	1	7	C1, 8
4.	4	U	2	4	J7
5.	5	K	2	4	H1
6.	6	U	3	6	L4, N1, 2, 3
7.	7	H	3	3	O7, 9, 10
8.	8	U	3	4	K3, 4
9.	9	H	2	4	R1, 2
10.	10	U	2	3	S2, 4
11.	11	H	5	3	T1

**Written Response = 45 marks**

Multiple Choice = 55 (55 questions)

Written Response = 45 (11 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.

1. The element of “time” makes geology unique from other science disciplines. Some geological processes occur at such slow rates that they are almost imperceptible, while others are very rapid. Describe a geological process that occurs at a slow rate and a geological process that occurs at a rapid rate. Include an appropriate rate with correct units for each process. **(3 marks)**

- a) i) Geological process that occurs at a slow rate:  
ii) Appropriate rate with correct units:

Any one for  $1\frac{1}{2}$  marks:

- **Movements associated with plate tectonics, sea floor spreading, etc. (2 to 16 cm per year).**
- **Chemical and physical weathering (cm per century).**
- **Some types of erosion. River down-cutting may be 1 to 10 cm per year or much slower depending on the rock type, uplift, etc. Soil creep (mm to cm per year).**
- **Mountain building (mm to cm per year on average).**
- **Sedimentary deposition (mm to cm per year).**

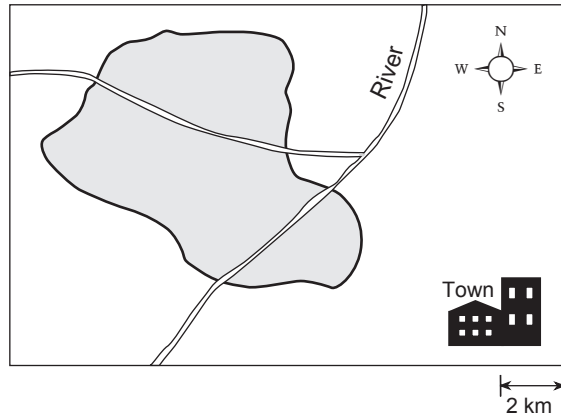
- b) i) Geological process that occurs at a rapid rate:  
ii) Appropriate rate with correct units:

Any one for  $1\frac{1}{2}$  marks:

- **Volcanic eruptions (lava flows - 1 cm/hour to 50 km per hour).  
(Explosions – hundreds of km per hour).**
- **Catastrophic erosional events – e.g., debris flows (hundreds of km per hour).**
- **River flood deposition (cm to metres per day).**
- **Earthquake (energy) release and propagation (km per second).**
- **Fault movement (metres per second).**
- **Meteorite impact (very fast).**

Note: **1 mark** for each description and  $\frac{1}{2}$  **mark** for each appropriate rate.

Use the following sketch map to answer question 2.



2. The shaded area shown on the map represents fractured volcanic rock that has been intruded and altered by mineral veins. Exploration of the area has found concentrations of chalcopyrite, galena and sphalerite.

a) Name and describe the process **most likely** responsible for the formation of this deposit.

(2 marks)

Name: • **Hydrothermal deposition / volcanogenic / massive sulphide.** ← 1 mark

• **“Intrusive body.”** ← ½ mark

Description: **A hot, mineral and water-rich solution, possibly derived from a magma, that has intruded the volcanic rock along veins and has altered both the volcanic rock and deposited ore minerals, or description of vents / smokers.**

} ← 1 mark

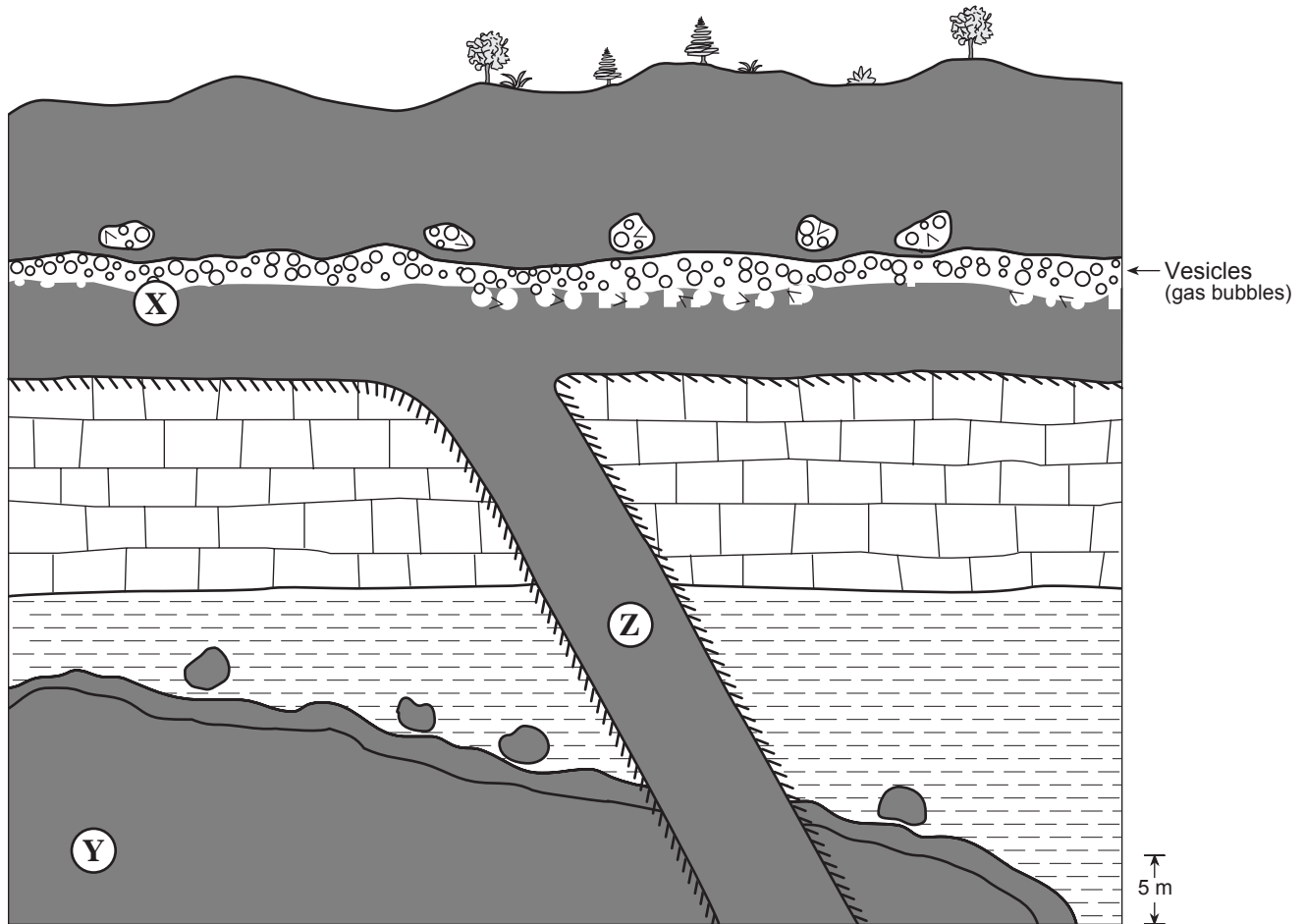
b) Describe **two** specific factors that must be considered before developing a mine in the area.








(2 marks)

Any **two** for 2 marks:

- **Is there sufficient ore to make mining worthwhile?**
- **Is the river likely to flood mine workings?**
- **Are the prices of the ore metals high enough to make mining worthwhile?**
- **Is the mine close enough to a smelter (transport costs) to make mining worthwhile?**
- **Concentration factor/ore grade.**
- **Is there any possibility of the river being polluted during mining and milling activities?**
- **Will there be any air pollution (dust/gases) that may affect the nearby town?**
- **Other environmental factors.**

Use the cross-section diagram below to answer question 3.



- |  |   |   |
|--|---|---|
|  Conglomerate                                 |  Limestone                 |  Shale |
|  Coarse-grained igneous rock                  |  Fine-grained igneous rock |   |
|  Pitted, rusty alteration to the igneous rock |  Contact metamorphism      |   |

3. a) Describe **two** features, visible in the cross section, which show that the contact between rock unit **Y** and the shale is an erosion surface. **(2 marks)**

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

- **Inclusions of Y within the shale.**
- **Rusty, pitted alteration/weathering on the top surface of rock unit Y.**
- **Uneven contact surface.**
- **Unconformity.**
- **Shale contact is not metamorphosed.**

b) The fine-grained rock unit **X** has been identified as a lava flow.

(2 marks)

i) Explain how the gas bubbles present show that rock unit **X** is not a sill.

**If rock unit X were a sill, the confining pressure of the surrounding rock would have prevented the dissolved gases from expanding and forming bubbles.**

} ← 1 mark

ii) Describe **one** other piece of evidence that could be used to show that rock unit **X** is not a sill.

**Either answer for 1 mark:**

- **There are inclusions of rock unit X in the overlying conglomerate.**
- **Rock unit X has contact metamorphosed the rocks below but not the ones above.**

c) Rock unit **Z** shows a difference in crystal sizes across its width.

(2 marks)

i) Describe a **specific** location where the smallest crystals would be found and explain why they would be found there.

Location: **At the edges of dyke Z or chilled margin of Z.**

} ← 1 mark

Explanation: **At the edges of dyke Z, where it is in contact with the (cooler) country rock, the magma would cool fastest and thus smaller crystals would form.**

} ← 1 mark

d) Describe a change that could be observed in the texture of the limestone at its contact with rock unit **X**.

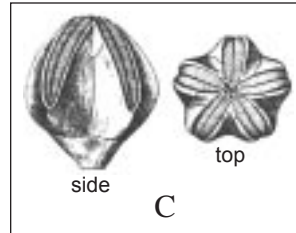
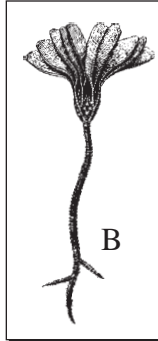
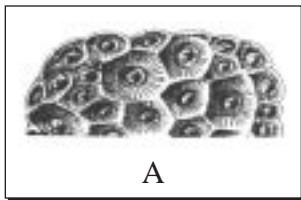
(1 mark)

**Any one for 1 mark:**

- **Recrystallization from a sedimentary texture to a granular, non-foliated texture.**
- **Recrystallization/elimination of any fossils present.**
- **Elimination of any porosity. A denser rock would result.**

$\frac{1}{2}$  mark for “marble”

4. The following four fossils are in a collection.



a) Which fossil seems out of place with the others?

**(1 mark)**

**Fossil D.**

**← 1 mark**

b) Give **two** reasons for your conclusion in a) above.

**(2 marks)**

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

- **Fossil D is non-marine, and therefore it is unlikely to be located with ocean/marine fossils.**
- **Fossil D was not alive at the time of the other fossils, and not alive at the time of deposition.**
- **Fossil D is a plant.**
- **Fossil D probably carbonized while others did not.**

c) What is the maximum time-span, in millions of years, represented by this fossil collection?

**(1 mark)**

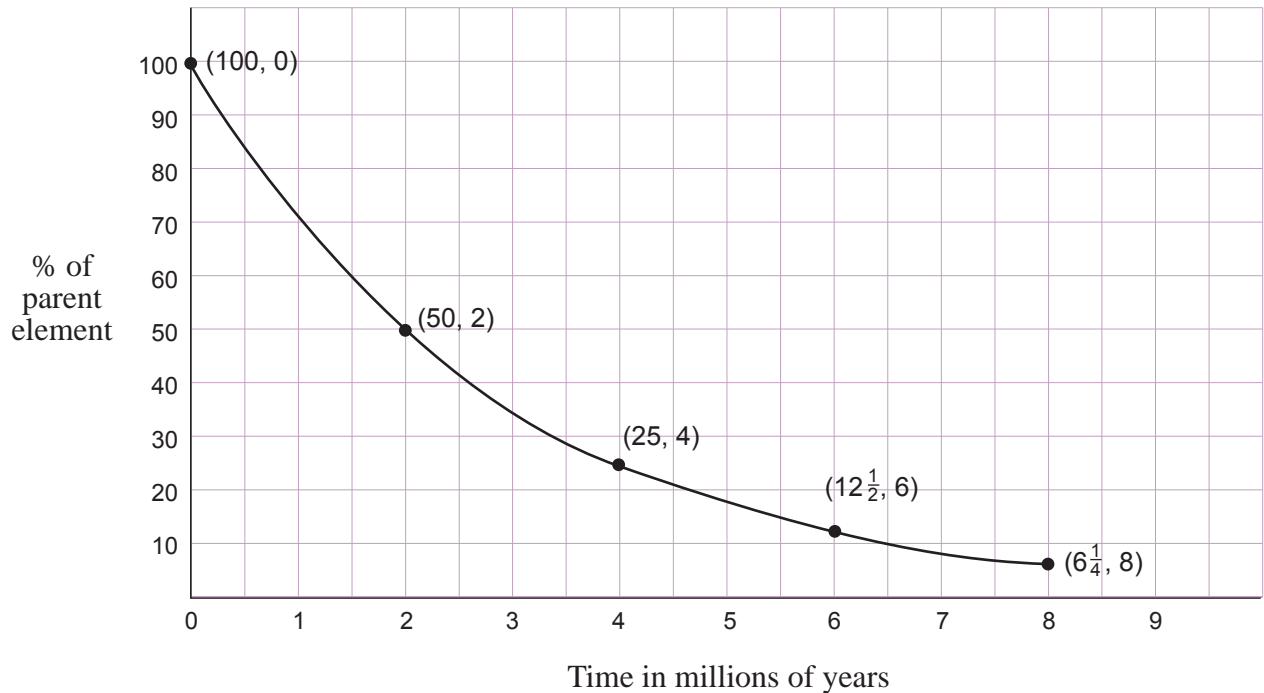
- **74 m.y. or 360 – 286 m.y.**
- **“Carboniferous”**

**← 1 mark**

**←  $\frac{1}{2}$  mark**

5. a) On the grid below, sketch a radioactive decay curve for an element with a half-life of 2 million years. Your sketch must contain: **(3 marks)**

- Appropriately labelled vertical and horizontal axes.
- Smooth and clearly drawn decay curve for four half-lives.



**1 mark for appropriately labelling “% of parent element” (y-axis), and “time” (x-axis).**

**1 mark for having the decay curve drawn smoothly.**

**1 mark for having the correct half-life labelled, i.e., 2 million years at 50%.**

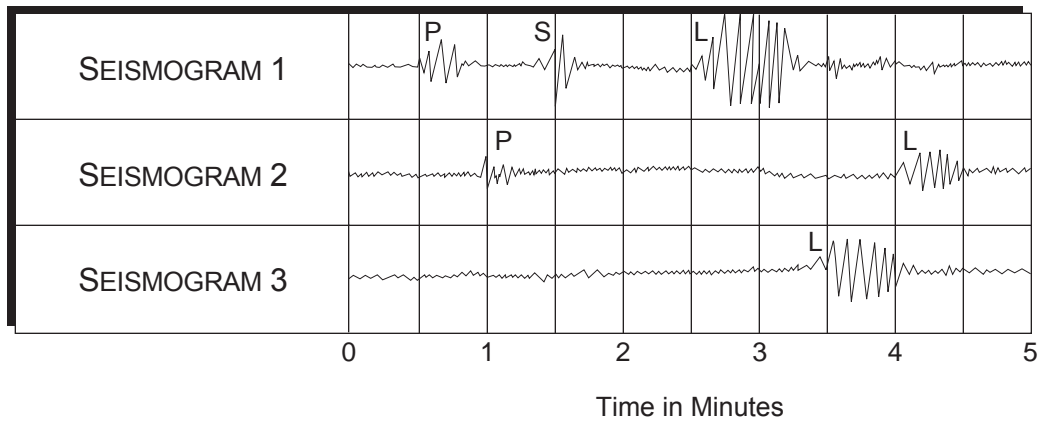
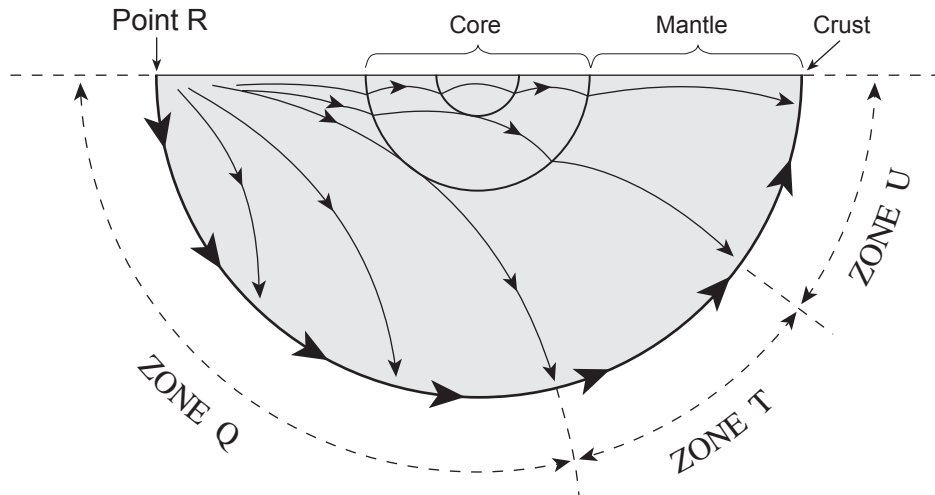
b) Describe **one** problem associated with radiometric dating of a heavily-weathered conglomerate. **(1 mark)**

**Either answer for 1 mark:**

- **Dating matrix or fragments not time of formation of rock.**
- **Weathering and erosion could bring in/take away parent and daughter material (weathering adjusts parent/daughter ratio).**



Use the following cross section of the earth and seismograms 1, 2 and 3 to answer question 6.



6. The diagram shows part of a cross section through the earth together with some typical paths taken by seismic waves from an earthquake at point **R**. Seismometers set up in each of the three zones, **Q**, **T** and **U**, produced the three seismograms that are shown for this earthquake.

a) What is the difference in arrival times of the P-waves between seismograms 1 and 2? (1 mark)

**0.45 – 0.5 minutes or 25-30 seconds.**

← 1 mark

b) Describe **one** other difference in the recorded P-waves that you can see between seismograms 1 and 2.

(1 mark)

**The amplitude of the P-waves in seismogram 1 is larger than it is in seismogram 2.**

} ← 1 mark

c) Suggest a reason for the differences identified in a) and b).

(1 mark)

Either answer for 1 mark:

- Seismometer 1 is closer to the earthquake than seismometer 2.
- Zone Q is closer than zone U.
  
- Different “location” or “area”. ←  $\frac{1}{2}$  mark

d) Explain why seismometer 2 did not receive any S-waves.

(1 mark)

The wave path to seismometer 2 is probably through the liquid outer core. As S-waves cannot be transmitted by liquids, they are missing from seismogram 2.

} ← 1 mark

$\frac{1}{2}$  mark for “It is in the shadow zone.”

e) Which seismogram was obtained from zone T?

(1 mark)

Seismogram 3.

← 1 mark

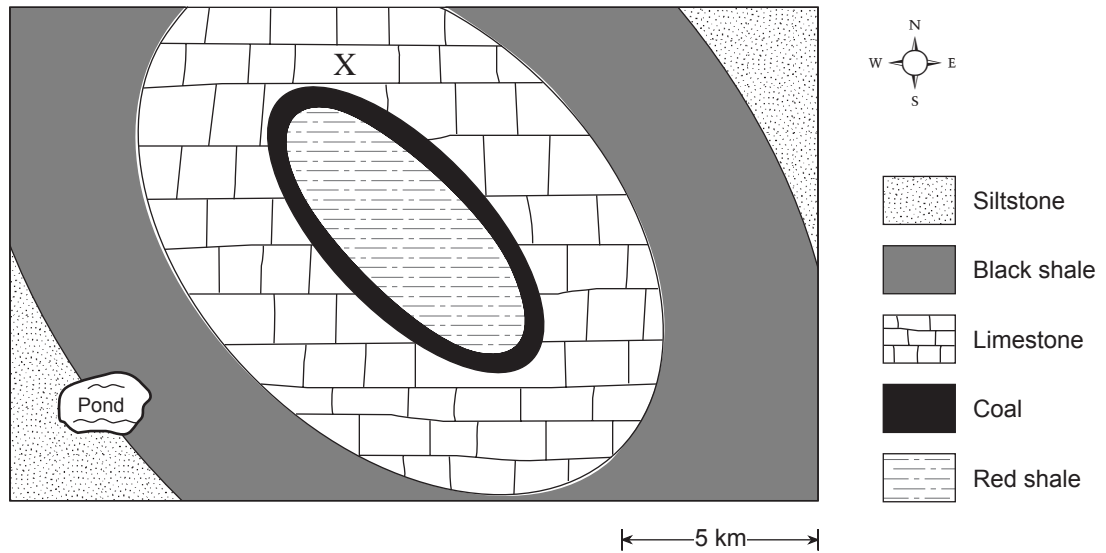
f) Which of the three types of seismic waves (P, S or L) follows the path around the earth’s surface?

(1 mark)

L-waves.

← 1 mark

Use the following sketch map of a geological structure to answer question 7.



7. The geological structure shown in the sketch map is either a dome or a basin.

a) Give evidence involving:

(2 marks)

- i) the dip and strike of the strata, and
- ii) the ages of the strata

that a geologist could look for to prove whether the structure is a dome or a basin.

i) Evidence using the dip and strike of the strata:

**Either answer for 1 mark:**

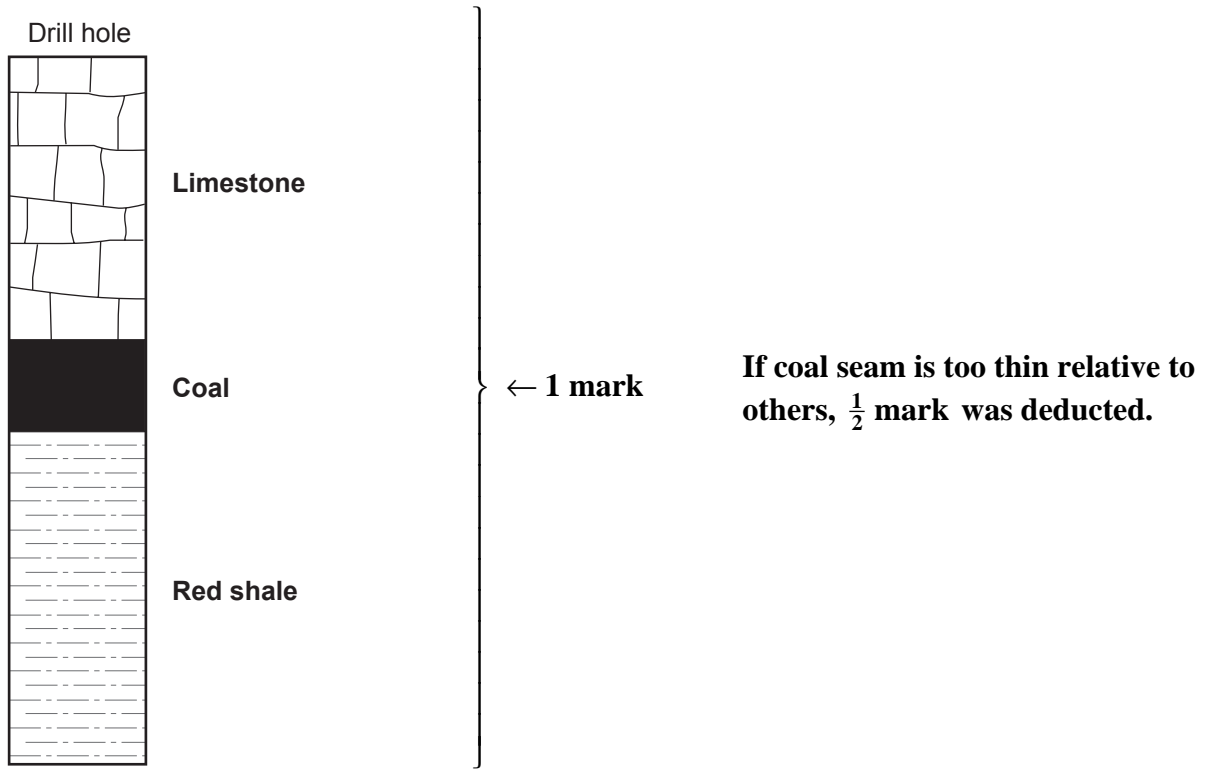
- If the structure is a dome, all the strata will dip away from the centre.
- If the structure is a basin, all the strata will dip toward the centre.

ii) Evidence using the ages of the strata:

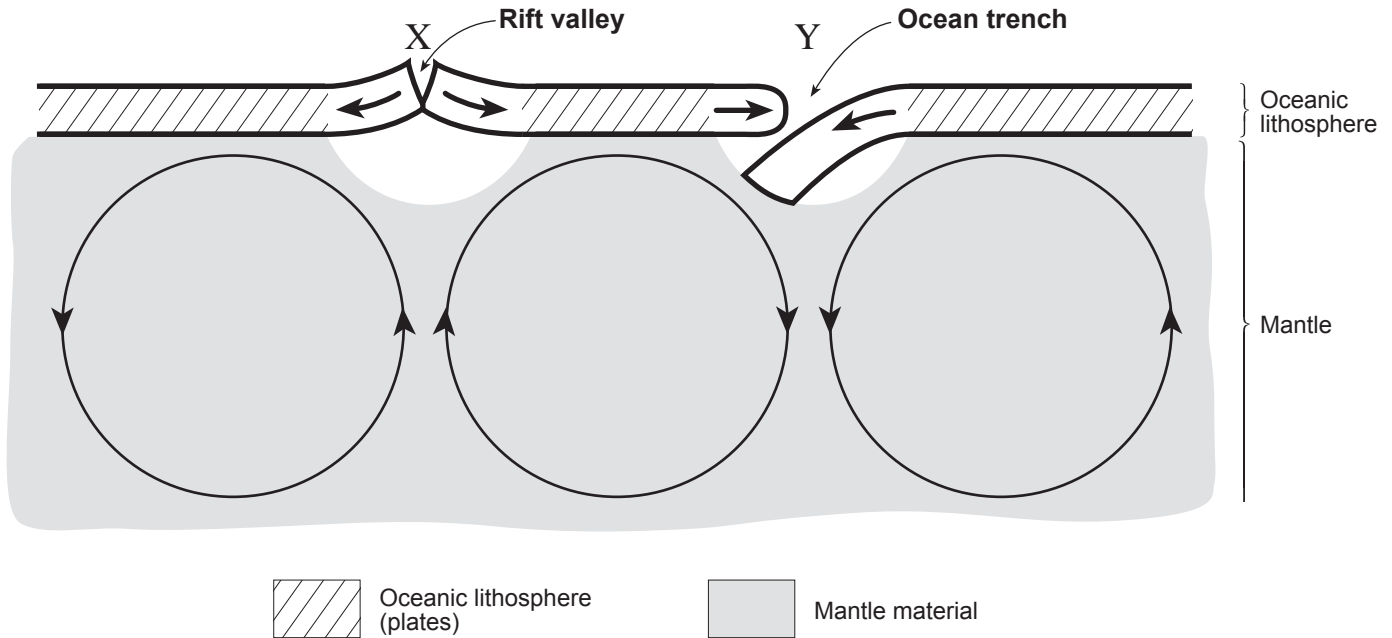
**Either answer for 1 mark:**

- If the structure is a dome, the oldest rocks will be in the centre.
- If the structure is a basin, the youngest rocks will be in the centre.

b) A vertical hole drilled at location **X** on the structure encountered three different rock strata. Assuming that the structure is a **dome**, sketch, in the space provided below, the first three strata that would be encountered in the drill hole. **(1 mark)**



Use the following cross section of three mantle convection currents and part of the oceanic lithosphere to answer question 8.



8. a) Explain what causes the mantle convection currents to rise and then fall. (1 mark)

**Mantle convection currents rise where they are hottest and consequently least dense. When the mantle material cools, it becomes denser again and sinks toward the bottom of the mantle.**

} ← 1 mark

b) Complete the oceanic plates appropriately in the gaps below **X** and **Y**. Label with arrows showing the direction of movement. (2 marks)

**See diagram.**

**Correct diagram** ← 1 mark

**Correct arrows** ← 1 mark

Note: Subducting side does not matter. Rise at X not required.

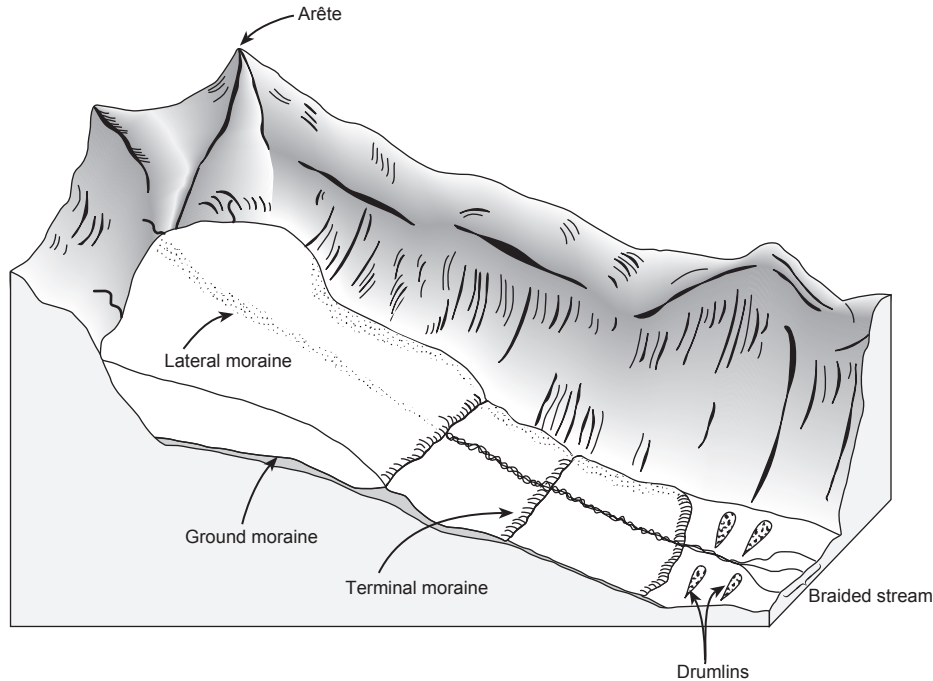
c) On the completed diagram, label an ocean trench and a rift valley. (1 mark)

**See diagram.**

**Correctly sketched and labelled rift valley** ←  $\frac{1}{2}$  mark

**Correctly sketched and labelled trench** ←  $\frac{1}{2}$  mark

Use the following cut-away sketch of a glacier in a valley to answer question 9.



9. The sketch above was drawn from memory by a geology student. A few errors were made in the details and the labelling of the sketch. Name **four** such errors, and describe how the drawing could be corrected. **(4 marks)**

Any **four** for **4 marks**:

Error 1 and correction:

**A horn has been labelled as an arête. The arête would be a knife-like edge between the horns.**

Error 2 and correction:

**A medial moraine has been labelled as a lateral moraine. The lateral moraine would be at the valley side of the ice.**

Error 3 and correction:

**A recessional moraine has been labelled as a terminal moraine. The terminal moraine would be the farthest one down the valley.**

Error 4 and correction:

**The drumlins are pointing in the wrong direction. The pointed ends should be pointing down the valley.**

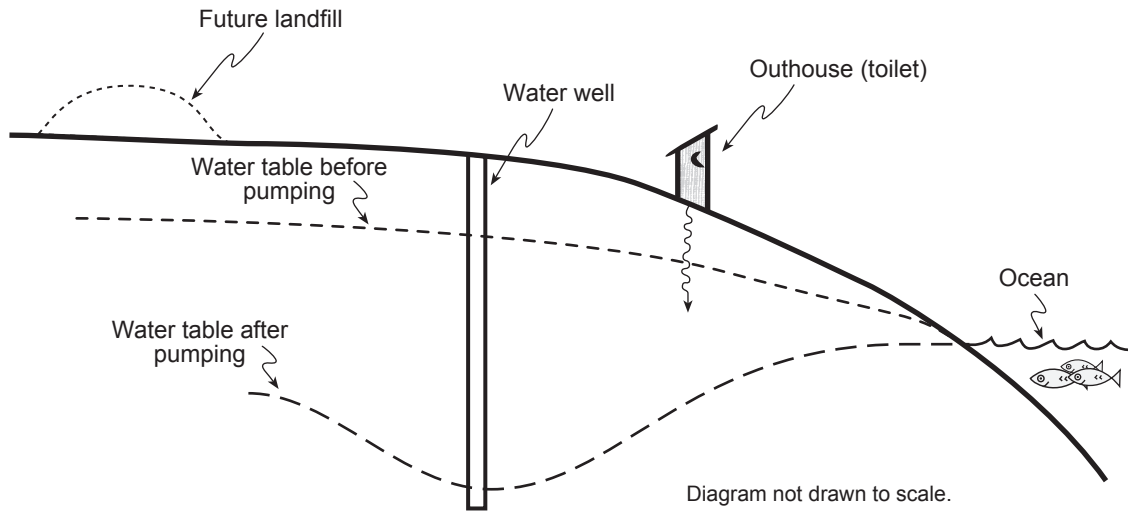
Error 5 and correction:

**Drumlins are not usually associated with alpine glaciation. They should not appear on the diagram.**

Error 6 and correction:

**Braided stream should be closer to terminus.**

Use the following cross section of a water well to answer question 10.



10. a) The people using the water well in the diagram above should be very concerned about the quality of their water supply. Describe **two** existing problems for a well in this location.

**(2 marks)**

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

- **Waste from the outhouse could leach into the water supply.**
- **Saltwater from the ocean could reach the water table.**
- **High use/low recharge in the summer could lead to the use of bottom water.**
- **The well would become dry.**

b) What measures could be taken to prevent material from the future landfill site from leaching into the water supply?

**(1 mark)**

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

- **Line the base of the landfill with clay.**
- **Line the base of the landfill with plastic.**
- **Cover the landfill to prevent rainfall reaching the landfill.**
- **Collection, removal, or treatment of leachates.**

11. Describe **three** characteristics of the planets of our solar system, other than distance from the sun, that justify their classification into inner and outer groups. As there is some question at this time whether Pluto is a planet, omit Pluto from your answer. **(3 marks)**

Any three for 3 marks:

	CHARACTERISTIC	INNER PLANETS	OUTER PLANETS
	<b>Example:</b> <i>Distance from the sun.</i>	<i>Four inner planets are closer to the sun.</i>	<i>Outer planets are farther away from the sun than inner planets are.</i>
1.	<b>Equatorial radius</b>	<b>Inner planets are small (2 440 km to 1.0 – relative to the earth).</b>	<b>Outer planets are much larger (24 000 to 71 400, excluding Pluto).</b>
2.	<b>Mass</b>	<b>Inner planets are small (0.0558 to 1 – relative to the earth).</b>	<b>Outer planets are very large (14.54 to 318 times the earth's mass).</b>
3.	<b>Density</b>	<b>Inner planets have a high density (3.94 – 5.520)</b>	<b>Outer planets have a low density (0.69 – 1.31)</b>
4.	<b>Number of moons</b>	<b>Inner planets have very few moons (0 to 2).</b>	<b>Outer planets have many moons (8 to 16).</b>
5.	<b>Planetary spacing</b>	<b>Inner planets are closely spaced.</b>	<b>Outer planets are widely spaced.</b>
6.	<b>Presence of rings</b>	<b>Inner planets don't have any rings.</b>	<b>Outer planets have rings.</b>
7.	<b>Composition</b>	<b>Inner planets are rocky.</b>	<b>Outer planets are gaseous.</b>
8.	<b>Surface temperature</b>	<b>Inner planets have temperatures above <math>-23^{\circ}\text{C}</math>.</b>	<b>Outer planets have temperatures below <math>-150^{\circ}\text{C}</math>.</b>
9.	<b>Gravitational field strength</b>	<b>Weak</b>	<b>Strong</b>
10.	<b>Orbital period</b>	<b>Short</b>	<b>Long</b>

END OF KEY