Geology 12

August 2005 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	T	PLO	Q	K	C	S	T	PLO
1.	B	U	1	1	B1	29.	D	U	1	3	K1
2.	C	U	1	1	B2, 3	30.	D	K	1	3	K3
3.	B	U	1	1	B3	31.	B	U	1	3	K4
4.	C	U	1	1	B2	32.	A	U	1	3	K6
5.	C	U	1	1	C3	33.	D	U	1	3	K7; O3
6.	D	U	1	1	C3; G2, 5, 6, 7	34.	C	U	1	3	L1
7.	B	U	1	1	C6	35.	D	U	1	3	L3
8.	A	K	1	1	C7	36.	B	K	1	3	L4
9.	C	U	1	1	C1, 2	37.	B	U	1	3	N3
10.	A	H	1	1	D1	38.	C	U	1	3	N1, 3
11.	D	U	1	1	D3	39.	C	U	1	3	N3
12.	D	U	1	1	D4	40.	A	U	1	3	O1
13.	C	U	1	1	D3; A4	41.	A	K	1	3	O8
14.	C	U	1	1	E1	42.	D	H	1	3	O6
15.	B	U	1	1	E2	43.	B	U	1	3	O4, 7
16.	A	K	1	1	F3	44.	D	U	1	3	O7, 4
17.	A	U	1	1	F8	45.	B	U	1	4	P1
18.	D	K	1	2	G1	46.	A	H	1	4	P2
19.	C	H	1	2	G4	47.	A	K	1	4	Q3
20.	D	U	1	2	H2	48.	A	U	1	4	P4
21.	D	U	1	2	H4	49.	B	U	1	4	S2
22.	C	K	1	2	I1	50.	D	H	1	4	Q4
23.	C	U	1	2	J1	51.	A	U	1	4	R1
24.	B	K	1	2	J2	52.	D	K	1	4	R1
25.	D	K	1	2	J3	53.	C	U	1	5	T1
26.	A	H	1	2	J4	54.	D	U	1	5	T2
27.	B	K	1	2	J6	55.	C	H	1	5	T3
28.	C	U	1	2	J7						

Multiple Choice = 55 marks

Part B: Written Response

Q	C	S	T	PLO
1.	H	4	1	A5; C2; D1; E1; K8
2.	U	2	1	D4
3.	H	6	1	B2, 3; F3; Q3
4.	U	2	2	G5, 2
5.	H	2	2	H2, 3
6.	U	7	2	I2; F7, 6; J4, 6; G2
7.	U	4	3	L4
8.	U	4	3	O5, 3
9.	U	2	3	K2, 3, 7; O10
10.	U	2	3/4	M1; R2
11.	H	3	4	S2, 4
12.	U	2	4	P2, 3; B2
13.	U	2	4	P5
14.	U	3	5	T3, 4

Written Response = 45 marks

Multiple Choice = 55 (55 questions)
Written Response = 45 (14 questions)
EXAMINATION TOTAL = 100 marks

LEGEND:

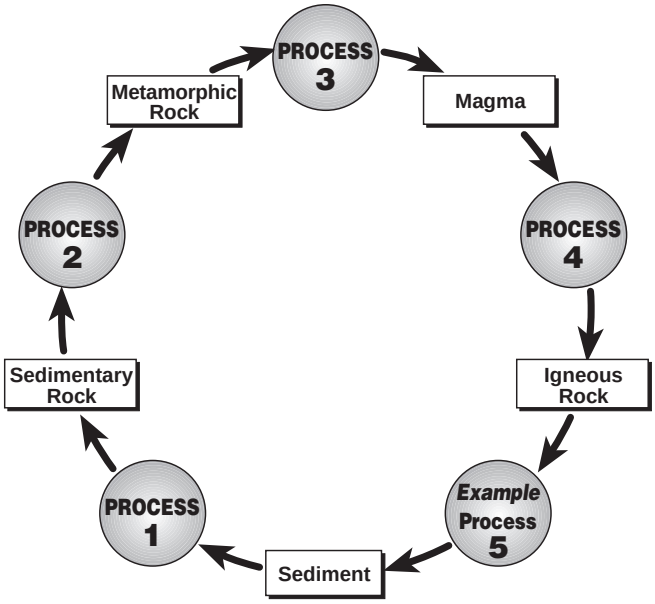
Q = Question Number **K** = Keyed Response **C** = Cognitive Level
S = Score **T** = Topic **PLO** = Prescribed Learning Outcome

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.

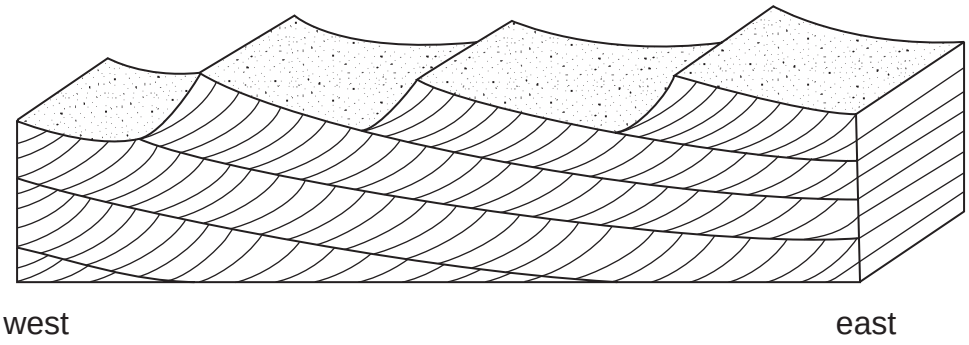
Use the following partial, simplified, rock cycle diagram to answer question 1.



1. Choose any **two** processes from the diagram above. For each process, describe the process and its probable plate tectonic location. An example is given. **(4 marks)**

Process #	Description of Process	Plate Tectonic Location
*Example: **Process 5***	***Igneous rocks** in volcanic mountains are weathered and eroded to become **sediments**.*	*Volcanic mountain range at converging plates.*
1	**Sediment is carried to the ocean by streams and deposited in layers that are then lithified to become sedimentary rock.**	**Ocean trenches at subduction zones.**
2	**Sedimentary rocks are heated near plutons or under extreme pressure in collision zones, which causes them to become metamorphic.**	**Near plutons or tectonic collision zones.**
3	**Rocks are melted at depth to become magma.**	**Subducting plate at a depth of 200–300 km.**
4	**Magma cools as it exits the earth, becoming an igneous rock.**	**Volcano or spreading ridge.**

Use the following diagram of ripple marks and cross-bedding to answer question 2.



2. Describe how this structure might have formed. Include direction of flow in your answer.

(2 marks)

Fluid transporting sand-sized sediment travelled from east to west. Sediment was transported up the gentle slope of the first ripple, then deposited over and down the slip face in a tilted layer.

← **2 marks**

Use the following description of a mineral to answer question 3.

"A valuable mineral X forms mainly in hydrothermal veins, often associated with quartz and sulphide minerals. It is often found in placer deposits of unconsolidated sand, as well as sandstone and conglomerate. It may be confused with pyrite and chalcopyrite because of its similar appearance, but is easily distinguished on the basis of its higher density."

3. a) i) What is mineral **X**? **(1 mark)**

gold ← 1 mark

Note: If gold is not chosen, marks can still be awarded for following questions.

ii) Describe another test and its results that would distinguish mineral X from pyrite and chalcopyrite. **(2 marks)**

$\frac{1}{2}$ mark for each box. Total 2 marks.

Test	Result for Mineral X	Result for Pyrite	Result for Chalcopyrite
1. Streak	yellow	greenish-black	black
2. Form	flakes, grain, massive	cubic dodecahedral	tetrahedral
3. Hardness	2.5 – 3.0	6.0 – 6.5	3.5 – 4.0

b) Describe how a placer deposit forms. **(2 marks)**

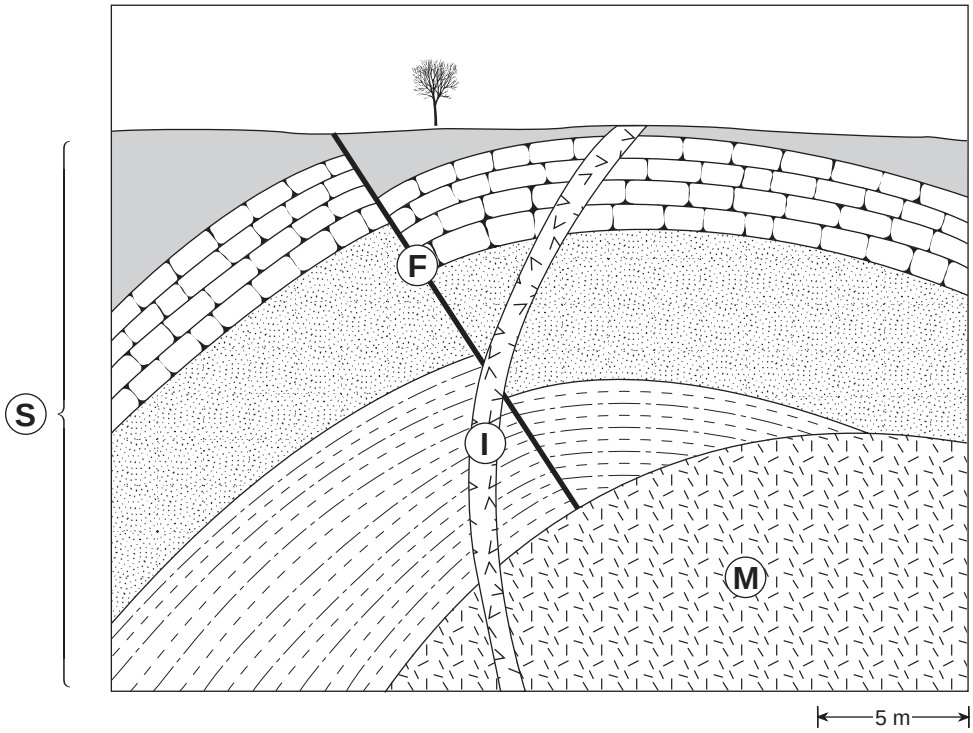
Sediments weathered from rock are transported. Dense grains are harder to transport and tend to be deposited more easily than lighter, silicate minerals. Grains of gold are thus often found in sand or gravel deposits. Alluvial placer deposits are found most often where stream velocity drops. ← **2 marks**

c) Chalcopyrite is mined so that copper can be extracted from it. Describe one use of copper. **(1 mark)**

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

- **water pipes**
- **electrical wiring**
- **cooking pots**
- **component of alloys bronze and brass**
- **copper sulphate is used to control moss**

Use the following geologic cross section to answer question 4.



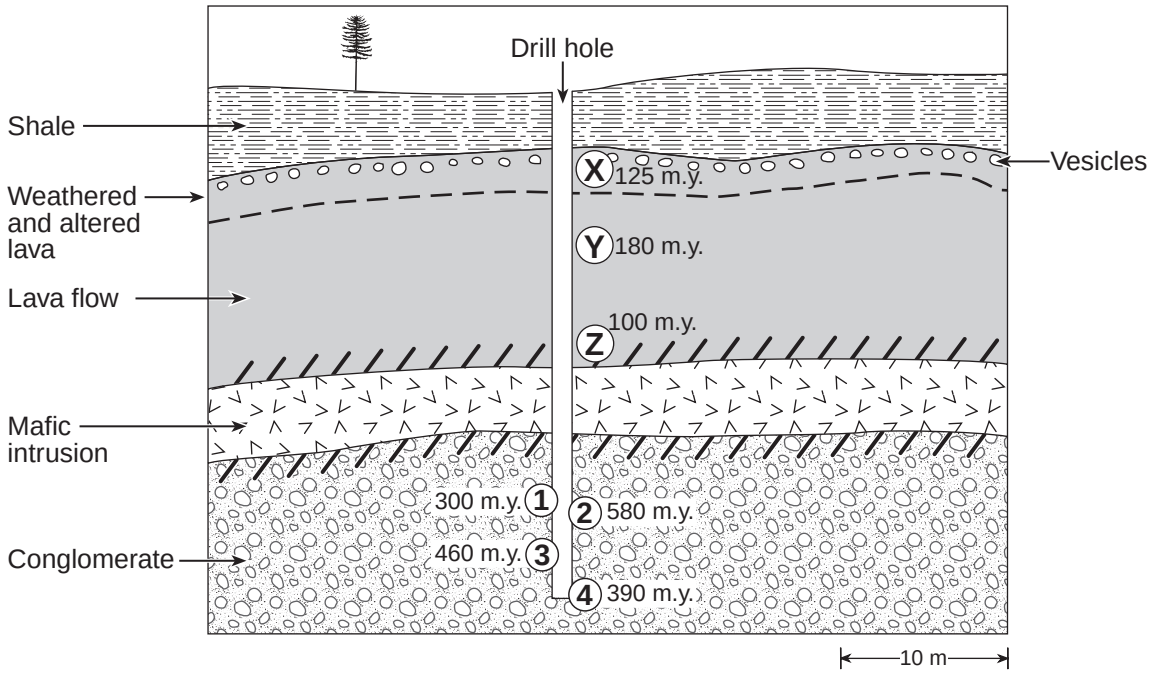
Geologic event (arranged in random order)	Cross section symbol
Faulting	F
Igneous intrusion	I
Mafic intrusion	M
Deposition of sedimentary unit	S

4. In the table below, place these geologic events in the order they occurred, with the oldest at the bottom and the youngest at the top. **(2 marks)**

$\frac{1}{2}$ mark for each correct geological event.

Youngest
I – Igneous intrusion
M – Mafic intrusion
F – Faulting
S – Folding of sedimentary unit
Oldest

Use the following geologic cross section to answer question 5.



5. The diagram shows a hole drilled through layers of rock to a conglomerate.
The potassium-argon method was used to date a buried lava flow at **X**, **Y** and **Z**.
Each measurement was done accurately, but gave different ages for the same formation.
The true age of the lava flow is 180 million years.

   a) Choose the lava at either **X** or **Z** and explain why its radiometric age differs from the age at **Y**. **(1 mark)**

Lava location chosen: **X**

Explanation:

Argon gas may have escaped from the sample causing a younger reading. ← **1 mark**

Lava location chosen: **Z**

Explanation:

Contact metamorphism "adjusted" the radiometric date compared to the samples at Y. ← **1 mark**

or

Argon gas may have escaped from the sample causing a younger reading.

Lava location chosen: **Z**

Explanation:

A slight error in depth measurement could mean the second reading might have come from the mafic intrusion. } ← **1 mark**

b) Four separate samples of conglomerate were dated using the uranium-lead method. Their ages were determined to be 300 million years, 390 million years, 460 million years and 580 million years.

Explain why there are differences in age between the conglomerate samples. **(1 mark)**

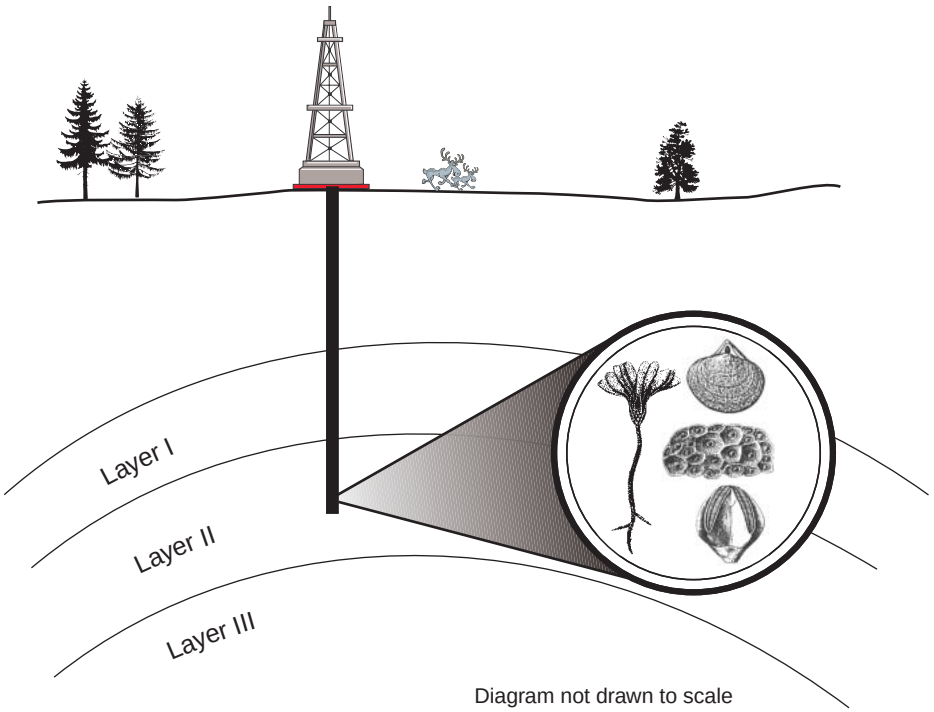
Different clasts in the conglomerate would yield different ages, not the age of the conglomerate layer itself. } ← **1 mark**

Reference Data Pages in the Appendix

For question 6, refer to the diagram below and to the following references in the Appendix.

page 2: Geological Time Scale
page 3: Fossil Samples

The diagram shows a drilling operation in Northeastern BC.
Each rock layer represents a different geologic period.



6. While drilling, geologists found a rock layer containing the fossils shown in the diagram above.

   a) In what type of environment did the ancient organisms that left these fossils live? **(1 mark)**

(shallow) marine ← **1 mark**

b) Based on the diagram above, suggest a fossil from the chart of fossil samples that might be found in layer III, and describe the reason for your selection. **(2 marks)**

Fossil number: **7, 10, 11, 12, 15 or 17** ← **1 mark**

Reason: **right Period or right environment** ← **1 mark**

c) Suggest a reason why it would be unlikely to find fossil 16 in layer II. **(1 mark)**

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

- **Fossil 16 is the wrong Period for layer II.**
- **Layer II would be the wrong environment for fossil 16.**
- **Fossil 16 is terrestrial.**

d) The rock found in layer I has a high porosity but a low permeability.

i) Describe why a rock might have high porosity. **(1 mark)**

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

- **The rock may have rounded sediment particles with large spaces in between.**
- **The shape of the sediments in the rock contributes to void space between the sediments.**
- **The rock may be vesicular (contain holes).**
- **The rock may have many fractures (i.e., limestone).**

ii) Describe why a rock might have low permeability. **(1 mark)**

Either one for **1 mark:**

- **The low permeability might be due to small grain size, e.g., mud or shale.**
- **The low permeability must be due to the pores not being well connected, e.g., pumice or vesicular basalt.**

iii) If layer I were an oil reservoir, and 3 km underground, explain why an oil company might decide **not** to extract the oil from this layer. **(1 mark)**

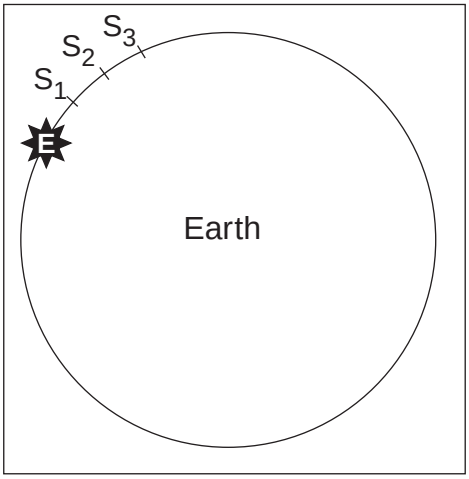
Any **one** for **1 mark:**

- **The oil company might not decide to extract the oil because it would be hard to extract.**
- **The oil reservoir may be too small to make it worthwhile developing.**
- **There may be environmental issues.**
- **There may be land claim issues.**
- **Too far from major pipelines.**

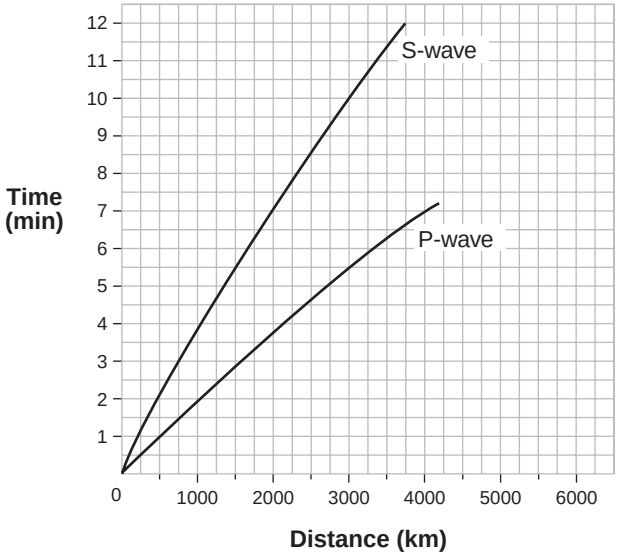
Use the following to answer question 7:

i) **Earth diagram and three seismograph stations: S_1, S_2 and S_3;**
ii) **time-distance graph for P- and S-waves;**
iii) **seismograms for a single earthquake, E.**

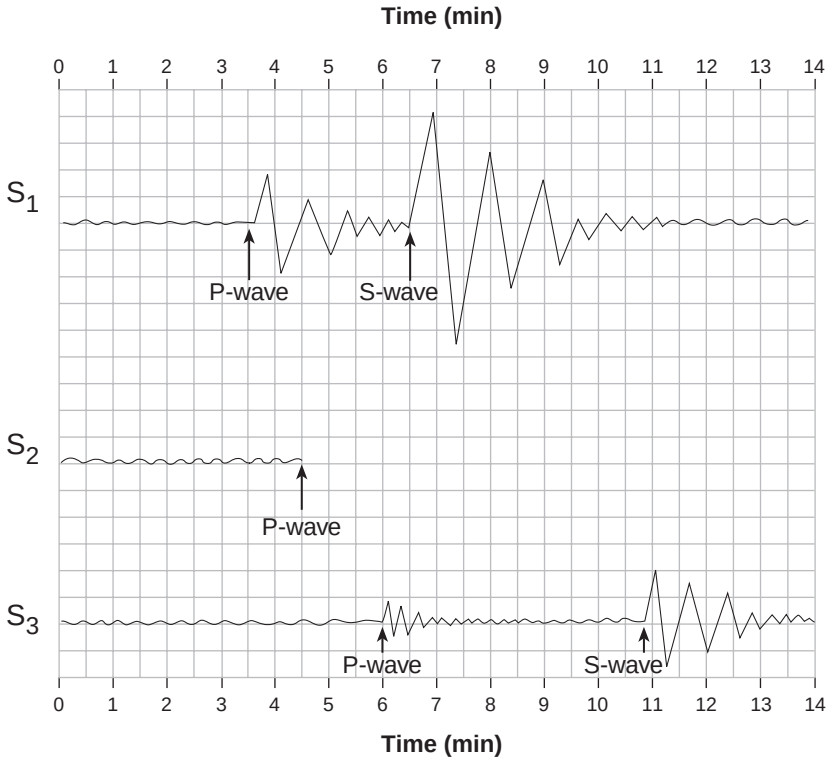
Earth diagram



Time-distance graph

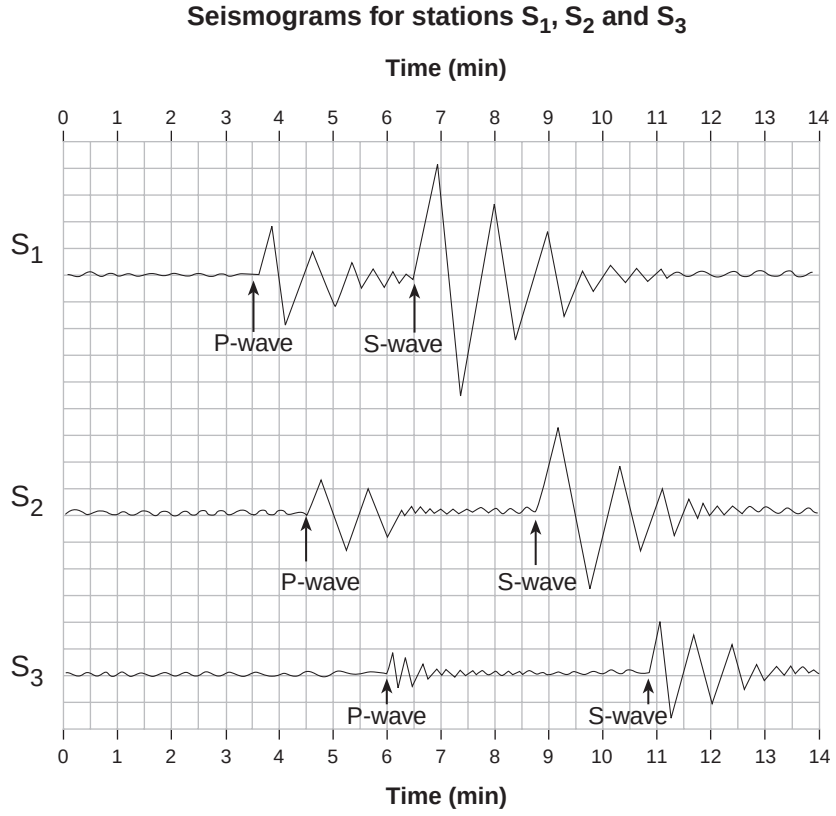


Seismograms for stations S_1, S_2 and S_3



7. a) Draw an appropriate seismogram for station S_2 in the space provided between S_1 and S_3.
Ensure that you label the S-wave arrival and consider the amplitude.
Note the scale and grid given. **(2 marks)**

2 marks for correct seismogram at station S_2



Range of S_2 P- S-wave time difference acceptable is 3.5–4.5 minutes.
Amplitude is between S_1 and S_3 size.

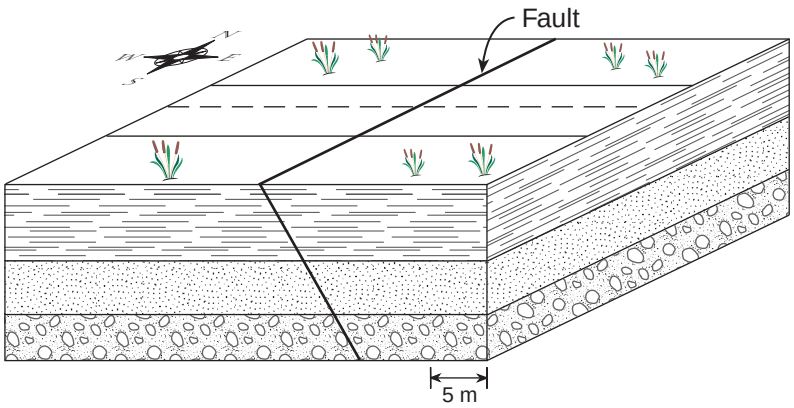
b) How far away from the earthquake was S_1? **(1 mark)**

between 1500–2000 km ← 1 mark

c) What information in the seismogram suggests that S_3 is outside the seismic shadow zones? **(1 mark)**

S_3 has both S- and P-waves. ← 1 mark

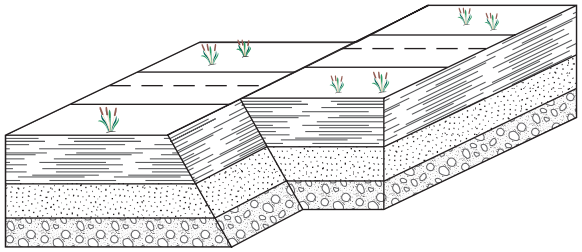
Use the following block diagram of a fault to answer question 8.



8. a) Sketch **and** describe the changes that would be observed in the block diagram above after an earthquake if the fault were strike-slip. **(2 marks)**

1 mark for sketch. 1 mark for description.

Strike-slip sketch of block diagram



Description

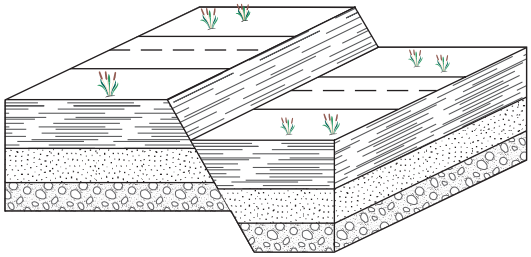
There would be no vertical movement, only lateral and only in a north-south direction. The road would be cut but still be on the same plane.

The road is offset. $\leftarrow \frac{1}{2}$ mark

b) Sketch **and** describe the changes that would be observed in the block diagram above after an earthquake if the fault were dip-slip. **(2 marks)**

1 mark for sketch. 1 mark for description.

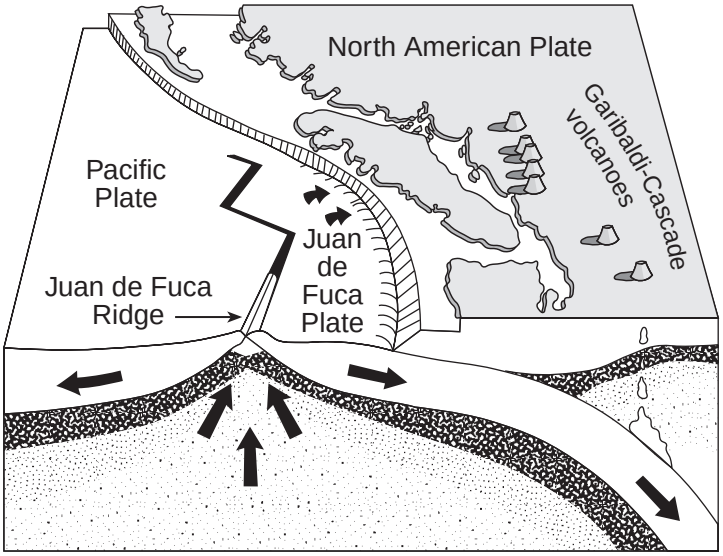
Dip-slip sketch of block diagram



Description

There would be no north-south movement, only vertical and east-west. The road would have a cliff section at the fault now.

Use the following block diagram of the southwest coast of BC to answer question 9.



9. The subduction zone that lies under BC's coast created the Garibaldi-Cascade volcanic chain.

   a) Why do these volcanoes lie parallel to the subduction zone? **(1 mark)**

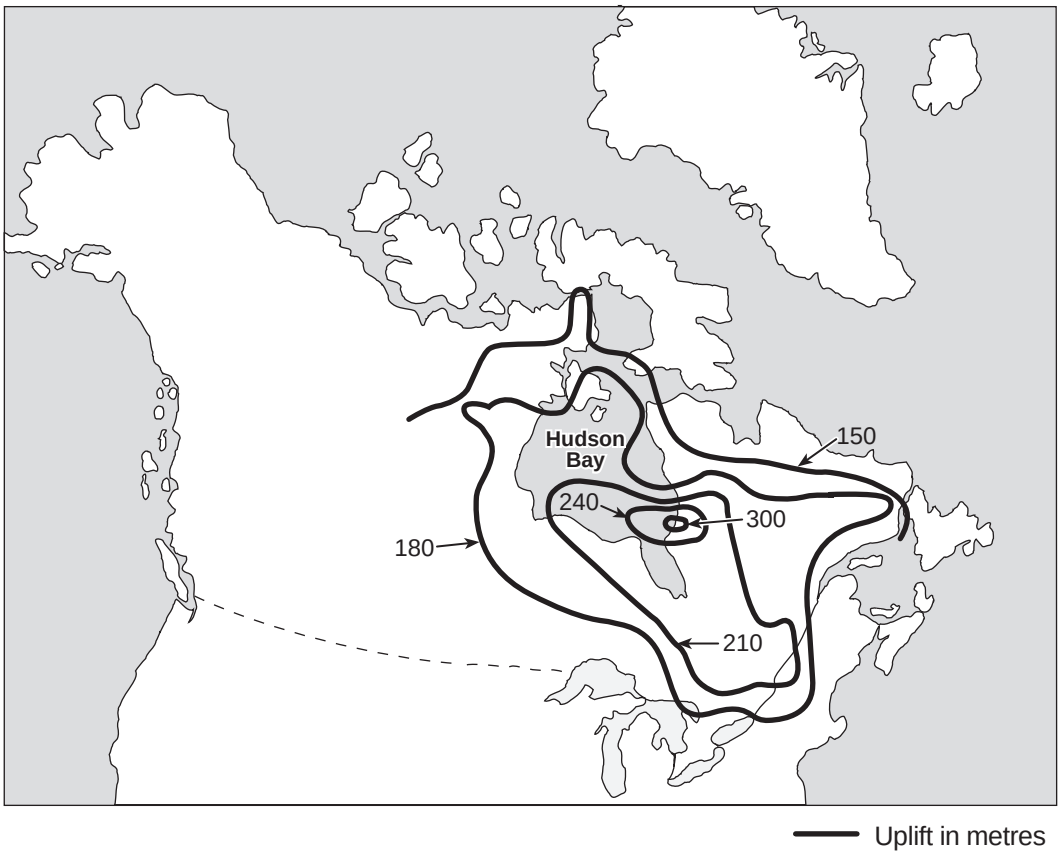
As the plate is subducted, it will melt at the same depth and distance from the subduction zone. } ← **1 mark**

b) Describe **one** piece of evidence that could be found in or on the seafloor rocks that would indicate that seafloor spreading has occurred at the Juan de Fuca Ridge. **(1 mark)**

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

- **The age of the rocks becomes progressively older further from the ridge.**
- **Symmetrical magnetic stripes on either side of the ridge.**
- **High heat flow at or near the ridge.**
- **Thickness of sediments increase further away from the spreading ridge.**

Use the following map of Canada that shows an area of crustal uplift centred on Hudson Bay to answer question 10.



10. The darker lines on the map connect points of equal crustal uplift. This uplift has occurred in the last 7000 years, since glaciers melted from this region.

a) Describe **one** reason why the crust is being uplifted in this region. **(1 mark)**

During the last glacial period, the weight of the continental glacier that existed in this area of Canada depressed the crust. Now that the glacier has melted, the crust is rebounding back to its original position. ← **1 mark**

OR

Isostatic rebound has occurred.

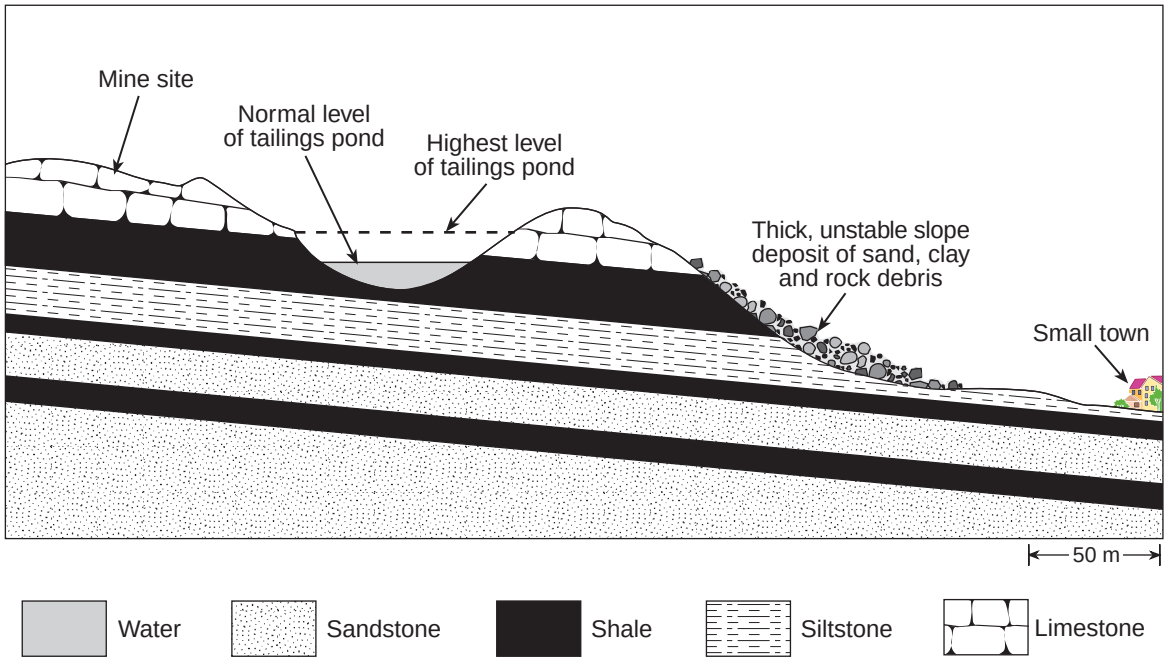
b) Explain why the crustal uplift is greatest in the area around southern Hudson Bay. **(1 mark)**

The glacier was probably thickest and thus heaviest in the area of southern Hudson Bay, therefore the crust was depressed most in this region. Now that the ice has melted, this same region has risen the most. ← **1 mark**

OR

It could have been the earliest to de-glaciate, and therefore had longer to rebound.

Use the following geologic cross section to answer question 11.



11. A tailings pond has been excavated to store toxic liquid wastes produced by the mining process. A geologist has been asked to determine the geology around the area of the tailings pond and to assess the risk to the town to the east of the facility. The geologist drilled holes in the area and tested core samples of the rocks for porosity and flow rate (permeability). The results are shown in the table below.

Rock Type	Porosity %	Flow Rate (Permeability) litres/hour
Sandstone	20	50
Shale	20	0.0005
Limestone	30	56
Siltstone	15	0.001

a) Why was the shale chosen for the site of the toxic waste pond? **(1 mark)**

Shale has a very low permeability and therefore very little toxic waste will flow into the groundwater. } ← **1 mark**

b) Referring to the cross section and the data in the table, describe, in detail, **two** reasons why the town could be at risk. **(2 marks)**

Any **two** reasons for **1 mark** each:

- **When the pond is filled to the maximum level, the waste could leak into the highly permeable limestone and flow down unstable slope, causing a landslide to flow towards the town.**
- **When the pond is filled to the maximum level, the waste could leak into the highly permeable limestone and then flow towards the town and poison the inhabitants.**
- **Liquid waste may cause the shale and limestone layers to slide down over each other towards the town.**

Note: **Groundwater pollution is unlikely due to shale layers.**

Reference Data Pages in the Appendix

For question 12, refer to the following references in the Appendix.

page 1: Bowen's Reaction Series
page 4: Percentage of Minerals in Igneous Rocks
page 5: Properties of Common and Important Minerals

12. A company makes large ornamental fountains and pools. The company has decided that the two most attractive rocks to use are a polished limestone and a polished granite. The mineral composition of the rocks is given in the table below.

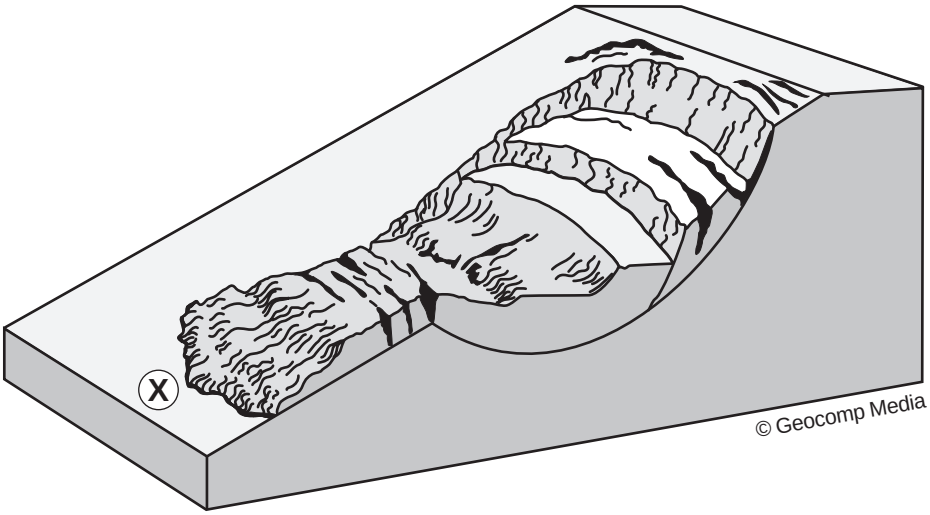
Rock	Minerals present
Granite	mainly quartz, potassium feldspar
Limestone	calcite

Describe **two** mineral characteristics that would make the granite more suitable than the limestone. **(2 marks)**

Characteristic 1: **The main minerals in granite (quartz and feldspar) are more resistant to chemical weathering than the calcite in the limestone and will resist the acidic rain and fountain water.** ← **1 mark**

Characteristic 2: **The main minerals in granite (quartz 7, feldspar 6) are much harder than the calcite (3) in limestone and will resist scratching and wear.** ← **1 mark**

Use the diagram of a rotational slump to answer question 13.



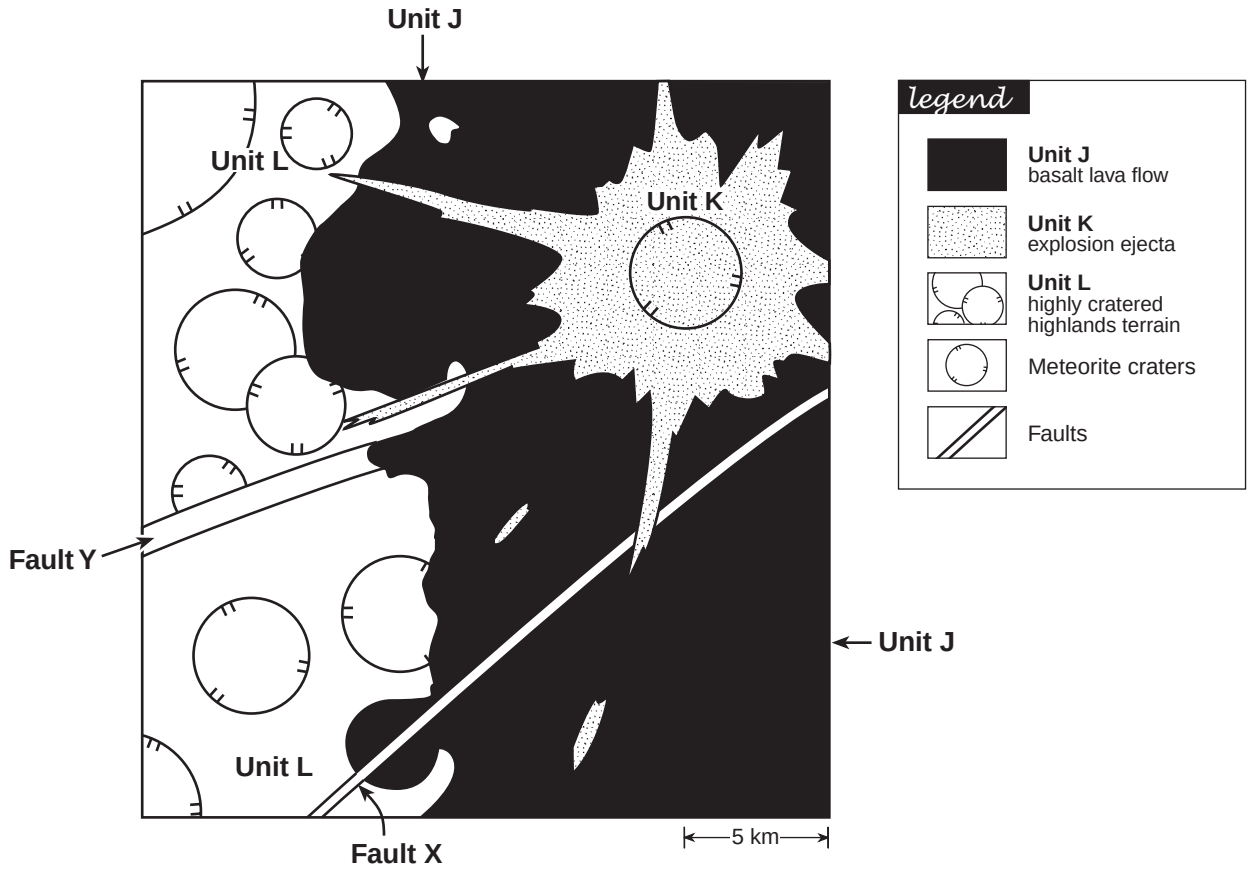
13. The slope shown above has become very unstable and is threatening a highway just below **X**. Describe **two** methods that would be used to stabilize the slope and safeguard the highway.

(2 marks)

Any **two** methods for **1 mark each:**

- **Remove water – drain the slope using perforated pipes.**
- **Divert water away – build drainage channels to divert water away from this part of the slope.**
- **Plant trees and vegetation that will help to hold the slope sediments and remove water.**
- **Build a retaining wall at the base of the slump.**
- **Remove a portion of the upper part of the slump in order to reduce weight.**

Use the following geologic map of a small area of Earth's moon to answer question 14.



14. a) Describe **one** reason why unit **K** must be younger than unit **L**. **(1 mark)**

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

- **The ejecta from unit K covers unit J. Unit J covers the craters of unit L.**
- **The ejecta from unit K covers fault X. Fault X cuts craters of unit L.**
- **The ejecta from unit K covers unit L.**
- **K covers J. J covers Y. Y cuts L.**
- **K covers J. X cuts J. J covers L.**

b) Referring to evidence from the geologic map, describe evidence that the Moon's surface is geologically inactive when compared to Earth's. **(1 mark)**

The Moon still has many ancient craters. On Earth, these have been destroyed by plate tectonics, folding, faulting, weathering, erosion, etc. } ← **1 mark**

c) Give a reason why large meteor impacts on the Moon cause basalt lava flows on its surface. **(1 mark)**

Heat generated by impact melts parts of the mantle which flow to the surface. ← **1 mark**

OR

Impact causes cracks/fissures, allowing molten material to flow to the surface.

END OF KEY