Name: _____

Internal Processes and Structures ...Handouts

The mysterious innate intuition of some animals

GEOLOGY 12 Name _____

CHAPTER 9 WS #2

PLATE TECTONICS

- Read each statement carefully and choose the best answer.

1. Supporting evidence for continental drift includes all of the following EXCEPT:
   A. matching of continental edges
   B. the existence of transform faults
   C. finding cold-climate fossils in equatorial regions
   D. polar-wander curves

2. The average thickness of the oceanic lithosphere in _____ kilometers.
   A. 5 B. 50 C. 500 D. 5,000

3. The weak or plastic zone just below the brittle plates is the
   A. asthenosphere B. lithosphere C. crust D. mantle

4. Magnetic minerals in a magma
   A. tend to align themselves parallel to the earth's magnetic field
   B. all have the same Curie temperature
   C. cause magma to flow toward the magnetic poles
   D. all of these choices

5. The magnetic stripes of the sea floor
   A. record the recent reversal history of the earth's magnetic field
   B. show a symmetric pattern on either side of a spreading ridge
   C. are created as magma crystallizes at ridges
   D. all of these choices

6. The oldest rocks recovered from the sea floor are about _____ years old.
   A. 200 B. 200,000 C. 200 million D. 2 billion

7. All of the following are characteristic of convergent plate boundaries EXCEPT
   A. subduction zones B. earthquakes C. transform faults D. island arcs

8. The oldest rocks on the continents are much older than the oldest rocks on the sea floor. Why?
   A. The seafloor rocks are too warm to preserve old ages.
   B. Sea floor rocks are buried by younger sediments.
   C. Oceanic lithosphere is readily subducted and destroyed; continental lithosphere is not.
   D. All of these choices.

9. The rate and direction of plate movements can be determined using
   A. ages of sea floor rocks at various distances from a spreading ridge
   B. polar-wander curves
   C. tracking the volcanic "footprints" of hot spots
   D. all of these choices.

10. A hot spot is
    A. an isolated area of active volcanism away from a plate boundary
    B. an area of intensive earthquake activity
    C. an area in which subduction is causing partial melting
    D. a zone of continent-continent collision

11. A typical rate of plate motion would be
    A. 1-2 millimeters per year
    B. 1-2 centimeters per year
    C. 1 –2 meters per year
    D. 1-2 kilometers per year

12. A possible driving force for plate tectonics is
    A. magnetic reversals
    B. convection in the asthenosphere
    C. convection in the lithosphere
    D. polar wandering

13. Studies of past plate motions indicate that
    A. any two adjacent plates must move in the same direction, to avoid plates' breaking up
    B. once they begin to move, plates always continue to move in the same direction
    C. plate movements have occurred for hundreds of millions, probably billions, of years
    D. all of these choices

14. The rocks of the continents are recycled into the mantle by
    A. continent-continent collision
    B. weathering and subduction of sediments
    C. metamorphism in the lithosphere
    d. sea floor subduction

15. Lithospheric plate motion may be driven by
    A. convection cells within the asthenosphere
    B. the weight of subsiding portions of the lithosphere
    C. convection cell within the lithosphere
    D. none of these choices

16. The orientation of the Hawaiian Island group
    A. shows the direction of movement of the Pacific Plate
    B. is a function of a rift zone
    C. is defined by the edge of the Pacific Plate
    D. has no significance

17. Two centimeters of continental drift per year for 100 million years
    A. would amount to 2,000 kilometers
    B. would amount to 4,000 kilometers
    C. is highly unlikely to have occurred in the geologic past
    D. would be an insufficient amount of plate movement to allow reconstruction of Pangaea.

18. Which of the following are associated with subduction zones?
    A. earthquakes
    B. volcanoes
    C. island arcs
    D. all of these choices

19. the San Andreas Fault is an example of a
    A. subduction fault
    B. rotating fault
    C. divergent margin
    D. transform fault

20. The Curie temperature of a magnetic mineral is
    A. above the melting point of that mineral
    B. the same as the melting point of that mineral
    C. the temperature above which magnetic properties are lost
    D. the same for all magnetic minerals

21. Magma escaping from a rift under the ocean eventually cools and forms basaltic rock, which is
    A. reversely magnetized
    B. normally magnetized
    C. magnetized in the prevailing direction of the earth's magnetic field
    D. magnetized 90 degrees from the prevailing direction of the earth's magnetic field

22. Compared to basalts farther away from a mid-ocean ridge, those basalts collected closest to a ridge are
    A. younger
    B. more radioactive
    C. older
    D. more fine-grained

23. The asthenosphere behaves
    A. rigidly B. plastically C. fluidically D. as a liquid

24. The average depth of the asthenosphere is about
    A. 50 kilometers B. 5 kilometers C. 5,000 kilometers D. 500 kilometers

25. The layer above the asthenosphere is the
    A. upper mantle B. stratosphere C. lithosphere D. ionosphere

26. Climatic evidence for continental drift
    A. includes the fact that ancient climates appear to have been very different from the current climate of the same region
    B. is, in part, based on the types of sedimentary rocks that formed in the past
    C. considers types of plant fossils found in sedimentary rocks
    D. all of these choices

27. Support for the theory of continental drift includes
    A. direct evidence of land bridges between continents
    B. distributions of similar fossils on adjacent continents
    C. different rock strata on adjacent continents
    D. none of these choices

28. Continental drift
    A. was a readily accepted concept
    B. is not viable today because of the lack of evidence
    C. is now supported by the broader theory of plate tectonics
    D. was first proposed in the eighteenth century

29. Polar-wander curves indicate
    A. the apparent movement of the magnetic poles relative to a continent
    B. the actual movement of the magnetic poles through time
    C. the predicted movement of the magnetic poles in future years
    D. none of these choices

30. When two continents collide
    A. one is subducted beneath the other
    B. neither is completely subducted, but both are thickened and extensively deformed
    C. earthquakes are rare occurrences
    D. due to resistance of the continental mass, directions of plate movements are reversed

31. A mid-ocean spreading ridge is associated with
    A. a divergent plate margin
    B. a convergent plate margin
    C. a transform boundary
    D. intraplate mantle hot spots

32. The term "lithosphere"
    A. refers to a rigid outer layer of the earth that includes the crust and upper mantle
    B. is of constant thickness throughout the world
    C. is a thick outer layer of the earth, generally 500 km thick
    D. underlies the rigid asthenosphere

33. Evidence for sea floor spreading includes
    A. the age distribution of sea floor rocks
    B. magnetic stripes on the ocean floor
    C. magnetic stripes on the ocean floor and the age distribution of sea floor rocks
    D. none of these choices

34. Rates of spreading at sea floor ridges are usually in the range of
    A. a few meters per year
    B. a centimeter per million years
    C. a few centimeters a year
    D. a centimeter per thousand years

35. All of the following are characteristic of divergent boundaries EXCEPT:
    A. transform faults
    B. rifting
    C. volcanic activity
    D. island arcs

36. The Red Sea
    A. formed from continental rifting.
    B. is a shallow sea that is slowly disappearing due to convergence.
    C. was formed following the Pleistocene due to a dam made of ice-deposited sediment.
    D. is an intraplate sea.

37. The name given to the large landmass that comprised the continents of the southern hemisphere after the breakup of the original supercontinent is
    A. Pangaea
    B. Laurasia
    C. Gondwanaland
    D. Micronesia

38. Iceland is an example of a(n)
    A. above sea-level expression of a divergent boundary.
    B. stalled convergent boundary.
    C. intraplate hot spot.
    D. extinct volcano.

39. The best possible explanation for the driving force for plate movement is
    A. convection in the asthenosphere.
    B. convection deep in the mantle.
    C. the downward pull of gravity on down-going slabs of lithosphere in subduction zones.
    D. a combination of all of the above.

40. Professor Hess of Princeton University suggested the possibility of sea-floor-spreading. Which of the following describes his proposal?
    A. The sea floor had split and spread away from its ridges.
    B. The ocean floor had spread toward continents but the continents remained stationary.
    C. Continents, not ocean floor, had pulled apart.
    D. None of the above

41. Mountain ranges are produced from
    A. divergent plate boundaries.
    B. convergent plate boundaries.
    C. parallel plate movement.
    D. Intraplate fault zones.

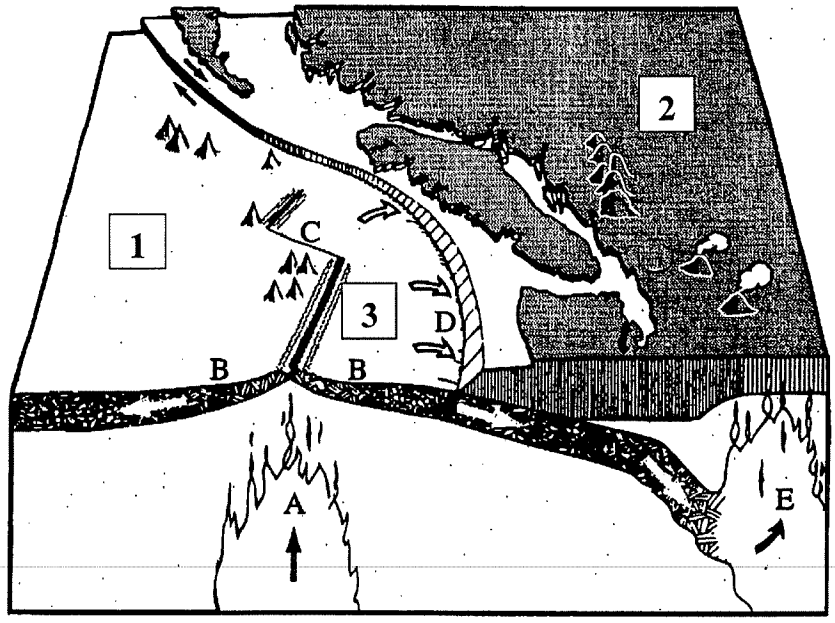
42. Some of the world's mountain belts, such as the Rockies, are not along active earthquake belts. This observation seems to contradict the idea that plate collisions can create mountains. A likely explanation of this observation is that these mountains
    A. are thick deposits of basalt.
    B. were formed by layers of sediment.
    C. are the sites of ancient collision boundaries.
    D. are points where new plate boundaries

WRITTEN RESPONSE

1. Explain why extremely ancient sea floor rocks are absent from ocean plates.

2. The diagram below shows the plate tectonic situation around the coast of British Columbia. Explain the labeled **geological processes** and **features** which are shown in this diagram.

Simplified cross section of
South Western British Columbia



Location B: **geological processes =**

features =

Location C: **geological processes =**

features =

Location D: **geological processes =**

features =

Location E: **geological processes =**

features =

Identify these tectonic plates by name.

Plate 1 _____

Plate 2 _____

Plate 3 _____

The Geological Formation of BC

In the distant past the west coast of Canada was near Salmon Arm. The continent was made of a granite batholith, that formed as the Earth cooled 4.5 billion years ago, and sedimentary rocks from erosion. Sediments were also building up into layers on the west coast as erosion washed them toward the Pacific Ocean. In the tropical climate that existed here, due to our more southern location on the globe (as a part of Pangea), there were many swamps where vegetation lived, died and fell into. There was an inland sea covering Alberta and Northeastern BC where marine organisms lived, died and were buried. (Dinosaurs also lived in this area.)

About 200 million years ago Pangea broke up.

About 170 million years ago several strings of volcanic islands (a terrane) collided with the coast (the collision took many, many years at the rate of a few centimeters a year). The sedimentary layers that had been piling up were folded and faulted (thrust faults) by the compressional forces and became the Rocky Mountains. BC would have been 300 km wider if the crumpling had not occurred. Erosion wore the Rockies down at the same time (and ever since) or they would be 10 km higher than they are now.

These volcanic islands (that collided) had their tops eroded off over time and isostacy caused their roots (batholiths, magma cooled underground) to be raised up. These are the current Coast Mountains that we see north of Vancouver.

More "recently" lava has extruded through the Coast Mountains forming Mt Garibaldi (near Squamish) and Mt Edziza (recent, north of Terrace).

A hot spot has formed the Anahim chain of volcanoes Southeast of the Queen Charlotte Islands. The North American plate moved northwest over the stationary hot spot forming the chain with the youngest (most recently formed) furthest east.

Also, the Juan de Fuca plate is subducting under the North American plate. This causes the composite volcanoes in the Cascade Mountains (i.e. Mount St Helen's, Mount Baker, etc.). It also causes the threat of the "BIG" 9.5 earthquake we are expecting here.

The Rock Types

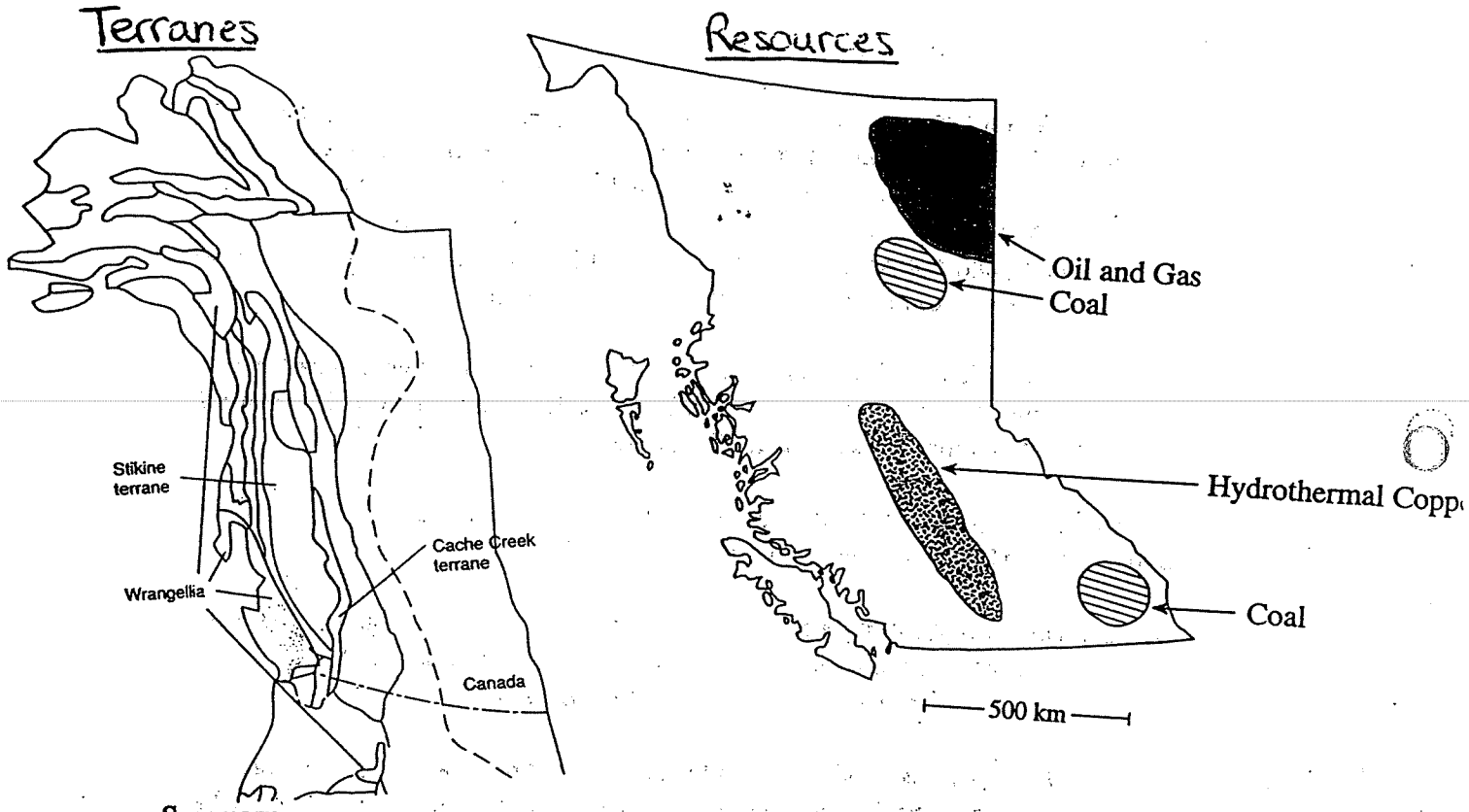
BC has all three rock types:
Igneous - wherever there are volcanoes, roots of volcanoes, or dikes slicing through
Sedimentary - in the Rockies and all over BC from the erosion that has occurred (3/4 of the continent's exposed rock is sedimentary)
Metamorphic - in collision zones (from 170 million years ago or the subduction right now), involved significant T, P and water content changes yielding altered rocks

The Resources

The sedimentary layers in the Rockies contain coal that formed from vegetation falling into the swamps prior to the collision.

Northeastern BC and AB have oil and gas from the marine organisms that lived and died in the inland sea.

Metallic minerals (such as copper) are formed by magmatic processes and consequently are found near the Coast Mountains (roots of ancient volcanoes), Anahim chain (hot spot volcanoes), and Cascade Mountains (subduction volcanoes).



Summary

BC formed by elongated segments of mini-continents (terranes) that drifted across the Pacific and docked onto the older part of North America. This pushed up the Rockies. Erosion (glaciers, streams, mass wasting, wind) has formed/is forming what we see today.

Name:_____

Where Terranes Collide

1. Cordilleran - the name given to _____

2. The story began _____years ago and continues _____.

3. What is happening at the Jaun de Fuca ridge?

4. The Jaun de Fuca ridge is moving toward us at a rate of _____ and is _____ beneath the North American continent.

5. If the earth's history is a 24 hour clock, until 2:30 pm was taken up by _____

_____.

In the last 1,700,000 years _____

_____ occurred.

What appeared 3.5 million years ago (8 minutes to midnight)? _____

6. Over 950 million years, sediments accumulated to a depth of _____ thick.

7. How are mountains like old hotels?

8. North America separated from _____ and _____.

9. The climate at the western edge of North America at the time was _____

10. Coral reefs from the tropical seas (now Alberta) contain _____.

11. Petroleum is formed from _____.

12. The Banff mountains are made of _____.

13. What was the edge of the North American continent 180 million years ago?

_____

14. Terranes = pieces of crust which _____

_____.

15. The formation of the mountains of North America started 200 million years ago.
Four terranes amalgamated into the _____.
Then the whole thing _____.

16. Ominica belt - formed from _____ of collision.
type of rocks _____

17. A second collision with North America by the _____ formed the _____ which are made up of _____ rocks.

18. The main effect of these two main collisions was the formation of the _____

19. Mt Rundle (part of the Rockies) was formed by a _____ fault.

20. Draw a thrust fault:

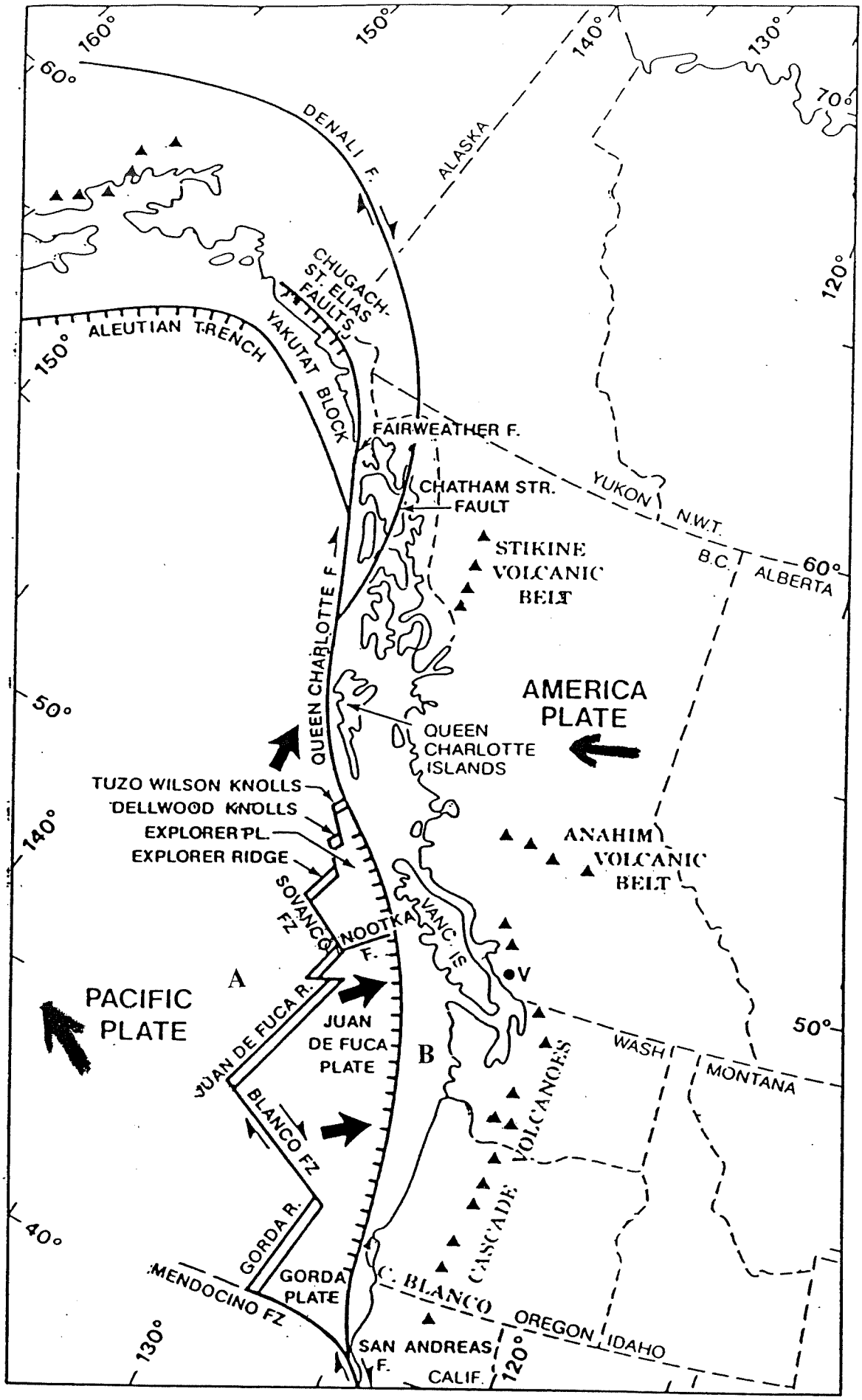
21. _____ has dramatically changed the look of the Rockies.

22. The last ice age began _____ years ago.

23. How did "The Big Rock" get there?_____
It is an _____.

24. Mt Garibaldi is formed how?

25. North America will eventually collide with _____.



"Local Plate Tectonics"

Legend

Subduction Zone

Rift Zone

Transform Fault

Assignment

1. Draw a cross-section from A to B. Label. (4)
2. Explain the age of the Anahim Volcanic Belt. (2)
3. Why are the Cascades all the same age? (1)

Chapter 10 Earthquakes

Earthquake - when the strength of the _____ fails and it _____ in response to _____
- occur along _____

stress - _____ applied to an object
- _____ stress - _____ the object
- _____ stress - _____ object apart
- _____ stress - cause diff parts of object to move in _____, slide past other part.

strain - deformation, a change in _____ and/or _____, due to _____, _____ or _____
- _____ deformation - returns to _____, etc when _____ removed, shape changes _____
- _____ deformation - when _____ of a material is reached, shape changes _____, add _____ extra stress = _____ change in shape
- _____ - material _____ if stress increased, brittle materials will rupture _____, before any plastic deformation, _____ = more brittle

rocks usually stronger under _____ than _____ stress

creep - movement along existing faults that occurs _____ and _____ (broken curbs)

when there is no creep (friction or no fault prevents) stress accumulates _____ until _____ = earthquake, then stressed rocks, released, _____ to original dimension, called elastic rebound.

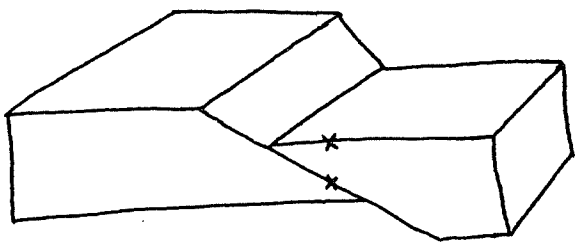
Parts of an Earthquake
focus - (or hypocenter) the point on a _____ at which the _____ movement or _____ occurs during an earthquake

epicenter - the point on the earth's _____ directly above the _____

fault-trace - the line along which the _____ intersects the earth's _____

fault-scarp - the _____ formed if there is _____ movement along the fault

Label the diagram



most earthquakes occur at plate boundaries

deep-focus earthquakes (>100km deep)
- only occur in _____ where brittle, cold, _____ is pushed into _____ (other plate boundaries would only have shallow focus since brittle _____ isn't pushed down)

Seismic Waves - stored up _____ released in earthquake, travel _____ the focus

body waves (P and S) - travel through _____ of earth

surface waves (L) - travel along _____

P waves - _____ waves (like sound in air), travel _____

S waves - _____ waves (side-to-side sliding motion of material), travel _____, go through _____ only

used to determine epicenter - P waves arrive _____ to seismograph

_____ - instrument used to detect _____ caused by P and S waves

the difference in _____ between P and S waves is a function of the _____ travelled (see graph in Fig 10.8)

Need __ seismograph stations at different places to pinpoint an earthquake exactly (actually need more)

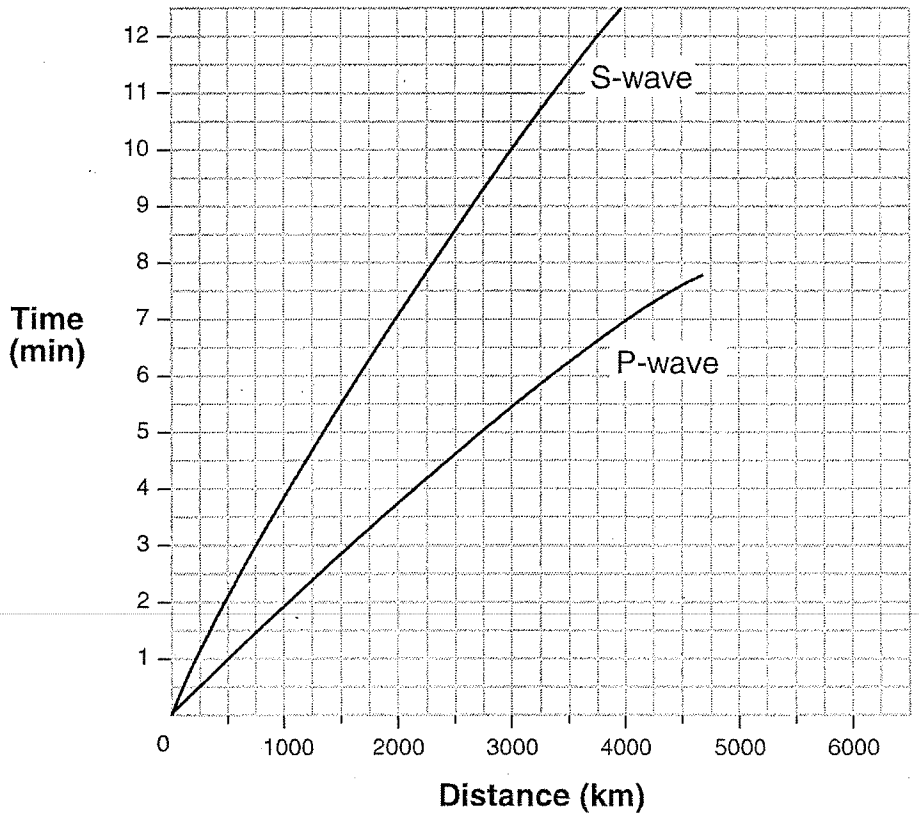
Surface waves - cause ground surface "ripples" like in water, cause most earthquake _____
Rayleigh waves - cause _____ ground motions
Love waves - cause _____ shear motion

Magnitude - amount of _____ or _____ motion, usually reported by Richter Magnitude scale, adjusted for _____ from epicenter

Richter Scale - logarithmic measure of _____
i.e. magnitude 5 is ____ ground movement as magnitude 4
magnitude 5 is ____ ground movement as magnitude 3
etc
- for every increase in magnitude, energy released goes up by ___ times.
- ___ upper limit, max recorded was~8.9 in Japan and Ecuador

13a

P and S Seismic Wave Travel Time Graph



Modified Mercalli Scale

Rating	Description
I	Barely felt.
II	Felt by a few sensitive people, some suspended objects may swing.
III	Slightly felt indoors as though a large truck were passing.
IV	Felt indoors by many people, most suspended objects swing, windows and dishes rattle, standing autos rock.
V	Felt by almost everyone, sleeping people are awakened, dishes and windows break.
VI	Felt by everyone, some are frightened and run outside, some have trouble walking, some chimneys break, some furniture moves, slight damage.
VII	Considerable damage in poorly-built structures, felt by people driving, most are frightened and run outside.
VIII	Slight damage to well-built structures, poorly-built structures are heavily damaged, walls, chimneys, monuments fall.
IX	Underground pipes break, foundations of buildings are damaged and buildings shift off foundations, considerable damage to well-built structures.
X	Few structures survive, most foundations destroyed, water moved out of banks of rivers and lakes, avalanches and rockslides, railroads are bent.
XI	Few structures remain standing, total panic, large cracks in the ground.
XII	Total destruction, objects thrown into the air, the land appears to be liquid and is visibly rolling like waves.

Intensity - a measure of the earthquake's _____ on _____ and _____
- same magnitude earthquake can give _____ intensity depending on local geologic conditions, quality of structures, distance from epicenter, the observer's description

Modified Mercalli Scale - most widely applied _____ scale

Hazards

1) Ground _____ and _____ along the fault
   Solutions
   - build city _____
   - put _____ in pipelines crossing faults
   - design earthquake _____ buildings
     (difficult - no data of waves in major quake
     - can't reproduce in lab)
   - built on _____ rather than deep soil
   - consider characteristics of quakes in region
     - _____ - weaker than principal tremor, many of these follow original quake
     - _____ - if building can only last 25 sec of quake and it lasts 250 sec . . .

adobe - mixed earth and sand

(can't tear down all the old buildings though!!)

2) Secondary hazard - _____
   - fuel lines and power lines, spark = fire
   - water mains break, can't douse flames
   Solution
   - put many _____ so can shut off affected area

3) Landslides - _____ areas
   - quakes may trigger _____ slope to slide
   Solution
   - don't build there

4) _____
   - wet soil shaken by quake, soil particles jarred apart, water seeps between, looses strength, becomes like quicksand, buildings topple or sink
   Solution
   - keep soil ___ (drainage)
   - avoid the area (Richmond)

5) _____ - seismic sea waves
   - sudden _____ of sea floor may set up waves
   - in mid-ocean is just _____
   - breakers when reach shore >15m easy and up to ___
   - travel up to 1000km/hr
   - can warn people ___ enough away

Earthquake Control?

_____ - spots on active fault zones that are quiet (locked?)
- need way to _____ fault _____ and _____
- _____ in fault zones may help movement
- fluid injection? don't know enough yet, too dangerous

Earthquake Prediction
- save _____, not _____
- based on _____ - things that happen or rock properties that change prior to an earthquake
  i.e. ground surface _____ or _____
  P wave velocities ____ then ____
  electrical resistivity _____ then _____
  _____ in radon concentration in wells
  changes in water _____ in wells
  anomalous _____ behaviour
- in general, length of time over which precursor phenomenon occurs is related to quake size:
  _____
- not all quakes show ____ pattern of precursor
- some great successes, some failures in prediction
- quake forecast - less precise prediction
- would people listen anyway?!

pg 214 - 219 -- good examples of earthquakes -- READ!

Important Facts about our Planet Earth and the Universe

PLANET Earth is 4,600,000,000 years old, has all 94 natural chemical elements, and supported life for about 3 to 4 billion years. Modern Man is only 10,000 years old. Today the estimated world population is 5.5 billion and growning at a rate of 84 million people per year. In addition, there are billions of plant and animal life forms inhabiting our planet. Physically, Planet Earth is an oblate spheroid. Polar diameter is 7,900 miles, equatorial diameter 7,926 miles, circumference at the equator is 24,901 miles, 24,860 at the meridian. The surface area is approximately 196,937,400 square miles. The period of a rotation sidereal day is 23 hours 56 minutes 4.0996 seconds. The mass of the Earth is 658,560 trillion tons and volume is approximately 259,875,300,000 cubic miles. Area covered by water is 139,670,000 sq. miles or 71% of the surface. Fresh water is only 3% of the total water on the planet, with 81,200,000 sq. miles or 29% of land above water. Forests and rangelands cover 84% of the planet's surface.

Earth, the 3rd planet of nine from our Sun, has one moon whose mean distance from Earth is 238,855 miles center to center. The Earth and the moon travel an average 66,620 MPH (miles per hour) on an elliptical orbit of 584,017,800 miles around the Sun. Distance from Sun at perihelion 91,402,00 miles and aphelion of 94,510,000. Our solar system travels around the center of the Milky Way galaxy once every 225,000,000 years at a speed of 481,000 MPH. The Milky Way Galaxy 10,000 light years* thick (1 light year is 5.878,499.814,000 miles long) and 100,000 light years wide travelling anywhere from 500,000 MPH to 1.1 million MPH in the direction of the constellation Virgo.

There exists 10,000 million other galaxies in the universe. The age of the universe is now estimated at 8 to 18 billion years. So far life and intelligent life is unique to our planet Earth, but the search continues to seek life on other Worlds.

*Light years equal distance light travels in 1 Earth year (365 days) at 186,000 miles per second.

Our planet Earth being part of our larger solar system originated from a turbulent cloud of dust, gas and asteroids surrounding our sun. The cloud settled over a period of 700 million years placing the planets into the calm orbits they now occupy. Our planet then began to harden. This is believed to have occurred approximately 4.5 billion years ago. Planet Earth is considered to be in its mid-life. The natural destruction of the Earth will occur in 4 to 5 billion years when the sun will have burned all its own hydrogen fuel causing it to expand and incinerate all the surrounding planets.

The Earth's atmosphere is approximately 18,000 miles wide. Our weather is restricted to the first 5-10 miles. Most or 99% of the atmosphere is condensed into the first 50 miles.

There are approximately 2,200 thunderstorms at any given moment on the Earth, and lightning is over 5 times the temperature of the surface of the sun, or 30,000 degrees Centigrade.

There are 1.7 million plant and animal species on the Earth that are catalogued and known to exist. On the other side, there are believed to be 5 to 35 million the we do not even know about. The land surface on Earth is only 29.2% of the total surface of the Earth or 57,514,000 square miles.
The Earth's History is subdivided as follows: Precambrian - began 4-5 billion to 600 million years ago. Paleozoic -600 million to 200 million years ago. Mesozoic - 200 to 60 million years ago. Cenozoic - 60 million years to the present, (last ice age, 10 million years ago).

A few ways to protect our fragile planet for the future:
Plant trees! A fast growing tree can recycle 48 pounds of carbon dioxide each year. Buy energy efficient appliances. Recycle as much as possible, including newspapers, aluminum, glass, and other materials. Make sure your house is well insulated, this saves energy. Educate your family and friends. Support environmental conservation organizations that are fighting to save our pl
Write to your government explaining your support of environmental legis and action.

GEOLOGY 12
EARTHQUAKES
HOME ASSIGNMENT
20 MARKS

16

EPICENTRE LOCATION.

At 02:48 PST on Nov. 30, 1975, Southern Vancouver Island and the Lower Fraser Valley were shaken by an earthquake. Wooden buildings creaked, dishes rattled and some people were awakened. The earthquake was a mild one, registering 4.9 on the Richter scale.

Seismic recording stations at Victoria, Port Alberni, and Haney made a record of this event. These seismograms are reproduced on the attached sheet. The markings along the top and bottom of the sheet are time marks. Each mark represents one second. The clock time is indicated on the left edge and the line is read from left to right.

The normal trace of these recorders is an almost straight line. The first disturbance of this line is the arrival of the P waves. A sudden increase in movement of the line is the arrival of the S waves.

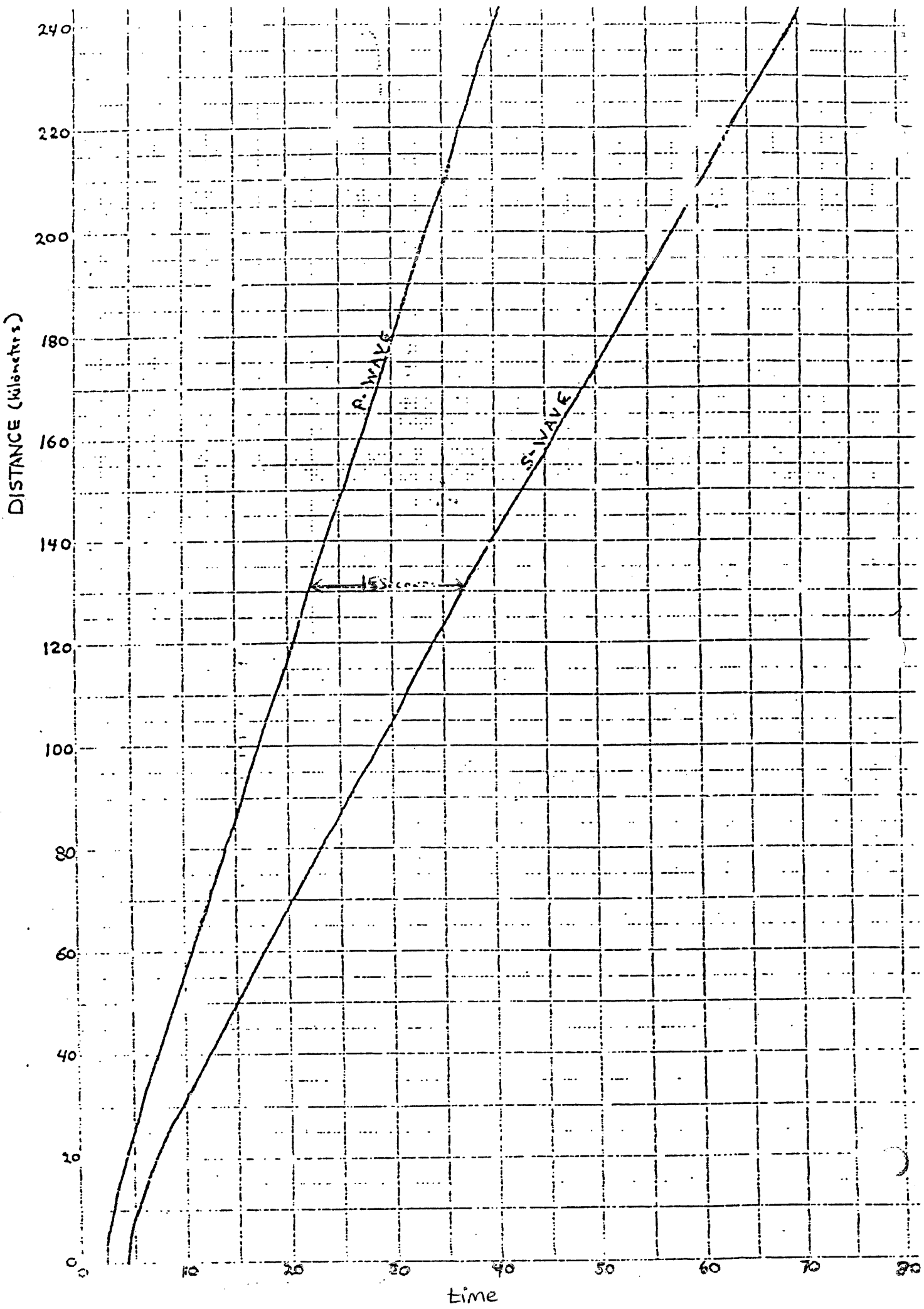
Include in this assignment is a copy of the Time/Travel graph appropriate for the area. This graph gives the time of travel in seconds and the distance travelled in km. Also included is a map of the area. The map scale is shown on the bottom.

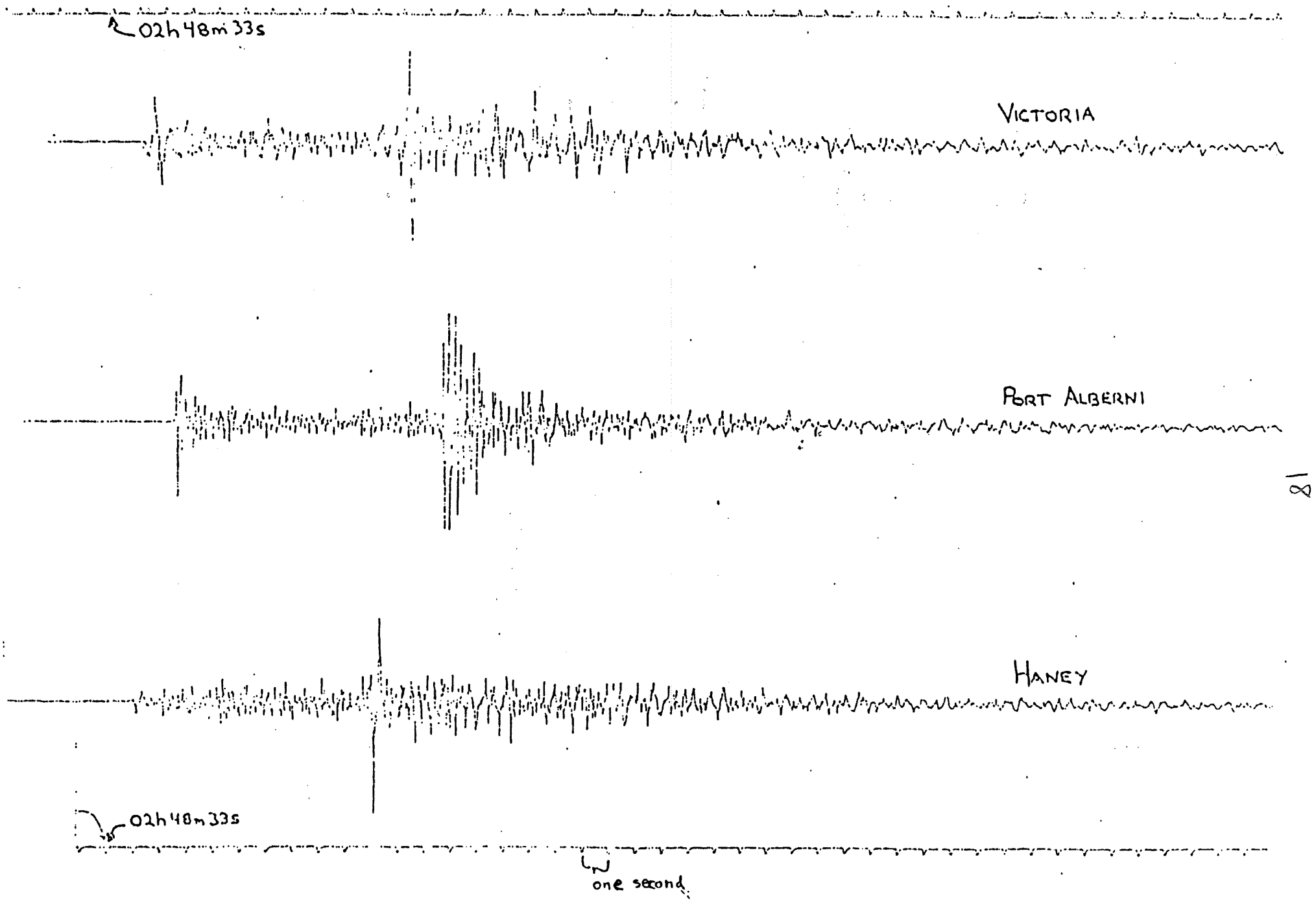
Assignment:

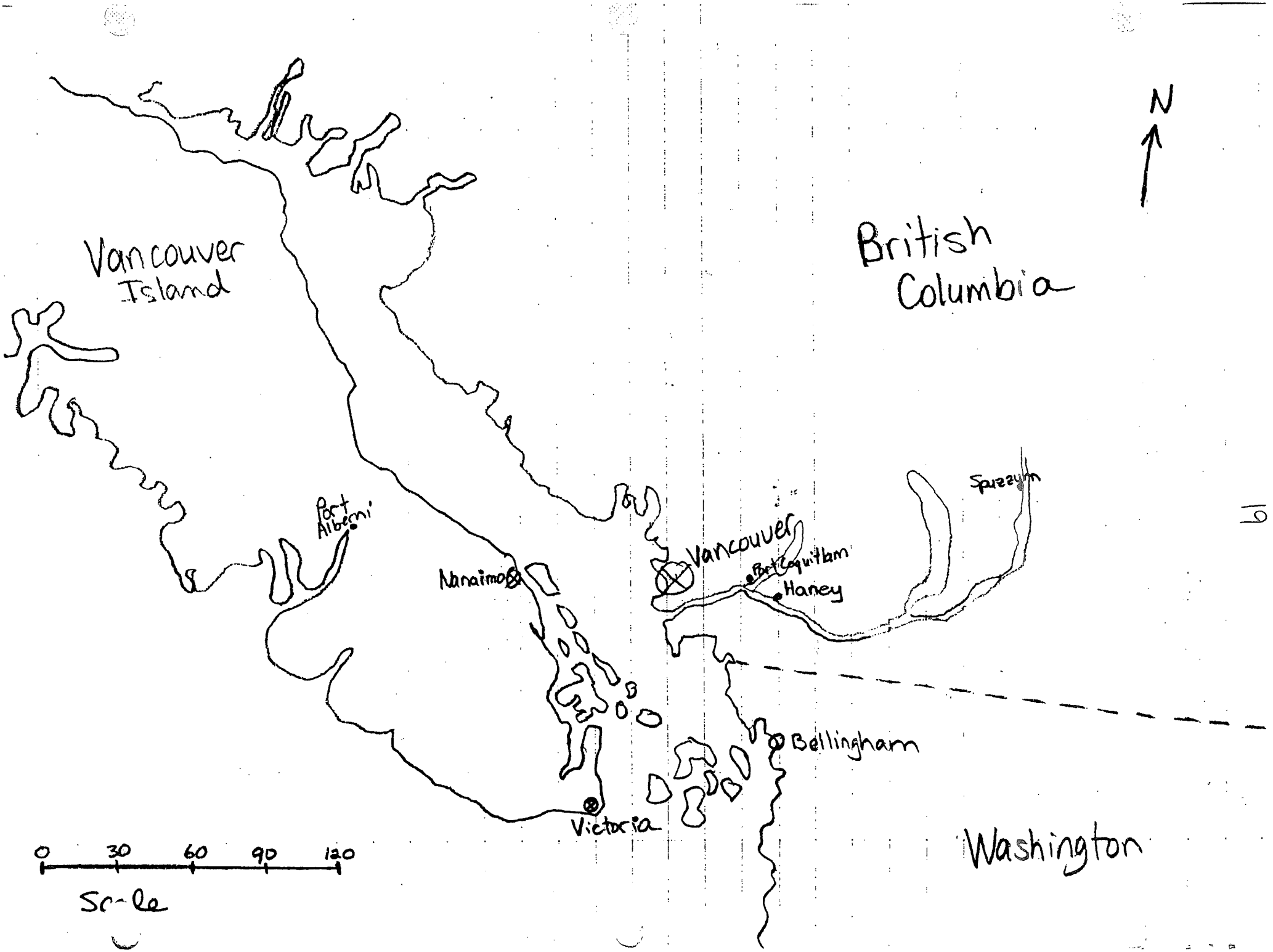
1. Design and fill in a data table to show:
   : clock time of P wave arrival at each station
   : time difference in P and S wave arrivals at each station
   : distance in km from each station to the epicentre

2. Locate the epicentre on the map using the standard method

3. Explain in words how the location of the epicentre is found using data from seismograph stations.


DISTANCE (kilometers)
240
220
200
180
160
140
120
100
80
60
40
20
0
P-WAVE
S-WAVE
15 seconds
0
10
20
30
40
50
60
70
80
time


02h 48m 33s
VICTORIA
PORT ALBERNI
HANEY
02h 48m 33s
one second


N
British Columbia
Vancouver Island
Port Alberni
Nanaimo
Vancouver
Port Coquitlam
Haney
Squamish
Bellingham
Victoria
Washington
0 30 60 90 120
Scale

Name: _____

EARTHQUAKES

1. The outermost layer of the earth. (5)
2. When the earth shakes. (10)
3. The movement of the continents on the mantle. (5)
4. A person who studies earthquakes. (12)
5. L-waves were named after this person. (4)
6. A distress signal, abbreviation. (3)
7. A scale for measuring the magnitude of an earthquake. (7)
8. This is an earthquake-prone area. (6) Turkey
9. The solid part of the earth. (11)
10. Large pieces of the earth's crust, which may carry whole continent or oceans. (5)
11. A famous American fault. (10)
12. An element found in the earth's crust. (7)
13. Large waves at sea, caused by earthquakes. (the incorrect name) (10)
14. Having to do with earthquakes. (7)
15. The day of the tsunamis in Port Alberni. (10)
16. The point on the earth's surface directly over the focus. (9)
17. An area of weakness in the earth's crust. (5)
18. Short form for earthquake. (5)
19. The layer of the earth below the crust. (6)
20. Abbreviation for Seismic Sea Wave Warning System. (5) SSWWS
21. Many earthquakes occur in this part of the world. (5) Japan
22. The earth's outer core contains this material. (4)
23. The gaseous part of the earth. (10)
24. The earth's crust contains quite a few of these. (5)
25. The correct word for tidalwave. (8)
26. The discontinuity or border that separates the crust and mantle. (4)
27. Abbreviation for estimated time of arrival. (3)
28. The point at which an earthquake originates. (5)
29. How do L-waves compare to P-waves in terms of speed? (4)
30. The innermost layer of the earth. (4)
31. This city is close to the San Andreas fault. (12)
32. The first earthquake wave to arrive at the seismograph station. (7)
33. Prefix meaning "earth." (3)
34. P-waves are opposite in speed to L-waves. (4)
35. When an earthquake occurs, large parts of the crust do this. (4)
36. This type of rock makes up part of the earth's crust. (7)
37. Opposite of liquid. (5)
38. A shaking. (6)
39. After an earthquake this is responsible for many of the deaths. (4)
40. The Mercalli is one, and so is the Richter. (5)
41. Much of this occurs to buildings and property as a result of earthquakes. (6)
42. A safe thing to be under in the classroom if an earthquake occurs. (4)
43. The most northern state. (6)
44. Mountain range in Italy. (4)
45. A dangerous explosive, trinitrotoluene. (3) TNT

↑ Good Friday

E	R	E	T	N	E	C	I	P	E	B	D	T	U	O	S	D	A	L
N	A	P	A	J	A	S	H	A	K	S	A	L	A	M	A	I	I	F
S	S	R	I	C	H	T	E	R	C	K	B	E	F	M	N	U	P	A
I	T	O	T	G	O	C	P	D	S	C	A	N	A	V	F	Q	H	S
M	P	S	R	H	S	U	O	E	N	G	I	G	T	D	R	I	F	T
A	G	E	O	X	Q	A	D	C	H	P	E	X	M	G	A	L	A	N
N	O	A	C	L	T	U	R	K	E	Y	A	S	O	H	N	O	U	T
U	O	N	K	T	I	D	A	L	W	A	V	E	S	S	C	A	L	E
S	D	E	S	T	F	D	E	K	A	U	Q	I	P	M	I	D	T	P
T	F	U	R	Q	M	F	G	S	E	C	B	S	H	T	S	S	E	R
E	R	E	H	P	S	O	H	T	I	L	S	M	E	R	C	T	V	I
C	I	U	S	W	Z	C	H	J	K	E	F	I	R	E	O	Y	O	M
E	D	M	L	L	S	U	F	O	L	G	H	C	E	M	K	I	L	A
H	A	F	O	W	I	S	S	T	D	C	S	P	R	O	C	J	L	R
I	Y	A	W	U	E	P	N	A	C	O	T	Q	I	R	O	N	M	Y
T	S	S	S	E	T	A	L	P	S	A	N	A	N	D	R	E	A	S
C	S	E	I	S	M	O	L	O	G	I	S	T	P	Q	E	E	T	A

Name: _____

Block: _____

"The Core" (2 hours and 6 minutes)

1. What were the initial phenomenons noticed by Dr. Josh Keys?
   a. _____
   b. _____

2. What happened to the space shuttle Endeavor?

   _____

   _____

3. What does the movie say that the magnetic field (em field) protects us from? ____

   _____

4. What causes the electromagnetic (em) field? _____

5. Timelines for destruction of Earth:
   a. Stone age in _____months.
   b. Earth burns up after protective field collapses completely in _____year(s).

6. What is the name of the material that is unaffected by the machine's drilling? ____

   _____

7. Why do you think they chose to go down in the Marianas Trench? _____

   _____

8. Expected travel times to the core:
   a. Through crust in _____minutes
   b. Through mantle in _____hours
   c. Through outer core to outer/inner boundary in _____hours

9. What did they come across about 12 hours in? They were inside a giant

_____

10. If the suits can take the "pressure" outside the ship then what is unrealistic about them walking around? _____

_____

11. Which plan did they choose A, B or C? ____

12. Where is Project Destiny located? _____

13. How did the core start rotating again?_____

_____

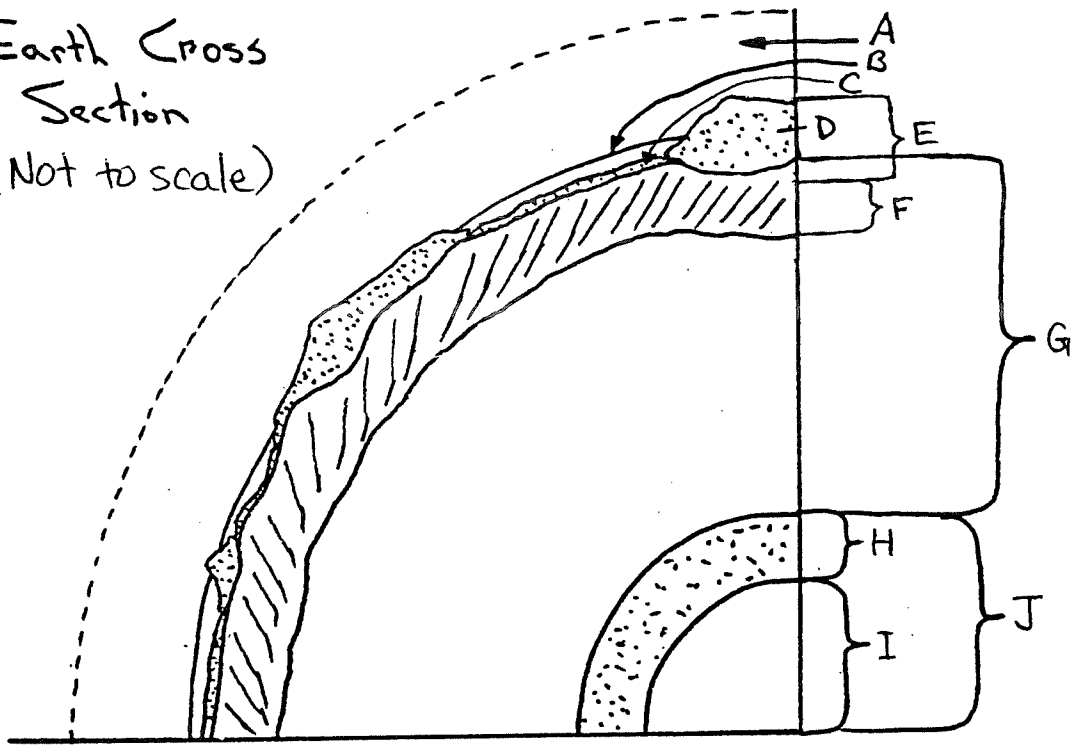
14. How did whales figure in near the end of the movie? _____

_____

15. Was the whole mission kept a secret like it was supposed to be? _____
Explain how you know this. _____

_____

Earth Cross Section
(Not to scale)



- Label
- thickness/depth
- composition (for crust, mantle, core)
- physical state (for lith, asthen, mantle, outer core, inner core)

Use Fig 1C on 9, 11

A

B

C

D

E

F

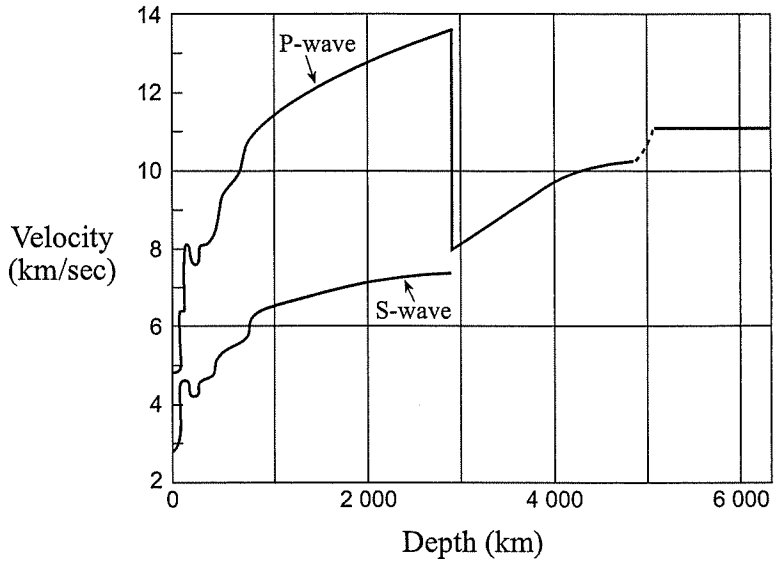
G

H

I

J

Use evidence from the following graph that shows P- and S-wave velocities at various depths in the earth.



a) Give **one** piece of evidence from the graph that the earth's interior has a layered structure.

Graph shows sharp changes in wave velocities. S-waves disappear at depth; P- and S-waves change velocities at the same depth. } **← 1 mark**

b) Give **two** pieces of evidence from the graph that could be used to determine the upper and lower boundaries of the earth's outer core.

Evidence for upper boundary: **S-waves disappear or P-waves decrease in velocity.** **← 1 mark**

Evidence for lower boundary: **P-waves increase in velocity.** **← 1 mark**

c) Give **one** piece of evidence from the graph that the density of material increases with depth.

The wave velocities increase between boundaries as the density increases. **← 1 mark**

GEOLOGY 12 CHAP 11 -REVIEW NAME _____

True-False

Indicate whether the statements below are true or false by filling in the blank to the left of each statement.

____ 11. Pressure increases with depth through the mantle, but decreases with depth in the core.

____ 12. Pressure increases with depth at the same rate throughout the earth.

T 13. The rate of pressure increase in the upper mantle is less than the rate of pressure increase in the outer core. [*Helpful hint:* Look at how much pressure changes for some equivalent amount of depth in each region, such as 500 km or 1000 km.]

____ 14. Pressures in the lower mantle range from about .3 to 1.3 millions of atmospheres.

F 15. Temperature increases slowly in the upper mantle, and then more rapidly throughout the rest of the earth.

____ 16. The temperature range in the core (outer and inner) is from about 3700° to nearly 4000° C.

____ 17. The temperature of the outer core must be higher than the melting temperature of the core material at that pressure.

____ 18. The temperature of the mantle in the low-velocity zone must be close to or higher than the melting temperature of the ultramafic rock of the mantle.

____ 19. The coolest temperatures in the earth are found closest to the earth's surface.

____ 20. Temperature and pressure change at the same rate in each zone of the earth.

Fill-in-the-Blank

Complete the sentences below with the correct terms or phrases.

21. Rock inclusions in igneous rocks are termed _____, literally meaning "stranger rocks."

22. Diamond-bearing volcanic pipes known as _____ provide samples of the mantle from depths of nearly 200 km.

23. Spectra analyses of the major elements of the sun's composition show it to be very similar to the composition of _____.

24. A graph which shows the estimated abundance of each element in the universe in order by atomic number is a _____.

25. The most abundant element (or oxide) in the earth's crust is _____.

26. The most abundant element in the earth as a whole is _____.

27. Compared to continental crust, the oceanic crust is richer in iron and _____.

28. Based on our knowledge of the densities of the crust, mantle, and the earth overall, the density of the core must be much _____ than the average density of the earth.

29. The earth's magnetic field cannot be produced by a solid body of magnetized iron at the core because temperatures at the core far exceed the _____ of iron, above which it loses its magnetic properties.

30. Body wave velocities are proportional to the _____ of the material through which they pass.

31. When seismic waves cross a boundary between two materials of very different densities they will be _____, or "bent."

32. The boundary at the base of the crust is called the _____.

33. Seismic wave velocities _____ at the base of the crust, as they enter the mantle.

34. The zone in the upper mantle in which seismic waves slow down notably is called the _____.

35. Rocks of the low-velocity zone are solid, but are thought to be very near to their _____ temperatures.

36. Small jumps in seismic velocities in the transition zone of the mantle are attributed to _____ in the minerals of the mantle.

37. _____, with their compressional motion, can travel through solids or liquids.

38. _____, which have a shearing motion, cannot pass through liquids.

39. The zone in which S-waves are not received from an earthquake is called the S-wave _____.

40. P-waves which travel through the inner core have _____ velocities than P-waves which travel only through the outer core.

41. A core composition of iron/nickel alloy is actually a bit too _____ to match the seismic velocity information we have for the core.

42. The earth's magnetic field is probably generated in the earth's _____, where molten metallic iron may be electrically conductive.

43. As a rule, pressure _____ with depth within the earth.

44. If we assume the crustal _____ gradient applies to the whole earth, projected temperatures within the body of the earth would become impossibly high for rocks to remain either solid or liquid.

45. Since most of the mantle is solid, temperatures must be _____ the melting curve for mantle rock at appropriate pressures.

46. Since the inner core is solid, temperatures there must be _____ the melting curve for iron at those pressures.

47. Project Mohole was proposed in the late 1950s to drill a well through the _____ into the upper mantle.

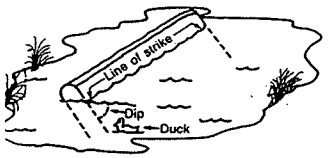
48. Project Mohole ultimately failed when Congress voted to cut off all funding in 1966.

Geology 12
Chapter 9, 10 & 11 Mid-Unit Test

Select 10 of the following questions and answer them on the paper provided. Each question will be marked out of 5, making the test out of 50 marks. Be sure to **answer as fully as possible**, to include all **pertinent details**, and to carefully read each question before beginning to answer it. Please clearly indicate **which question** you are answering.

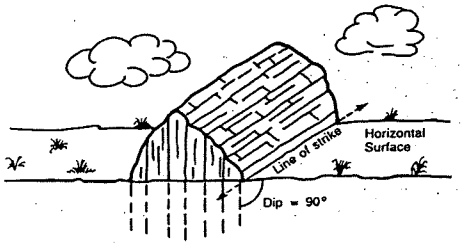
1. Define plate tectonics. Provide two separate pieces of evidence that support the idea of continental drift. Be sure to explain each piece of evidence fully and clearly.
2. Draw a subduction zone and label all parts.
3. Where do we find Earth's oldest rocks (on the seafloor or the continents?) Explain why.
4. Calculate the rate of plate motion on planet X, in cm/y, if a plate has moved 75km in 10,000 years. Show all your work for full marks. What is a typical rate on Earth and what causes our plates to move?
5. Explain how we know that the magnetic poles have reversed in the Earth's history.
6. Describe the following three earthquake hazards and associated possible solutions: a. liquefaction, b. tsunamis, c. fire.
7. Provide a complete and detailed definition for each of the following earthquake terms:
    a. epicenter
    b. focus
    c. P waves
    d. S waves
    e. L waves
8. Earthquake prediction can save lives, if not property. What are 5 precursor phenomena that can be used to forecast possible earthquakes?
9. Describe in detail how seismograms are used to locate the epicenter of an earthquake.
10. Relate the rock cycle to plate tectonics.
11. Describe our local geologic situation in terms of the earthquake and volcanic risks we face.
12. Seismic waves give evidence that the Earth is layered. Explain in detail.
13. Make a rough sketch of the interior of the Earth. Label all principal parts and approximate thicknesses of each layer.
14. What are the distinguishing characteristics (the reason they are divided from each other) of the: crust, mantle, core and the lithosphere, asthenosphere, mantle, outer core and inner core?

Strike and dip are fundamental geologic (and geometric) concepts. The textbook author suggests placing some ɔards or other flat surfaces in water to find the strike line. This is a good idea. Remember that strike will always be a ne. To get the strike of a plane (like a bedding plane), you must intersect that plane with another one in order to :fine a line. (Remember high school geometry? The intersection of two planes is a line!) The intersecting plane that :fines strike is an imaginary horizontal plane. Water makes a *real* horizontal plane. If you see tilted layers of rock i lake or stream, the water line is the line of strike for the layers.



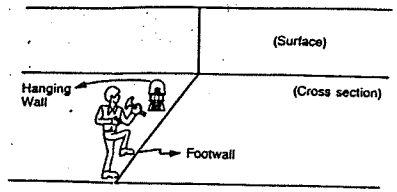
A water-line as a strike line.

Since not all rocks sit conveniently in water, geologists use a special compass that has levels, much like a ɪrpenter's level. When the compass is level, it is horizontal and the strike line can be determined. The strike line will : the intersection of the rock layer and the edge of the compass. Dip is always an angle, measured perpendicular to rike. This does not mean that the dip will be 90°. The dip will be whatever angle the rocks are tilting. Perfectly flat ing beds have no strike or dip. Perfectly vertical beds will have a strike and will dip 90°. Review pages 212 through 14 in your textbook, paying special attention to all figures.



Strike and dip of vertical beds.

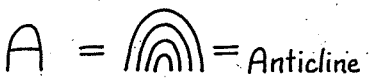
The next group of figures illustrates joints and faults. By definition, there is no movement along joints. There is, ɔwever, movement along faults. The basic concepts here are the different types of motion, and the idea of the ɪnging wall and footwall. The reason we need concepts like the hanging wall and footwall is that we don't see faults ɪtil *after* the motion along them has happened. Sometimes we can't tell what type of movement occurred. Terms like ɪnging wall and footwall allow us to describe the relative motion along dip-slip faults (sometimes called "gravity ults"), as it appears from the offset of discernible layers or "marker beds." I like to draw little stick "miners" along e fault planes. They stand on the "footwall" and hang their little lanterns on the "hanging wall." Or, you can draw tle hangmen if you prefer!



Hanging wall and footwall.

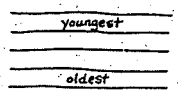
Actually, the terms originated in mining, since ore-rich veins often followed fault planes; the miners really did stand on the footwall of the fault! Learn to identify these features first. Then learn the "rules" for defining the various types of dip-slip faults. Review the information about joints and faults on pages 214 through 216 in your textbook, paying special attention to the figures.

The final group of figures illustrates various rock folds and components of folds. There are numerous tricks for remembering which fold is which. The easiest is to draw the letter "A" with a rounded top to remind you that "A" stands for anticline, which is the upturned fold. Then you need only remember that synclines are the other ones!

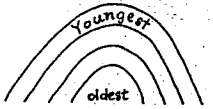


A trick for remembering "anticline."

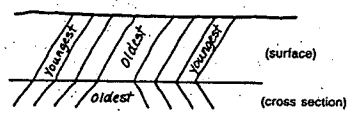
To remember the age sequence of rocks in each, draw a stack of rock layers lying flat and then fold them. You should reproduce what you see in the following figures. See figures 11.14 and 11.15 in the textbook.



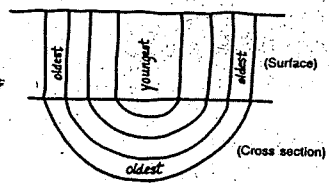
A stack of horizontal rock layers.



Rocks are up-arched to form an anticline.

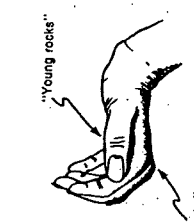


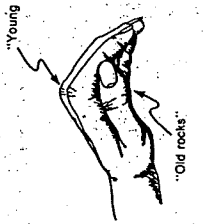
If the fold is eroded, the old rocks at its center are exposed.



Following the same procedure for a syncline yields this picture. The youngest rocks are in the center.

I also use my hand to make a fold. I simply curve my fingers downward for an anticline or make a cup-like shape for a syncline. Whichever part of my hand is on top becomes the younger rocks. For the anticline, I consider my palm the "older rocks" on the bottom, and my knuckles the "younger rocks" on the top. I admit I sometimes look stupid waving my hand about and staring at it—but I never miss a question about folds! Review pages 216 through 219 in your textbook, noting especially all the figures.





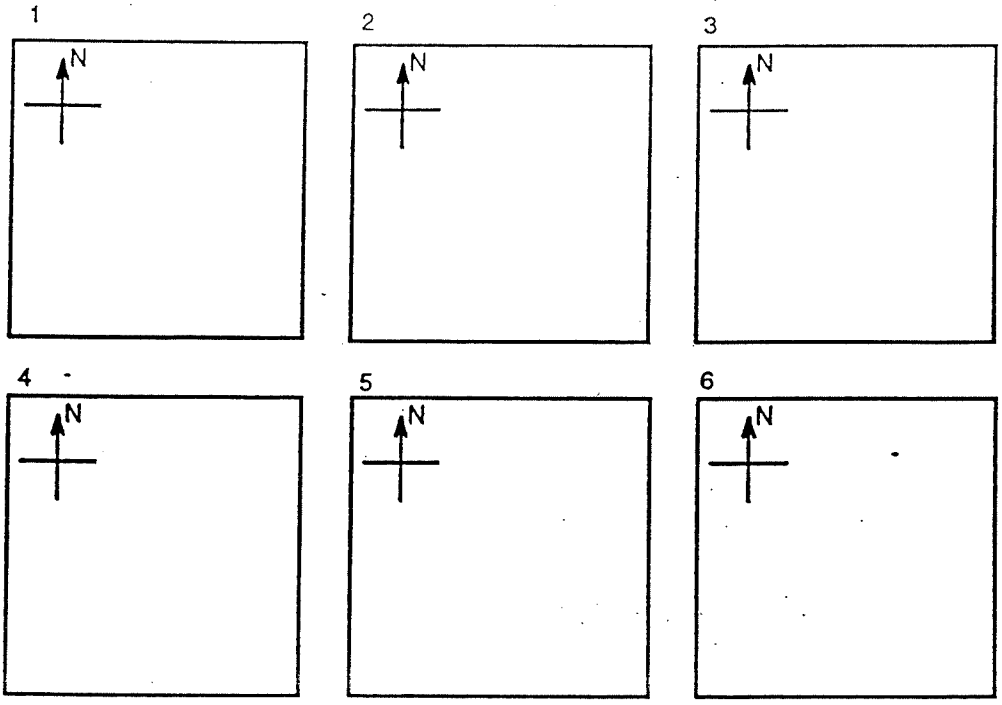
A "hand-made" anticline.

GEOLOGY 12
STRUCTURAL GEOLOGY
STRIKE AND DIP

NAME:_____

You will hand this sheet in as you leave the room. You may answer directly on this sheet.

1. Indicate, with the correct strike-dip symbol, the approximate strike and dip of each of the six (6) samples set up around the room. Sketch the edge of the planar feature in the square provided, mark the symbol on it (you can only guess at the angle of dip). Don't move the examples!



2. Describe in your own words the concepts of strike and dip.

3. What would be the strike-dip symbol for a horizontal structure?

4. What would be the strike-dip symbol for a vertical structure?

GEOLOGY 12

Name _____

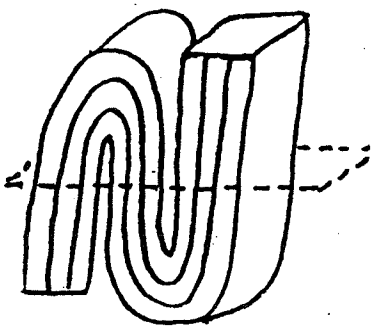
STRUCTURAL GEOLOGY #3

old Structures: Clay Exercise.

Text Reference: Chap. 11 p. 219 to 219.

You will be working in groups of 4. The slab of clay consists of 3 layers, white, gray, red. We will consider the top layer, the white one, to be the youngest. The object is to investigate the patterns that would be formed by the layers in folds when the folds are eroded. In each case you are to make a prediction of the pattern you would see before you "erode" the surface by cutting in the indicated direction. After you have made the prediction you are to cut and sketch the resulting pattern. Label the youngest and oldest layers each time they appear in the sketch.

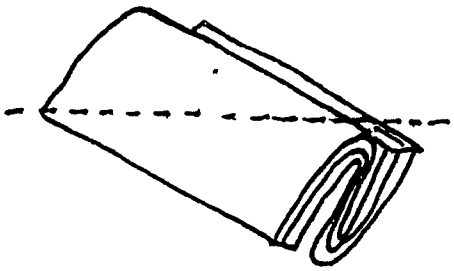
1. Anticline - Syncline pair
   - cut parallel to the fold axis



PREDICTION

SKETCH OF CUT SURFACE

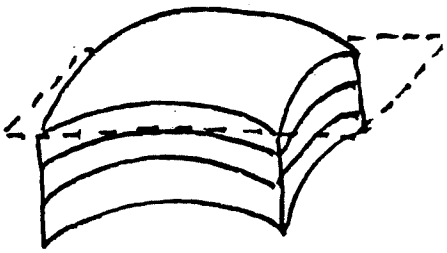
2. Plunging Anticline - Syncline Pair
   - cut at 45 o to the fold axis



PREDICTION

SKETCH OF CUT SURFACE

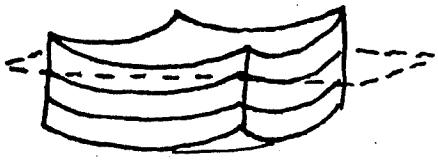
3. Dome Structure
- form by draping clay over a clay ball, then cut off the top



PREDICTION

SKETCH OF CUT SURFACE

4. Basin Structure
- difficult to make but try to predict what it would look like.

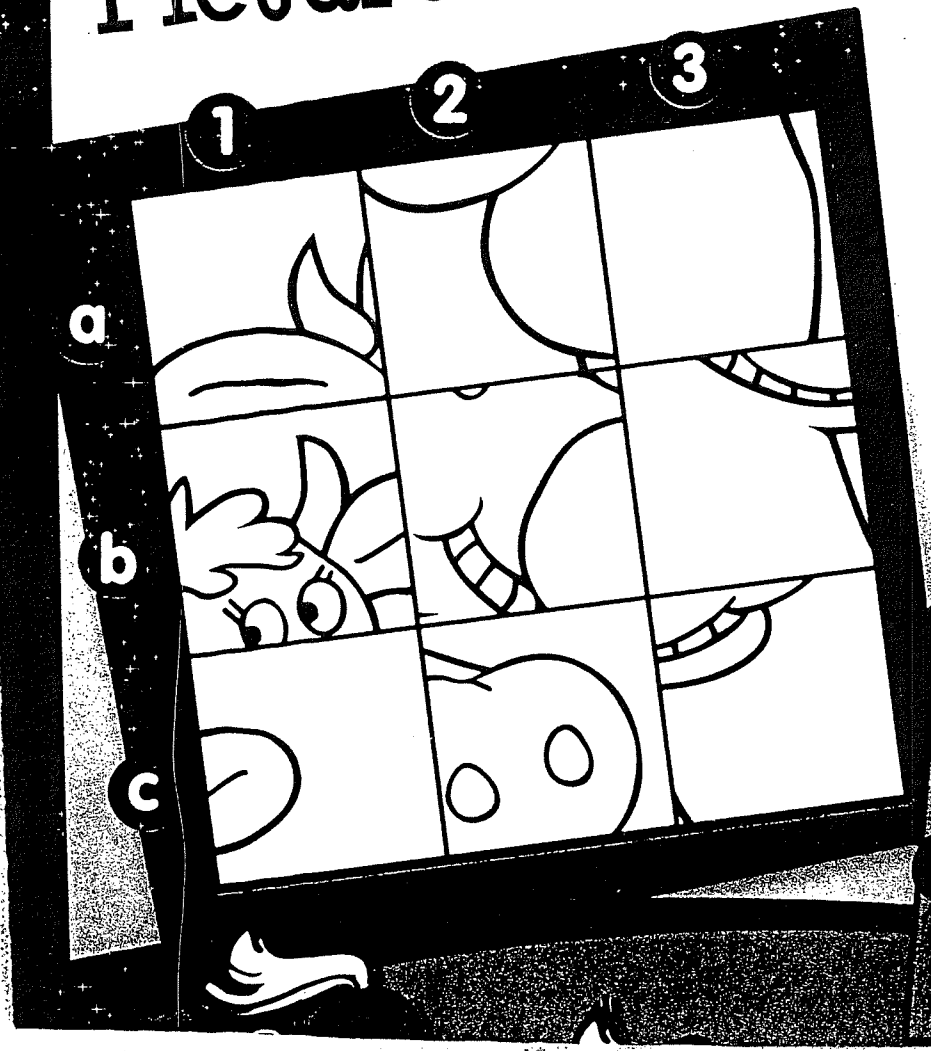


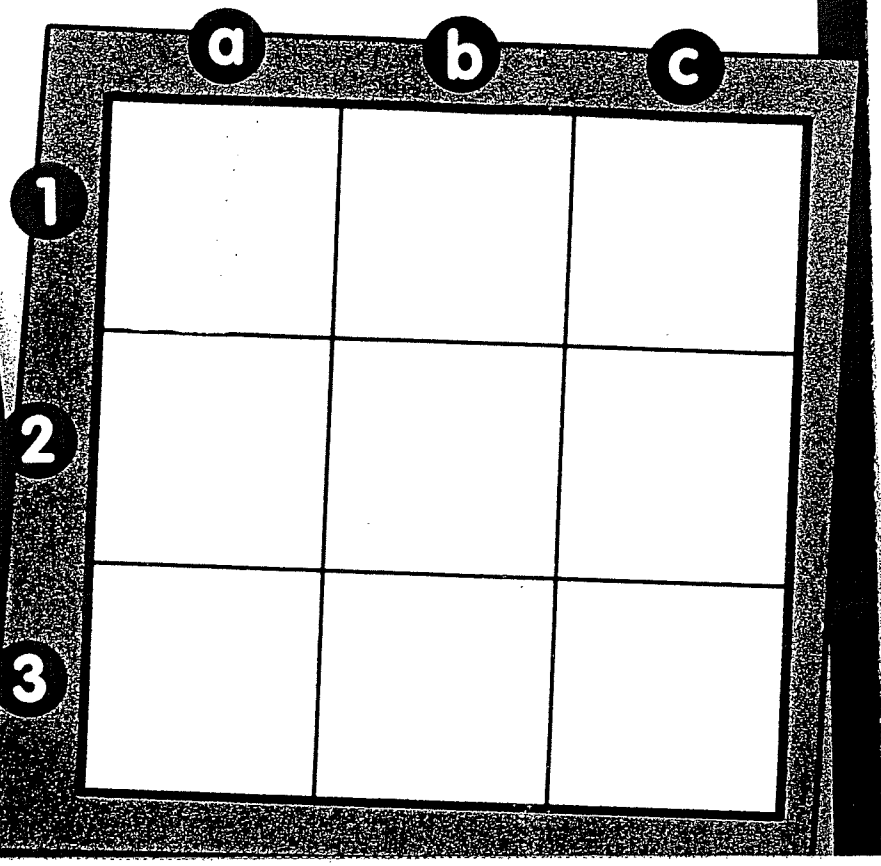
PREDICTION

SKETCH OF CUT SURFACE

Picture Mix-up!

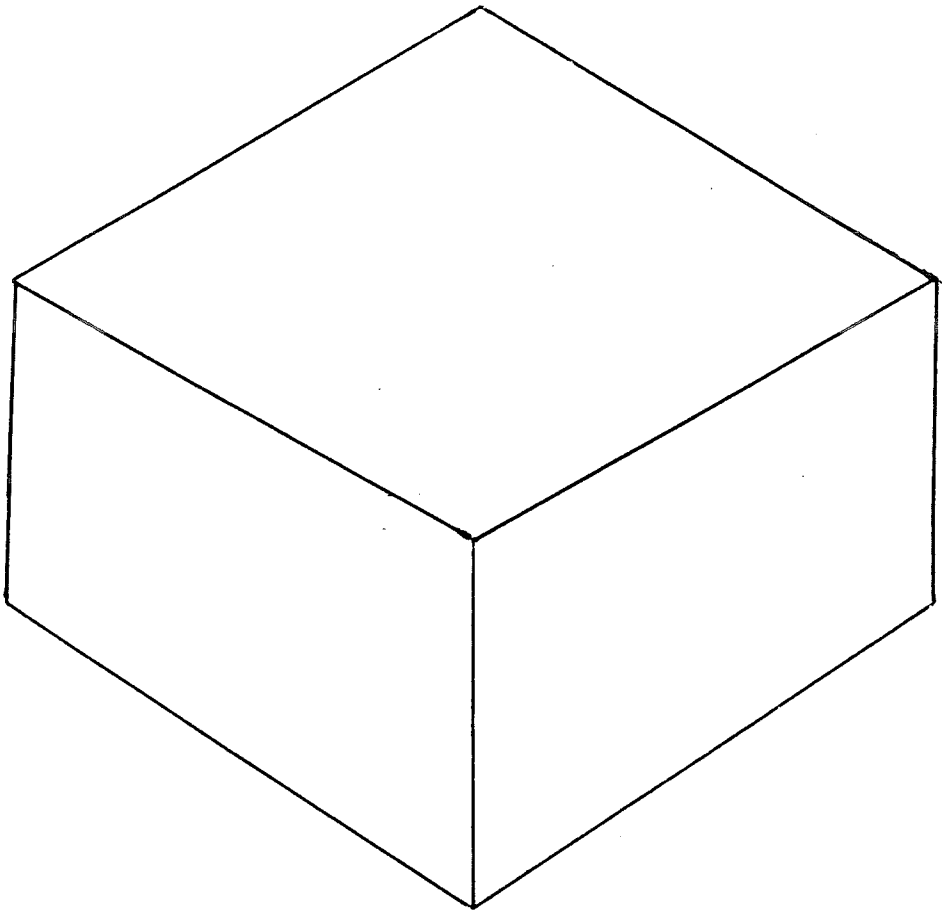
Using a pencil, copy the shape in "A-1" into the blank square "1-A". Continue by drawing "A-2" in "2-A" then "A-3" in "3-A", etc. to reveal an animal you would see at the rodeo!

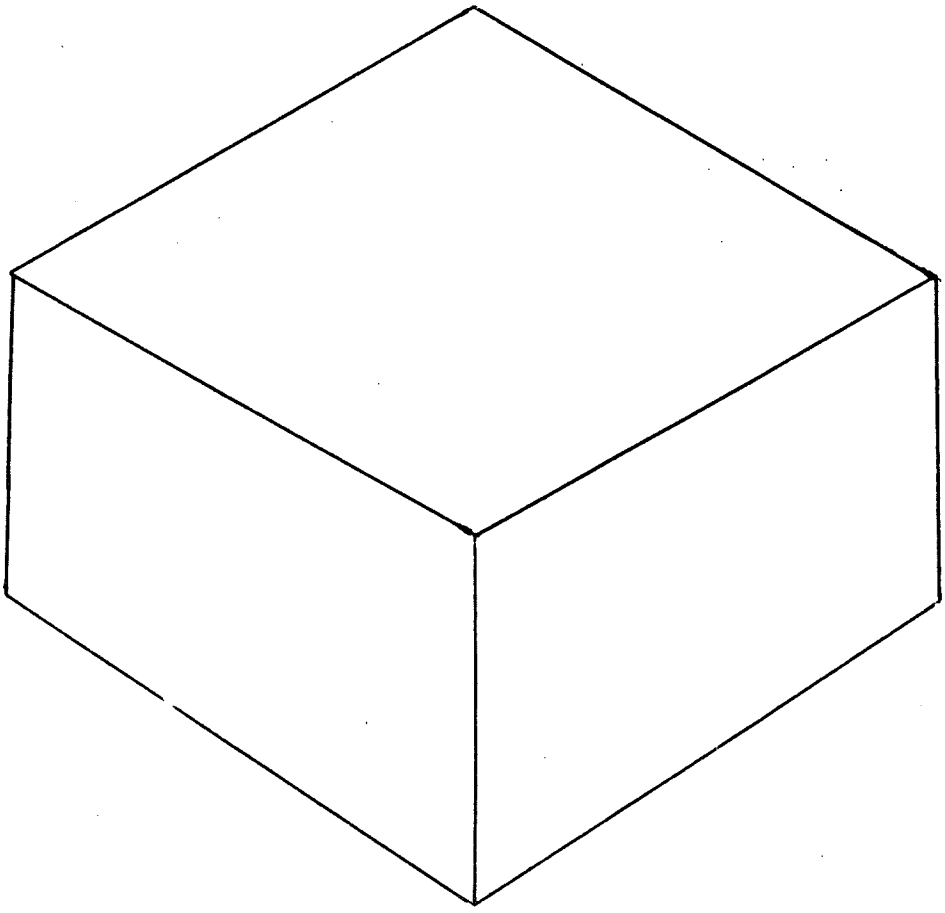


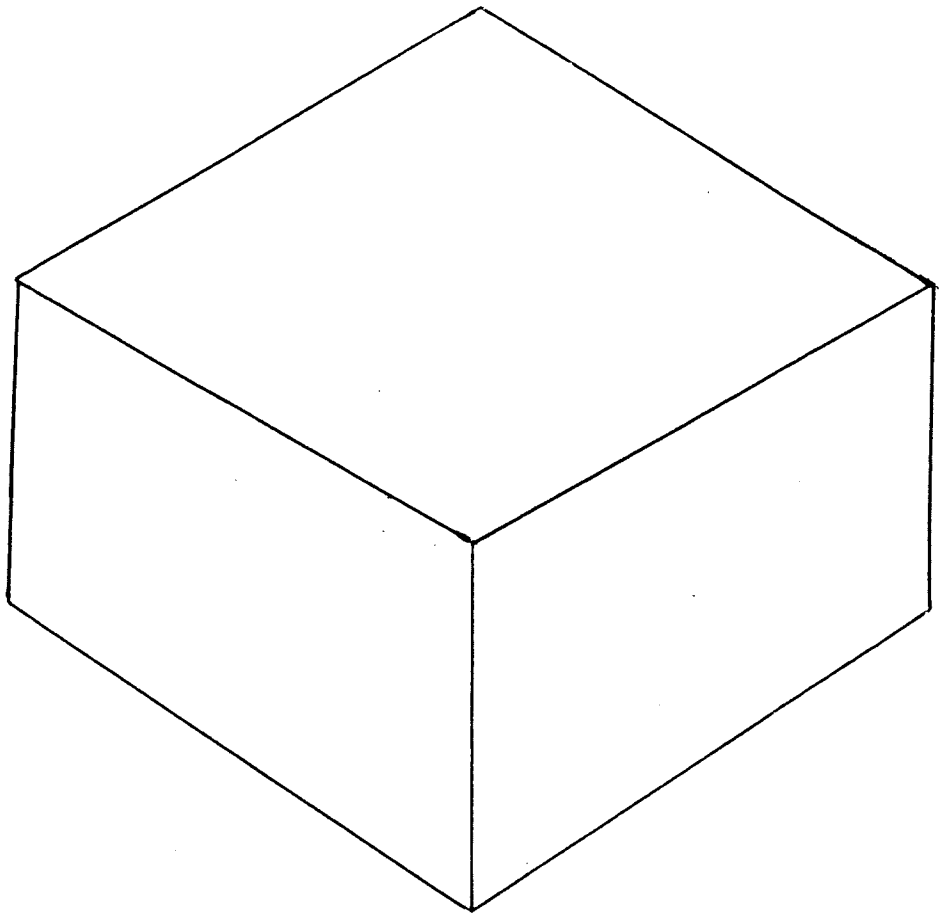


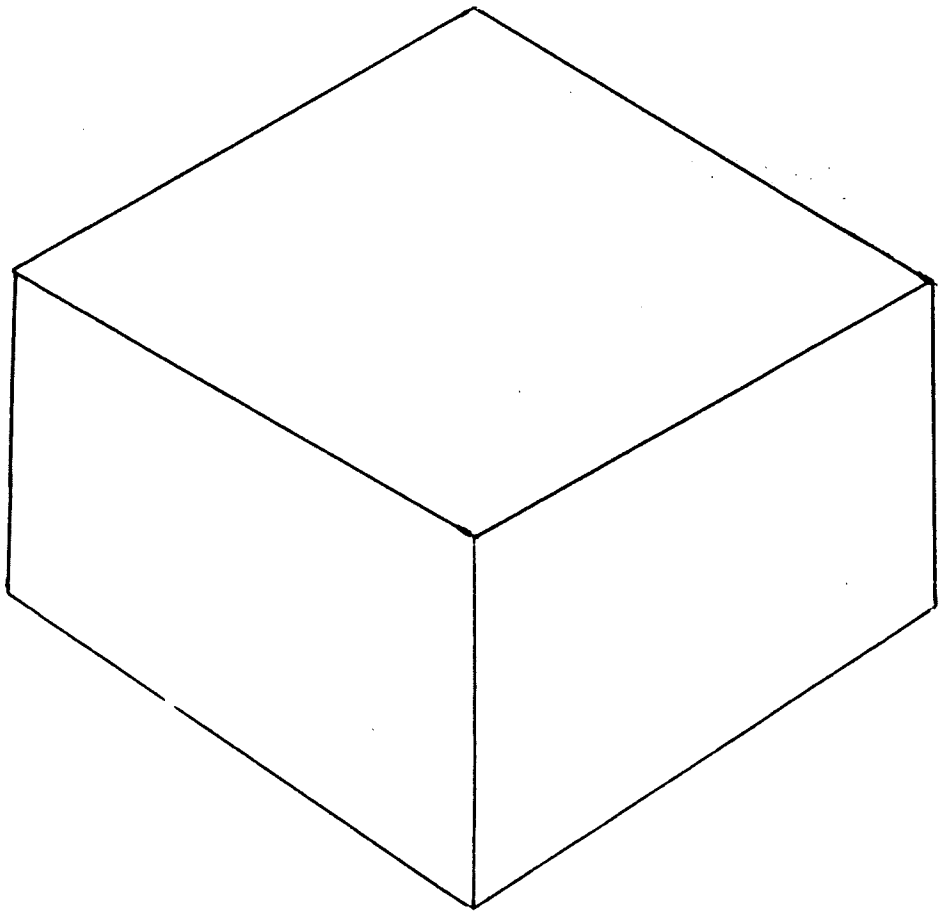
32

This will give you practice matching the contacts







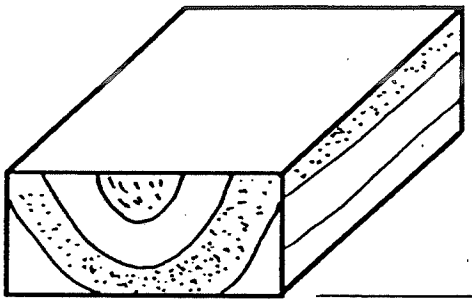


STRUCTURAL GEOLOGY

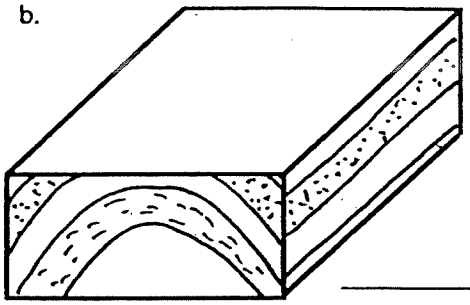
Block Diagrams

1. Complete the following on the Map Surface. Put Strike - Dip symbols on and state which type of fold it is.

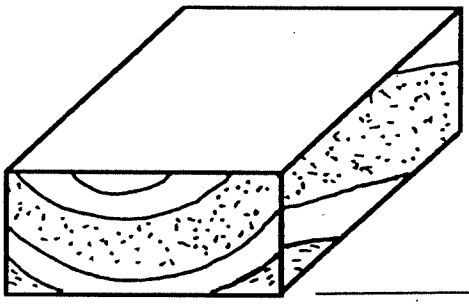
a.



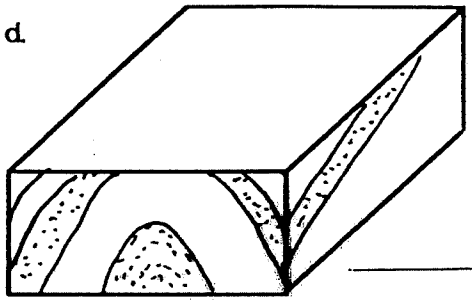
b.



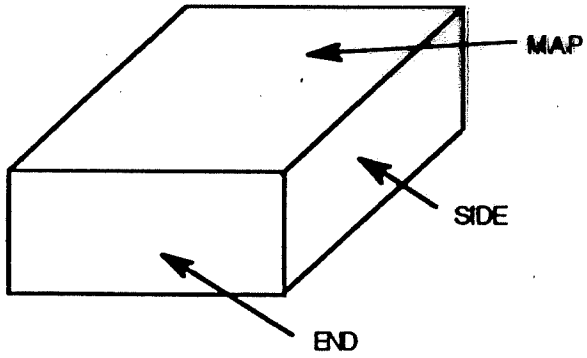
c.



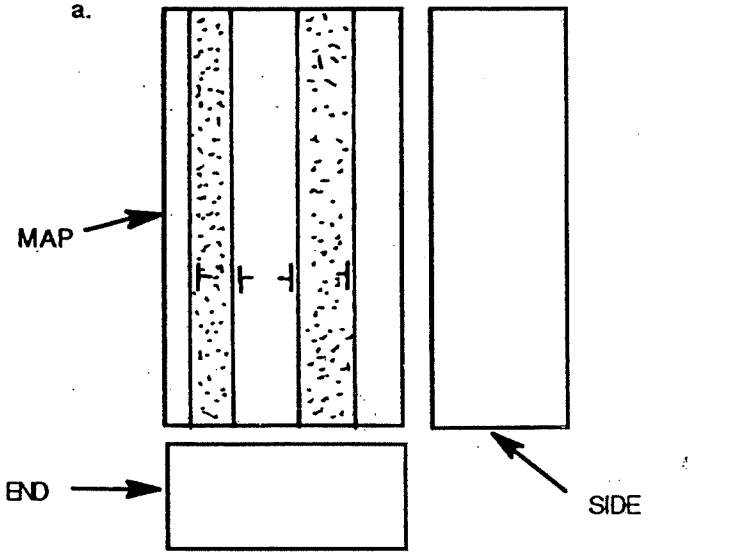
d.



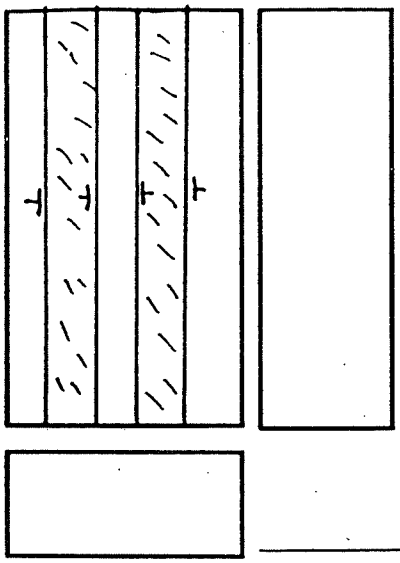
2. Complete.



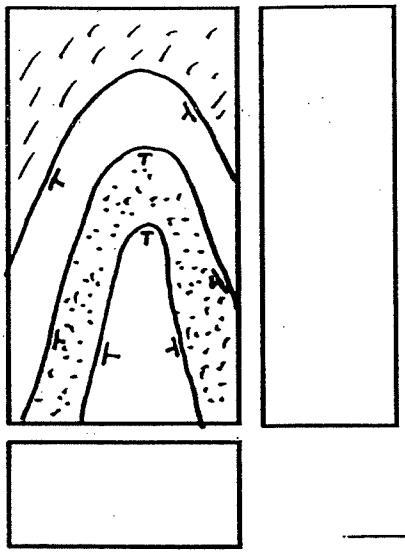
a.



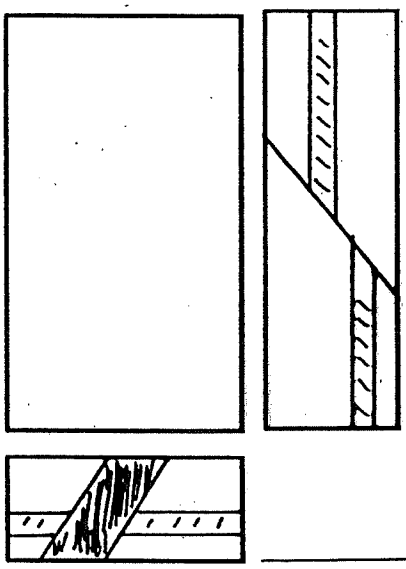
b.



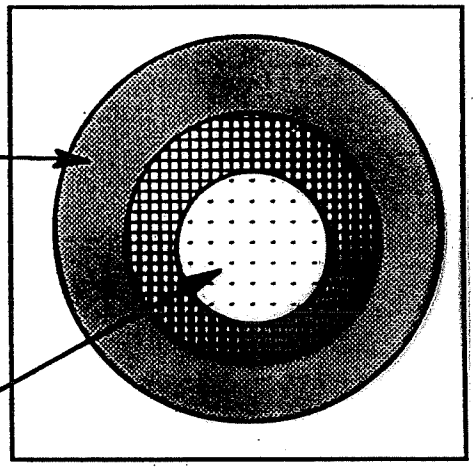
c.



d.



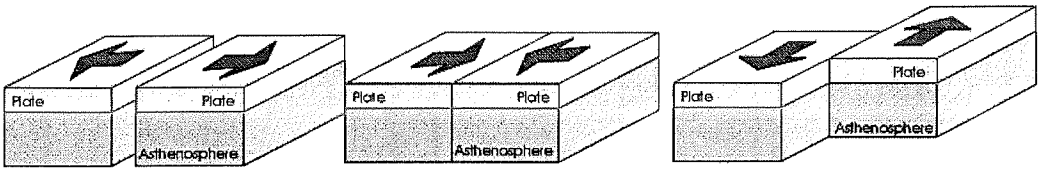
3.



What type of structure is this?

4. Sketch the cross-section of the Earth.
Label the 4 most important layers and give their thickness.
What is the MOHO ?
How is the asthenosphere noticeable to geologists?
How is the transition layer noticeable?
Why must the outer core be liquid?
How is the boundary to the inner core determined?

GEOLOGIC PROCESSES AT PLATE BOUNDARIES



Types of Boundaries

Complete the following chart by placing check marks in the appropriate columns.

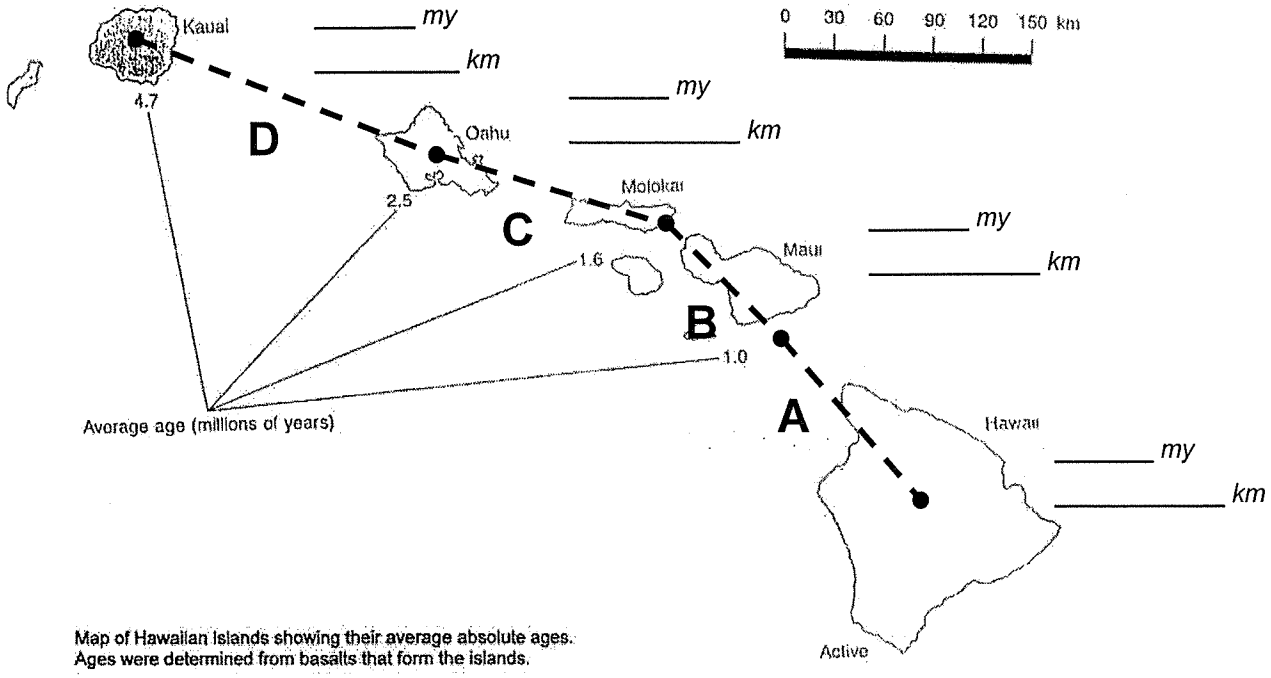
Geologic Process	Type of Plate Boundary		
	Divergent (ridges, rises, sea-floor spreading)	**Convergent** (subduction zones, colliding plates)	**Shear** (transform faults)
1. creation of oceanic crust			
2. destruction of oceanic crust			
3. thick accumulation of sediment			
4. volcanism			
5. formation of batholiths			
6. creation of fold-fault mountain ranges			
7. compression			
8. tension			
9. shear			
10. normal faulting			
11. strike-slip faulting			
12. reverse and thrust faulting			
13. shallow-focus earthquakes only			
14. both shallow & deep-focus earthquakes			

PLATE MOVEMENT

- You will need a ruler for this activity.
- Assume this map is to scale. Calculate the rate of movement of the Pacific Plate that carried the Hawaiian Islands away from the hot spot that is now located located at the southern tip of the big island of Hawaii.

  Use the following formula: Rate *(cm/yr)* = Distance Traveled *(cm)* / Age *(yr)*

CALCULATING RATE OF PLATE MOVEMENT



Map of Hawaiian Islands showing their average absolute ages. Ages were determined from basalts that form the islands.

Chapters 4, 9-12 Review Key

This review sheet will be much more use to you if you attempt all the questions (or at least a full page of questions) before looking at these answers. These are typical final exam questions so keep this for the midterm and final reviews!

Multiple Choice

1. a	11. d	23. b	33. d	44. a	55. a	65. a
2. c	12. d	24. b	34. b	45. c	56. d	66. b
3. d	13. b	25. c	35. a	46. b	57. b	67. d
4. a	15. b	26. a	36. a	47. b	58. b	70. d
5. d	17. d	27. c	37. b	48. b	59. c	71. c
6. b	18. c	28. b	38. c	49. b	60. d	72. c
7. b	19. c	29. b	39. c	50. c	61. a	73. b
8. c	20. a	30. d	41. c	51. a	62. c	74. a
9. c	21. a	31. c	42. d	52. d	63. d	
10. d	22. a	32. d	43. c	53. a	64. c	

Open Ended Questions

14. See notes or text. Be sure to include benioff zone, trench, volcano location, directions of motion, etc.

16. See Geological Formation of BC

a) isostacy caused roots of colliding volcanic islands to rise up as volcano eroded away

b) collision caused folding

c) Juan de Fuca plate subducting beneath North American causes cascade volcanoes

d) same subduction zone

40. a) coast lines match b) diverging plates

54. a) A

b) Clue 1: P waves arrive earlier at A

Clue 2: amplitude of waves is greater at A

Clue 3: the difference in P and S wave arrival times is less at A

68. a) This is a non-plunging syncline with straight lines from front to back on map and strike dip on map (strike parallel to lines and dip pointing toward middle). Then end and side should be completed as well. The end will look like a smile with conglomerate on bottom then shale then sandstone. The side will have one line running straight back with conglomerate on the bottom half and shale on top. ENSURE contacts match up!

b) non-plunging syncline

69. a) normal b) reverse c) thrust d) right lateral strike slip