L4 Chapter 18
Plate Tectonics

Topics
1. Causes of plate tectonics Sect 18.1
2. Volcanoes Sect 18.2
3. Earthquakes Sect 18.2
4.Terms foci, location of plate boundaries

Volcano/Earthquake activity

Choose a well known Earthquake or Volcano

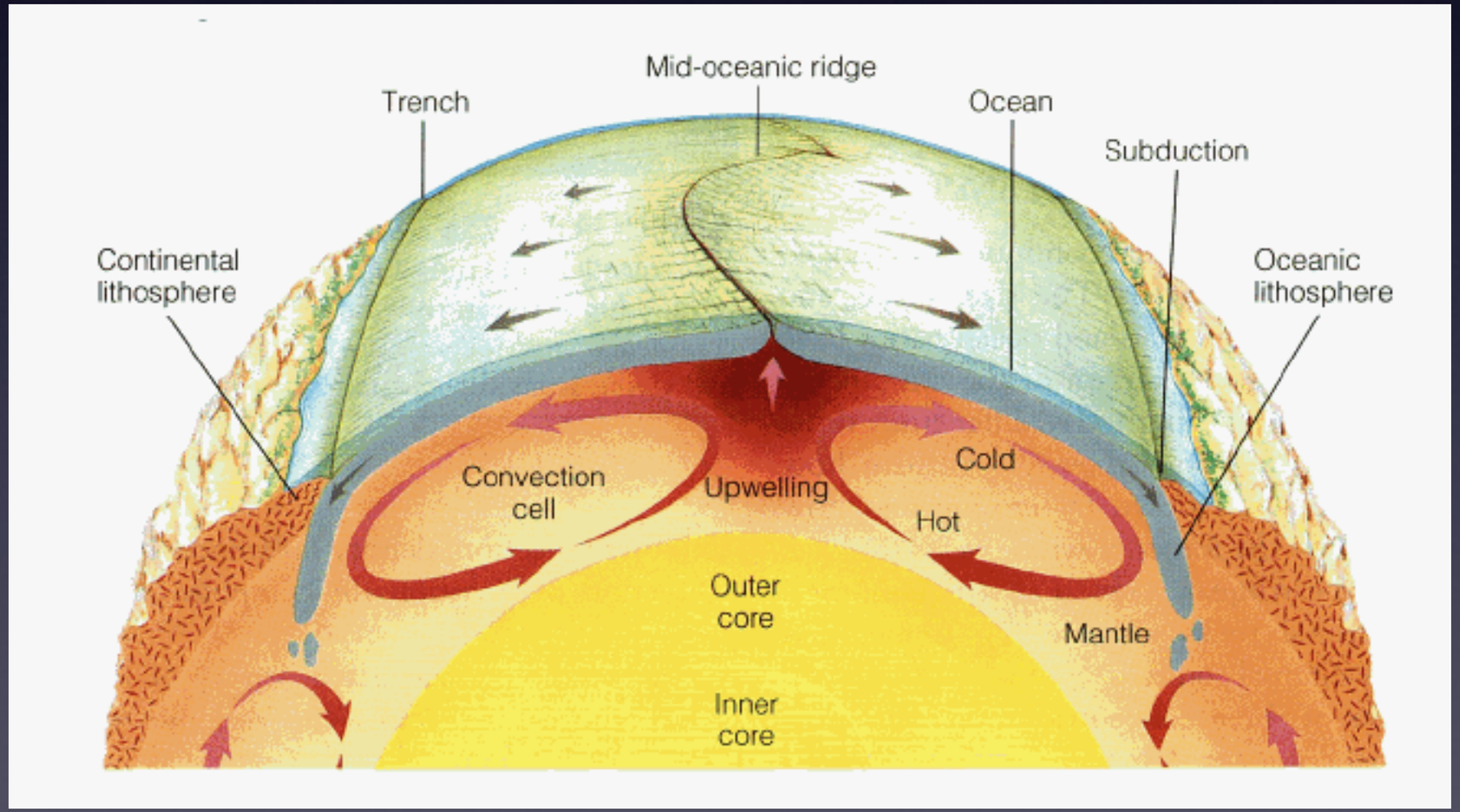
- Who will you be working with (groups of up to 3 people)?
- What questions do you have?
- How will you address these questions?

18.1 Topics

1. Mantle convection causes plate movement
2. Ridge push ⟵ ⟶
3. Slab pull
4. Earth features
    1. Mountains
    2. Rifts
    3. Trenches

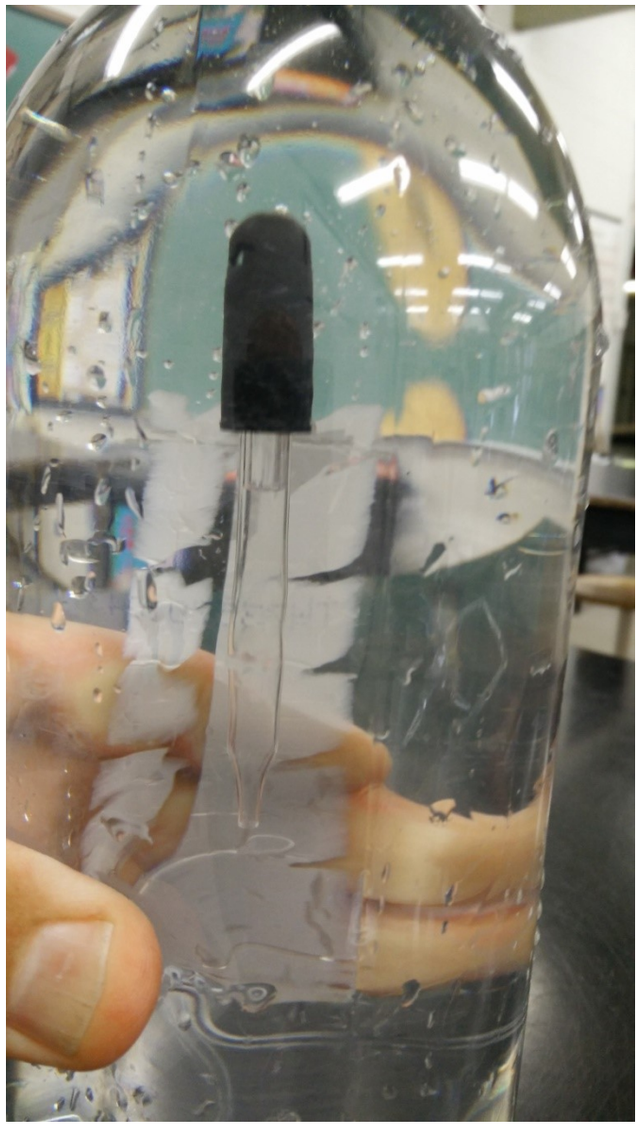
L4 Causes of plate tectonics

1. All plate movement is caused by mantle convection. Mantle convection is driven by the heat in the earth.



What makes the diver fall?

How do we change its density?

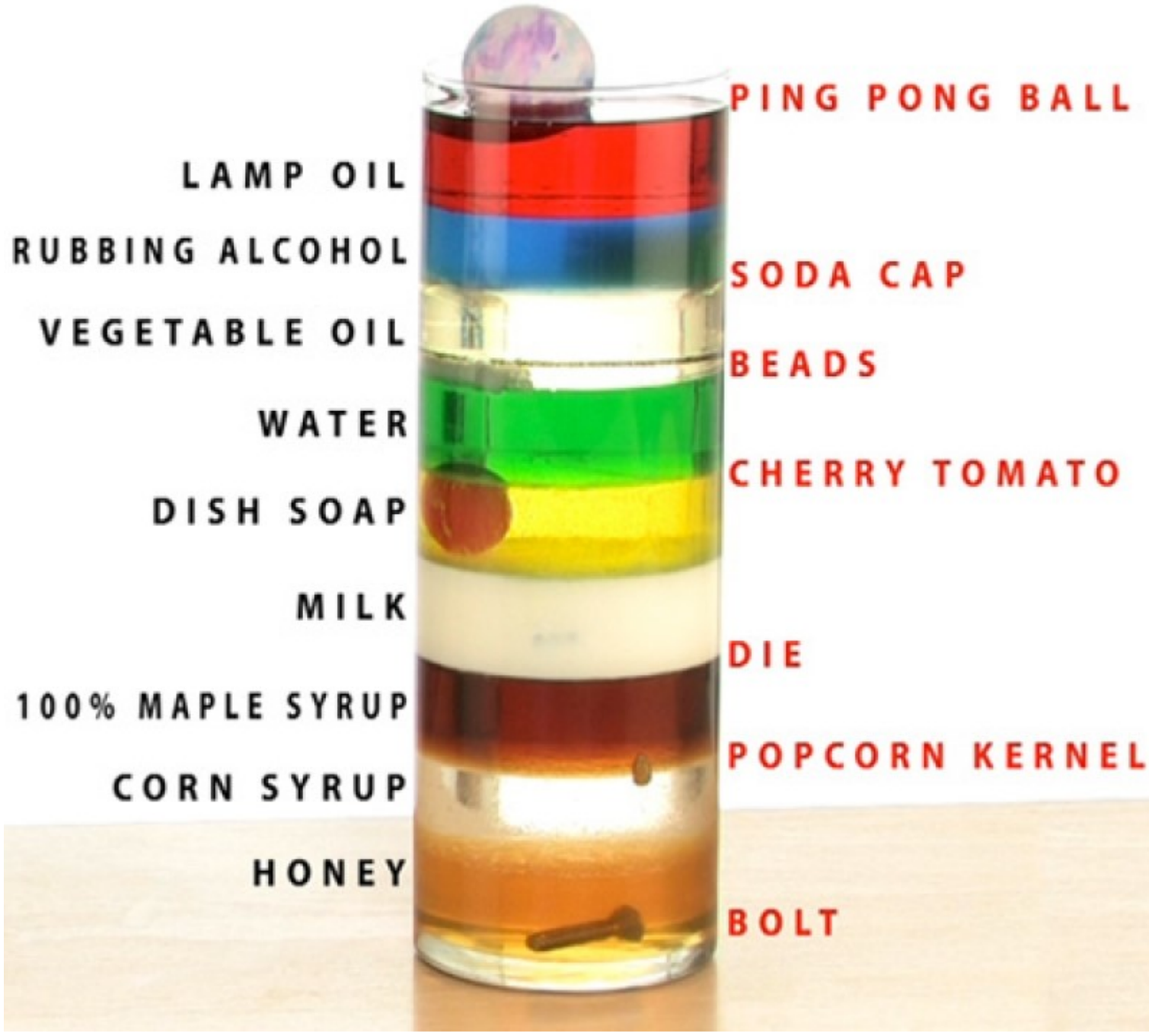


How volcanic are you?

What makes the fluid rise?

Density

Materials with more density (mass/Vol) will float above denser ones.



Will it float?

Predict, then test whether each of these will float in water (1.00 g/mL):

After the activity, turn in your paper with your estimates for the density

Material:	Density /g·mL^{-1}
√ cork	
plastic	
glass	
rubber	
wax	
aluminum	
x sed. rock	
golf ball	

Please show your work for your estimates.
Ex:

Aluminum:

Weigh it: 44g

Measure it: 0.9*0.9*5cm

44/(0.9*0.9*5)

44/4.05 = 11g/mL

Cork:

Float it: About ½ below surface of water

0.5*1g/mL = 0.5 g/mL

Will it float?

Predict, then test whether each of these will float in water (1.00 g/mL):

Cork, plastic, glass, copper, rubber, wax, aluminum, rock

After the activity, write an estimate for the density between 0.1 to 10 g/mL

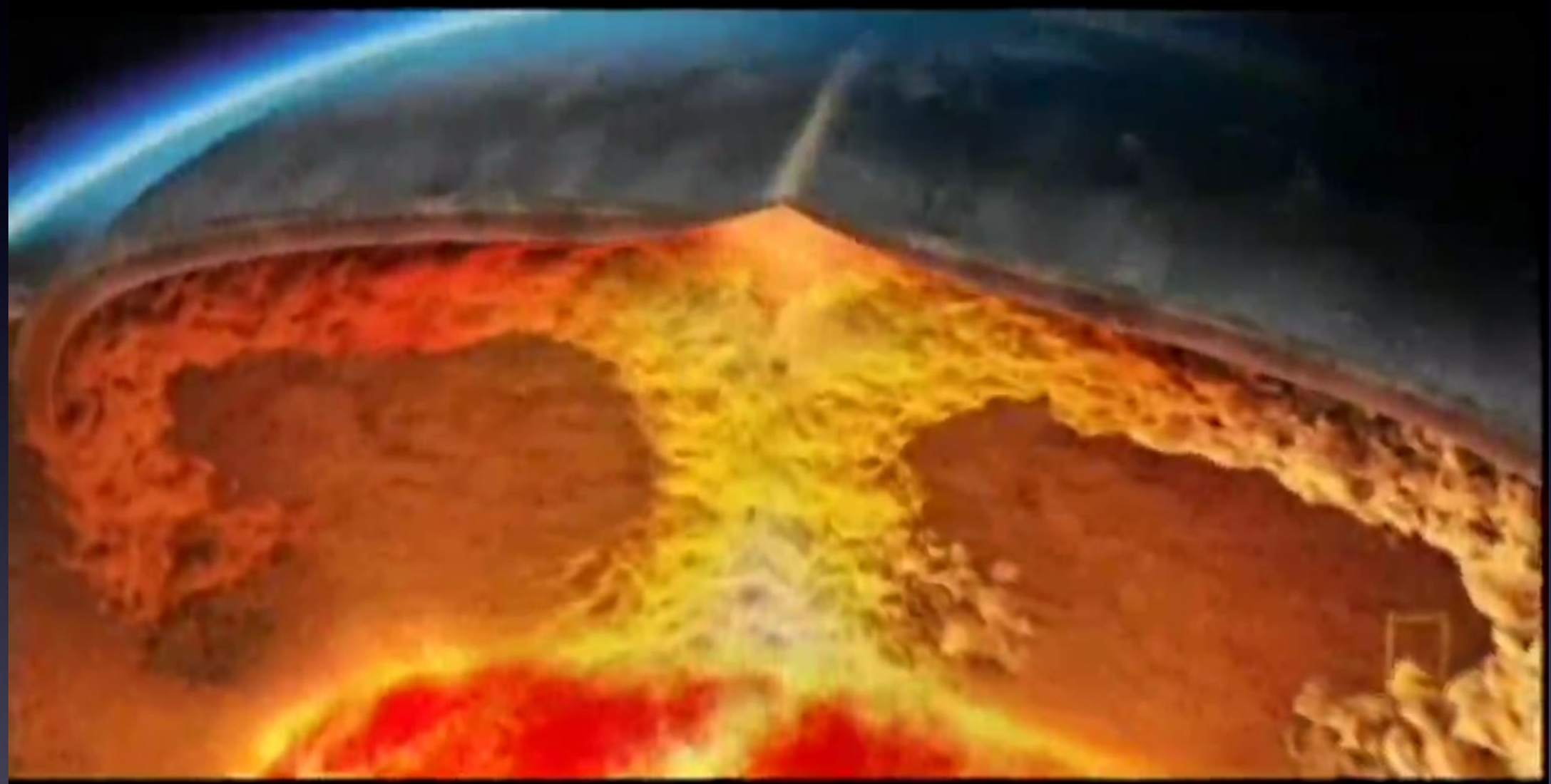
Material:	Density /g·mL^{-1}
cork	0.2
plastic	0.9
glass	3
copper	9
rubber	1.5
wax	0.8
aluminum	3
s. rock	6
golf ball	1.2

Lab S

Careful not to break any glass

Use common sense about food and drink

Mantle convection



http://www.youtube.com/watch?v=p0dWF_3PYh4

Ridge push: as the mantle convection pushes up on the crust it causes the crust to break and spread apart.

Slab pull: as the plate subducts under the continents it gets pulled down by its own weight.

Demo: chain pulled down off desk

L4 Features of plate tectonics

1. Mountains: made by convergent boundaries
2. Rifts and rift valleys: made by divergent boundaries
3. Trenches: made by convergent subduction boundaries.

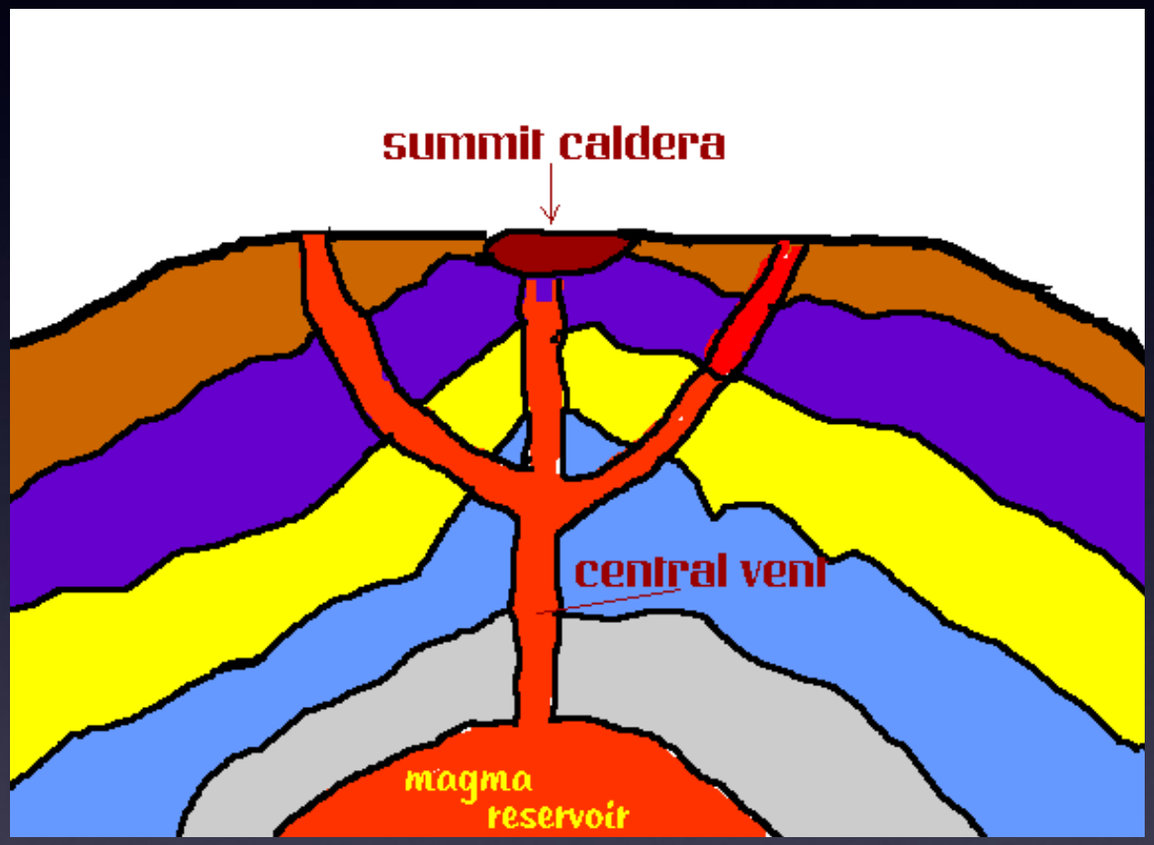
L5 18.2

3 Types of Volcanoes

pg 522-524

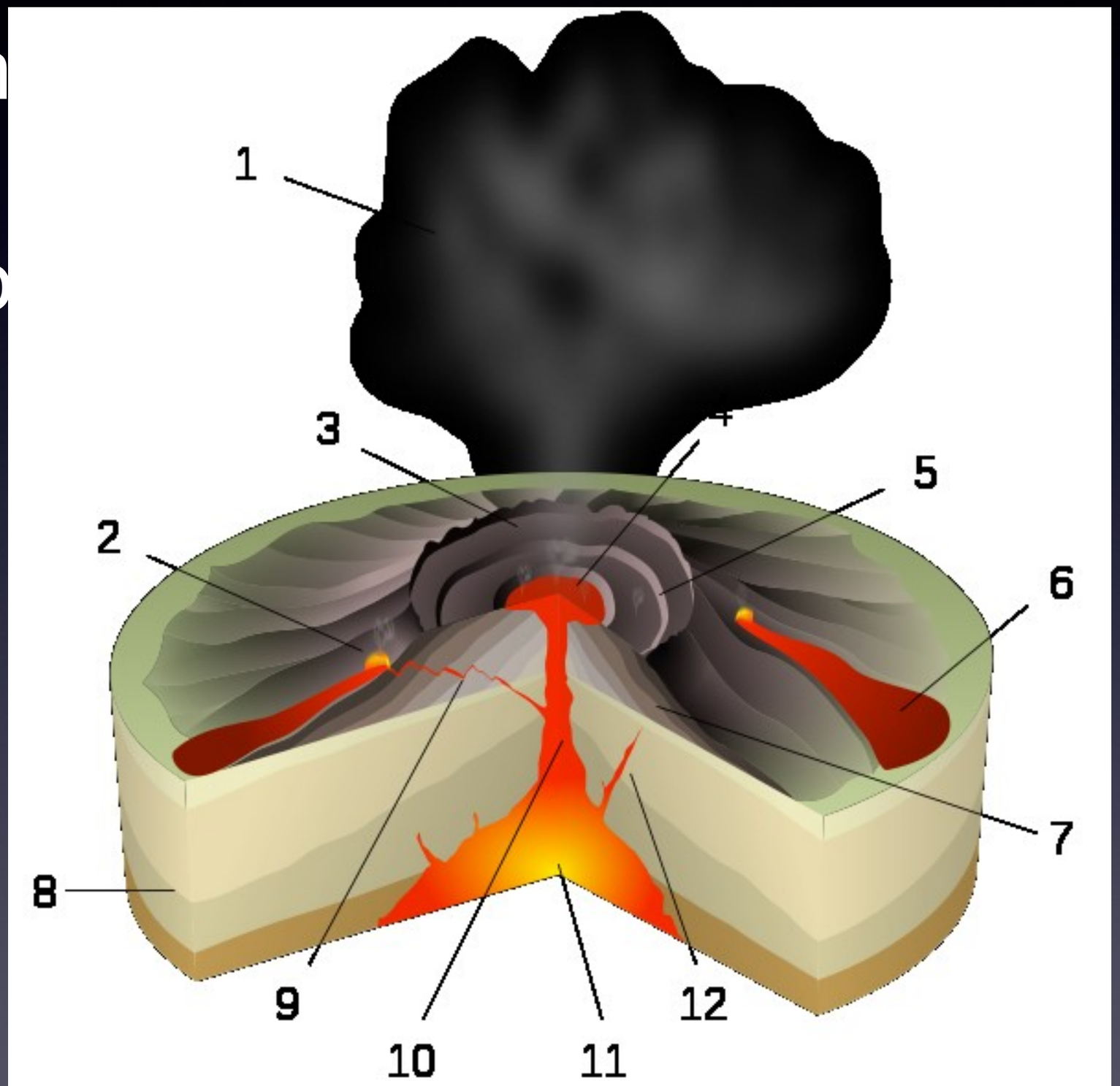
1. Hot Spot Volcanoes. Shield volcano eg Hawaii
2. Rift volcanoes at mid ocean ridges eg Iceland
3. Subduction zone. Composite volcanoes, e.g. Mt St. Helens

Shield Volcanoes



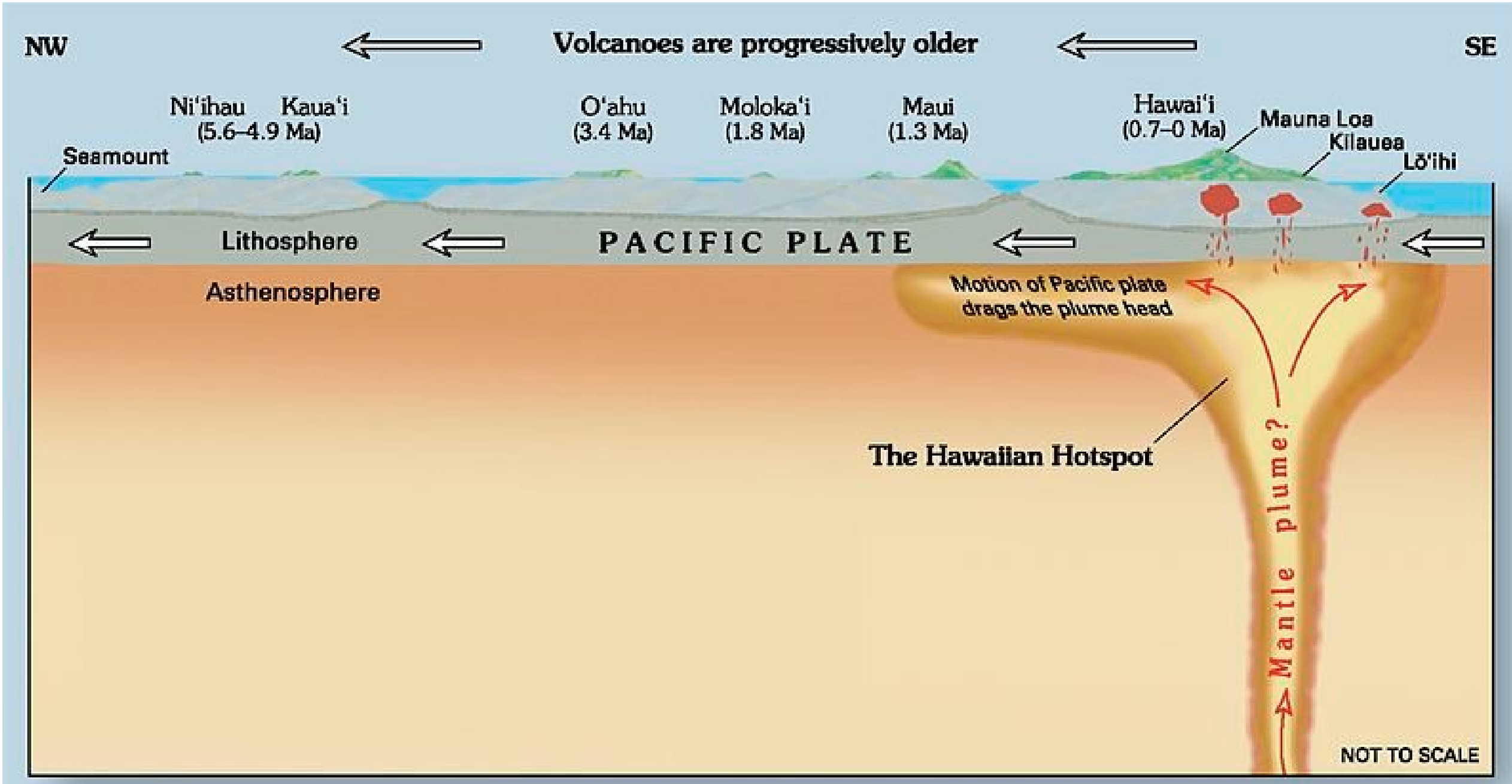
L5 Characteristics of Shield Volcanoes

1. Wide an
2. Hot and
3. Found o



Form on Hot Spots in the crust

eg. Hawaii, Galapagos Islands.


NW
Volcanoes are progressively older
SE
Ni'ihau
Kaua'i
(5.6–4.9 Ma)
O'ahu
(3.4 Ma)
Moloka'i
(1.8 Ma)
Maui
(1.3 Ma)
Hawai'i
(0.7–0 Ma)
Mauna Loa
Kīlauea
Lō'ihi
Seamount
Lithosphere
PACIFIC PLATE
Asthenosphere
Motion of Pacific plate
drags the plume head
The Hawaiian Hotspot
Mantle plume?
NOT TO SCALE

Shield Volcano eruption, Hawaii

Note how fluid it is....or runny

Get this man a shield

Shield volcano lava.

Shield volcano
lava fountain...

and
splattercone!

Rift Eruptions

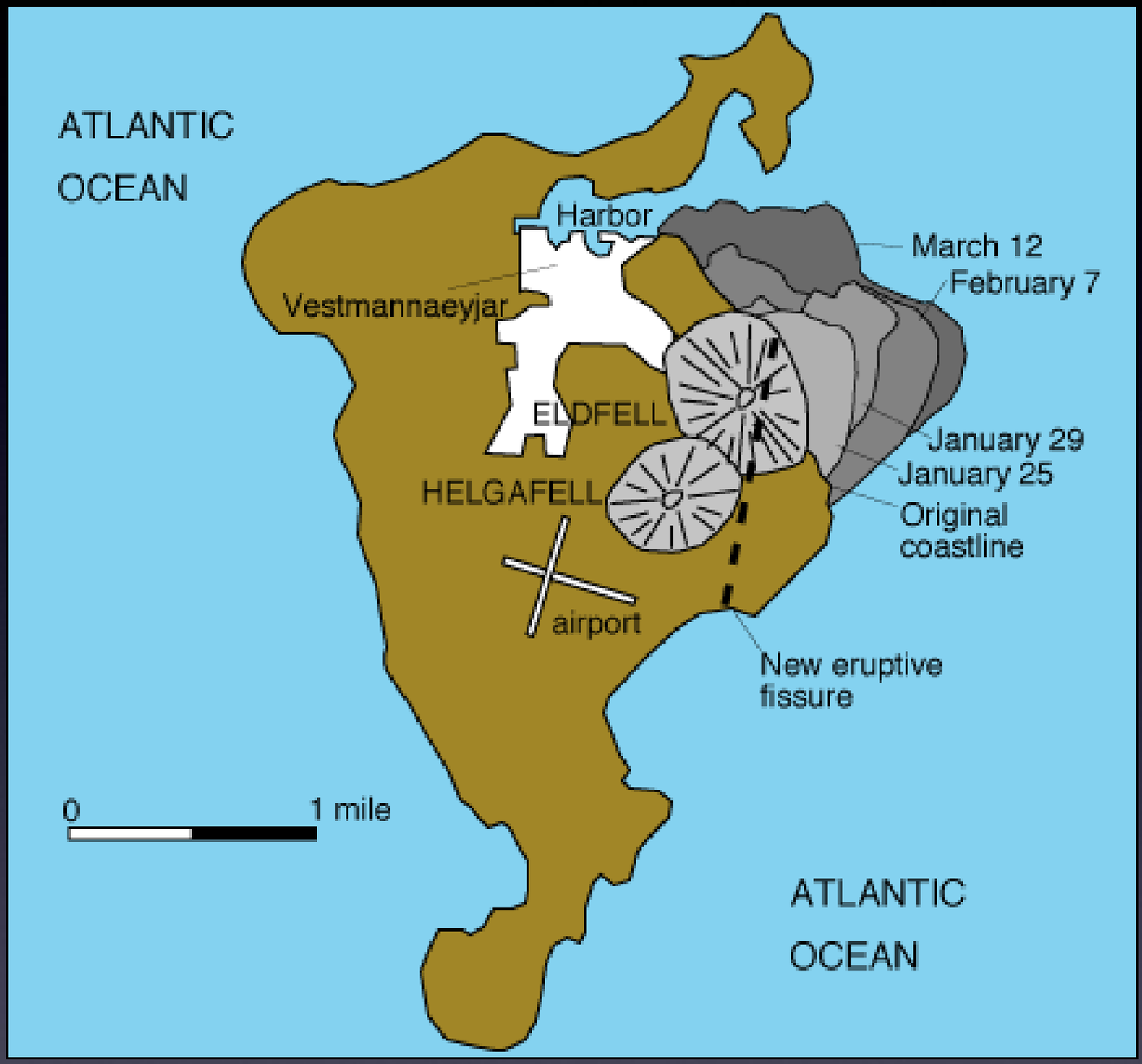
Rift eruption along the Mauno Loa volcano

Rift Eruptions

-Occur along cracks in the lithosphere
-Are long and spew out large amounts of slow moving lava
-lots of tephra (hot rocks)

The 1973 eruption on the island of Heimaey

The 1973 eruption on the island of Heimaey


ATLANTIC
OCEAN
Harbor
Vestmannaeyjar
ELDFELL
HELGAFELL
airport
March 12
February 7
January 29
January 25
Original
coastline
New eruptive
fissure
0
1 mile
ATLANTIC
OCEAN

Composite Volcanoes

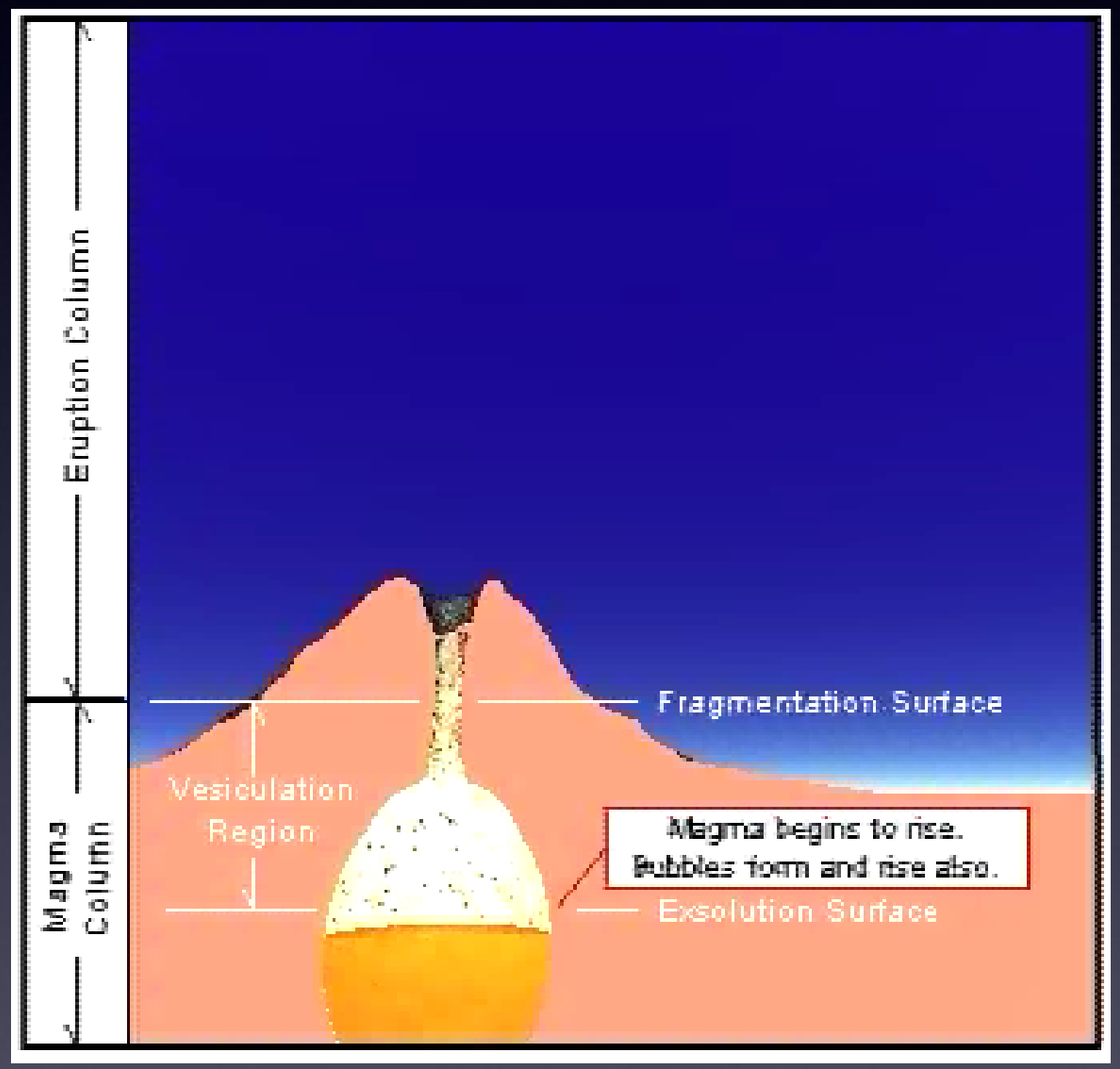
Mt.
Fuji
Japan

Mt. St. Helens
is a composite style volcano

Characteristics

- It erupts in an explosive gassy way.
- composed of layers of ash and lava
- lava is slow moving and sticky
- found on subduction boundaries!!
- most dangerous

Composite cones build up pressure
from
gasses and then they blow...

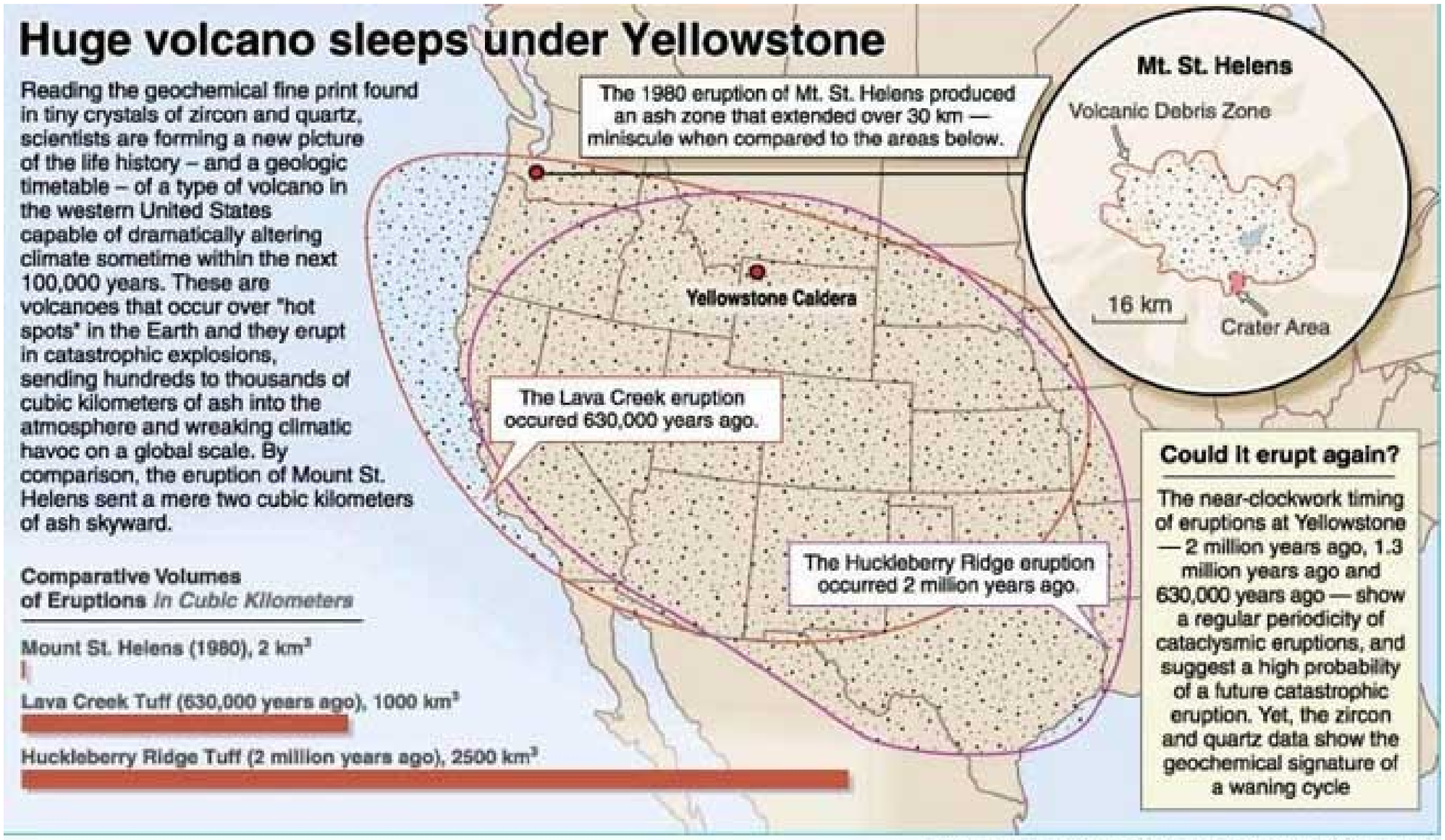


L5 Composite cones produce a pyroclastic cloud that can kill people and destroy houses. Watch out!

Bodies trapped by ash from a pyroclastic flow

L5 These composite volcanoes produce a blocky sharp
lava called Aa.

Yellowstone



Check Your Understanding

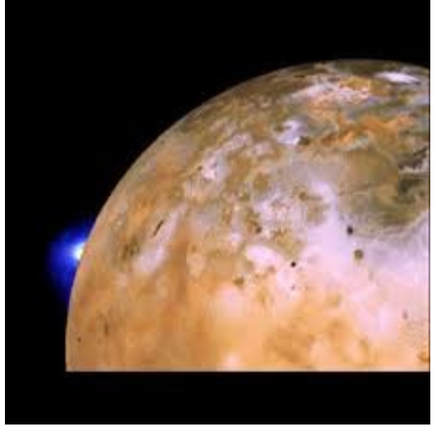
p. 528 Odd Todd

Quiz Friday: study the maps on p. 6 & 7

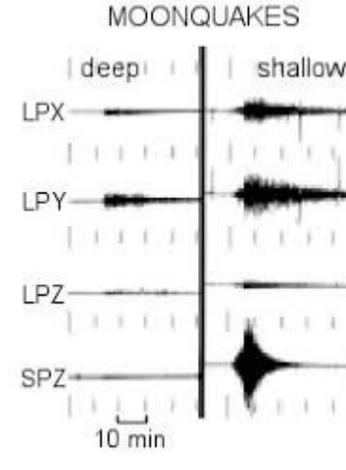
Q: What plate boundary is responsible for the Japanese archipelago?

A: Convergent subduction

Extraterrestrial Tectonics?



Use your device or iPads to find activity related to Earthquakes or Volcanoes. In groups of up to 3, make small presentation comparing your choice with activity on Earth, share with **gsjokvist@gedu.sd73.bc.ca**

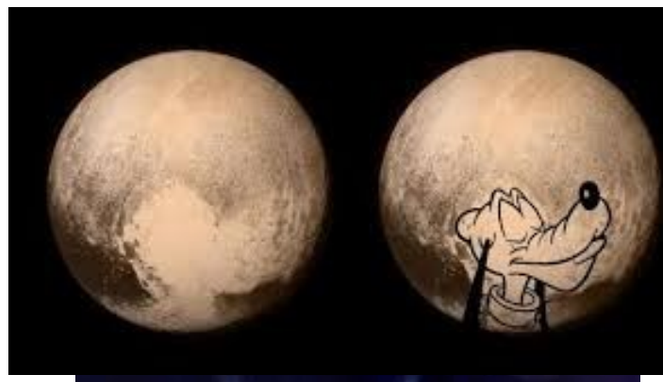


You will be assessed on your Evaluation (with support)

Ex: - compare Europa's ocean trenches with Mariana

-compare Moonquakes with Earthquakes

-compare Solar flares with Volcanoes



LAKES AND OCEANS

DEPTHS AND ANIMAL/SHIP/BOAT LENGTHS ARE TO SCALE; HORIZONTAL DISTANCE IS NOT.

EDMUND FITZGERALD
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
DEATH VALLEY
GREAT SLAVE LAKE
CRATER LAKE
LOCH NESS
LAKE BAIKAL
BURJ KHALIFA
KURSK
LUSITANIA
ANDREA GAIL (PROBABLY)
FREE-DIVING DEPTH RECORD
SCUBA RECORD
BIKE TIRES GO FLAT
AIRCRAFT CARRIER
PRESSURE AT THIS DEPTH WOULD POP THE CORK INTO A CHAMPAGNE BOTTLE
TITANIC
SEAWISE GIANT (LARGEST SHIP EVER)
PRESSURE AT THIS DEPTH WOULD FORCE WATER BACK UP A HOUSEHOLD FAUCET
EMPEROR PENGUIN
OHIO-CLASS NUCLEAR SUB DEPTH LIMIT
TYPHOON-CLASS NUCLEAR SUB DEPTH LIMIT
BLUE WHALE
DEEPWATER HORIZON
DEAD SEA
CHILEAN MINE
COLLAPSE
MINER REFUGE
LEATHERBACK TURTLE
OIL WELL

FUN FACT:
THE *EDMUND FITZGERALD*, THE *KURSK*, AND THE *LUSITANIA* ALL SANK IN WATER SHALLOWER THAN THEY WERE LONG.

AT THIS DEPTH, IF YOU SHOOT A HOLE IN A PRESSURIZED SCUBA TANK, INSTEAD OF AIR RUSHING OUT, WATER RUSHES IN.

KOLA BOREHOLE:
SOVIET PROJECT TO TRY TO DRILL THROUGH THE EARTH'S CRUST TO THE MANTLE JUST TO SEE WHAT WOULD HAPPEN.
RUSSIANS ARE *AWESOME*.

1,000 m
2,000 m
3,000 m
4,000 m
5,000 m
6,000 m
7,000 m
8,000 m
9,000 m
10,000 m
11,000 m
12,000 m

BOW
STERN
MID-OCEAN RIDGE
SPERM WHALES DIVE THIS DEEP.
THEY COME UP COVERED IN WOUNDS AND SUCKER MARKS, SO PRESUMABLY THERE ARE BIG SQUID DOWN HERE?
... MAN, WE KNOW *NOTHING* ABOUT THE OCEAN.

ALVIN DEPTH LIMIT

ABYSSAL PLAIN

DAVID BOWIE & FREDDIE MERCURY

PUERTO RICO TRENCH
THE ABYSS
IT'S RUDE TO STARE
MILWAUKEE DEEP
MARIANAS TRENCH
CHALLENGER DEEP
MYSTERIOUS DOOR WHICH JAMES CAMERON BUILT HIS SUB TO REACH AND OPEN.
HE WILL NOT SAY WHAT HE FOUND WITHIN.

MARIANAS TRENCH (ACCURATE HORIZONTAL SCALE)

MAUNA KEA, HAWAII (ACCURATE HORIZONTAL SCALE)

OIL

Map preQuiz

- On page 6, find an example of a:
- 1. Subduction zone volcano
- 2. Hot Spot volcano

- On page 7, find an example of a country that owes its existence to:
- 3. Rift volcanoes
- 4. Convergent zone volcanoes
- 5. What plate is subducting under the West coast of Mexico?

Map preQuiz key

- On page 6, find an example of a:
- 1. Subduction zone volcano: Mount St. Helens, Mount Baker
- 2. Hot Spot volcano: Yellowstone
- On page 7, find an example of a country that owes its existence to:
- 3. Rift volcanoes: Iceland
- 4. Convergent zone volcanoes: New Zealand, Japan, Phillippines, Indonesia, Samoa, Fiji, …
- 5. What plate is subducting under the West coast of Mexico? Cocos plate

Map Quiz

- On page 6, find an example of a U.S. state where you can find a :
- 1. Subduction zone volcano:
- 2. Hot Spot volcano:
- On page 7, identify which types of volcanoes we would expect to observe in each country:
- 3. Iceland:
- 4. New Zealand:
- 5. What plate is subducting under the East coast of Japan?

PLATE

JUAN DE FUCA RIDGE

JUAN DE FUCA PLATE

GORDA RIDGE

GORDA PLATE

NORTH AMERICAN PLATE

Mt. Baker

WASH.

Mt. St. Helens

MONTANA

N. DAK.

OREGON

CALIF.

NEVADA

IDAHO

UTAH

Yellowstone

WYOMING

COLORADO

ARIZONA

SAN ANDREAS FAULT

N
W
E
S

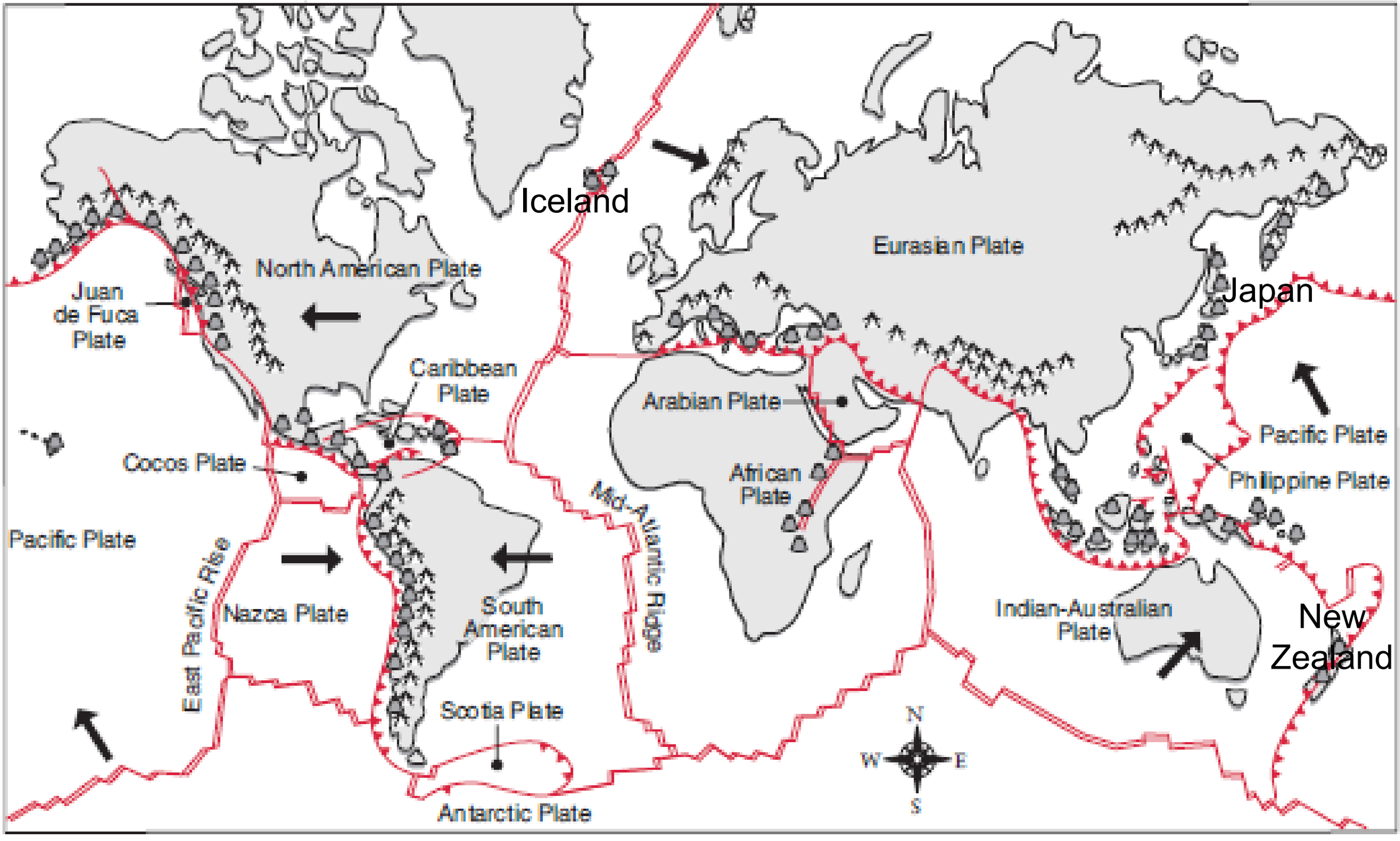
rm boundary

gent boundary

nt boundary

ovement

WORLD TECTONIC PLATE BOUNDARIES MAP



Divergent boundary

Convergent boundary

Transform boundary

Mountains

Plate movement relative to the African Plate

Volcanoes

Map Quiz key

- On page 6, find an example of a U.S. state where you can find a :
- 1. Subduction zone volcano: Washington, Oregon, California
- 2. Hot Spot volcano: Wyoming
- On page 7, identify which types of volcanoes we would expect to observe in each country:
- 3. Iceland: rift
- 4. New Zealand: subduction,
- 5. What plate is subducting under the East coast of Japan? Pacific or Philippine plate

sportinglife

Rugby World Cup final route prediction

The Final

Wales!!

Japan v Wales

Semi Final

Japan v England

Semi Final

Ireland v Wales

Quarter Final

Ireland v S. Africa

Quarter Final

New Zealand v Japan

Quarter Final

England v Australia

Quarter Final

Wales v Argentina

Ireland
Japan
Scotland
Samoa
Russia

New Zealand
South Africa
Italy
Canada
Namibia

England
Argentina
France
Tonga
USA

Wales
Australia
Fiji
Georgia
Uruguay

L6 Earthquakes

1. Fill in the blanks: 4 types of earthquake waves pg 526

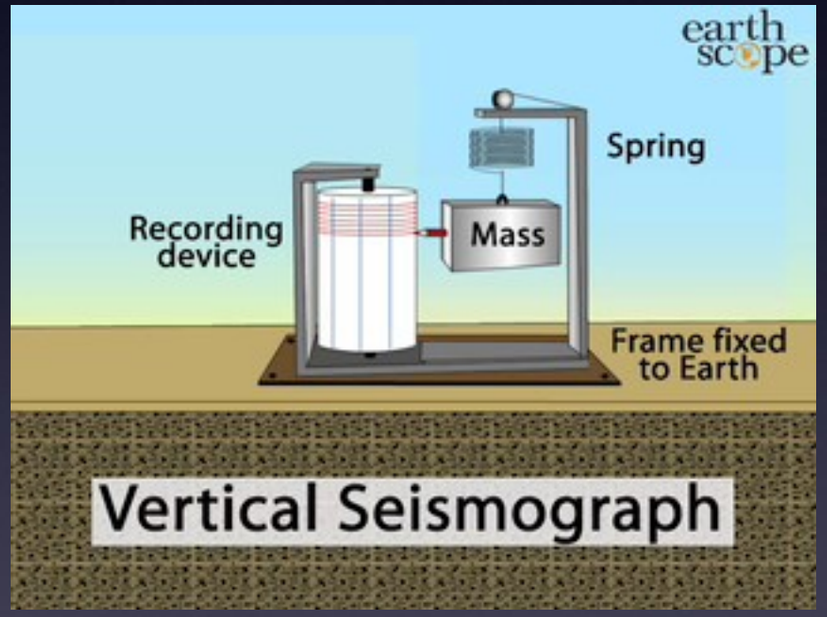
    1. Surface waves:
    2. *Body waves:*

        a) Primary (pressure or parallel) waves:

        b) Secondary (sidewinder snake or shear) waves:

Earthquakes

Earthquakes occur because of moving plates. Plates get stuck and the pressure builds up. Eventually the rock gives and the plates move suddenly.



Seismographs detect earth motions!

Wave Depth

Earthquakes occur at all plate boundaries.

Read pg 525 and 526 (figure 6 and 7, table 1) and determine the following.

Depth of Earthquake found at each boundary type

1. Mid ocean ridge (divergent): shallow
2. Subduction zone (convergent): very deep
3. Transform zone: intermediate

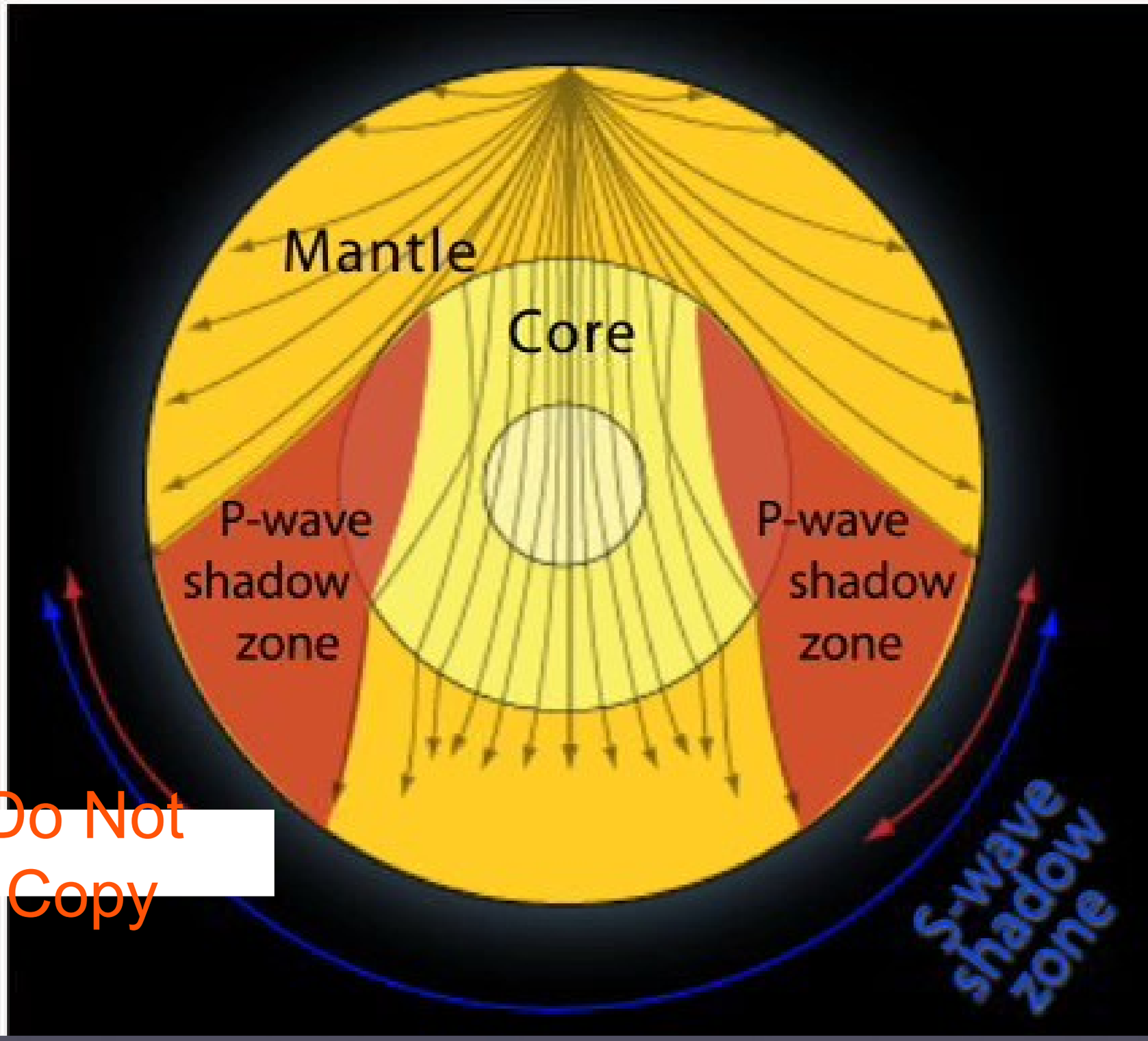
Tsunami from earthquakes

Seismic Shadow Zones

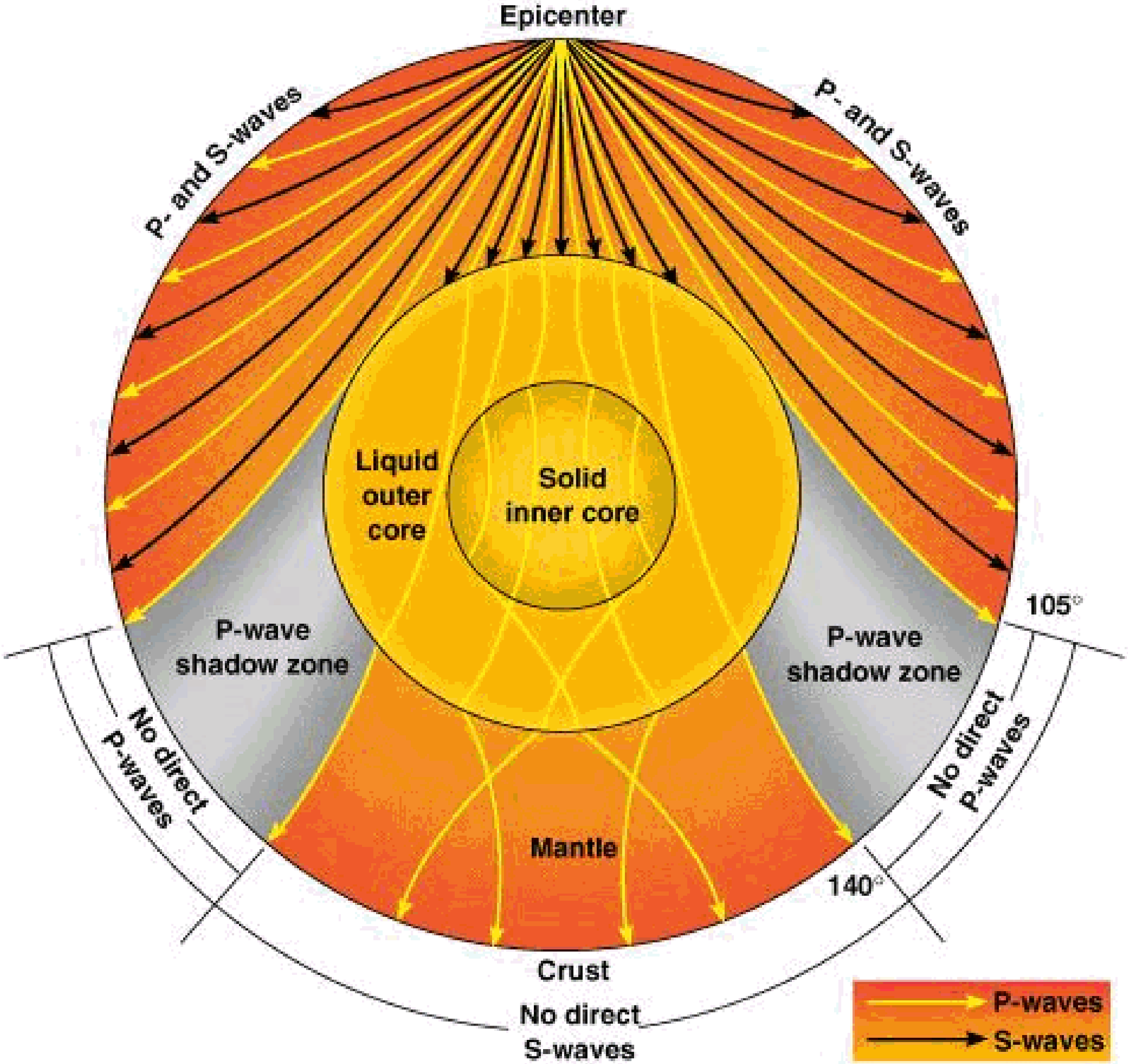
How the mantle and core were determined using the arrival times of direct P and S body waves

P waves (primary) are compressive waves that travel through solids & liquids.

S waves (secondary) are shear waves that travel through solids only.



Do Not Copy


Epicenter
P- and S-waves
P- and S-waves
Liquid outer core
Solid inner core
P-wave shadow zone
P-wave shadow zone
105°
No direct P-waves
No direct P-waves
Mantle
140°
Crust
No direct S-waves
P-waves
S-waves

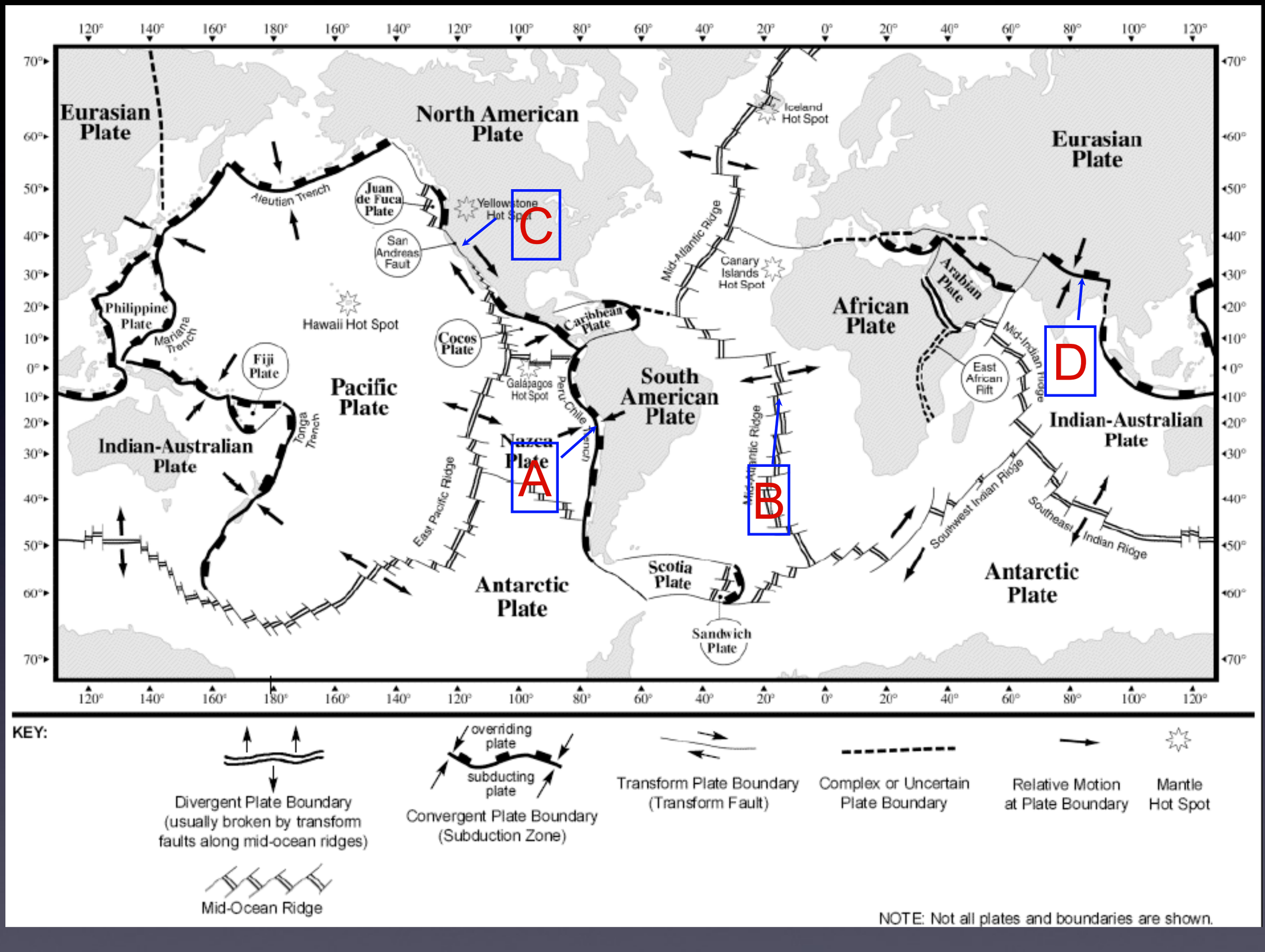
Practice Concepts

Plate Movement

Look at the following map and predict what features would be at each letter.

Use your data booklet for more information.

The first one has been done, the rest you will be able to discuss with your partner.


Eurasian Plate
North American Plate
Eurasian Plate
Iceland Hot Spot
Aleutian Trench
Juan de Fuca Plate
Yellowstone Hot Spot
C
San Andreas Faut
Mid-Atlantic Ridge
Canary Islands Hot Spot
Arabian Plate
African Plate
Philippine Plate
Mariana Trench
Hawaii Hot Spot
Cocos Plate
Caribbean Plate
Mid-Indian Ridge
D
East African Rift
Fiji Plate
Pacific Plate
South American Plate
Galápagos Hot Spot
Peru-Chile Trench
Indian-Australian Plate
Tonga Trench
Nazca Plate
A
B
Indian-Australian Plate
East Pacific Ridge
Southwest Indian Ridge
Southeast Indian Ridge
Antarctic Plate
Scotia Plate
Antarctic Plate
Sandwich Plate
120° 140° 160° 180° 160° 140° 120° 100° 80° 60° 40° 20° 0° 20° 40° 60° 80° 100° 120°
70° 60° 50° 40° 30° 20° 10° 0° 10° 20° 30° 40° 50° 60° 70°
KEY:
Divergent Plate Boundary (usually broken by transform faults along mid-ocean ridges)
overriding plate
subducting plate
Convergent Plate Boundary (Subduction Zone)
Transform Plate Boundary (Transform Fault)
Complex or Uncertain Plate Boundary
Relative Motion at Plate Boundary
Mantle Hot Spot
Mid-Ocean Ridge
NOTE: Not all plates and boundaries are shown.

Map activity

Location:

A: Convergent plate boundary: Composite volcanoes, mountains inland, trench, very deep earthquakes

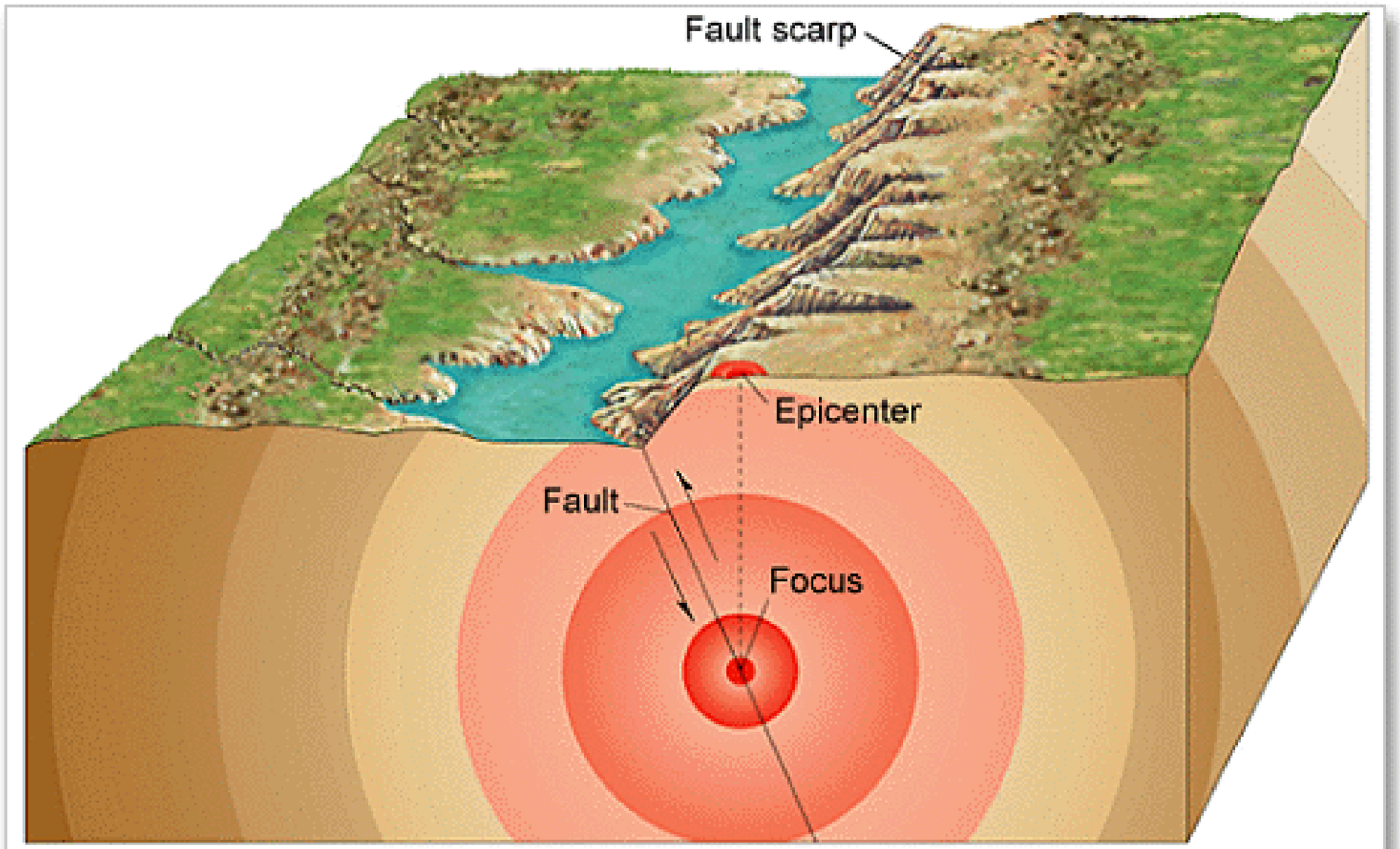
B:

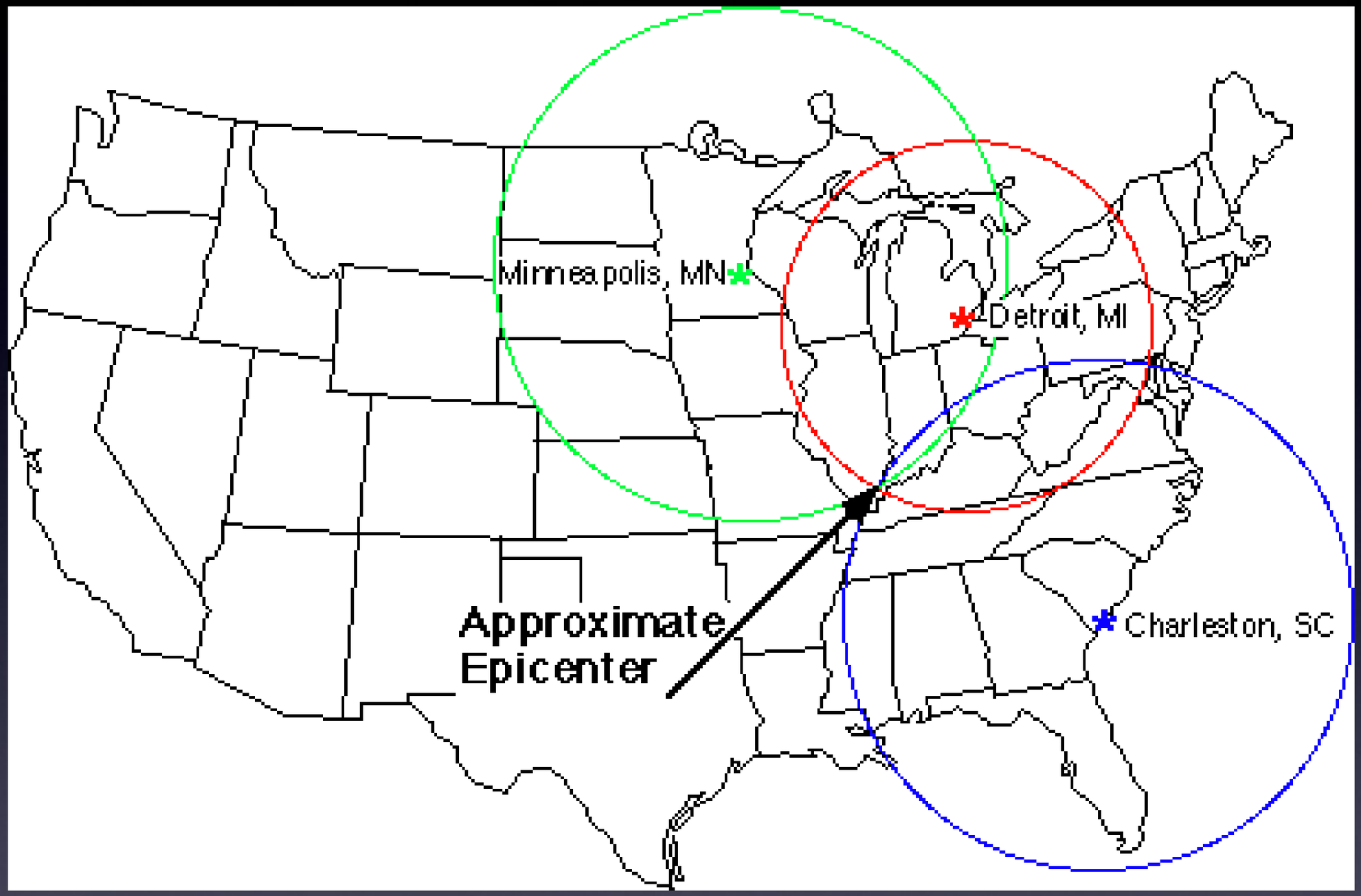
Activity: In groups of 4-5 design and build an earthquake proof building. You may use a small piece of sticky tack and up to 30 popsicle sticks. The building must stand at least 10cm tall and withstand at least a magnitude 1 earthquake. Marking rubric:

	3 marks	2 marks	1 mark
Height	Over ?? cm	Over 20 cm	At least 10 cm tall
Materials	Use only 10 popsicle sticks, no extra sticky tack	Use only 20 popsicle sticks, some extra sticky tack	Use all 30 popsicle sticks, double sticky tack
Strength	Withstand a magnitude 3 earthquake	Withstand a magnitude 2 earthquake	Withstand a magnitude 1 earthquake

Epicenter vs Focus

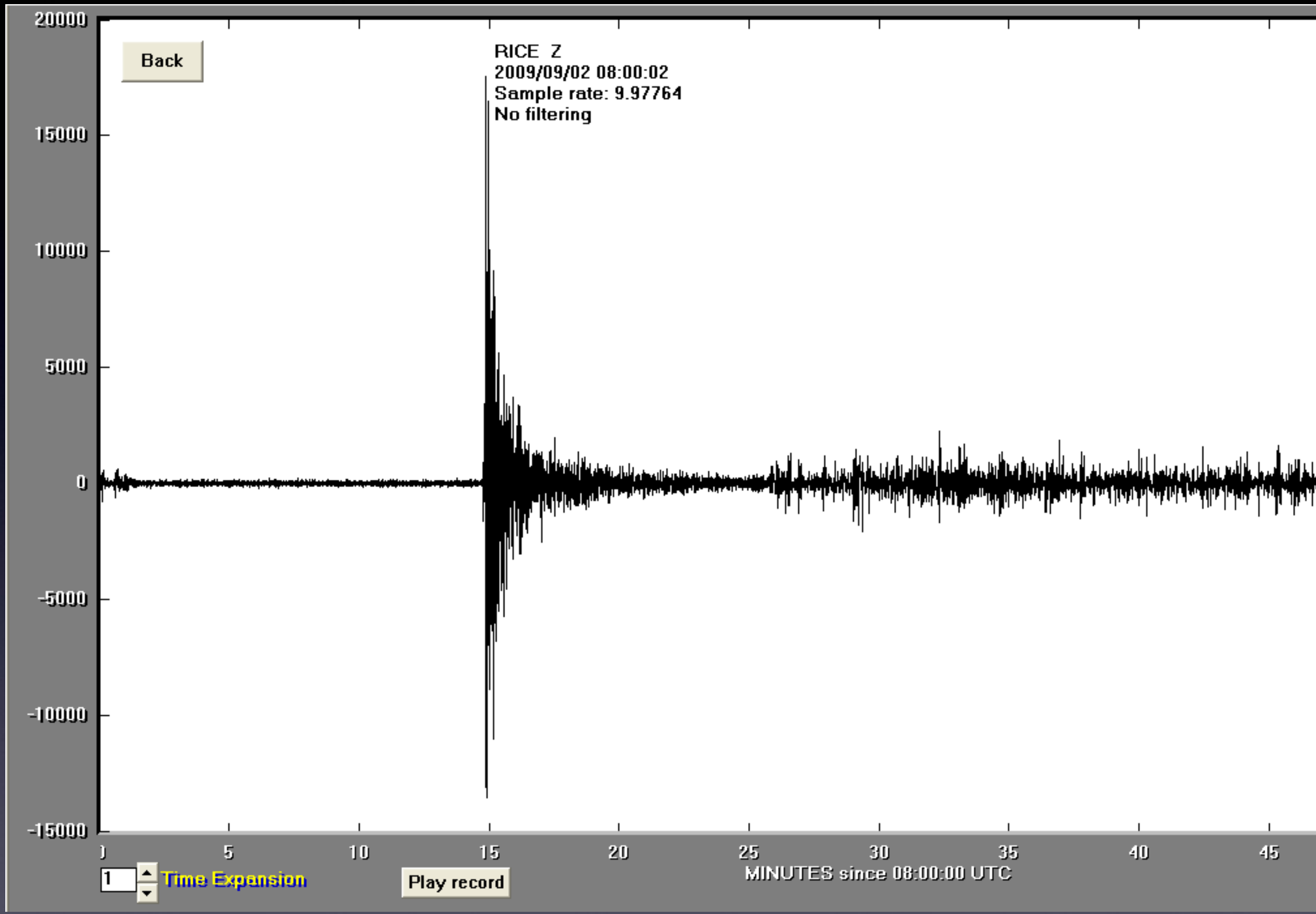
Epicenter is the location on the surface directly above the focus

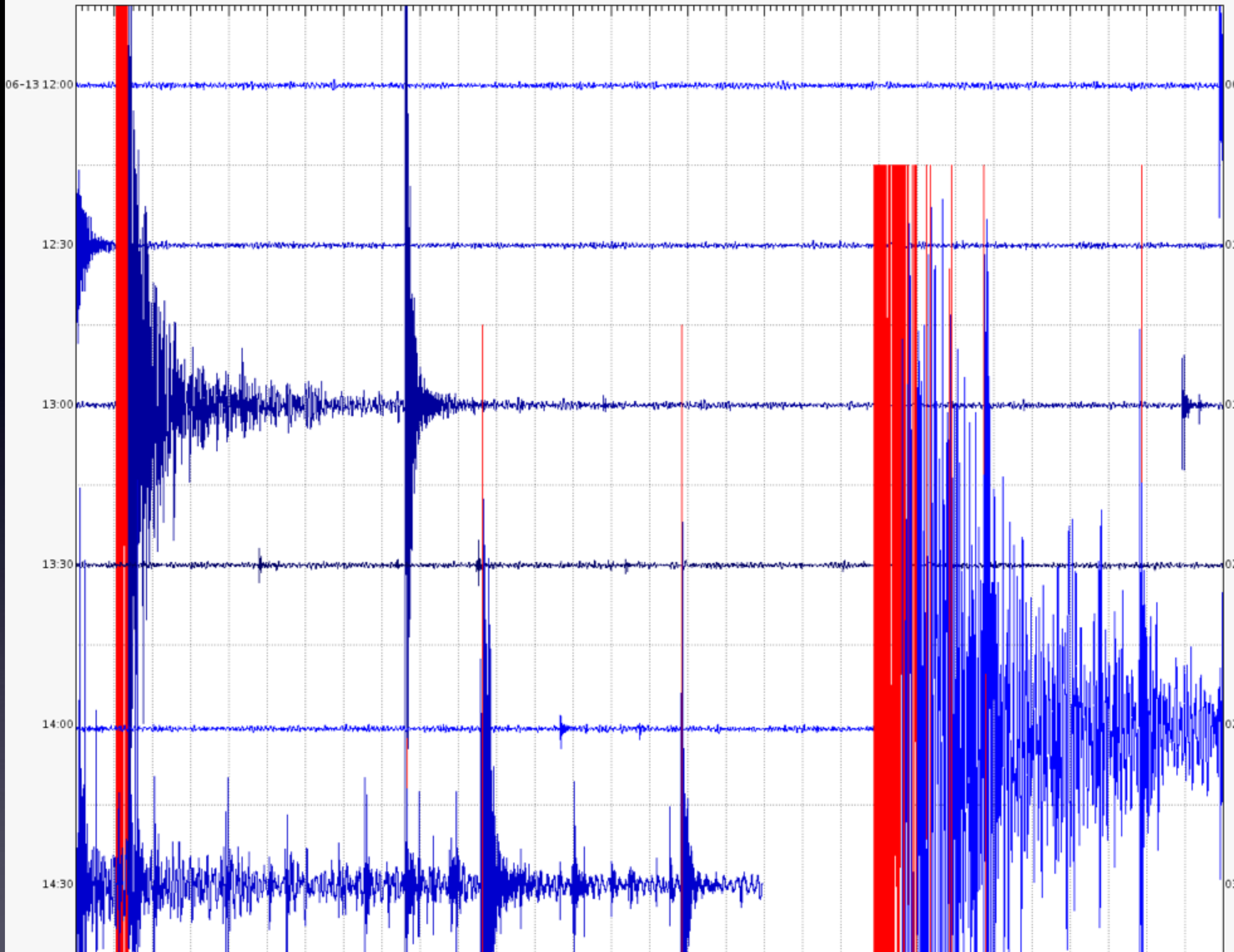



Minneapolis, MN
Detroit, MI
Approximate
Epicenter
Charleston, SC

Earthquake wave activity:
Take the slinky out to the hallway. Practice sending P (pressure) waves and S (shear or sideways) waves to your partner. Assessment of Evaluating (with support from evidence).

-Which waves are faster, P or S?
-Does changing the frequency alter the speed?
-Does changing the medium alter the speed?
-Do waves bounce off each other or pass through?
-Ask your own question


Back
RICE Z
2009/09/02 08:00:02
Sample rate: 9.97764
No filtering
20000
15000
10000
5000
0
-5000
-10000
-15000
0
5
10
15
20
25
30
35
40
45
MINUTES since 08:00:00 UTC
1
Time Expansion
Play record


06-13 12:00
12:30
13:00
13:30
14:00
14:30

Lake
Tahoe
Nevada
Sacramento
Napa
Oakland
San Francisco
California
San Jose
Fresno
Monterey
San Luis
Obispo
Bakersfield
Pacific
Ocean
Santa
Barbara
Channel
Islands
Los Angeles
Palm Springs
Santa Catalina Is.
San Diego
Mexico

L6 Prep Activity 18A
Pg 532
Write out a purpose
Procedure 1-5
Observations: fill out the table (next slide)
Fill out map and find the epicenter
Do Questions a-e
Conclusion
When finished, hand in then begin Vocab
(Choose 10 p. 534)

Oct 3
Climate change
multidisciplinary project
Wise planning
EDSM4200
Mind the Gap

Observations (P. 532)

Data Table 1 (1km=0.004 cm)

Station	Time between P&S /s	Distance /km	Circle Radius /cm
Sechelt	115	900	3.6
Sidney			
Dawson			
Penticton			
Edmonton			

Questions (a) to (e)

Conclusions: Summarize results (where was the epicenter, sources of error, possible improvements

Observations (P. 532)

Data Table 1 (1km=0.004 cm)

Station	Time between P&S /s	Distance /km	Circle Radius /cm
Sechelt	115	900	3.6
Sidney	120	950	3.8
Dawson	135	1100	4.4
Penticton	135	1100	4.4
Edmonton	165	1300	5.2

Questions (a) to (e)

Conclusions: Summarize results (where was the epicenter, sources of error, possible improvements

90

255

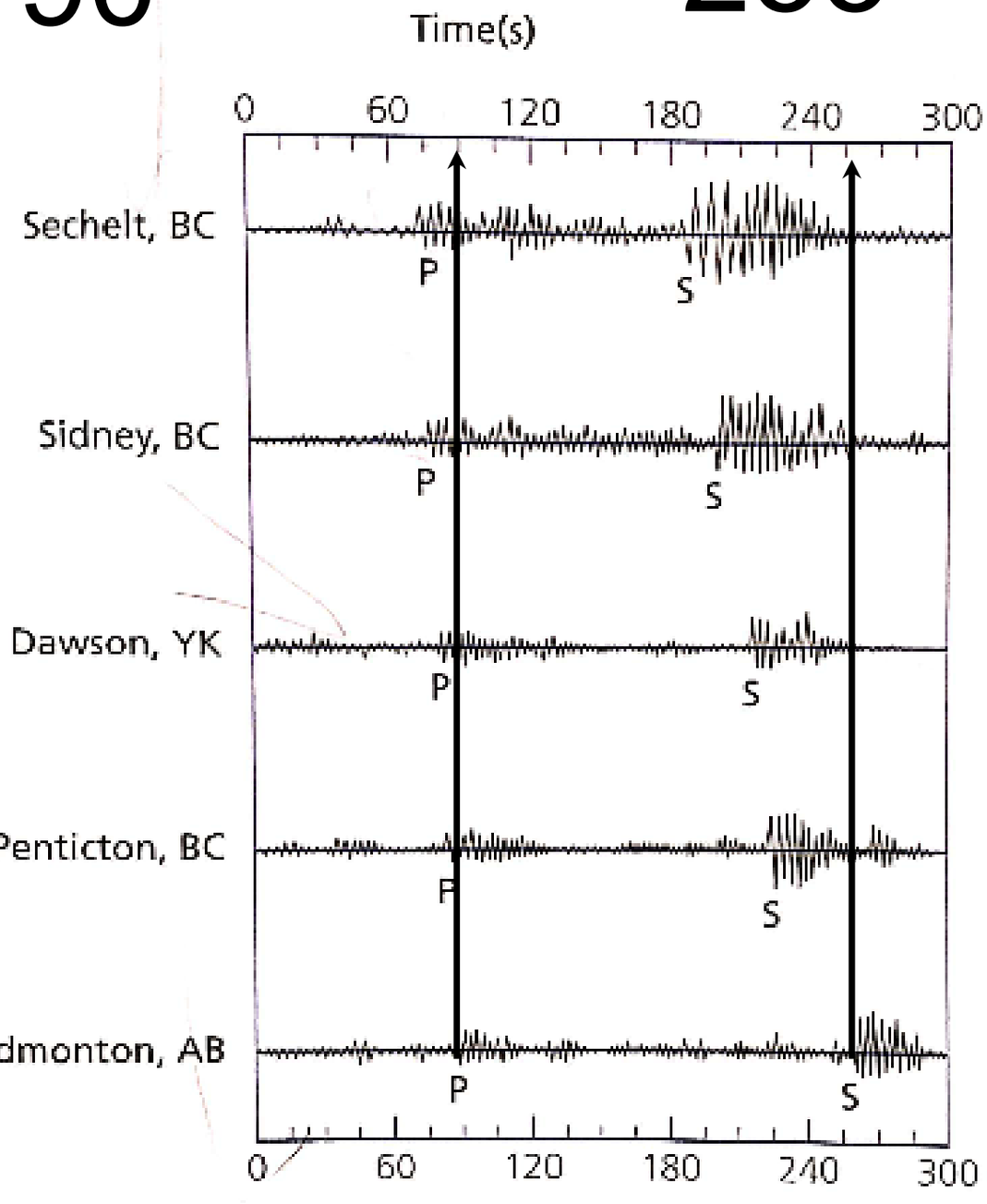


Figure 2 Seismograms from an earthquake felt on Vancouver Island and the lower mainland in October 2001.

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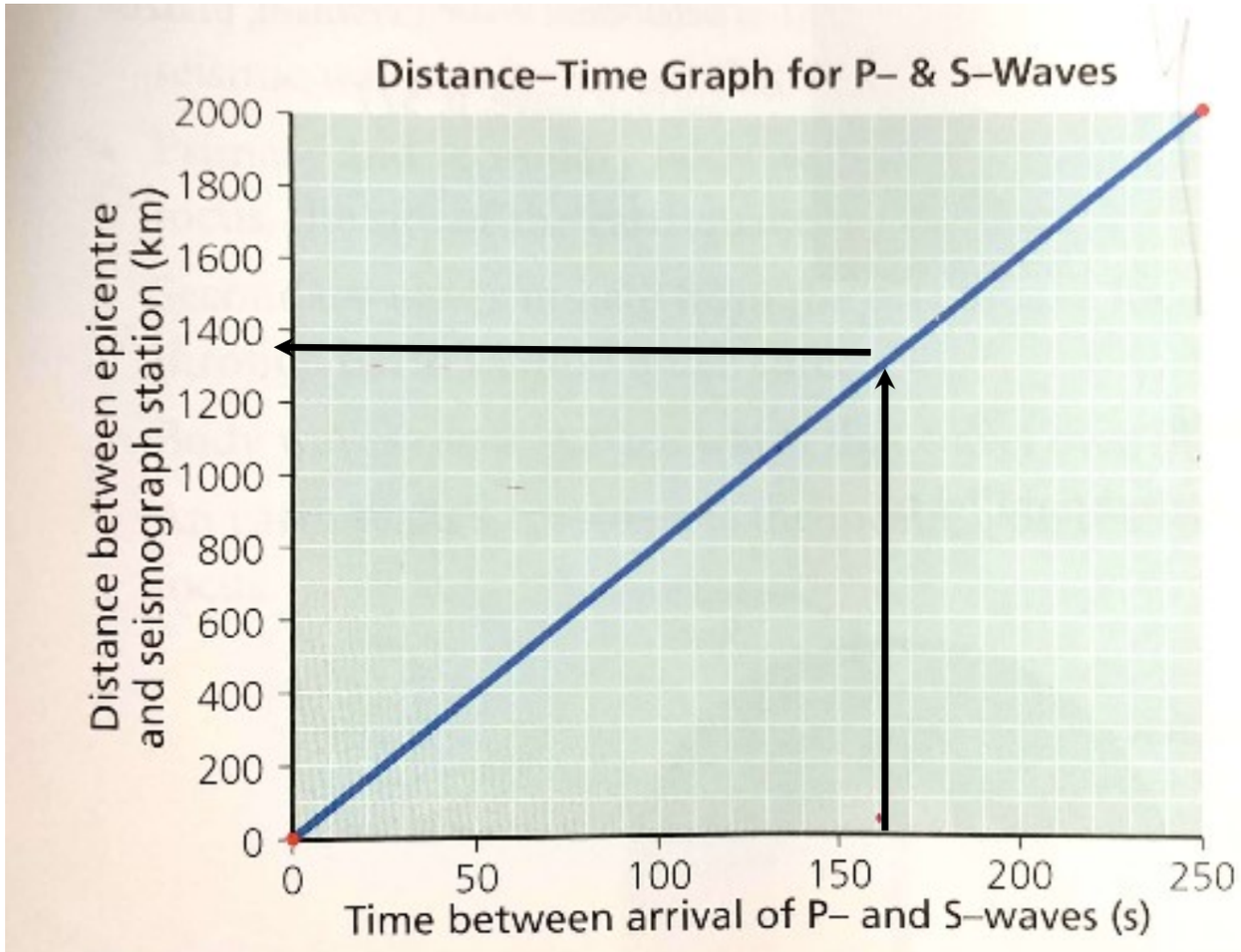

Figure 3 This distance–time graph is calibrated to find the distance between the epicentre and the seismograph station based on the time lapse between the arrival of P– and S–waves.

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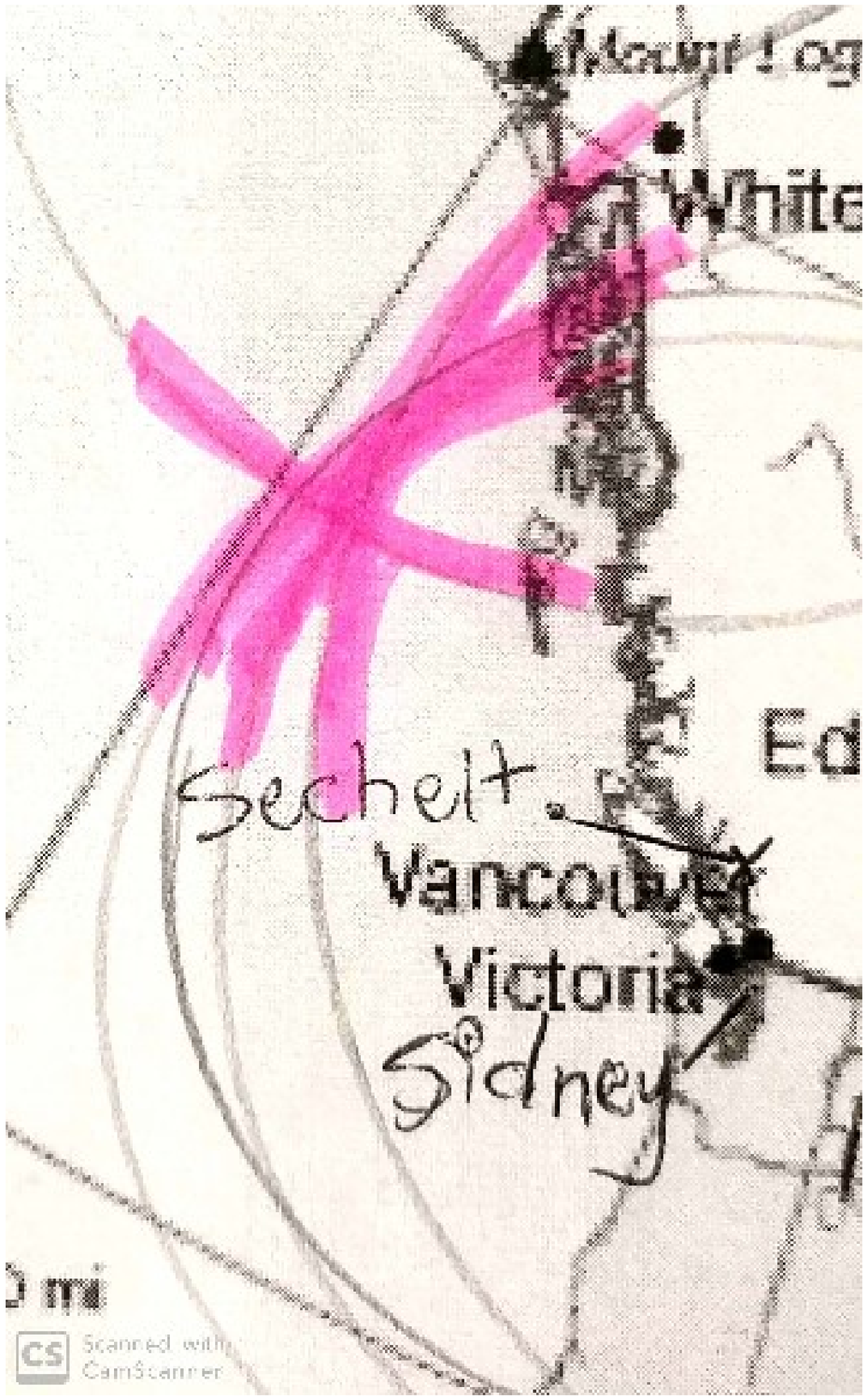
Mount Log
White
Ed
Sechelt
Vancouver
Victoria
Sidney
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Krakatoa

Earthquake Quiz tomorrow

Tectonics outline

- Layers of the Earth
- Wegener and continental drift
- Plate tectonics
- Evidence for plate tectonics
  - fossils and rocks
  - fit of continents
  - dating of rocks
  - magnetic mapping
  - ancient glaciation

Tectonics outline

- 4 types of plate boundaries
  - subduction convergence
  - convergence collision
  - transform (sliding)
    - diverging
- Do 1 -16 pg. 514 -515

Tectonics outline

- 3 things that makes plates move
  - mantle convection
  - ridge push
  - slab pull
- 3 features of plate tectonics - mountains, rifts, trenches
- 3 types of volcanoes
  - rift volcanoes at mid ocean ridges
  - hotspot volcanoes, shield volcanoes
  - subduction volcanoes

Tectonics outline

- Difference between focus and epicentre?
  - focus: earthquake in the lithosphere
  - epicentre: on the surface above the focus
- There are two main types of seismic waves: body waves, and surface waves
- There are two types of body waves: primary and secondary (pressure & shear)
- NPVW: 1 -16 pg. 536-537

- Pick 8 of 1 -14 pg. 536-537
- Finish Ch 18 Vocab choose 10
- Map Quiz later today
- Tectonics Quiz tomorrow
- iPad activity tomorrow

Unit Review

Chapter Review p. 538 Choose 10 MC, Choose 10 Written Response NPVW

Earthquake, volcano, and Tsunami Safety

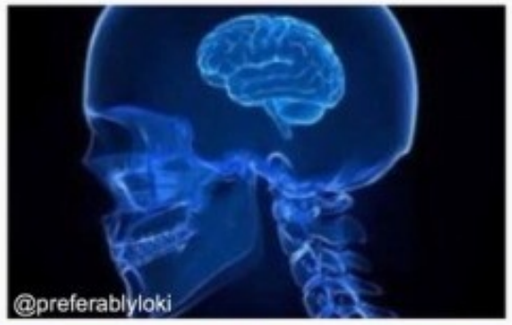
- Use the iPads and find
  - 3 rules for what to do during an earthquake.
  - 2 things to do when the shaking stops
  - 1 thing you can do during a volcano eruption
  - 2 things you can do after an earthquake near the water
  - Make a presentation to show the class

Review Presentations

In groups of 2-3, choose a topic from this unit, e.g.

- History (Wegener, continental drift, evidence)
- Types of plate boundaries
- Earthquakes
- Volcanoes
- Hot spots
- ?

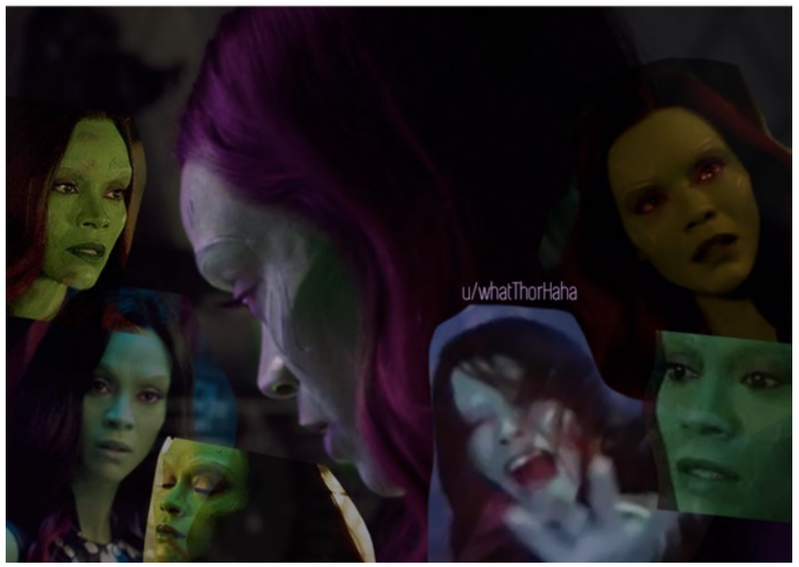
“Where is Gamora?”



“Who is Gamora?”

“whY IS GAMORA?”

people ask “why is gamora”
but not “how is gamora”



Geological Resources Project

Choose an essential geological resource to investigate. Questions we want to consider include:

- What type of rock is it likely found in? What strategies can we use for locating it? How can we use First Peoples knowledge of local geologic terrain and sustainability?

- What are the pros and cons of our current extraction and use of this resource?

- How can we improve the extraction and use of this resource to assist our transition to a sustainable future? *Innovation*

By the end of today

Started a document (doc, slide, etc) and share with gsjokvist@gedu.sd73.bc.ca

Choose a resource and tell me why your group chose it, and what role it plays in our future

Start a works cited page with proper references

Team names: _____

Bottle Rocket Write-up

Draw a sketch of your rocket, including materials

Indicate any specific construction techniques

How did the launch go? Write Pros and cons of your design. Possible improvements if (when) you launch again.

Big Idea: Plate tectonic theory explains the consequences of tectonic plate interactions.

First Peoples knowledge of local plate tectonic settings and geologic terrains

Properties of earth materials:

Minerals, igneous rocks, sedimentary rocks, metamorphic rocks, and geologic resources

Factors that affect plate motion

Evidence that supports plate tectonic theory

Surface and internal processes of the rock cycle