Seismology
(GEOL 595/L)

Lab 1: Daily Earthquakes and Interior Earth Structure

Earthquakes on your birthday !?!?

I. Earthquakes and Plate Tectonics

Please Do the Week Before Class!

A. Find Earthquakes at the National Earthquake Information Center:

- Go to http://earthquake.usgs.gov/regional/neic/
- Choose "Earthquake Catalog Search:
- Choose "Global Search"
- Enter your Birthday this year
  (Same date for start and end)
- Choose magnitudes greater or equal to 4.0
- Click "Submit"
- Copy and Save the list to a Word or text file.
- Print out your earthquake list. ***Bring this to class.***
  - Try to clearly separate the longitude and latitude columns

(Word or Excel is great for this).

B. Plot all the earthquakes from one day on the globe

- Carefully assemble your globe.
- Use the Latitude and Longitude locations of each earthquake to find the epicenter and draw a star or circle.
  - To do this – first find the ***Greenwich Meridian.***
    (Mark this longitude with a large "0" - "Zero").
  - ***Remember:*** *positive longitudes are "east of the Greenwich Meridian" and negative longitudes are "west of the Greenwich Meridian" - near London!*
  - Each latitude line is divided by 10^{o} increments.
  - Each longitude line is divided by 10^{o} increments.
- Draw a circle or star on the globe at the epicenter of each earthquake
- Plot the location of all the earthquakes that occurred on your birthday!
- Plot the earthquakes of each person in your group on the same globe

1. How many earthquakes occurred on your birthday ? _____
   (answer here)

2. Are the earthquakes randomly distributed across the Earth's surface ? _____
   a) yes b) no c) cannot determine

3. Do you see any patterns in the earthquake locations? If so, what patterns do you see ?
Discuss it with your group. Write your description or notes of your discussion here.

4. Can you use the earthquakes to draw any patterns on the globe like “connecting the dots” ?
Try this with a marker.

How many polygon shapes can you find by “connecting these dots” ? _____.
Are they all the same shape, same size ? _____.

5. What do you think is the cause of the earthquake distribution that you observe ?

6. If these are the Earth's tectonic plates, why are there earthquakes at their edges ?

C. Earthquake map (use map on next page)

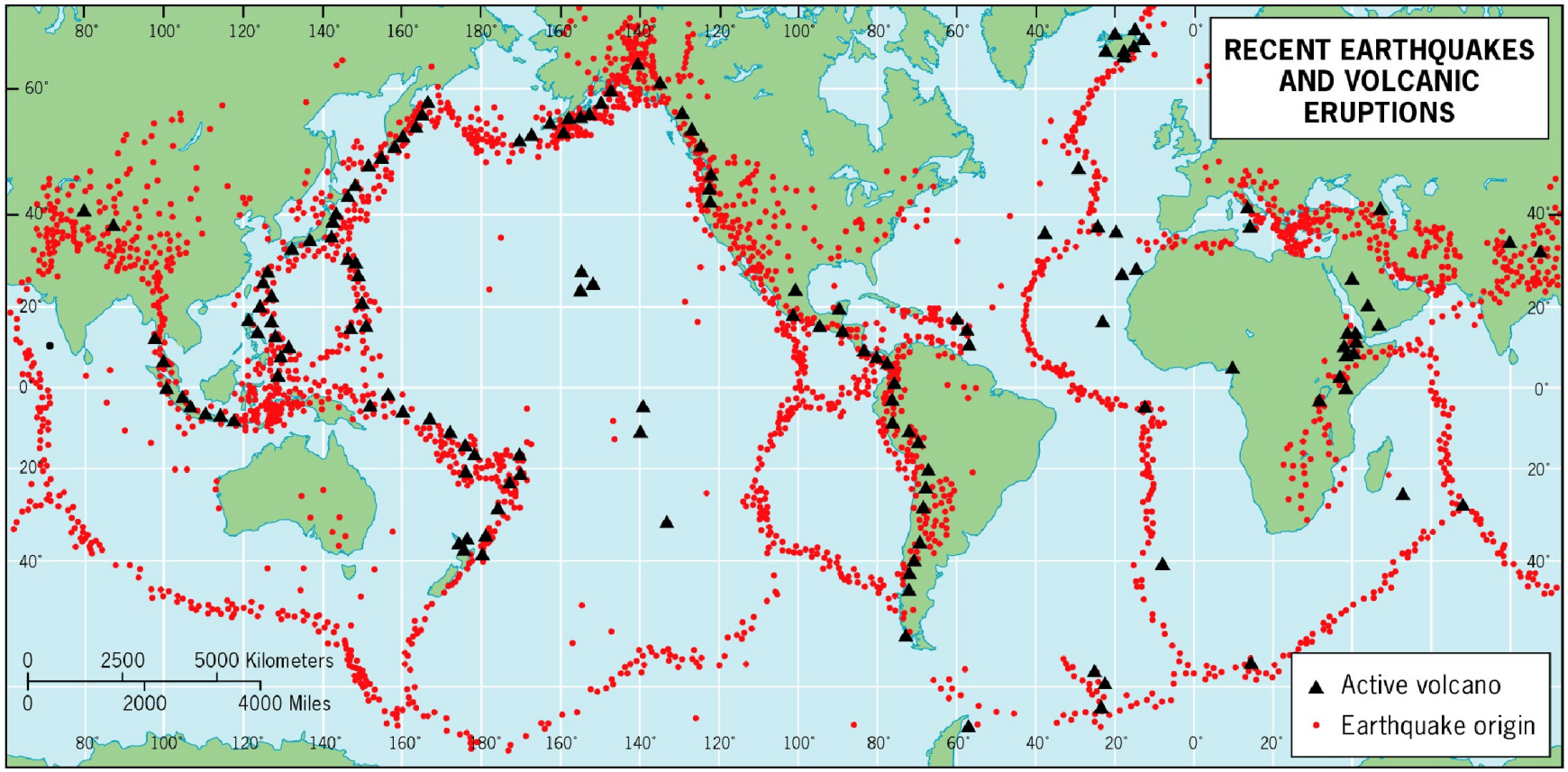
7. What are the red dots you see on this map ? _____
(answer here)
a) volcanic lava flows
b) shipping routes
c) earthquake locations from one year

8. Do you see any patterns in the earthquake locations ? _____
a) the red dots are randomly distributed around the globe
b) The red dots form lines which are very straight
c) the red dots form lines which are curved
d) the red dots form odd polygon shapes
e) both a & b
f) both b & c
g) both c &

9. “Connect the red dots” on this map with a pen.
How many tectonic plates can you find ? _____
(consider all sizes large and small!)

10. Find the plates listed below and label each on the map above. (10 pts)

- Pacific plate
- South American Plate
- Indo-Australian plate
- Antarctica plate
- Cocos plate
- African plate
- North American Plate
- Philippine plate
- Nazca plate
- Eurasian plate



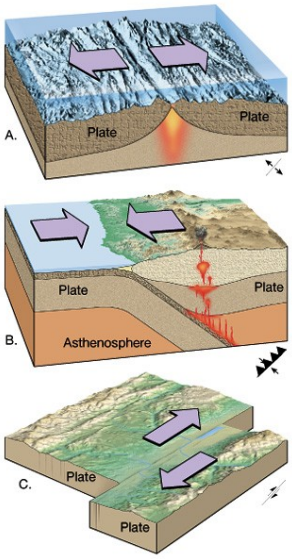
Earthquakes around the world in 7 days (1 week).

11. What are the 3 types of plate boundaries ? 11.1) _____

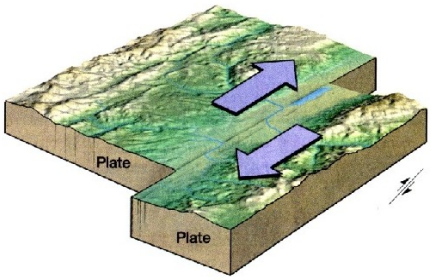
(You may choose from the possible answers given below. 11.2) _____

The sketches shown may help you.) 11.3) _____

Subvergent
Divergent
Convergent
Diverse
Transform
Converse

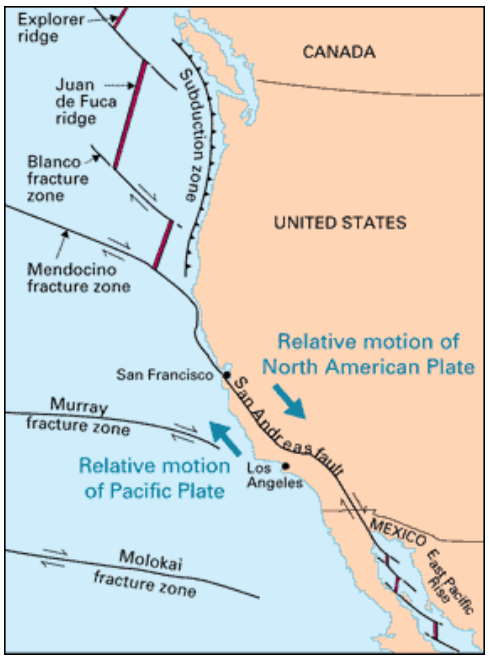


At **transform boundaries,** one plate slides past another as shown here. Although friction along this plate boundary is present, this type of boundary typically produces small earthquakes when stress is released and pulses of slip occur.



12. How many transform plate boundaries can you find ***offshore*** the western US ?

13. Name each of them:



14. Transform plate boundaries ***on land*** are somewhat rare. Can you find any in the western US ?

Give it's name: _____

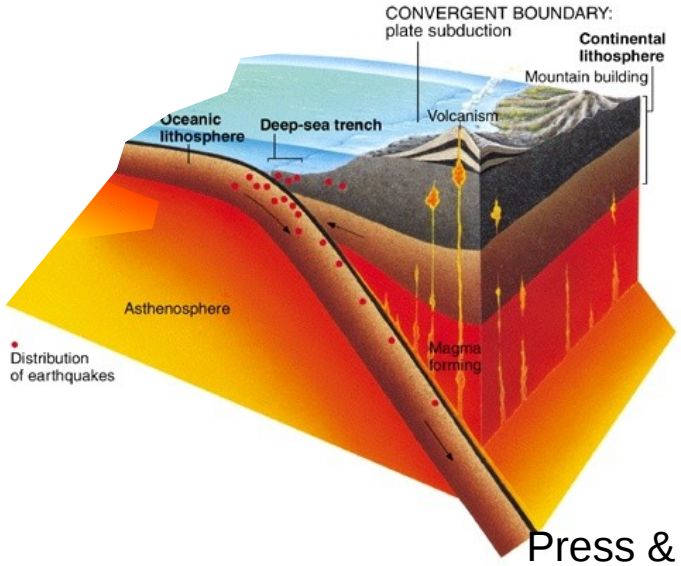
15. What are the black triangles shown in the map on ***page 3*** ? _____

16. Are the black triangles randomly distributed on the Earth's surface ? _____
Describe what you see.

Convergent plate boundaries occur when 2 plates collide with each other. In this "battle of the plates", usually one plate falls – or sinks below the other. When an ***oceanic plate*** converges with a ***continental plate*** the one with the heavier, more dense material will sink. Basaltic crust present at the surface of oceanic plates is more dense (~3.0 g/cm^3) than the granitic crust (~2.6 g/cm^3) found on continental plates.

17. When a continental plate converges with an oceanic plate, which plate will sink ? Why ?

_____



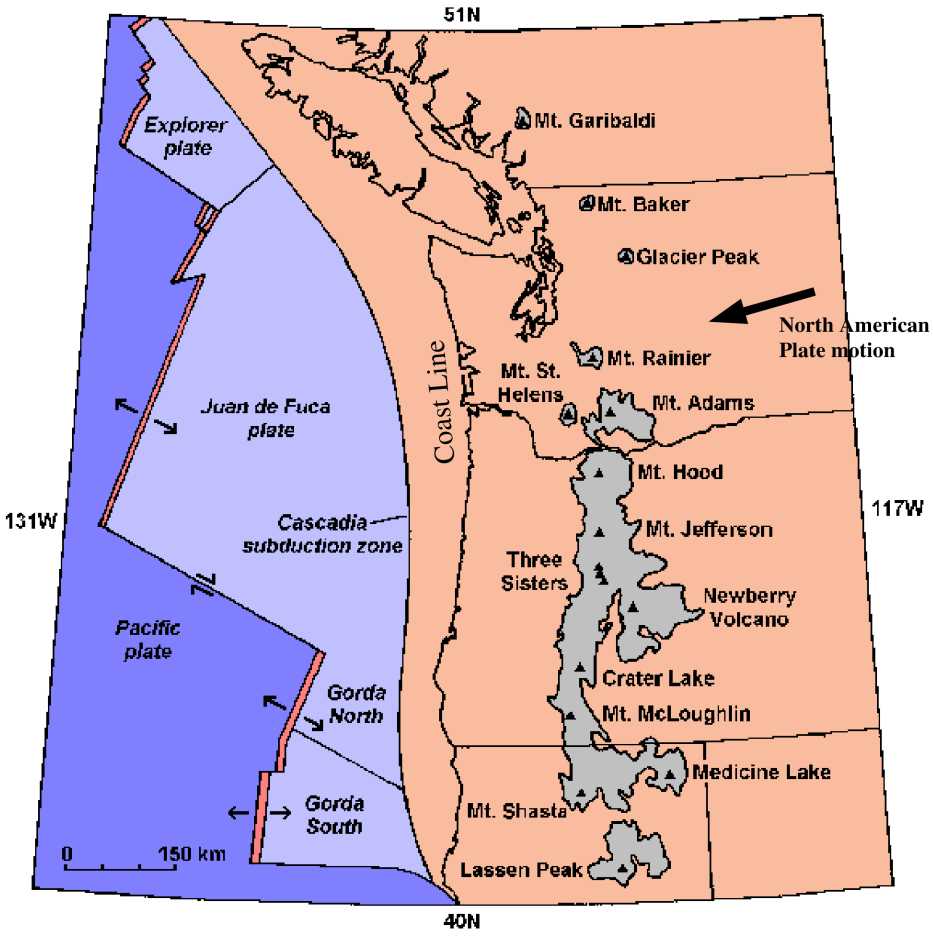
Press & Siever Fig. 1.16

In the ***subduction zone*** shown here an oceanic plates sinks below a continental plate. Notice how water rich hydrous phases in the oceanic crust sink into the mantle and start to melt. Melt then rises to form a volcano near the coast line.

18. In the map below, circle the locations of volcanoes (black triangles) found in the western US.
How many can you find ?

19. What pattern/shape does this group of volcanoes form ? _____
a) square
b) circular pattern
c) horizontal line
d) vertical line

20. Does this pattern of volcanoes have any relationship to the shape of the coast line ?
a) perpendicular
b) no relation
c) parallel
d) "L" shaped



21. What 4 oceanic plates to you see offshore the western US ?

22. What kind of plate boundary occurs between the North American plate _____
and the Juan de Fuca plate ? (Hint: Use the arrows showing plate motion direction)

23. If the North American plate and the Juan de Fuca plate collide,
which plate will sink ? _____.

24. Use the diagram shown below problem #17 to explain how the Cascadia volcanic range is related to the plate boundary off shore (the Cascadia subduction zone).

a.) Volcanoes and plate boundaries are not related
b.) Volcanoes form inland above the subducting Juan de Fuca plate.
c.) Volcanoes form above the subducting North American plate
d.) Magma from the Juan de Fuca spreading center causes the Cascadia volcanoes to form.

II. Seismic Waves and the Earth's Interior

On Aug 26, 2012 (last weekend!) a magnitude 7.3 earthquake struck off the coast of El Salvador.

Date: Aug 26, 2012
Time: 04:37 (UTC)
09:30 pm (PST)

Latitude: - 88.53 (West)
Longitude: 12.28 (North)

Depth: 20.3 km

Plot raypaths from this earthquake around the globe:

- Find the location of this earthquake on your globe and ***place a pin here.***
- Add the circular work board to the inside of your globe.
  (You may need to remove a few panels).
- Face the white side of the board towards you. Turn the board so that it is parallel to the axis of -90 and +90 longitude.
- Now find and open the program TauP on your computer (linux platform only).
  (You may need to ask me for help here.)
- In TauP, enter the relevant information from the El Salvador earthquake given above.
- For “Distance” enter a sequential list of values one at a time and look at each result.
  (choose “all phases” if necessary).
  Choose Distances (Degrees) from 0 to 360 in increments of 10.
  Imagine that you are able to place a seismometer at each of these locations on the surface.
- Place a pin at all distance locations around the globe where you observe a P or S wave arrival.
- Draw your best guess of the travel path of the S wave through the Earth's interior from the source (earthquake) to the receiver (seismometer location where you entered a distance value).
  (We will learn later that seismic ray paths travel through the earth in curved paths - always concave up - that start at the surface in one location and end at the surface some distance away).

25. Do you observe P and S waves at all distances around the globe ? _____

26. If not, what Distance values do NOT have P and S waves ? _____

26. What is preventing simple P and S wave arrivals from traveling to these regions ?

27. Can you estimate the ***size*** of the object that is preventing these raypaths from continuing through ? (Give your answer in km. *Remember 1^{o} latitude is 111 km*).

_____

28. What is this object inside the Earth's interior ?

29. Can seismic rays help us identify any other structures inside the Earth ? _____

30. What other layers in the earth have Earthquakes and their raypaths helped us identify ?

31. What are the differences between a ***P*** and ***S*** wave ?

32. Are there any unique materials that each can travel through ? If so, what are they ?

33. What can the travel paths of ***P*** and ***S*** waves tell us about the physical properties or composition of the Earths' core ?

34. What can the travel paths of ***P*** and ***S*** waves tell us about the physical properties or composition of the Earths' inner core