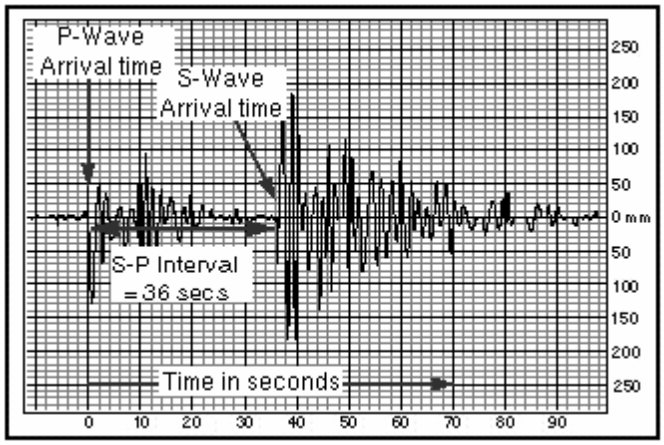
Name: _____

Locating an Earthquake and Determining Magnitude

What's a Seismogram?

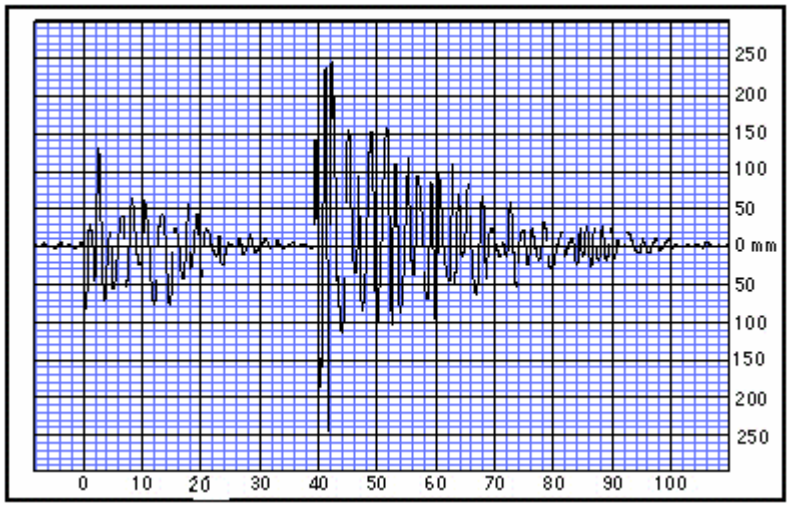
A highly simplified simulated recording of earthquake waves (a seismogram) can be seen to the right. Study this sample seismogram and be sure you can identify these parts:

- P-wave and the P-wave arrival time
- S-wave and the S-wave arrival time
- S-P interval (expressed in seconds)
- S-wave maximum amplitude
- (measured in mm from centerline)



(This exercise is based on the web page at http://vcourseware5.calstatela.edu/VirtualEarthquake)

Three Seismograms from Different Locations for the Same Earthquake
(Note: lines are 2 sec apart on the time scale and 10mm apart on the amp scale)



Las Vegas, NV.

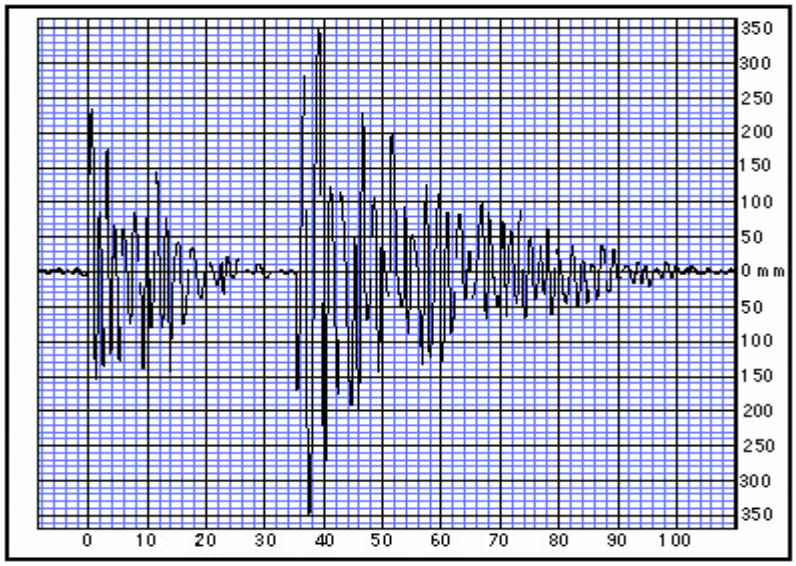
Measure the S-P time and amplitude & record them here:
S-P _____secs

Amplitude _____mm

Calculations (see next page):

Distance _____ km

Magnitude _____



Fresno, CA.

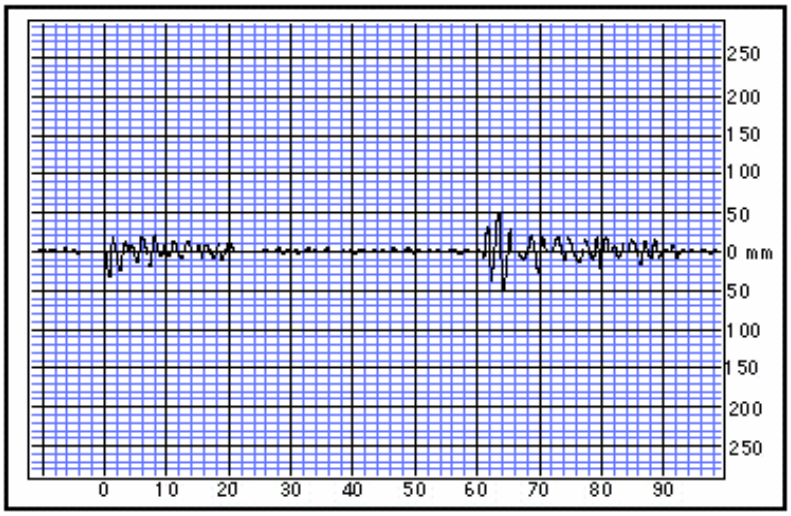
Measure the S-P time and amplitude & record them here:
S-P _____secs

Amplitude _____mm

Calculations (see next page):

Distance _____ km

Magnitude _____



Phoenix, AZ.

Measure the S-P time and amplitude & record them here:
S-P _____secs

Amplitude _____mm

Calculations (see next page):

Distance _____ km

Magnitude _____

Locating the earthquake (Step 1)

Measure the S-P time for each seismogram on the previous page. We know that P-waves travel about twice as fast as S-waves. We also know that for every second of S-P time the earthquake is about 8-10km (5-6 miles) away. For this lab use a value of **9.7 km/sec** to calculate the DISTANCE between each station (city) and the earthquake's epicenter. Write the distance it in the *blank* for each city on the previous page.

Locating the Earthquake (Step 2)

Now we are ready to locate the earthquake using a simple triangulation method.

Using the scale on the map (page 1), open your compass so it spans the distance from Las Vegas to the earthquake that you calculated in step 1. (Be sure you use the km scale and not the miles scale). If the distance is greater than the scale you must *extrapolate*. Now, draw a circle around Las Vegas with a radius of that distance.

Do the same for the other two cities. The circles should intersect at the epicenter of the earthquake.

1) Where was the earthquake? _____

Determining Local Magnitude

The "Richter scale" is NOT an instrument for measuring earthquakes. It is a mathematical relationship. We will use the "Richter scale" *nomogram* below to determine the magnitude of this earthquake.

You have already calculated distances and amplitudes for each city. Follow these steps for each city in the exercise. 1) Place a ruler or the edge of a piece of paper on the left-hand scale of the nomogram at the point equal to that distance. 2) Pivoting on that point, shift the ruler up or down the right-hand scale until it is lined up with the amplitude value you measured. 3) Draw a line. 4) Finally, where the line crosses the center scale read the magnitude to the nearest 0.1 and write it down. 5) To calculate the final magnitude of the earthquake you must average your three readings. (Note that the left and right scales are *logarithmic* and not linear.)

2) Average mag = _____

3) What would the amplitude be for this earthquake in San Bernardino? (Note that the right-hand scale is *logarithmic*.)

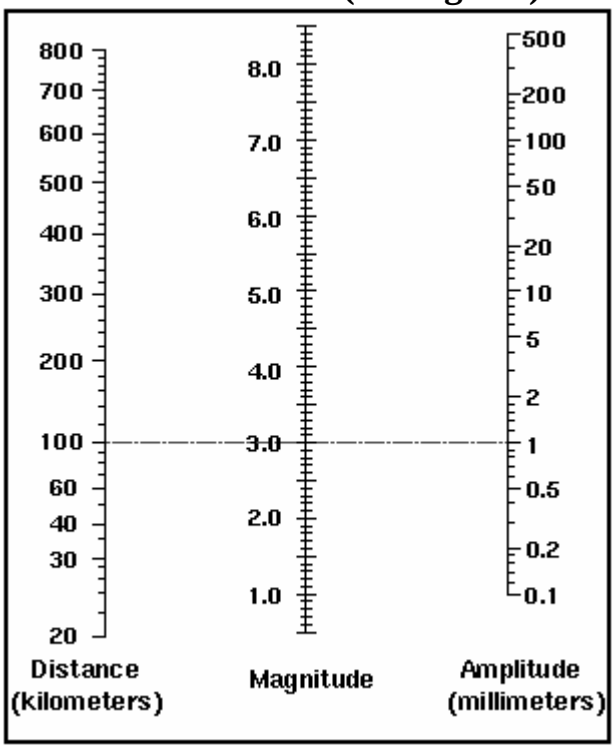
_____

The nomogram is based on the formula:

$$Magnitude = \log_{10}(amplitude) + distance\ correction$$

Note that this is NOT the "Richter Magnitude". There is no such thing. You use the Richter scale to calculate the "local magnitude" or $\mathbf{M_L}$ of an earthquake. There are many types of magnitude besides "local magnitude". These are often used for very small events (<2.0) and very large events (>6.5).

The "Richter Scale" (nomogram)



Questions

Place your ruler on the 100km mark on the left side of the nomogram for these next questions.

4) What would the amplitude be of an event of:

magnitude 3.0? _____ Of magnitude 4.0?_____ Of magnitude 5.0?_____

5) How would you summarize the relationship between amplitude and magnitude?

_____

_____

6) In general terms, what happens to the amplitude as you get farther away from the epicenter?

_____

7) What is the minimum number of seismograms needed to locate an earthquake with this technique? ____

Why? _____

8) Often the circles don't intersect perfectly at a point. List as many reasons as you can for why this is so.

_____

_____

_____

_____

_____

San Andreas Fault History

Earthquake prediction is not possible. However, we can same something about the likelihood (probability) of some earthquake events based on past history. Trenching studies at Pallett Creek and other locations along the Mojave section of the San Andreas fault have show a rough chronology for that section of the fault over the last 1,500 years – much longer than that covered by historic reports.

The last event, on January 9, 1857, had a magnitude of about 7.9. A repeat of an event of that size would be devastating to southern California. This is what is generally meant by the "the Big One".

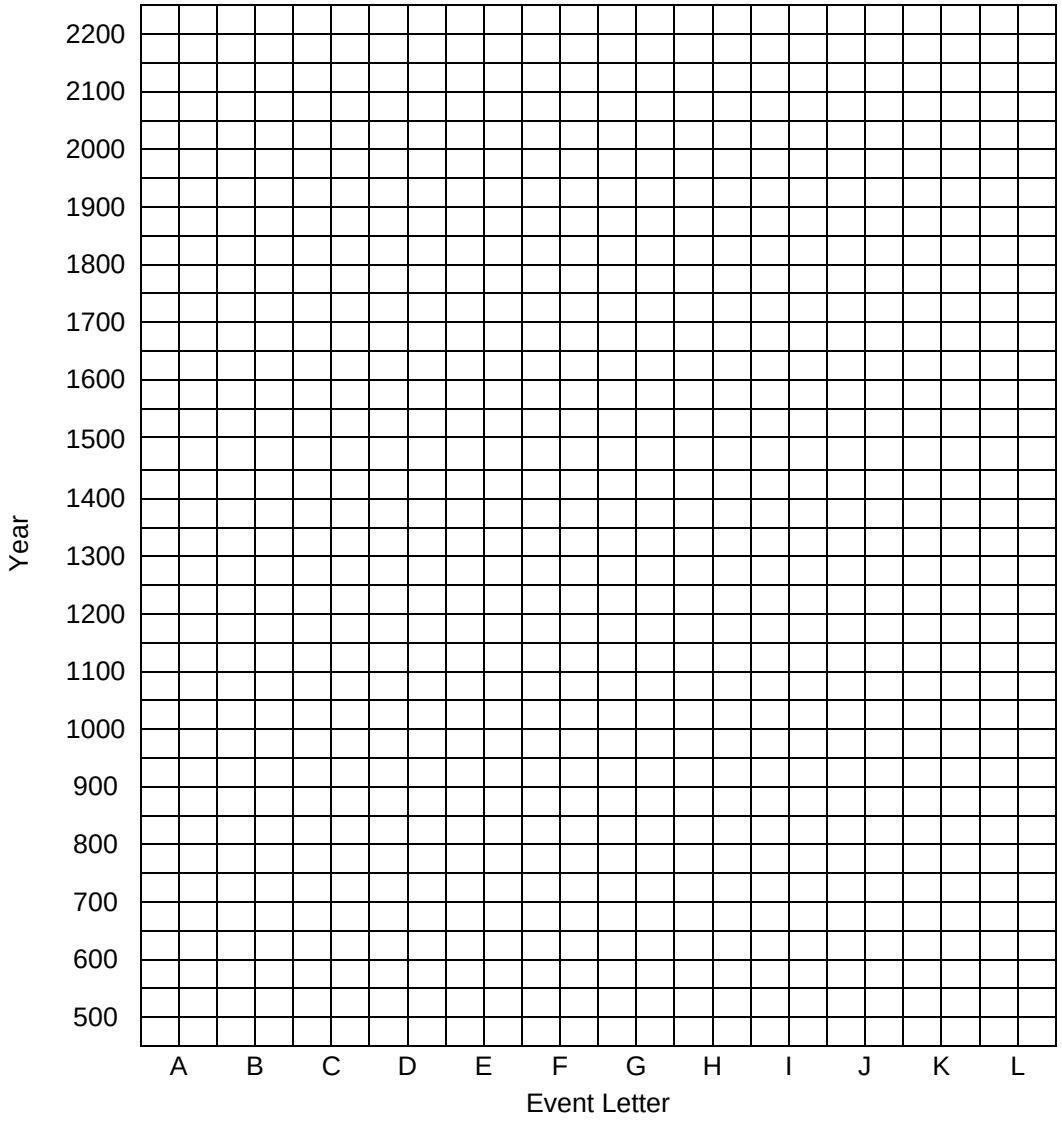
Times of Past San Andreas Events at Pallet Creek

	Preferred Event Date	Possible Date Range	Years Until Next Event
K	January 9, 1857	January 9, 1857	**?**
J	December 8, 1812	December 8, 1812	44.08
I	1480 A.D.	1465 - 1495 A.D.	332
H	1346 A.D.	1329 - 1363 A.D.	134
G	1100 A.D.	1035 - 1165 A.D.	246
F	1048 A.D.	1015 - 1081 A.D.	52
E	997 A.D.	981 - 1013 A.D.	52
D	797 A.D.	775 - 819 A.D.	200
C	734 A.D.	721 - 747 A.D.	63
B	671 A.D.	658 - 684 A.D.	63
A	before 529 A.D.	??? - 529 A.D.	> 142

(source: http://www.data.scec.org)

Exercise

Plot the times of the historic events from the table on the graph below.



Use these data to answer the following questions.

9) What is the average time between events? _____

10) How many years has it been since the last one? _____

11) Based on the graph, when would you expect the NEXT event to occur? _____

12) How would you describe your degree of certainty in your answer and why?

_____

_____

_____

_____