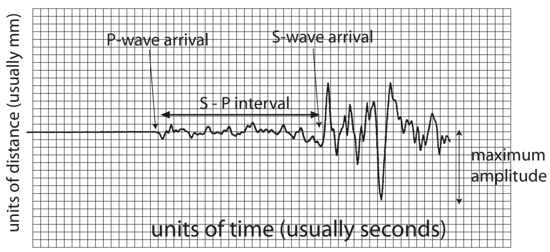
Name: ______________________
Lab Section: ________________

# Earthquake Lab

The goal of this portion of the lab is to learn how recording of earthquakes — seismograms — are used to locate earthquakes, determine their magnitudes, and to understand the sense of fault motion related to the earthquake.

Typical seismogram of a small earthquake recorded fairly near the source. The P-waves arrive first and are later swamped by the arrival of the S-waves, The S - P interval is the time between the first arrivals of the P and S waves; it is used to determine the distance from the epicenter). This interaction produces additional seismic waves (phases) which will be detected by seismographs. Refer to Fig. 10.14 in your textbook for an explanation of how seismographs work.





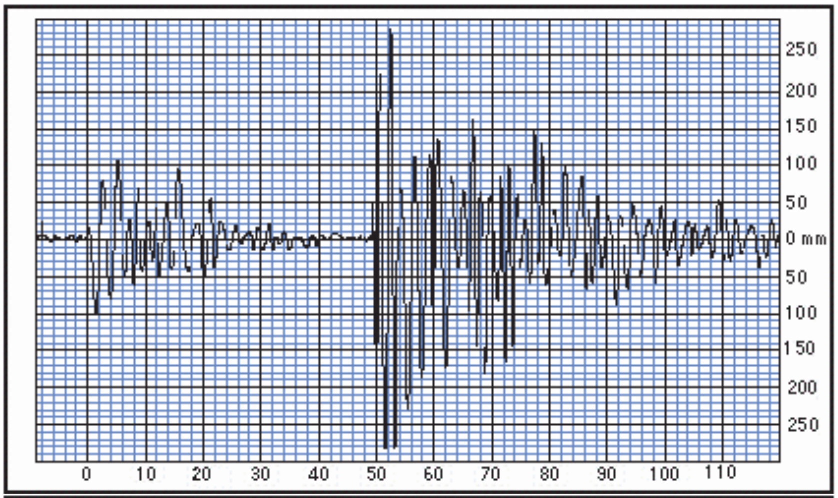
## A. Locate the Epicenter

1. Measure the S-P interval from the 3 seismograms shown on the following page, and enter the results in the table below. Then, use the S-P travel time curve (follows the seismogram) to determine the distance between the station and the epicenter and enter the data into the table.
2. Next, take a compass and set its radius to the epicentral distance for each station and draw arcs around each station. Ideally, the three arcs should intersect at a single point, which is the epicenter — if they do not, you should go back and check your work. Clearly mark the location of the epicenter.

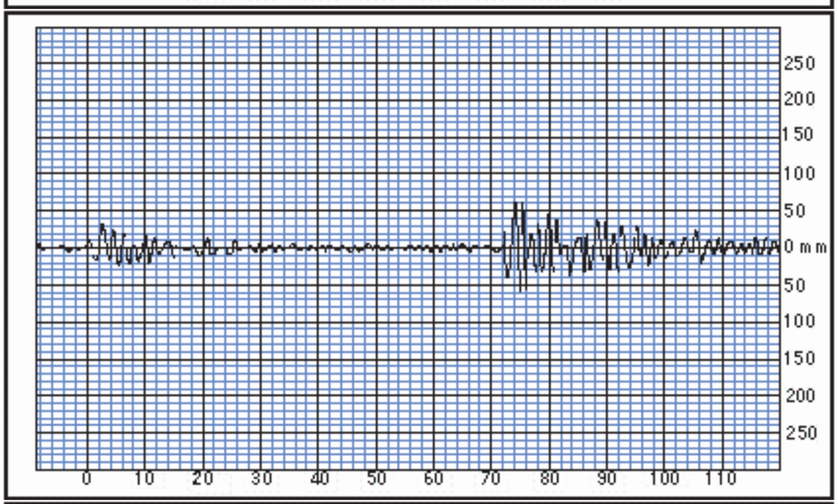
3. Is there a known fault in the vicinity of the epicenter that is likely to have slipped to create the earthquake? If so, name the fault.

| Station | S-P(sec) | Distance(km) |
|---|---|---|
| Elko | | |
| Eureka | | |
| Las Vegas | | |

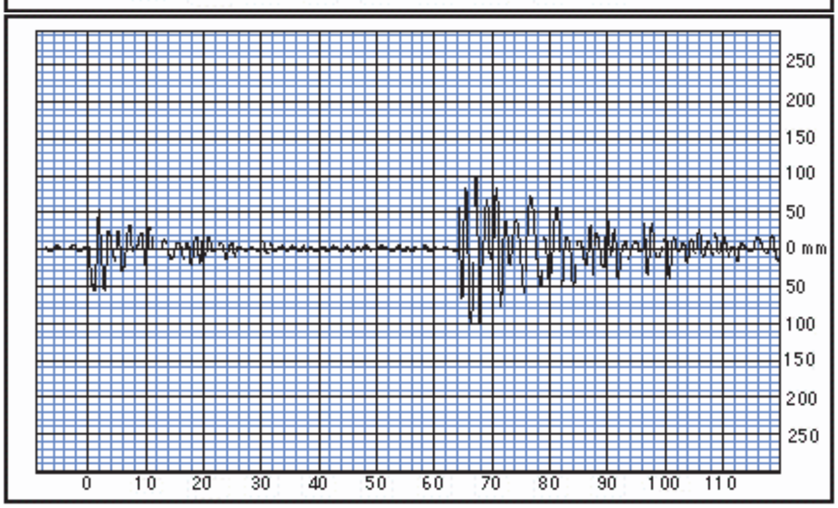
Eureka, Ca

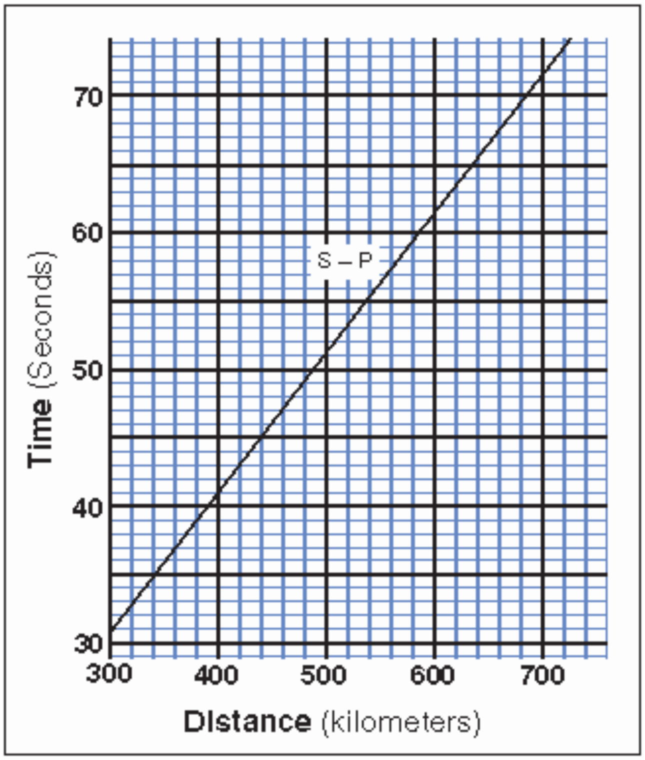



Elko, Nev




Las Vegas, Nev






P waves travel between 6 and 13 km/sec. S waves are slower and travel between 3.5 and 7.5 km/sec. In most regions, study of numerous earthquakes with well-known epicenter locations results in an empirical S-P curve, such as the one shown to the right.

## B. Magnitude of the Earthquake

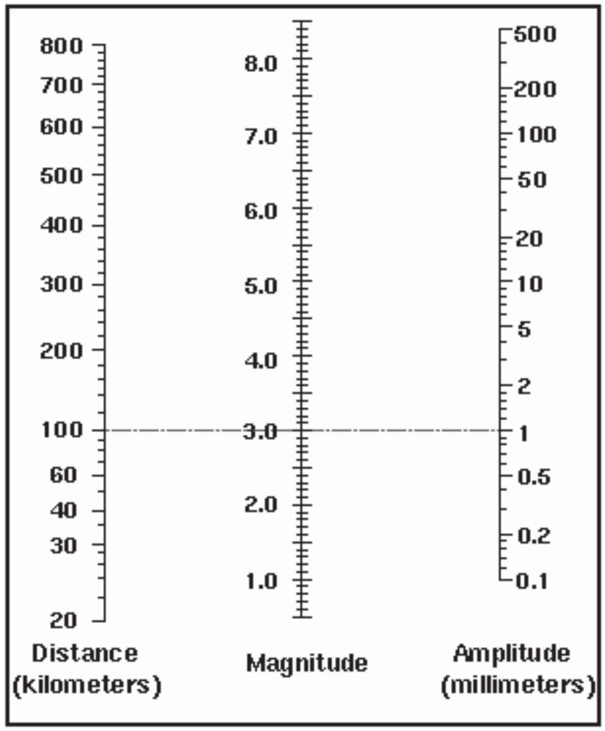
The magnitude of an earthquake provides a convenient measure of its size scaled to a small number usually less than 9. It is a unitless number, derived from the amplitude of ground motion associated with S-waves, adjusted for the distance between the epicenter and the seismograph station (the amplitude generally drops off with distance from epicenter). The table below helps puts earthquake magnitudes into perspective.

| | | |
|---|---|---|
| Richter Magnitude | TNT for Seismic Energy Yield | Example |
| -1.5 | 6 ounces | Breaking a rock on a lab table |
| 1.0 | 30 pounds | Large Blast at a Construction Site |
| 1.5 | 320 pounds | |
| 2.0 | 1 ton | Large Quarry or Mine Blast |
| 2.5 | 4.6 tons | |
| 3.0 | 29 tons | |
| 3.5 | 73 tons | |
| 4.0 | 1,000 tons | Small Nuclear Weapon |
| 4.5 | 5,100 tons | Average Tornado (total energy) |
| 5.0 | 32,000 tons | |
| 5.5 | 80,000 tons | Little Skull Mtn., NV Quake, 1992 |
| 6.0 | 1 million tons | Double Spring Flat, NV Quake, 1994 |
| 6.5 | 5 million tons | Northridge, CA Quake, 1994 |
| 7.0 | 32 million tons | Hyogo-Ken Nanbu, Japan Quake, 1995; Largest Thermonuclear Weapon |
| 7.5 | 160 million tons | Landers, CA Quake, 1992 |
| 8.0 | 1 billion tons | San Francisco, CA Quake, 1906 |
| 8.5 | 5 billion tons | Anchorage, AK Quake, 1964 |
| 9.0 | 32 billion tons | Chilean Quake, 1960 |
| 10.0 | 1 trillion tons | San-Andreas type fault circling Earth (NOT POSSIBLE); OR small asteroid impact |
| 12.0 | 160 trillion tons | Fault Earth in half through center(NOT POSSIBLE); OR Earth's daily receipt of solar energy |

modified from John Louie, U. Nevada Reno Seismology Lab

## B. Magnitude of the Earthquake

1. Measure the maximum amplitude of the S-waves from the 3 seismograms, and enter the results in the table below; add the distances from epicenter you obtained in the previous problem.
2. Then, use the graphical device to the right (called a nomogram) to determine the Richter magnitude of the earthquake as indicated by each of the three seismograms. Ideally, they should all converge on a single answer — if they do not, you should go back and check your work.




| Station | Distance from Epicenter (km) | Max S-wave Amplitude (mm) | Magnitude |
|---|---|---|---|
| Elko | | | |
| Eureka | | | |
| Las Vegas | | | |

## C. Recurrence Time of the Earthquake

The North American Plate and the Pacific plate are moving past each other at about 5 cm/yr, but this slip is distributed along many separate faults. The best estimate for the section of the San Andreas of interest here is 14 mm/yr. Use the typical slips in the table to the right to estimate the approximate recurrence interval for an earthquake of this magnitude.

| Magnitude | Avg. Slip |
|---|---|
| 8 | 4 m |
| 7 | 1.4 m |
| 6 | 40 cm |
| 5 | 10 cm |