Modified Mercalli Intensity Scale

Intensity Value & Description
I. Not felt except by a very few under especially favorable circumstances.
II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration like passing of truck. Duration estimated.
IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably.
V. Felt by nearly everyone, many awakened. Some dishes, windows, and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight.
VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate damage in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars.
VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structure. Chimneys, factory stacks, columns, monuments, walls may fall. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving cars disturbed.
IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks.
XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

Teacher Background Reading
Richter vs. Mercalli

When an earthquake occurs, we often hear news reporters describing it in terms of magnitude. Perhaps the most common question at a news conference is “What was the magnitude of the quake?” In addition to calculating the magnitude of an earthquake, however, we can describe the effect it had at a particular location by measuring its intensity. Magnitude and intensity are both measures of an earthquake, but they describe different characteristics. Each measurement has its uses.

Magnitude is a measurement of the amplitude of the earthquake waves, which is related to the amount of energy the earthquake releases. Magnitude is calculated from the size of the earthquake waves arriving at a seismic station. The most commonly used scale for magnitude is the Richter scale, developed by Charles Richter in 1935. The Richter scale is a logarithmic measurement of the maximum wave amplitude recorded at a seismograph station, corrected for distance from the epicenter. It is theoretically open-ended, although the largest quakes recorded in this century had a magnitude of 8.9. Each whole number increase in Richter magnitude indicates an increase in the severity of the ground shaking by a factor of 10. Thus a magnitude 6 earthquake will pro- duce shaking 10 times more severe than that produced by a magnitude 5 earthquake. Magnitude can also be related to the amount of energy an earthquake releases. Each whole number increase in Richter magnitude indicates an increase in the amount of energy released by a factor of roughly 30. Thus a magnitude 6 earthquake releases about 30 times more energy than a magnitude 5 earthquake, and roughly 900 times as much as a magnitude 4 earthquake. These factors are seldom described correctly in news accounts.

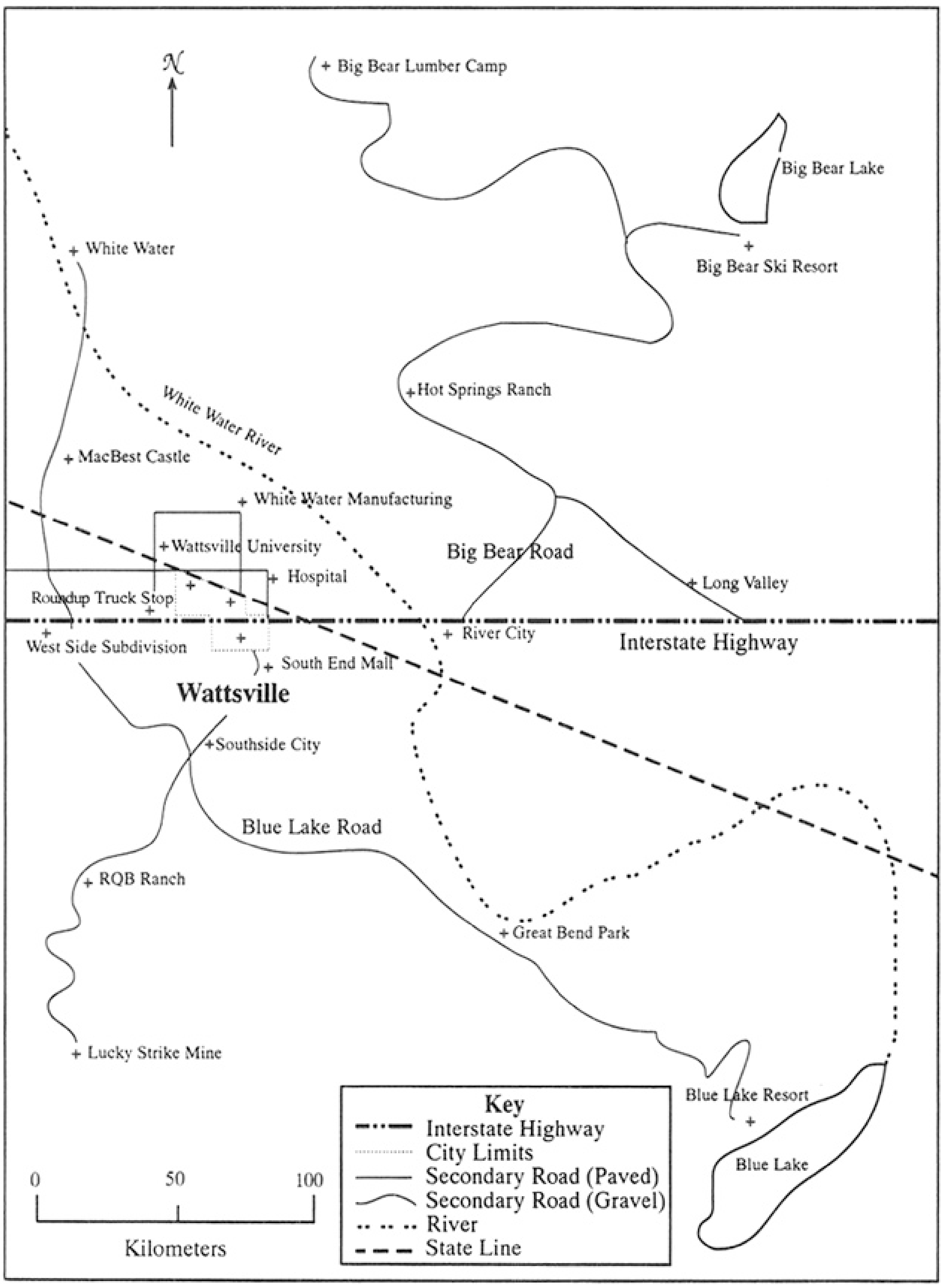
Each earthquake has a single magnitude that is independent of the location of the observer. If a magnitude 6.0 event strikes some location in the South Pacific, then that event will be described as a magnitude 6.0 by observers all over the world. Because magnitude is independent of observer location, it is a convenient measure to use in reporting the occurrence of an earthquake. No matter where it happened, or where you are, you get a feeling for the relative size of the earthquake by simply knowing its magnitude. This is why the press is so quick to report this number.

Intensity is a measure of the effect that the vibration had on natural and human-made structures. The most common measurement of intensity is the Modified Mercalli Intensity scale, originally developed in 1902 by Giuseppi Mercalli, an Italian geologist. Wood and Neumann adapted it to “modern” conditions in 1931. The intensity scale ranges from I, the lowest perceptible intensity, to XII, the greatest intensity. Intensity is a function of many variables, including magnitude, depth of the earthquake, distance from the earthquake, local geological conditions, and local construction practices. Generally speaking, the intensity felt at a given location will increase with increasing magnitude, decreasing depth, decreasing distance from the earthquake, and a decrease in the quality of construction. If an earthquake is shallow, its intensity will be greater. If it affects an area built on soft sediments, such as landfills or sedimentary basins, the intensity will also be greater. A single quake will produce a range of intensities that typically decrease with increasing distance from the earthquake. An isoseismal map illustrates this range.

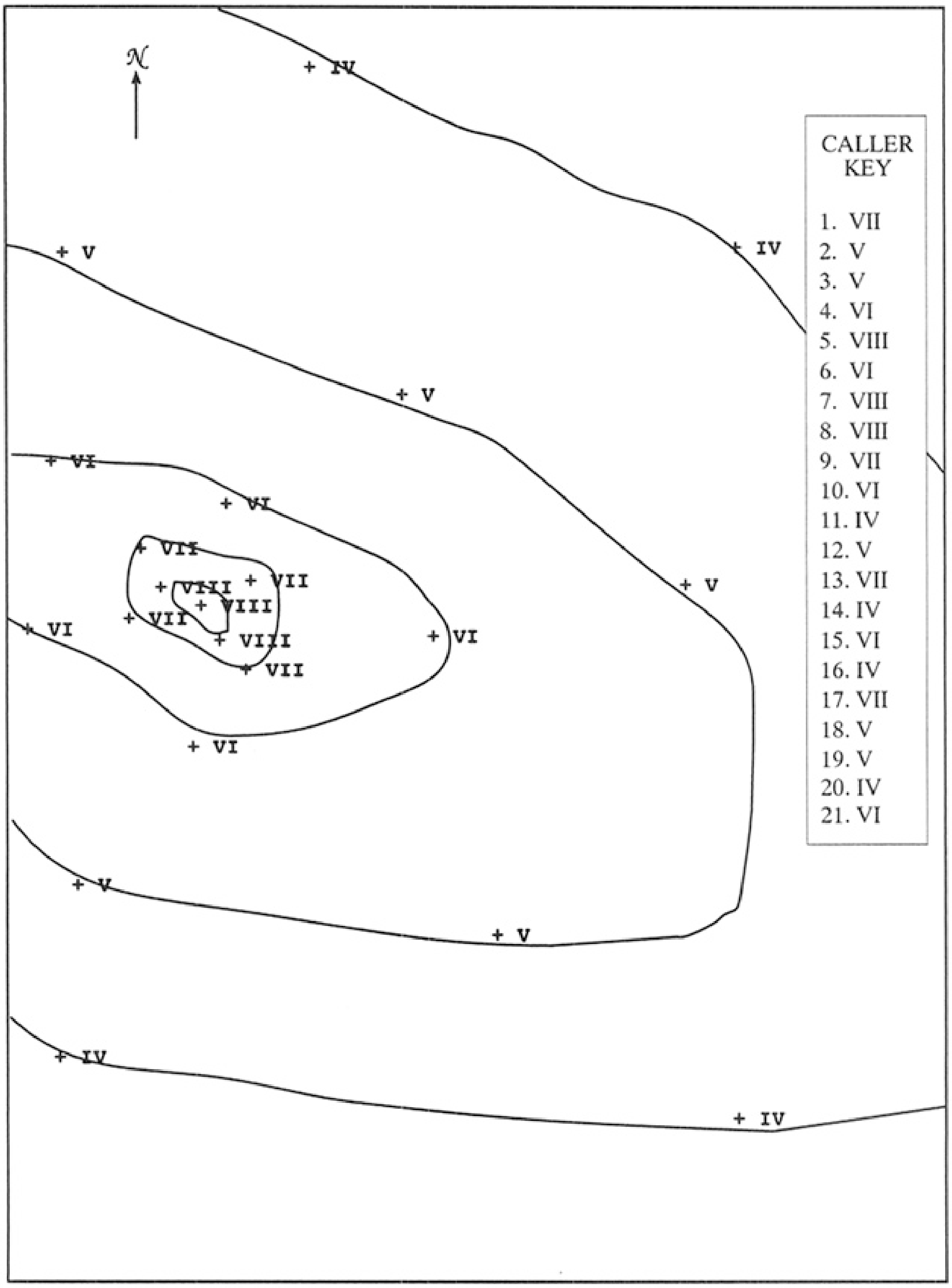
Intensity is more useful than magnitude as a measure of the impact that an earthquake had at any given location. Consequently, it is important to the professionals who establish building codes and insurance rates. If the maximum expected intensity in a given area is VII, for example, the building codes should specify construction practices that make buildings able to withstand this intensity, and property insurance rates will probably be high. If the maximum expected intensity is only III, the area can relax its building codes, and property insurance rates will be moderate.

Wattsville Map

Name ____ Date ____________________



Wattsville Map (key)



Note: *Isoseismal lines and locations may vary.*

KWAT Television Script

Jake Wilde: "We interrupt our regularly scheduled programming on KWAT to bring you a special bulletin. This is KWAT news anchor Jake Wilde, and moments ago the town of Wattsville was shaken by a strong earthquake. Residents in the KWAT broadcast area are invited to call our emergency response number, 324-KWAT, and give us your name, your location, and a brief summary of what you experienced during the quake. Stay tuned for the latest reports of what your neighbors saw and felt. To report your observations, again, call 324-KWAT. We have caller number 1 on the line."

Caller 1: "Hi, this is Charles from the hospital. Everyone ran outdoors and we only had moderate damage thanks to a well-built building."

Caller 2: "Hello my name is Roy, and I'm calling from RQB Ranch. Everything that wasn't nailed down in our tack room got turned upside down by the shaking. Some plaster is cracked too."

Caller 3: "Hi, this is Bob at Long Valley Mercantile, and we have a mess here. When the quake struck, it knocked over all of our displays, and broke windows out of the store. All the trees and poles were moving."

Caller 4: "Hi Jake, I'm Jane calling in from West Side Subdivision. Damage was slight here—only some plaster shaken off the walls and the heavy furniture moved around."

Caller 5: "Hi. This is Jo. I'm calling from the north end of town and we need some help down here. The water in our well has changed its level and we are trying to put out fires with buckets."

Caller 6: "Hello Jake, Lynda from Southside City Junior High School. Students felt it and did the drop, cover, and hold drill. We only had slight damage to the building, with some fallen plaster."

Caller 7: "Hi, this is Hank and I'm calling on my car phone. I just heard the news and thought I would report that right after I turned south into town off the Interstate, I felt a big bump—but there were not any potholes in the road. It was disturbing."

Caller 8: "Hello, this is Mary, and I'm calling from the basement of the First Bank in the center of Wattsville. The building has partially collapsed and people are trapped down here. Please send help."

Caller 9: "Hi this is Jim. We were at the mall when the quake struck. Everyone panicked and ran outside. Luckily no one was hurt, and damage was slight."

Caller 10: "Hi, this is Ron. I work at the MacBest Castle. Many of the tourists were frightened and ran outdoors, and our chimneys were damaged."

Caller 11: "Hello Jake. My name is Sue and I'm calling from the Big Bear Lumber Camp. The walls of our house were swaying and creaking during the earthquake."

Caller 12: "Hi. This is Len. We were picnicking at the Great Bend Park. Shortly after the quake struck we saw trees, telephone poles, and the flagpole swaying back and forth."

Caller 13: "Hi. This is Jim out at the Roundup Truck Stop. When the quake hit, our chimney broke and fell over."

Caller 14: "Hello, Jake. This is Marty up at Big Bear Ski Resort. The quake rattled our dishes and windows, and the walls made creaking sounds."

Caller 15: "Hi Jake. This is Keith in River City. Our chimney is damaged and some plaster has fallen."

Caller 16: "Hi. This is Diana calling from the Lucky Strike Mine. Over here, we thought that a big truck had struck the building."

Caller 17: "Hi Jake. This is Monte from Wattsville University. Everyone in our class felt the quake, and some of the older, more poorly built buildings have suffered considerable damage."

Caller 18: "Hello. My name is Marilyn, and I'm calling from Hot Springs Ranch. The strangest thing happened! Our big pendulum clock stopped dead when the quake struck."

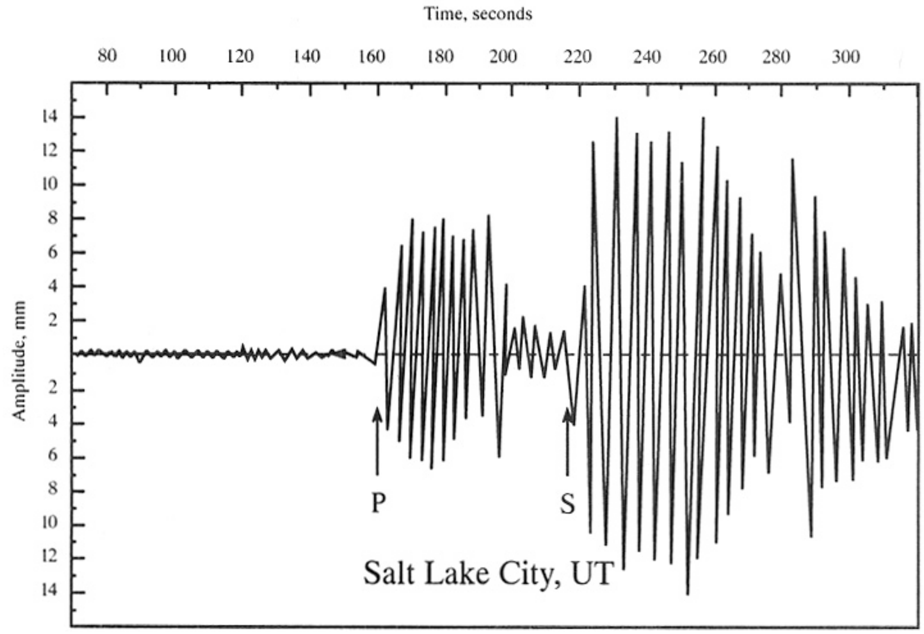
Caller 19: "Hi Jake, this is Karen. When the quake hit, I was in White Water visiting a friend. Nearly everyone felt it and we had a lot of windows broken. They were frightened, and I was too!"

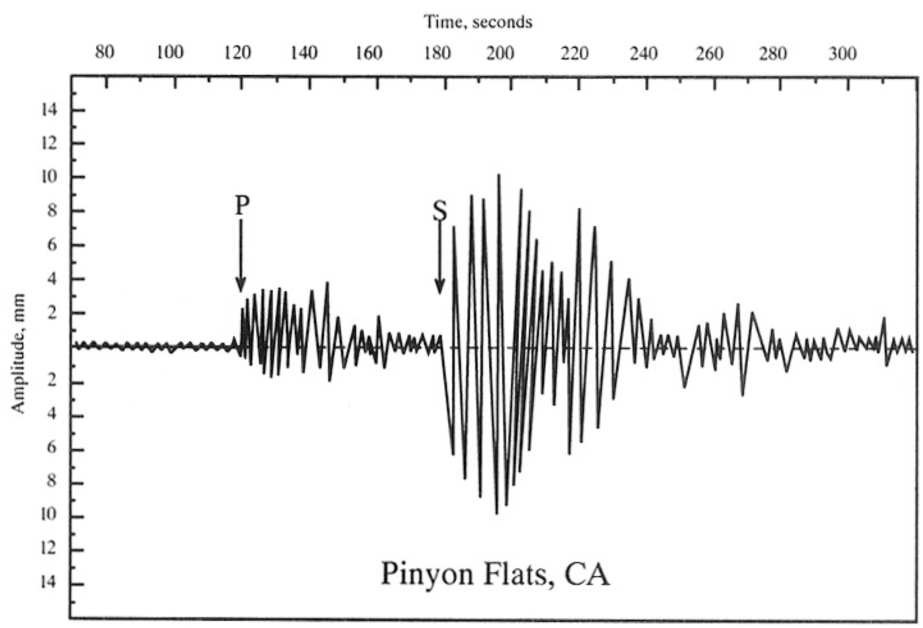
Caller 20: "Hello Jake. This is Frank. I was at Blue Lake Resort when all the cars in the parking lot started rocking back and forth."

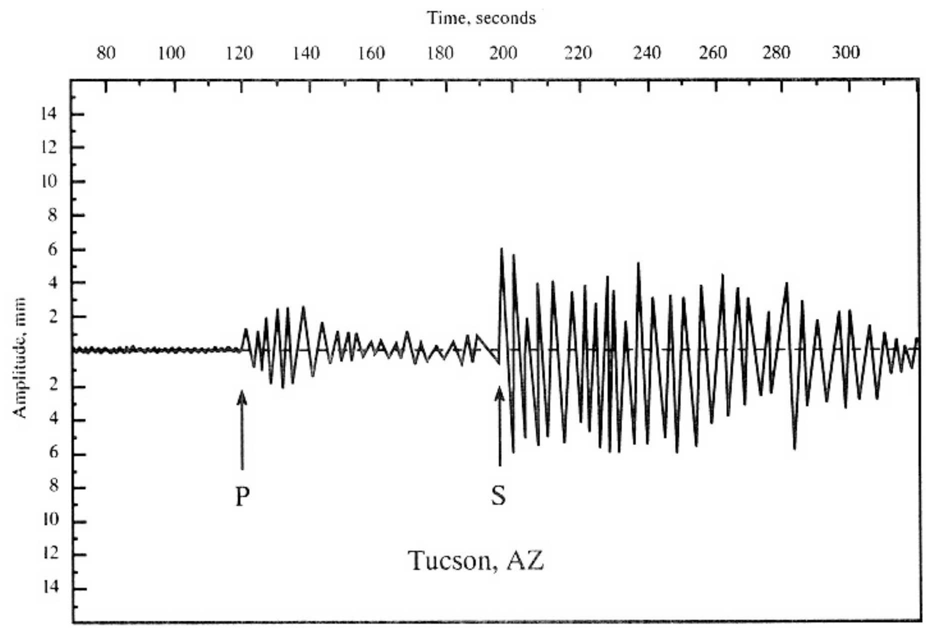
Caller 21: "Jake, this is Gene at White Water Manufacturing. All of the heavy furniture in the showroom was moved by the quake, and some of the plaster fell off the walls."

Five Seismograms
Simplified

Name ____ Date ______________________






Time, seconds
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Amplitude, mm
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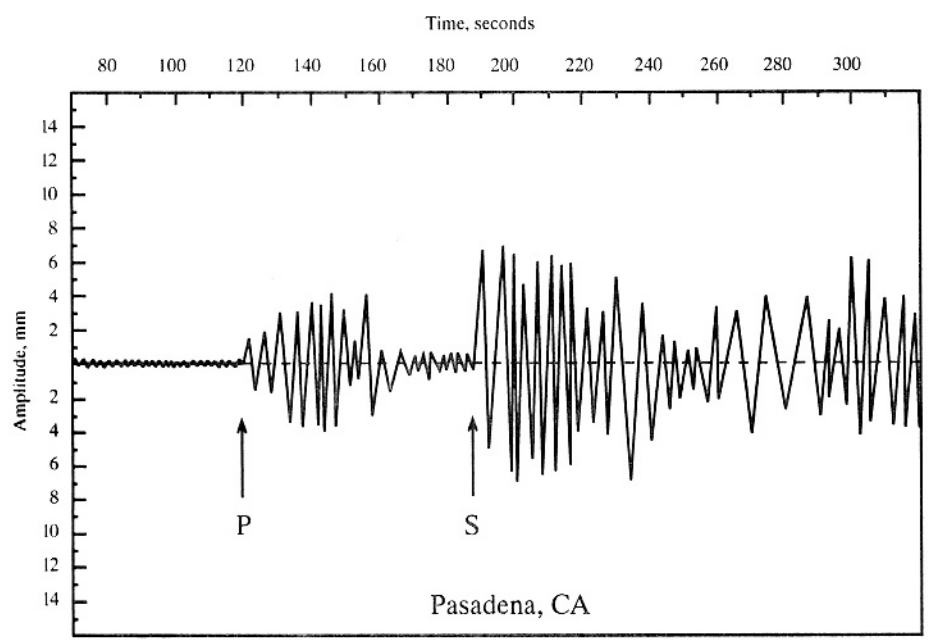
Time, seconds
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Amplitude, mm
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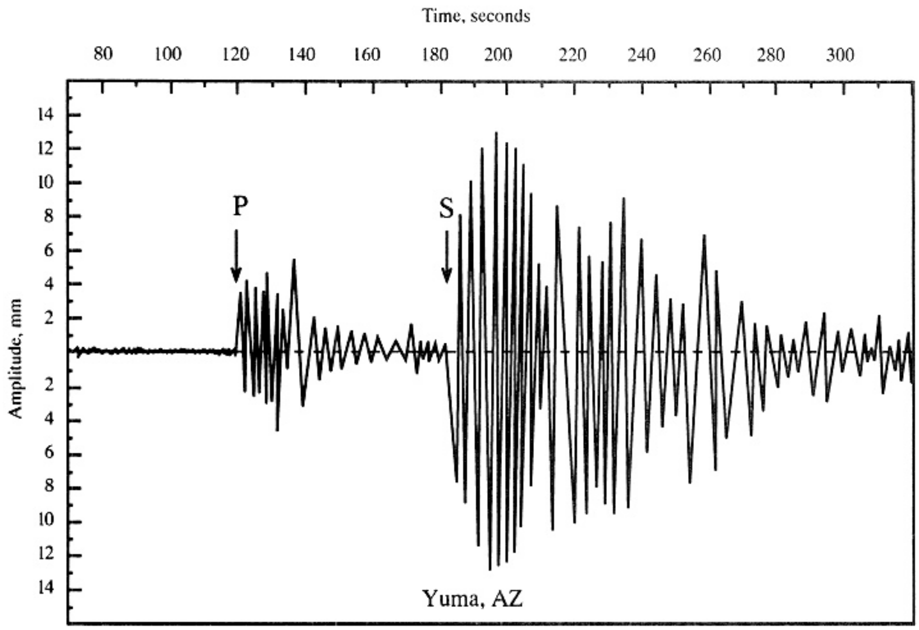
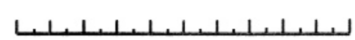




Richter Magnitude Data Table

Location	Amplitude	$T_s - T_p$	Distance	Magnitude
Salt Lake City, UT	mm	sec	km	
Pinyon Flats, CA	mm	sec	km	
Tucson, AZ	mm	sec	km	
Pasadena, CA	mm	sec	km	
Yuma, AZ	mm	sec	km	
			Final magnitude (average of 5)	

Five Seismograms (key)

Richter Data Table, Answer Key

LOCATION	AMPLITUDE	$T_s - T_p$	DISTANCE	MAGNITUDE
Salt Lake City, UT	14.0 mm	56 sec	448 km	5.6
Pinyon Flats, CA	10.0 mm	59 sec	472 km	5.7
Tucson, AZ	6.0 mm	75 sec	600 km	5.8
Pasadena, CA	7.0 mm	68 sec	544 km	5.7
Yuma, AZ	13.0 mm	62 sec	496 km	5.8
			Final magnitude	5.7

Note: *Answers will vary.*

St. George, Utah, Earthquake Data

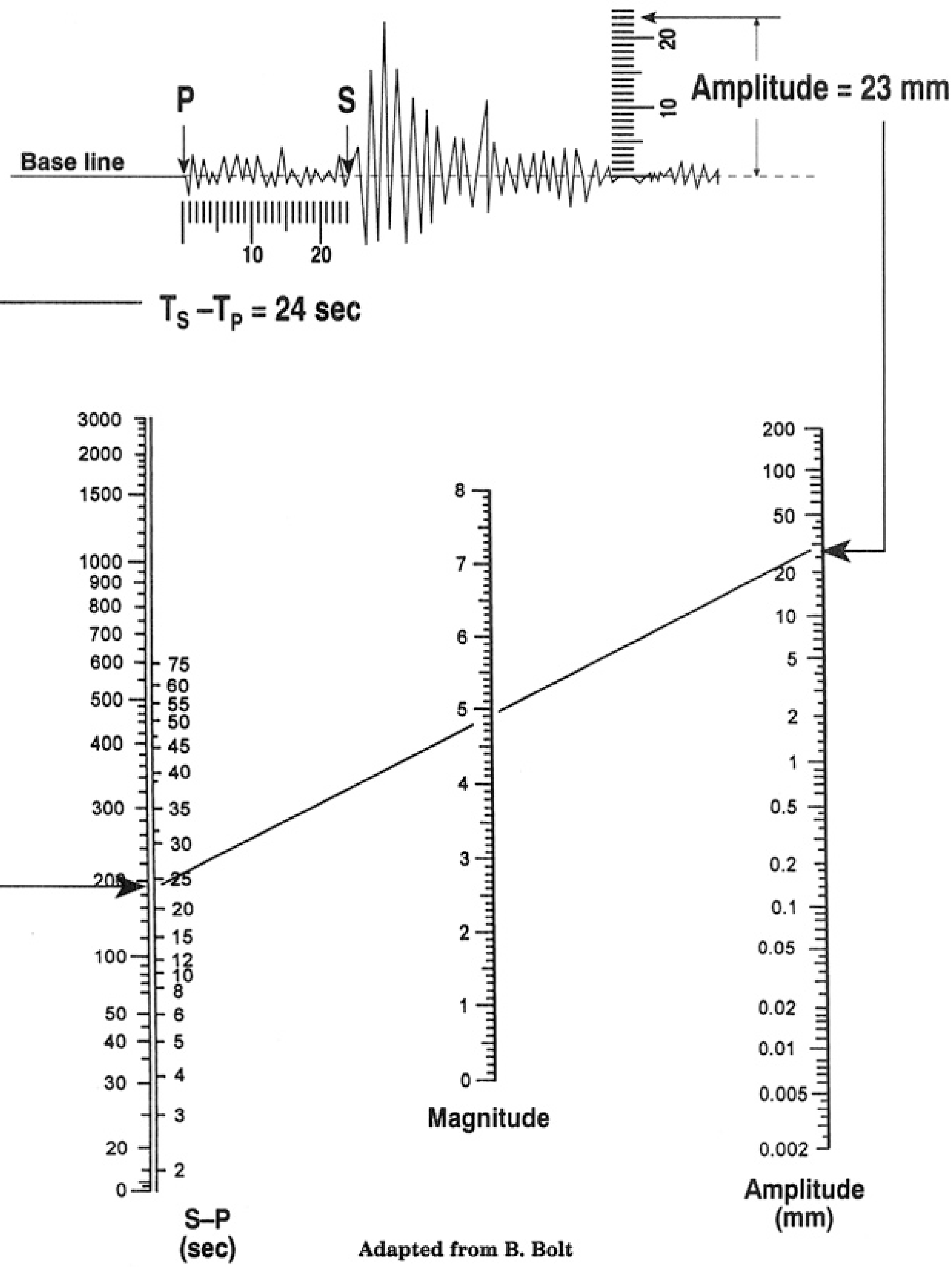
September 2, 1992 10:26 UTC

Location: 37 º 5.4' N latitude, 113 º 28.3' W longitude

Final Magnitude: 5.8

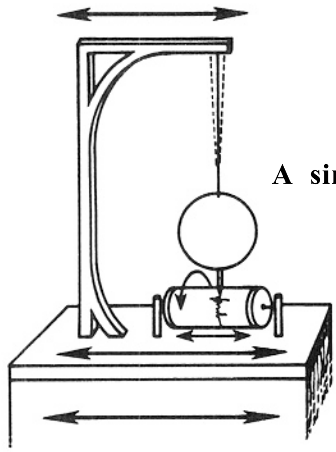
(Determined by University of Utah based on readings from 18 stations.)

Distance, Magnitude, Amplitude



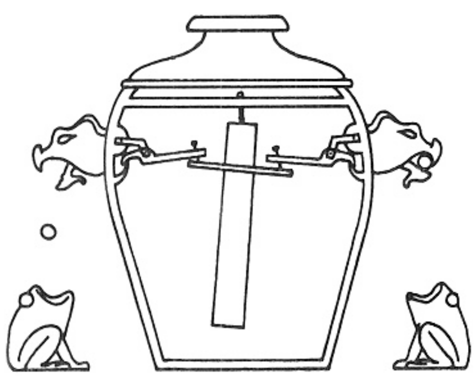
Adapted from B. Bolt

Several Seismographs

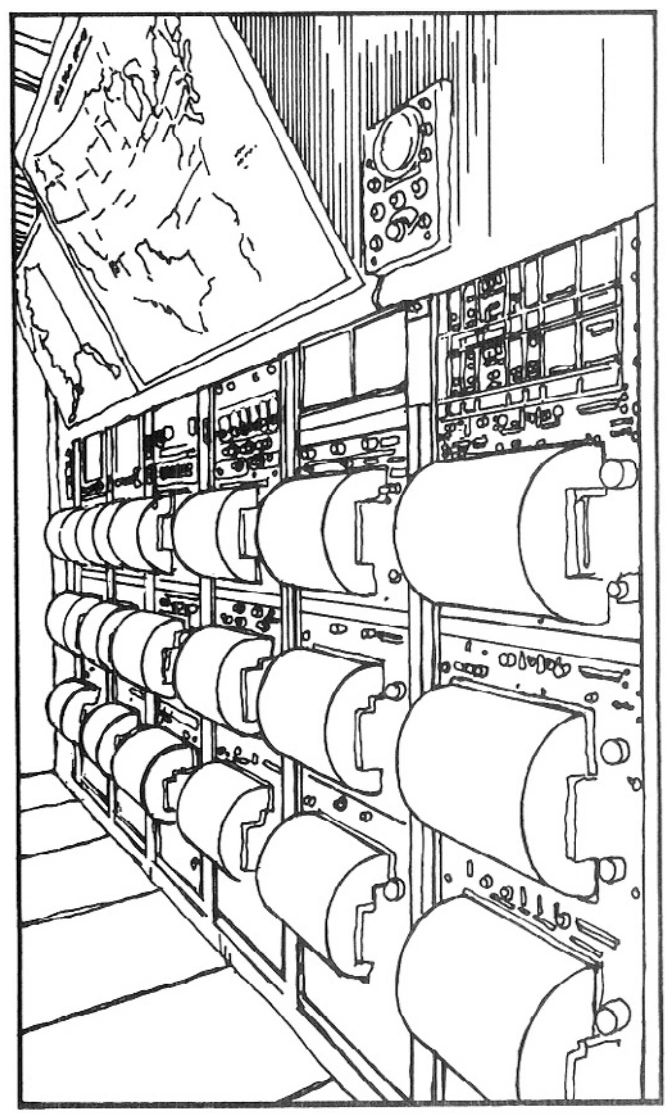


A simple pendulum seismograph

Chinese seismoscope, 132 A.D. The direction in which the first ball fell was thought to indicate the direction of the epicenter.



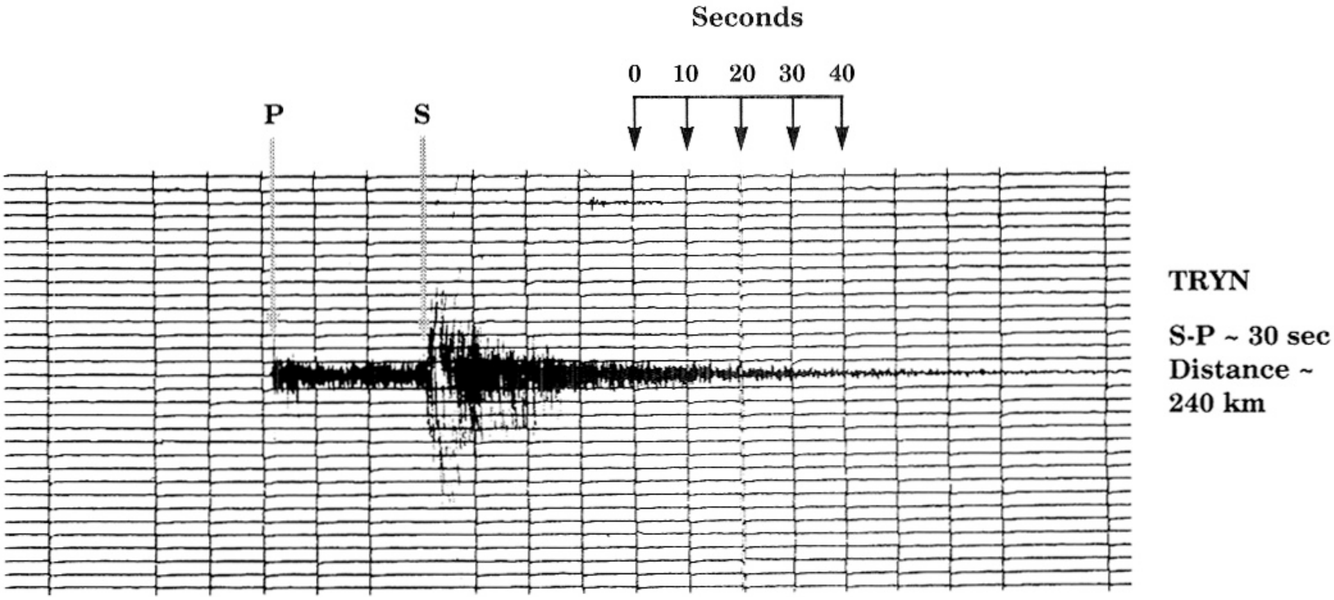
Inside view

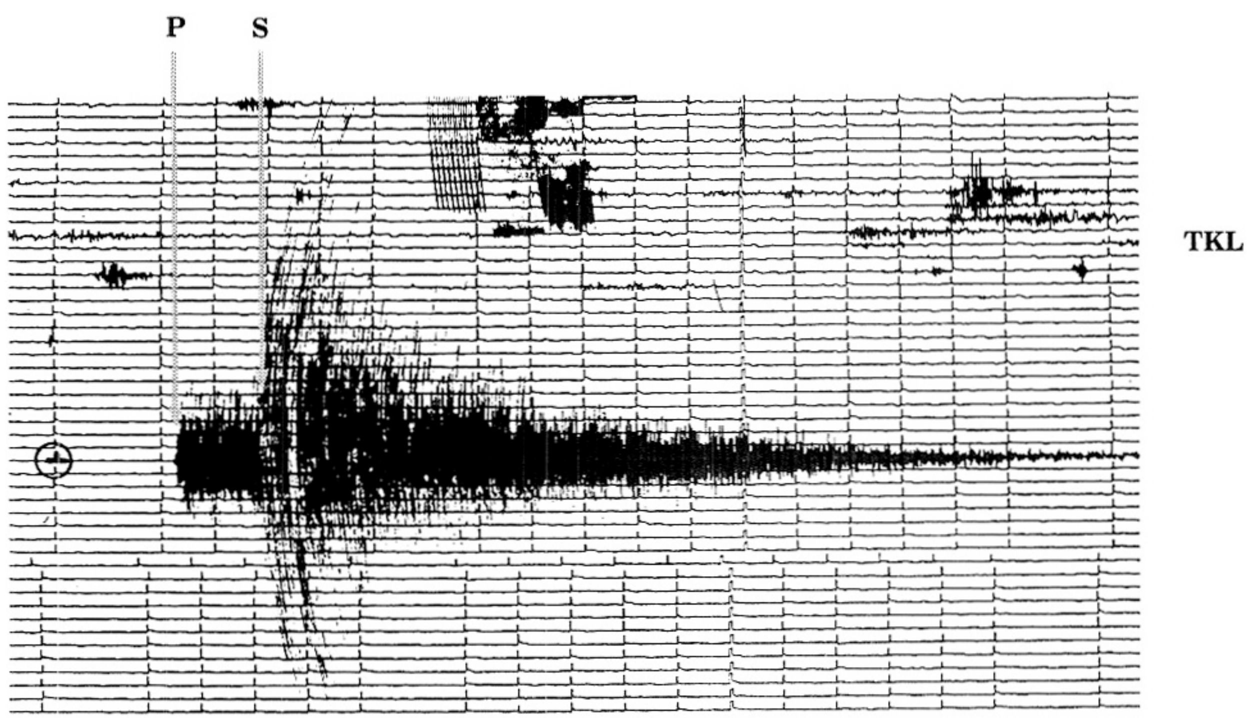


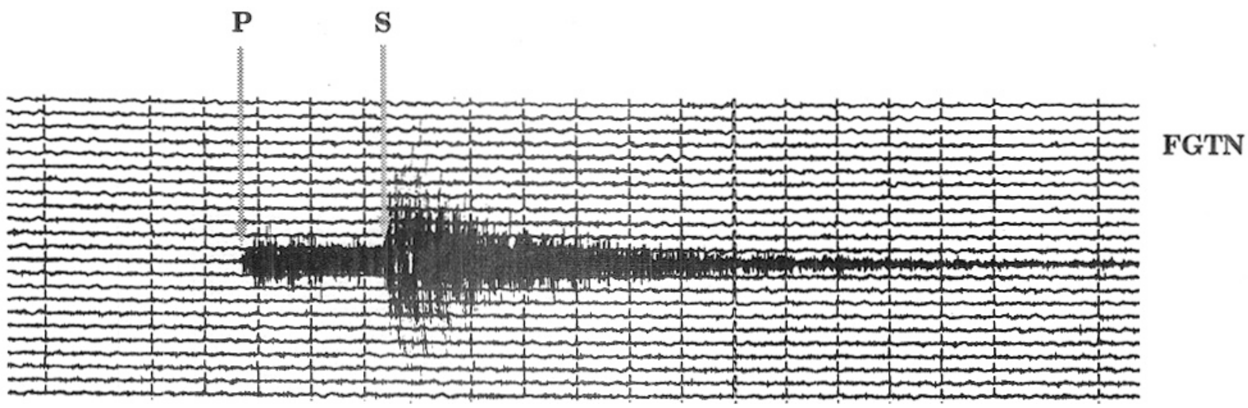
Modern seismographs

Sample Seismograms

Name ____ Date ______________________



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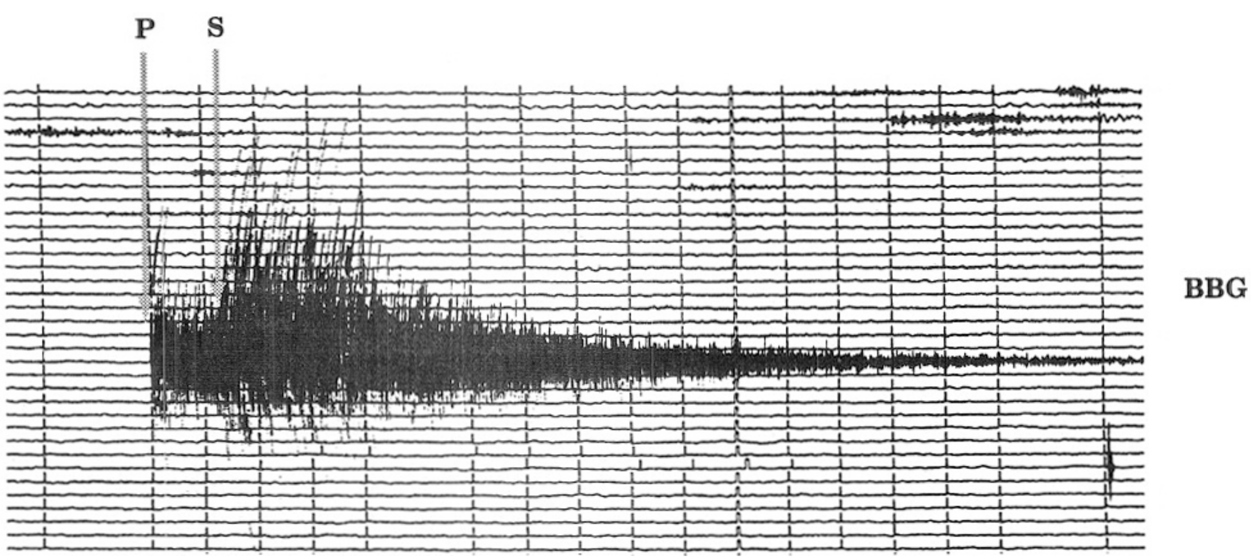
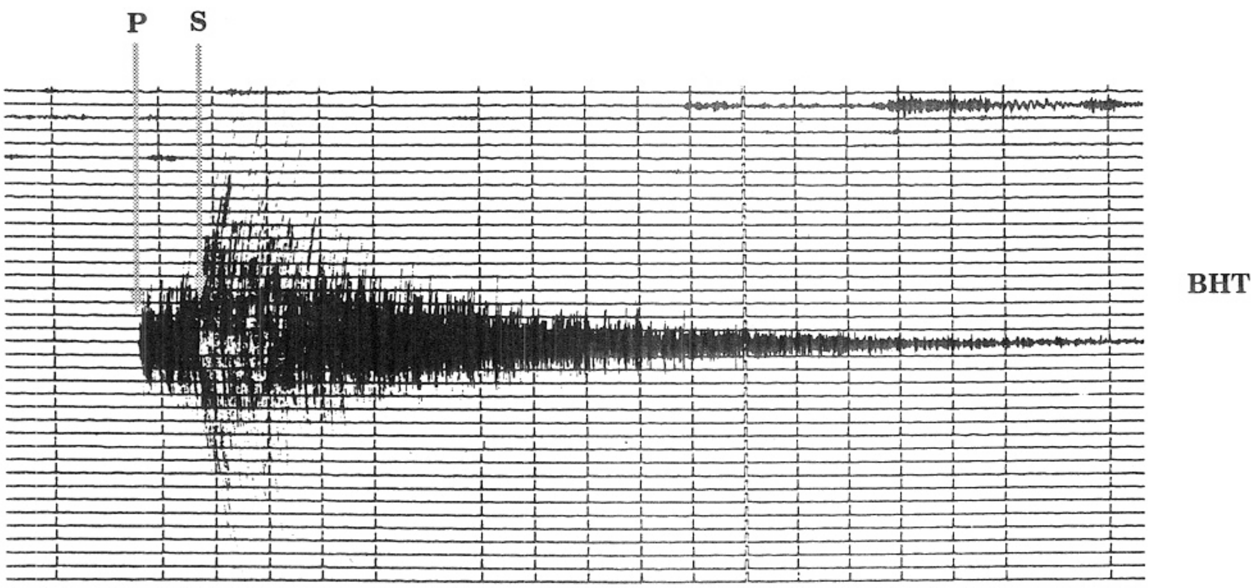
S
FGTN


P
S
BBG



Note: *Seismogram source: Center for Earthquake Research and Information, Memphis State University.*

STATION	T_p	T_s	$T_s - T_p$	DISTANCE
TRYN	2 sec	32 sec	30 sec	240 km
TKL				
FGTN				
BBG				
BHT				

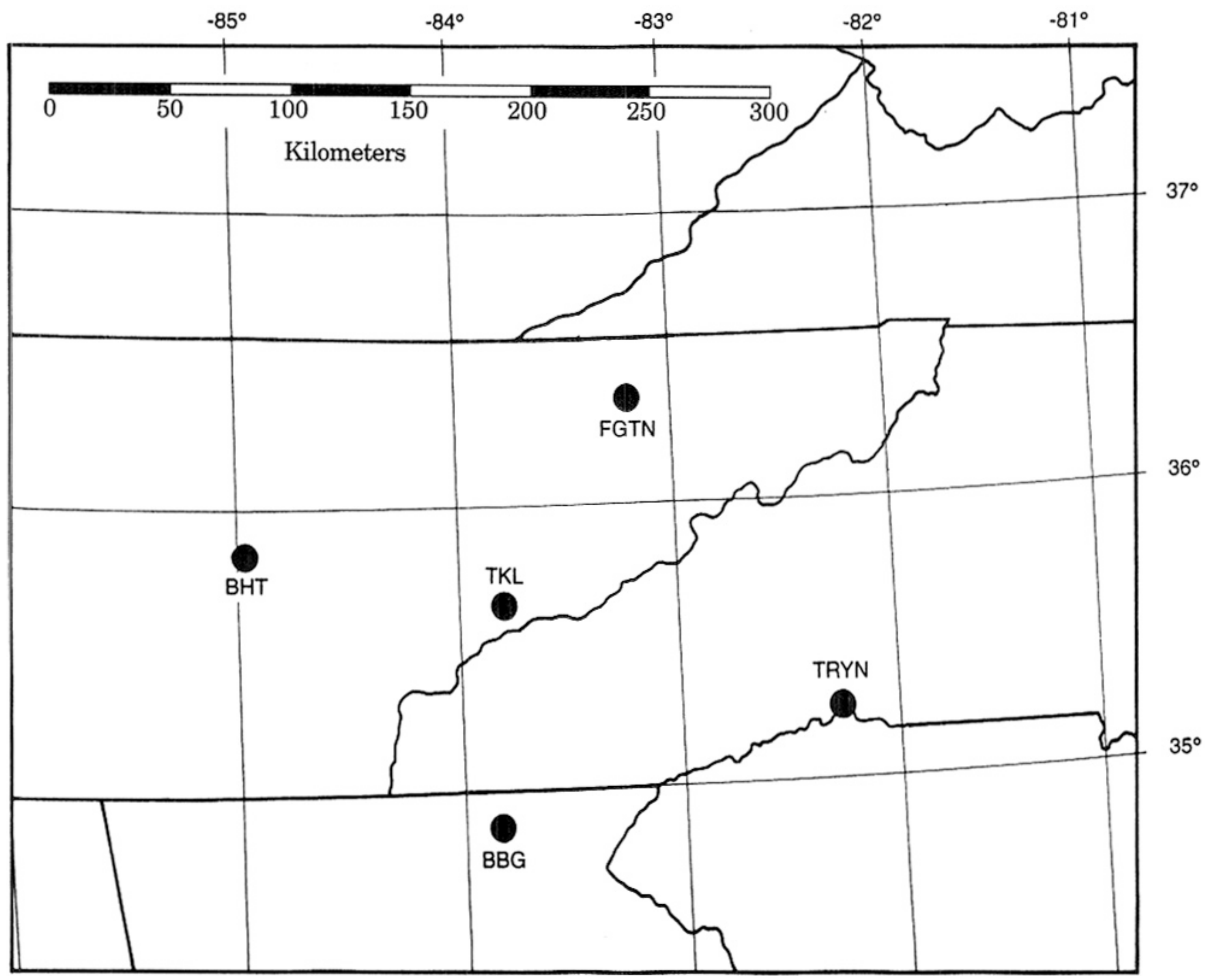
Sample Seismograms (key)

STATION	S-P	DISTANCE (kilometers)	RADIUS OF ARC IN MM (assuming 1mm=3km)	
TRYN	30	240		80
TKL	15	120		40
FGTN	27	216		72
BBG	12	96		32
BHT	11	88		29

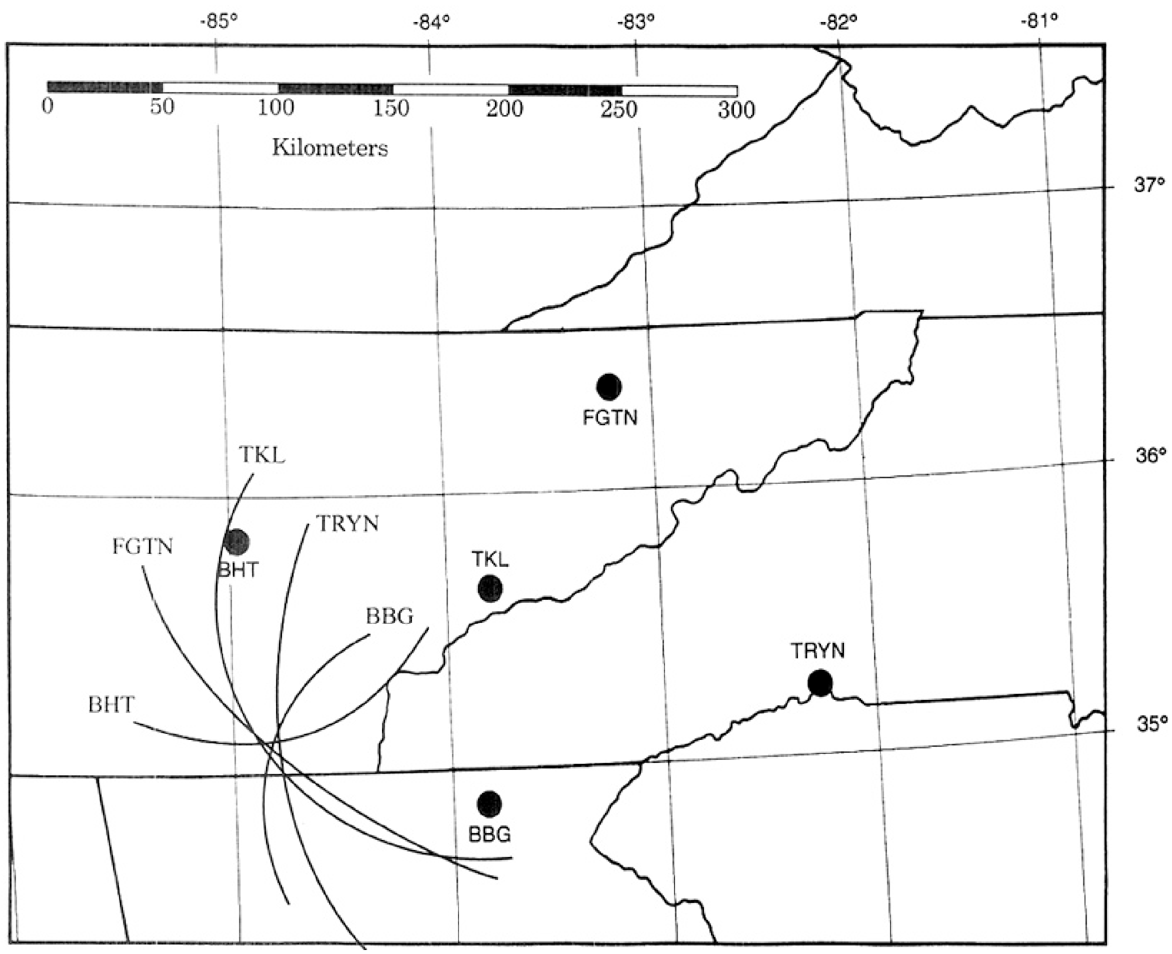
Note: *Answers will vary.*

Map of Station Locations

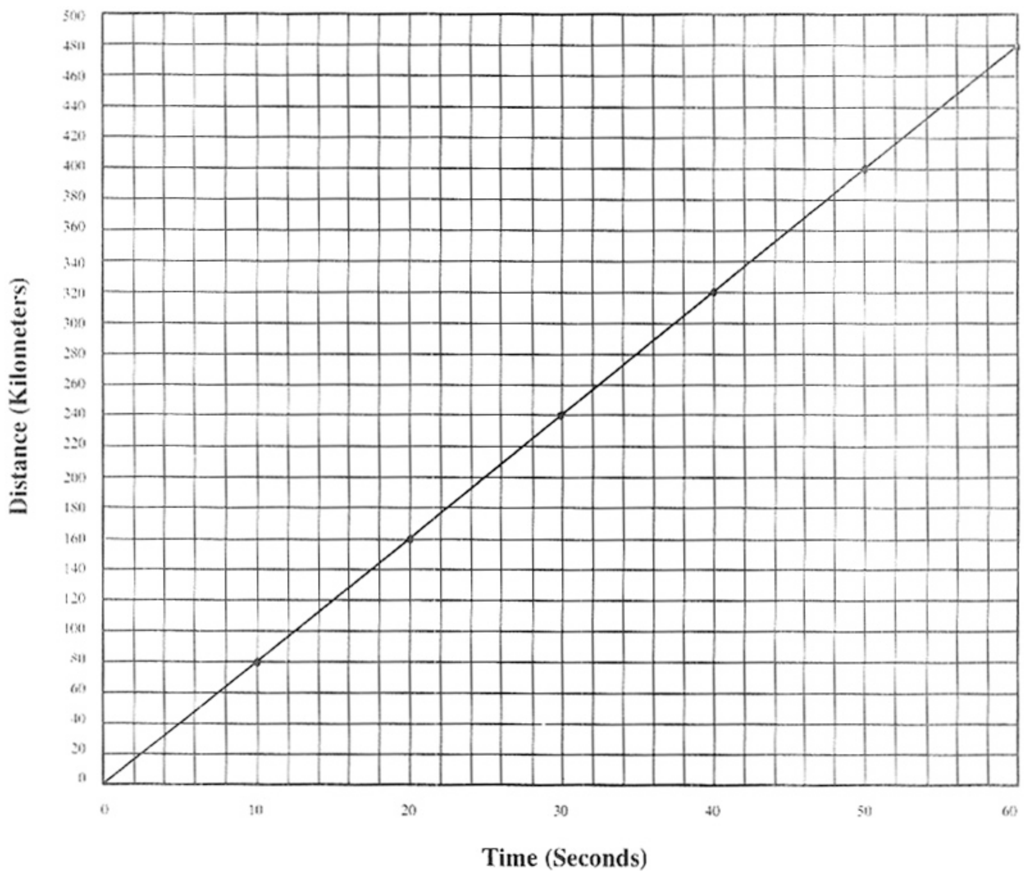
Name ____ Date ____________________



Map of Station Locations (key)



Time/Distance Reference Table



The slope of this line is based on the equation

$$(T_s - T_p) \times 8 = D$$

Examples

(60 - 50) x 8 = 80
(60 - 40) x 8 = 160
(60 - 30) x 8 = 240
(60 - 20) x 8 = 320
(60 - 10) x 8 = 400