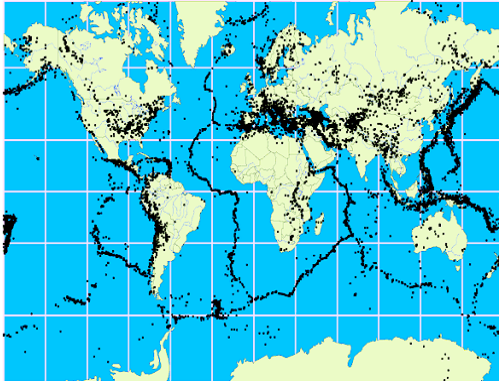


# IALP 2011 - Thunder-quake

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MIEET 1º ano



1:

Two people, Fernando and Orlando, one living in Faro, the other in Olhão (see map), are witnessing a beautiful thunderstorm. Both being students of MIEET, they decide to try to localize the rays.

In the first attempt they use trilateration; they count the time it takes between visually seeing the flash and audible hearing the thunder.

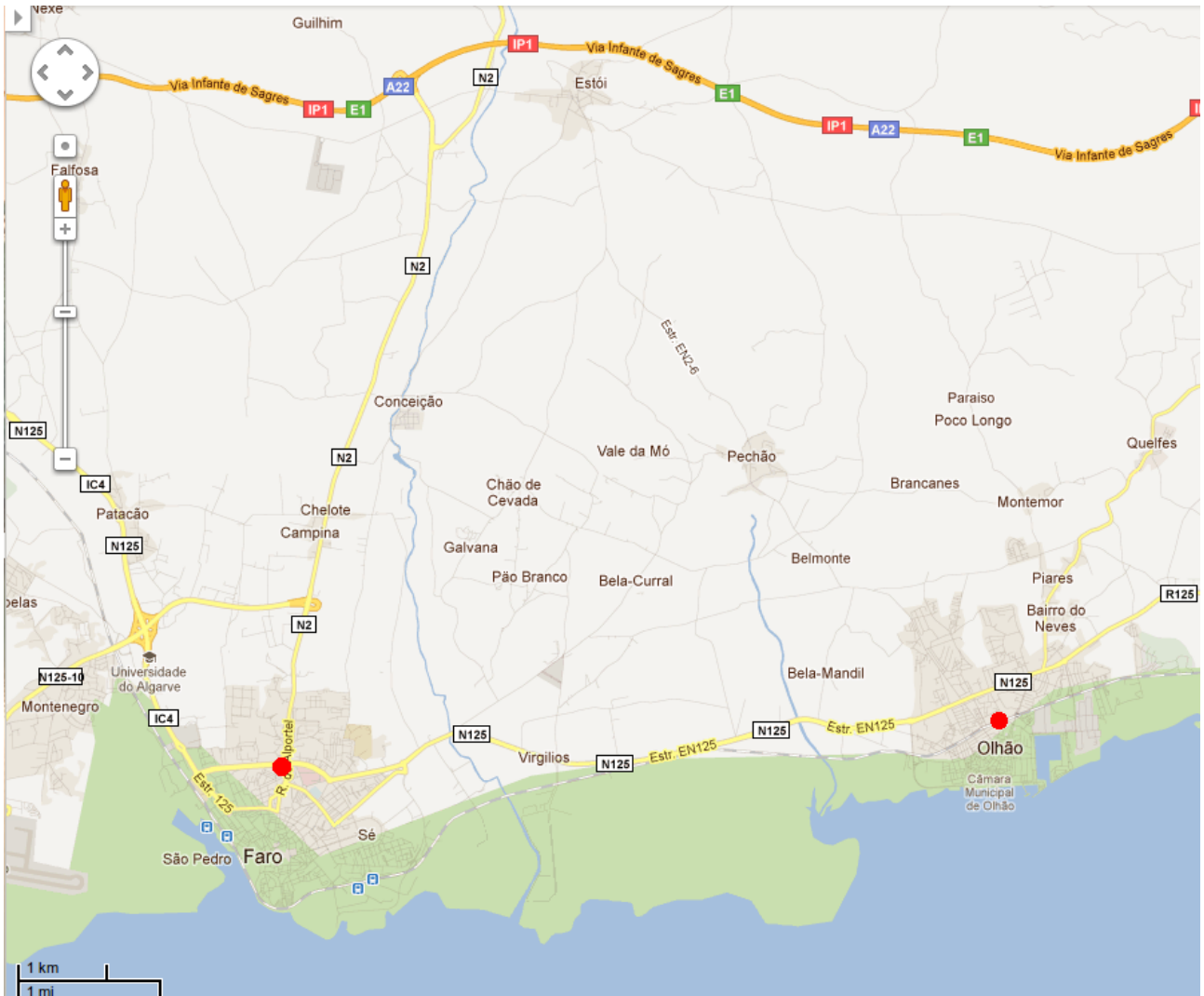
- Faro (Fernando): 19 seconds
- Olhão (Orlando): 12 seconds
  - Where did it hit? Indicate on the map

In the second approach they do triangulation. They define each others line of sight as  $0^\circ$  and measure where they see the flash

- Faro (Fernando):  $66^\circ$
- Olhão (Orlando):  $30^\circ$ 
  - Where did it hit? Indicate on the map
- Indicate on the map all the places that have a distance to Faro twice the distance to Olhão. Define Faro at  $(x,y) = (0,0)$  and Olhão at  $(8 \text{ km},0)$ . What is the expression for the points P that have  $(P\text{-Faro}) = 2x(P\text{-Olhão})$ ?

Speed of light:  $3 \times 10^8$  m/s

Speed of sound: 343.2 m/s



2:

On the next pages an exercise of University of Arkansas (Jansma). The exercise is to

- Locate the earthquake epicenter and
- Determine the magnitude on the Richter scale.

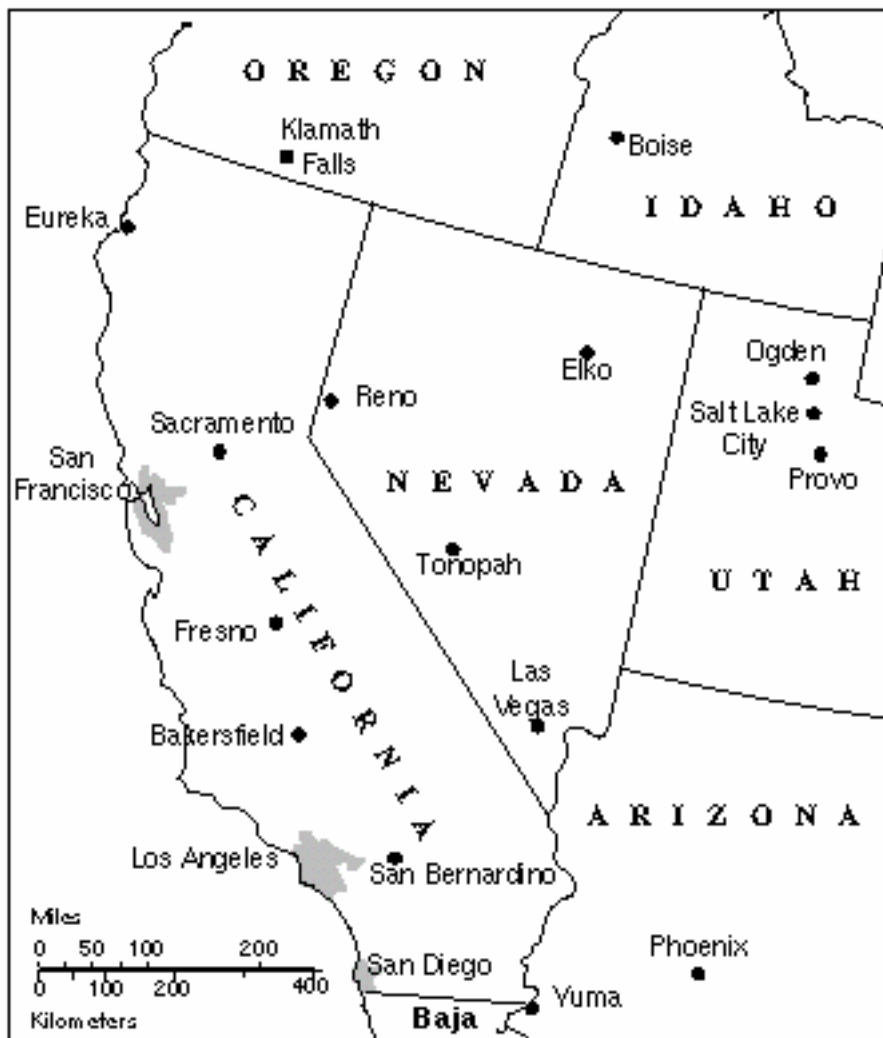
It is based on the ideas presented in the lecture on GPS

## Determining the epicenter and magnitude of an earthquake

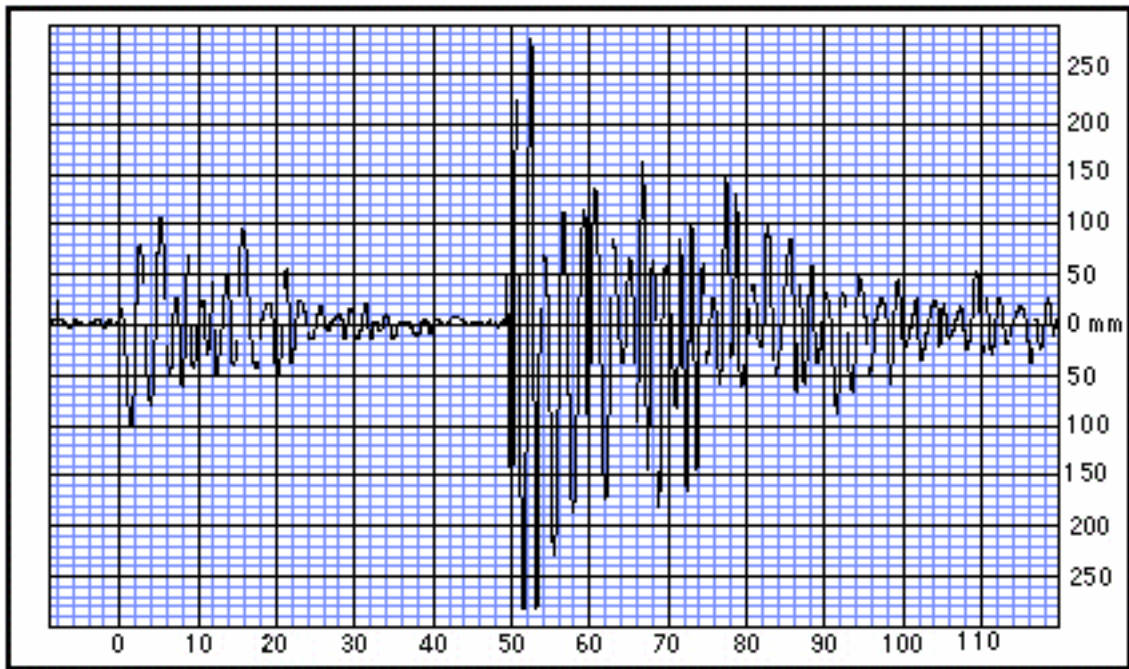
You will use seismograms from Eureka, CA, Elko, NV, and Las Vegas, NV to determine the epicenter and magnitude of an earthquake that affected the western United States. To determine the epicenter, one looks at the difference in the arrival time of the P and S waves (in seconds). To constrain the magnitude, one looks at the amplitude of the S-wave.

Plot the epicenter on the map below.

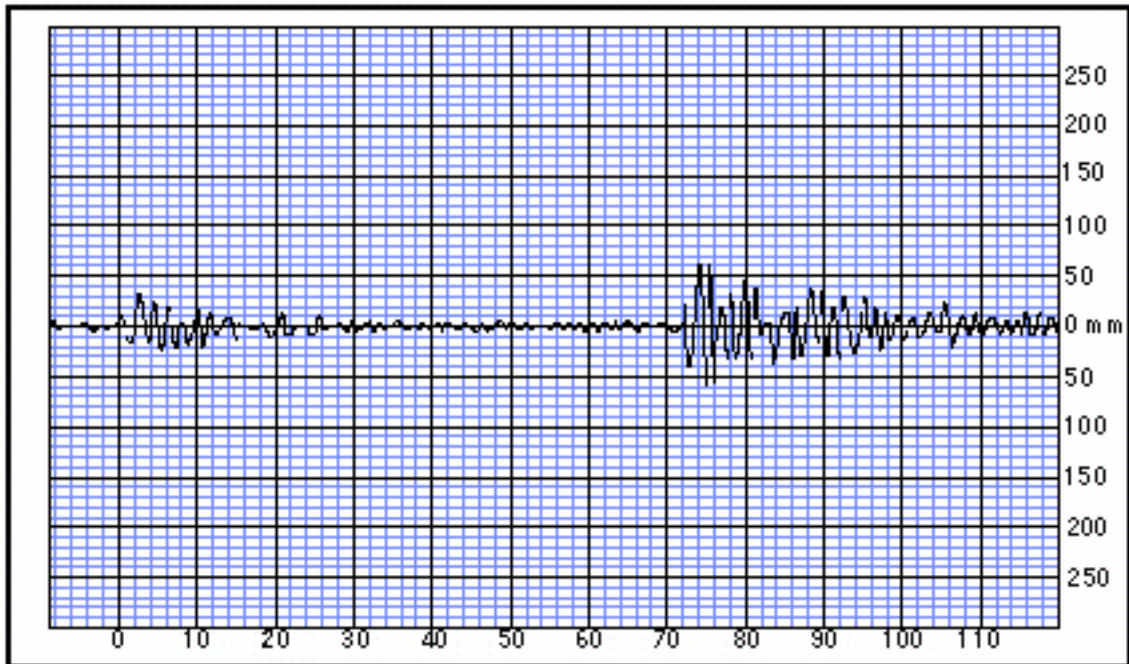
Determine the magnitude on the Richter nomogram below.



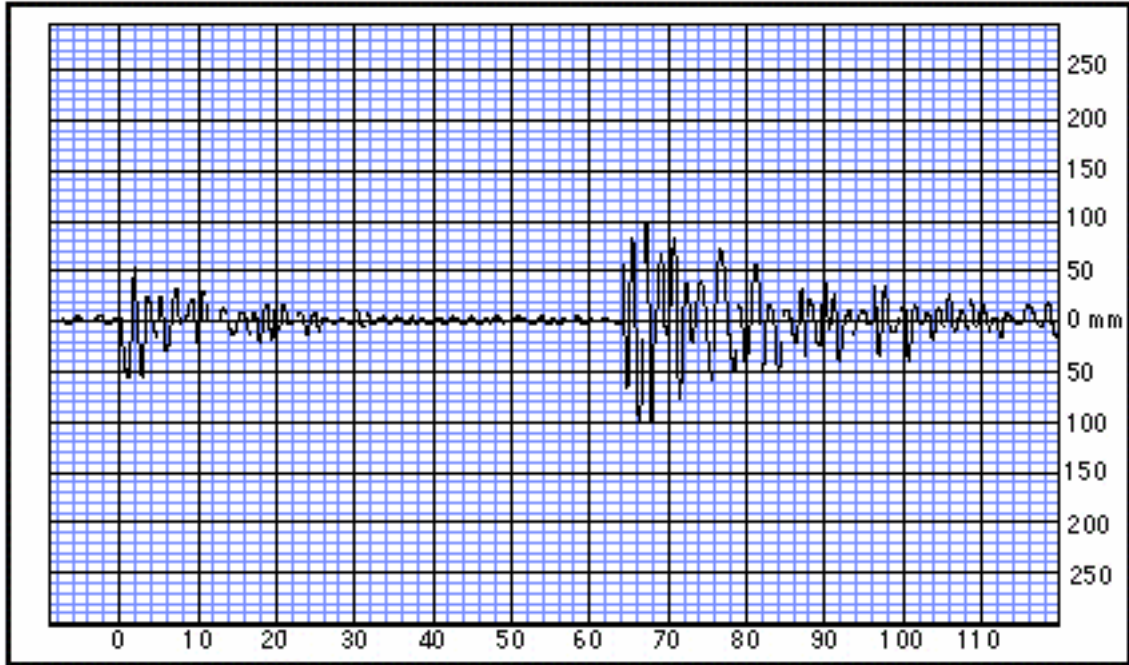
Map of western US



Eureka, CA



Eiko, NV



Las Vegas, NV

Eureka, CA

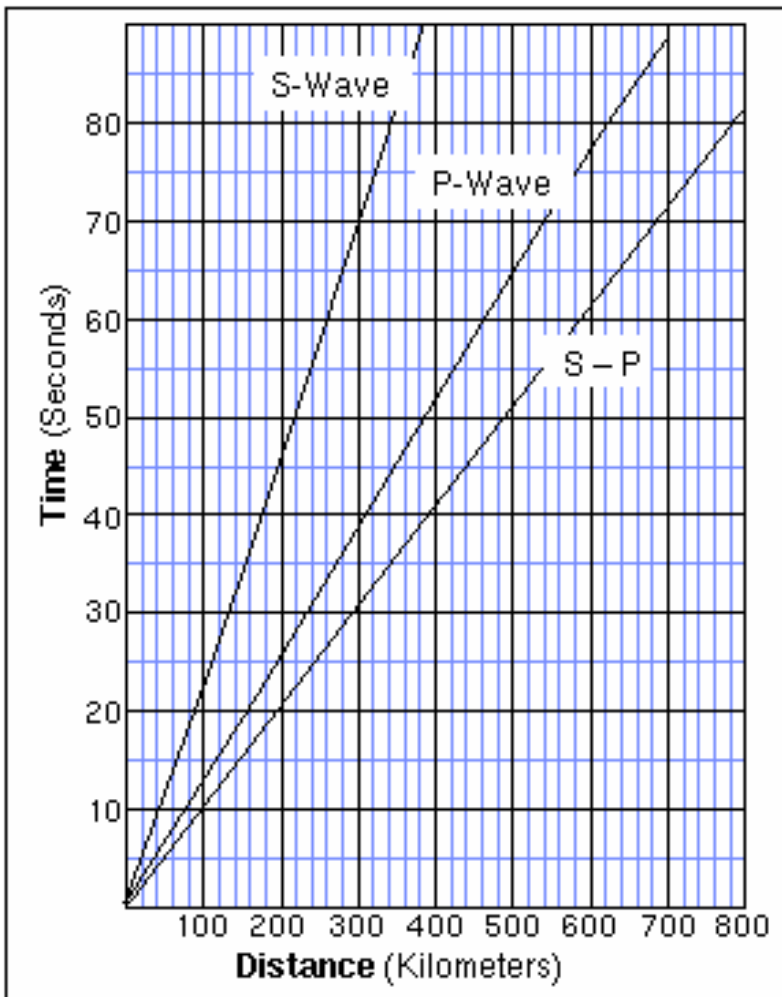
P-S arrival difference: \_\_\_\_\_ (seconds) S-wave amplitude: \_\_\_\_\_ (mm)

Elko, NV

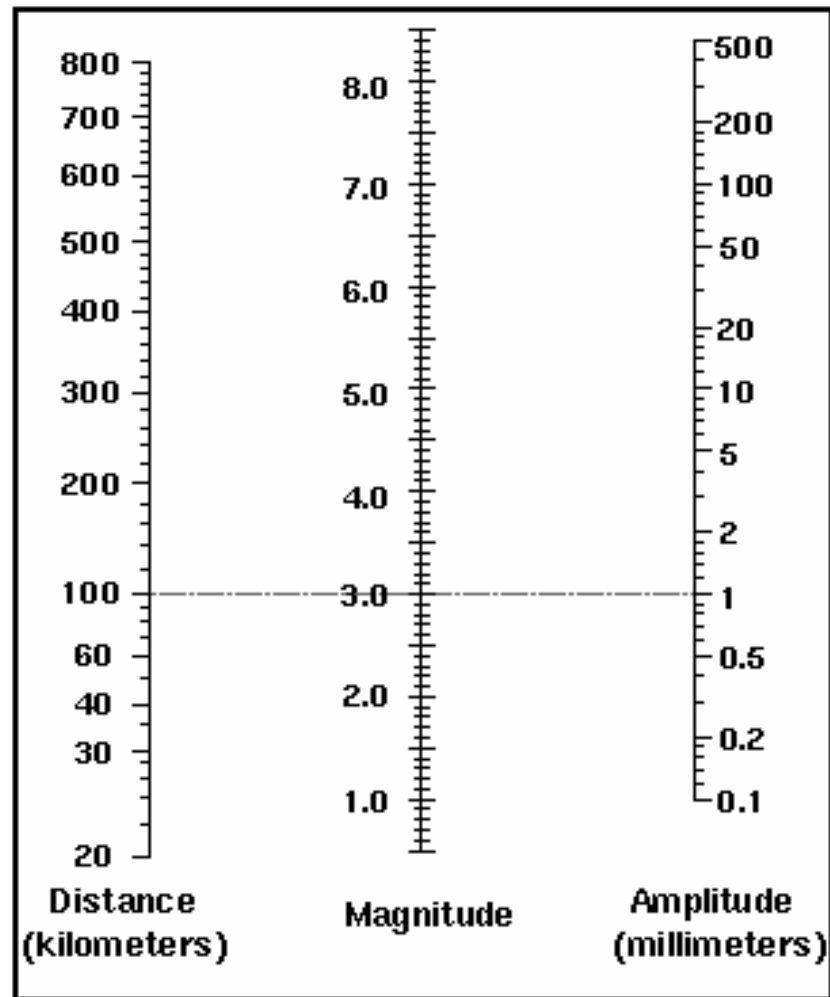
P-S arrival difference: \_\_\_\_\_ (seconds) S-wave amplitude: \_\_\_\_\_ (mm)

Las Vegas, NV

P-S arrival difference: \_\_\_\_\_ (seconds) S-wave amplitude: \_\_\_\_\_ (mm)



S-P arrival time chart



Richter nomogram