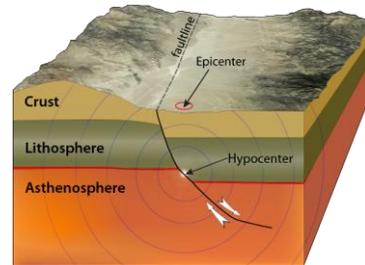


## Earthquakes and seismology

GS106

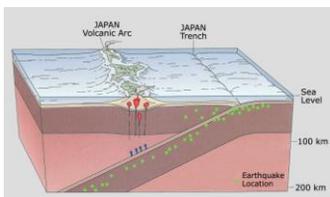
### Epicenter & Focus of Earthquakes

Epicenter—Location directly above EQ on Earth's surface.



Focus:  
or hypocenter; point within Earth where the EQ occurred.

### Why are there earthquakes? Brittle vs. ductile

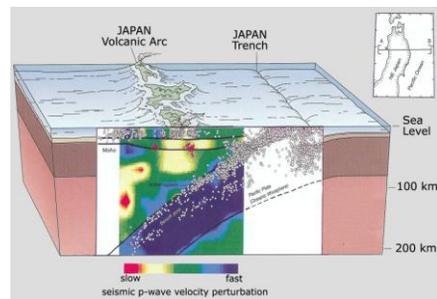


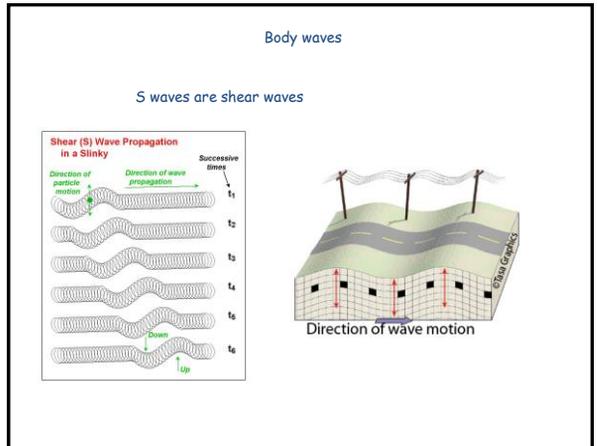
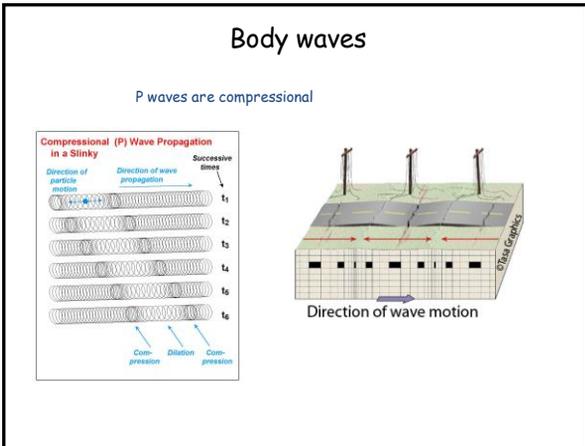
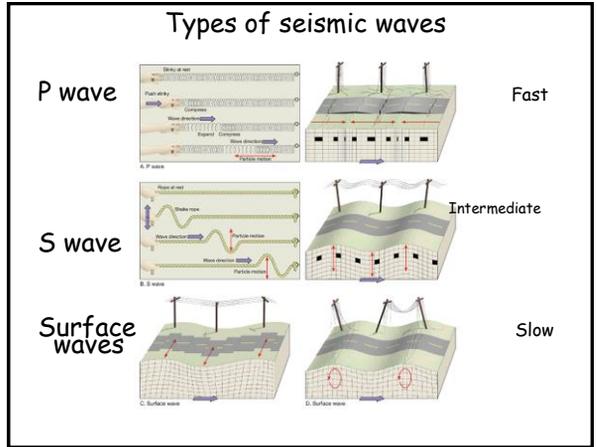
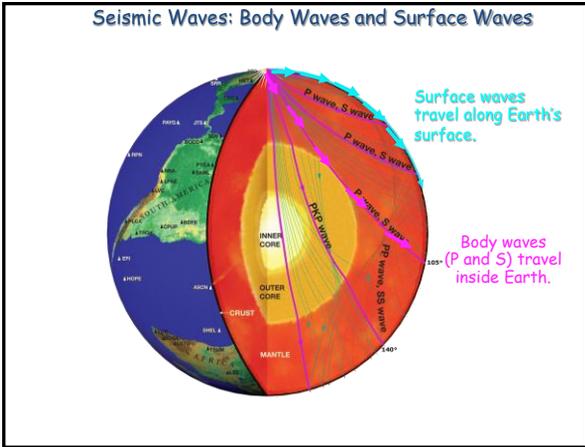
Example:

Subduction-zone earthquakes occur in discrete areas on and between plates.

Why?

### Why are there earthquakes? Brittle vs. ductile



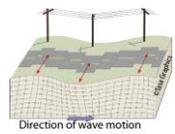
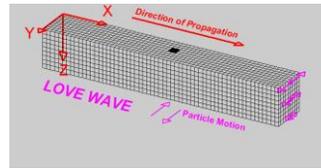
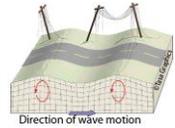
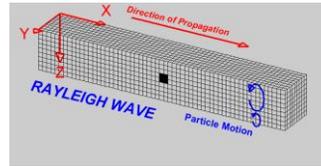


Activity

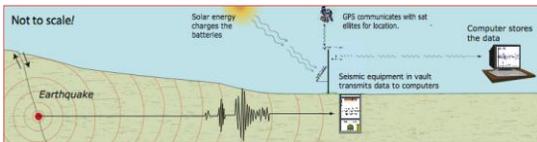
# Modeling seismic waves in the classroom

Surface waves

## Rayleigh & Love Waves



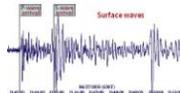
How do scientists detect earthquakes?



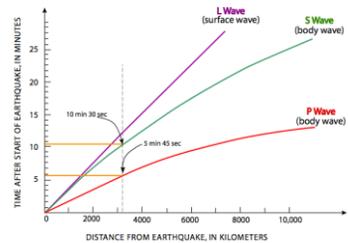
A seismograph detects and records EQs.



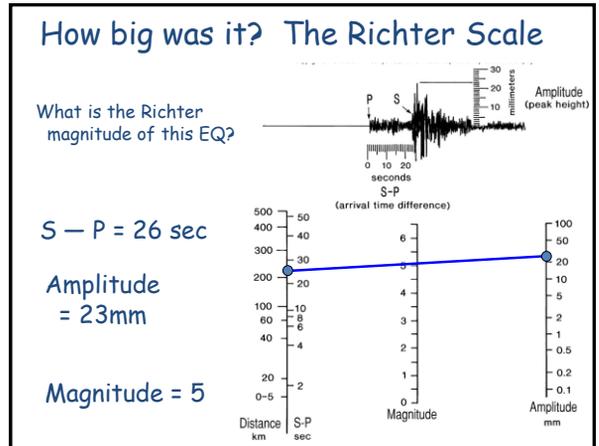
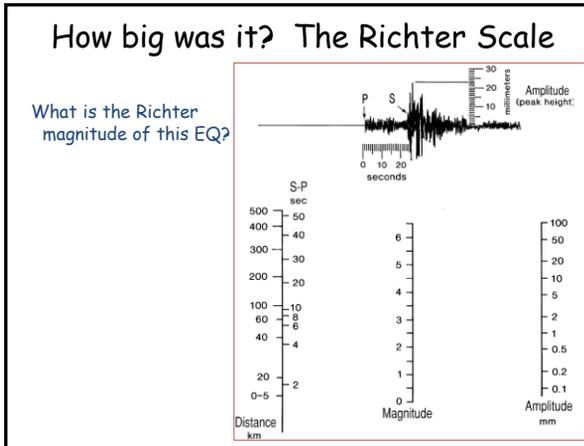
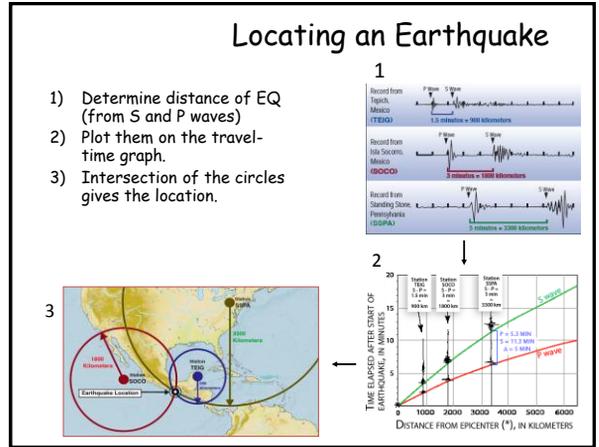
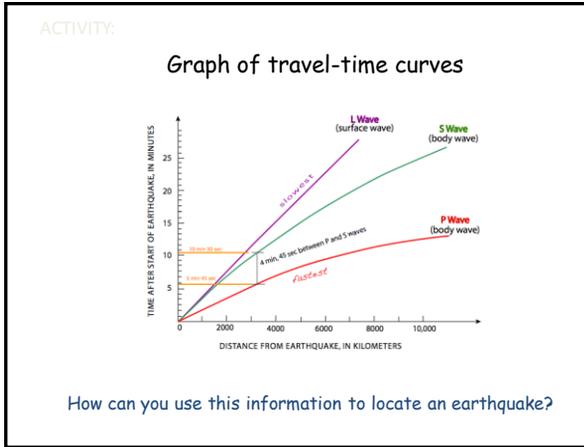
A seismogram is the EQ record.



How far away was the earthquake?



Calculate S-arrival time minus P-arrival time using this graph of travel-time curves.



## Magnitudes and Energy of Earthquakes

### Annual Numbers of EQs

Frequency of Occurrence of Earthquakes

Descriptor	Magnitude	Average Annually
Great	8 and higher	1 <sup>1</sup>
Major	7 - 7.9	17 <sup>2</sup>
Strong	6 - 6.9	134 <sup>2</sup>
Moderate	5 - 5.9	1319 <sup>2</sup>
Light	4 - 4.9	13,000 (estimated)
Minor	3 - 3.9	130,000 (estimated)
Very Minor	2 - 2.9	1,300,000 (estimated)

<sup>1</sup> Based on observations since 1900.  
<sup>2</sup> Based on observations since 1990.

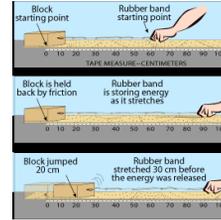
Magnitude vs. Ground Motion and Energy

Magnitude Change	Ground Motion Change (Displacement)	Energy Change
1.0	10.0 times	about 32 times
0.5	3.2 times	about 5.5 times
0.3	2.0 times	about 3 times
0.1	1.3 times	about 1.4 times

This table shows that a magnitude 7.2 earthquake produces 10 times more ground motion than a magnitude 6.2 earthquake, but it releases about 32 times more energy. The energy release best indicates the destructive power of an earthquake.

## The Earthquake Machine

Think forces, faults, and friction.



Earthquake **Intensity** is what you feel.

### What Controls the Level of Shaking?

- Magnitude**—More energy released
- Distance**—Shaking decays with distance
- Geology**—Local soils amplify the shaking
- Building style**—Construction, not height
- Duration of shaking**

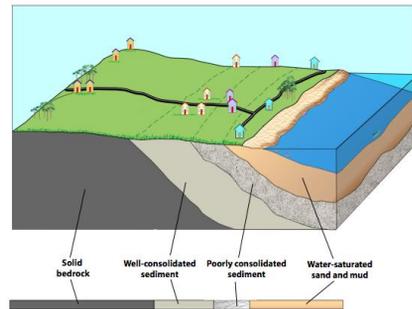
Example: 1994 Northridge EQ, M=6.7



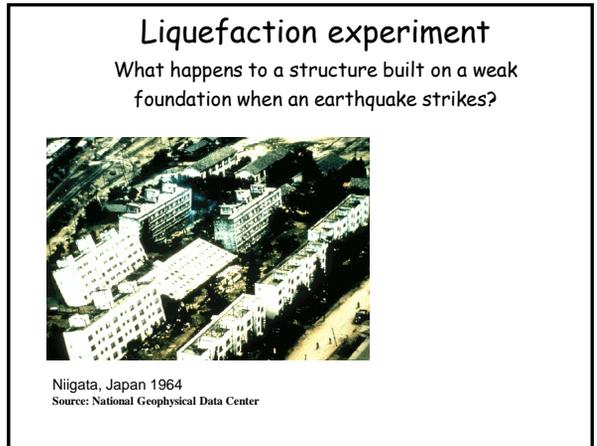
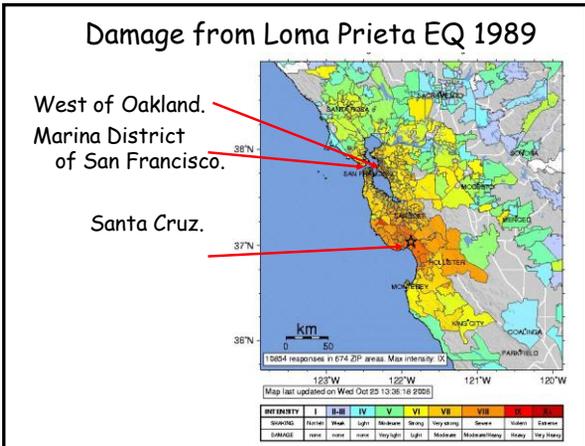
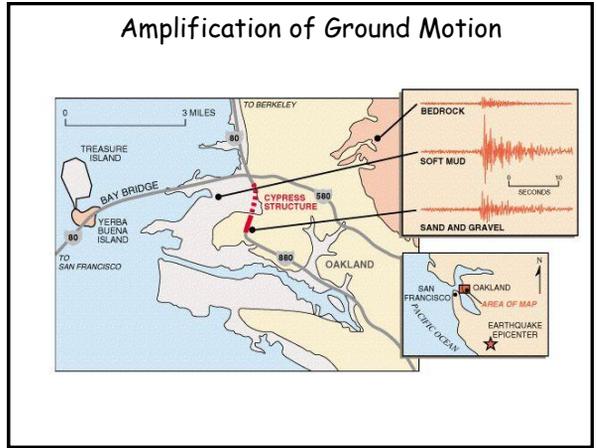
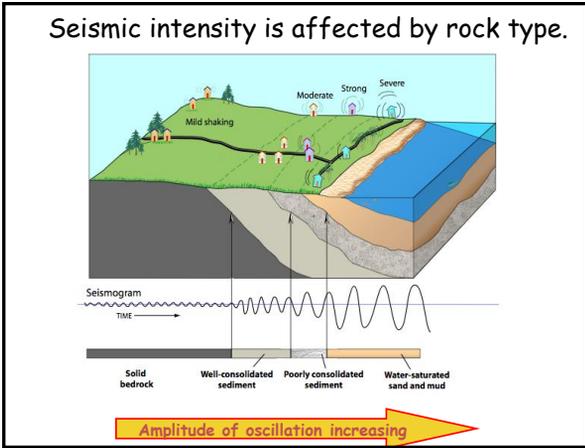
▲ The area including most major freeways that is spanned by the Northridge freeway is 100 percent more than the amount of the same area covered by the same freeway throughout most of the Los Angeles Basin. This indicates significant amplification of the Northridge earthquake in that region.



Seismic intensity is affected by rock type.



How would you expect the houses to react during an EQ?



### Discussion: Why is building damage selective?



#### Building design:

If the resonant frequency of a building is equal to the frequency of ground oscillation, then damage or collapse is likely.

What is resonant frequency?

### Building design



Resistance to shear is critical.

### Earthquake prediction eludes us.

*EQ forecasting*  
is more realistic  
and perhaps  
more useful.



What is the difference?