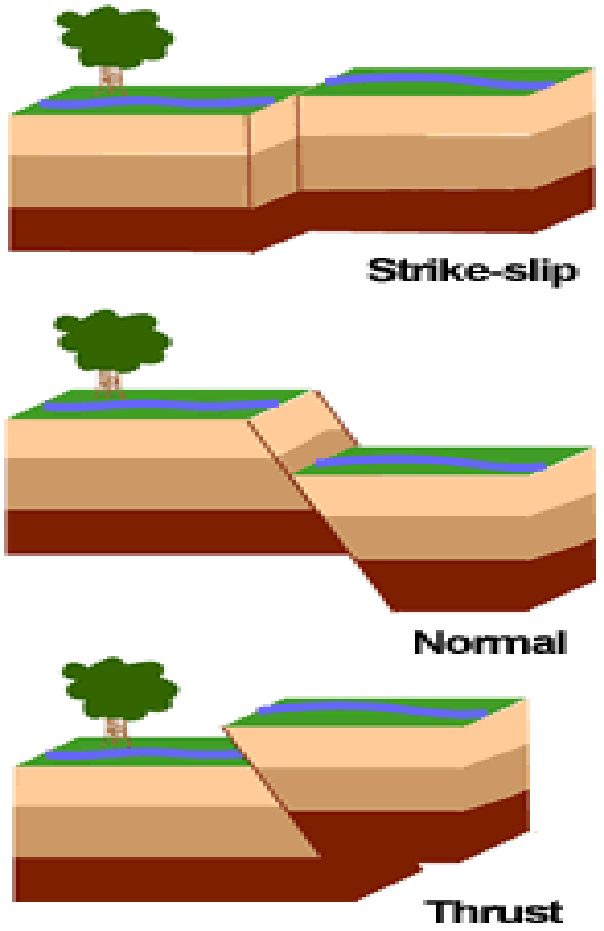
Geological Faults

Earthquakes most often occur along existing faults: planar fractures in a volume of rock, across which there has been significant displacement as a result of prior movement.

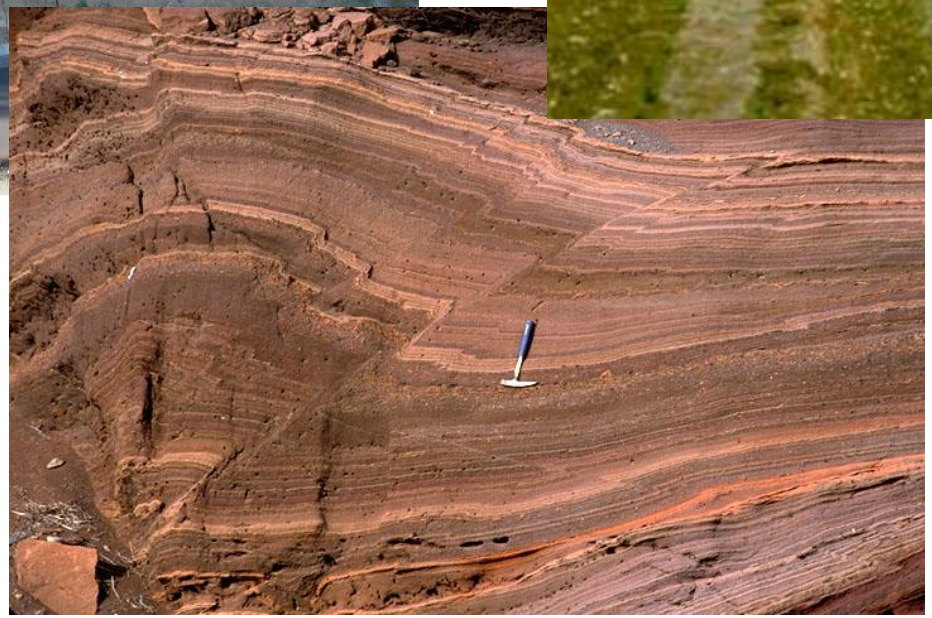
- **Strike-slip faults are vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally.**
- **If the rock mass above an *inclined fault* moves down, the fault is termed normal, whereas if the rock above the fault moves up, the fault is termed thrust.**
- **Faults are found alone or in clusters, creating a fault zone.**



What type of faults are these?

Normal

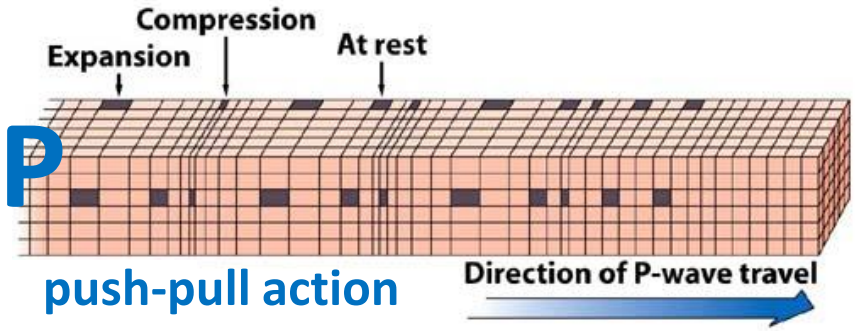
Strike-slip

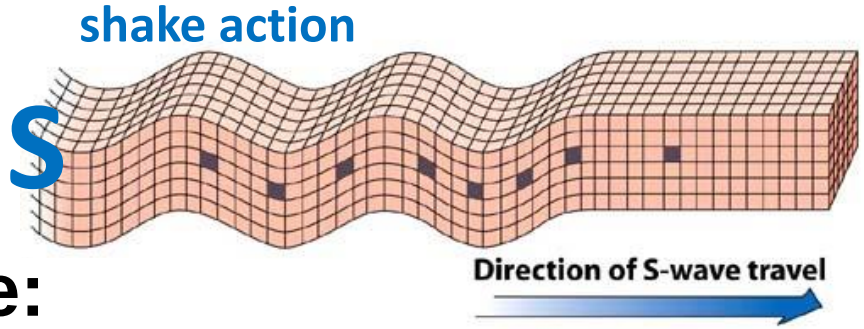


Thrust

Seismic Waves: Body Waves

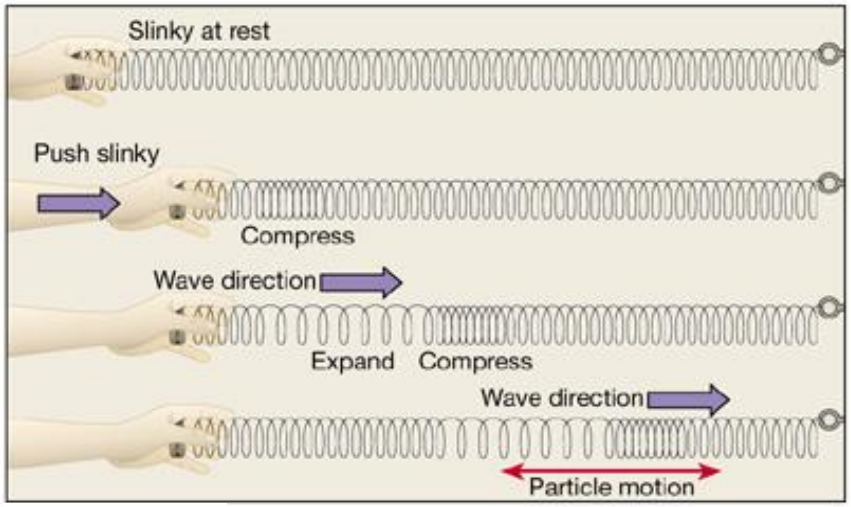
- **Primary or "P" Wave:**
  - Causes **compression and expansion of the ground in the direction** of wave propagation.
  - **Highest velocity** (the *first* to arrive after an earthquake).

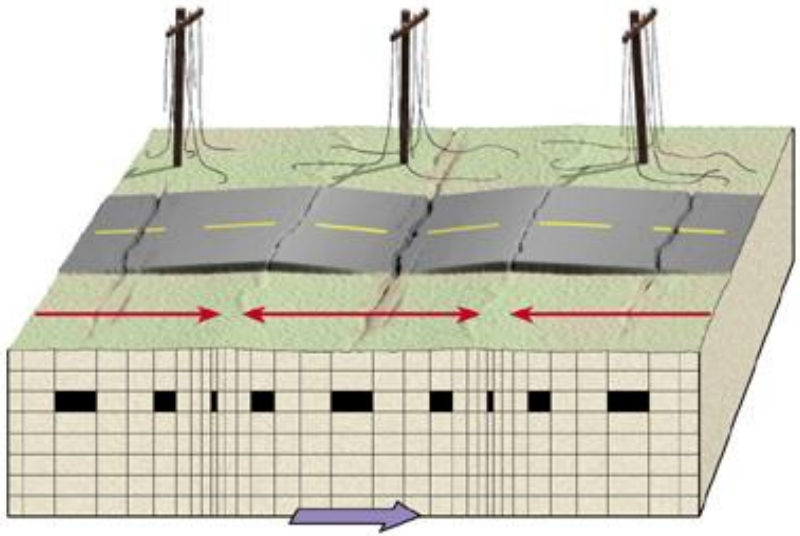




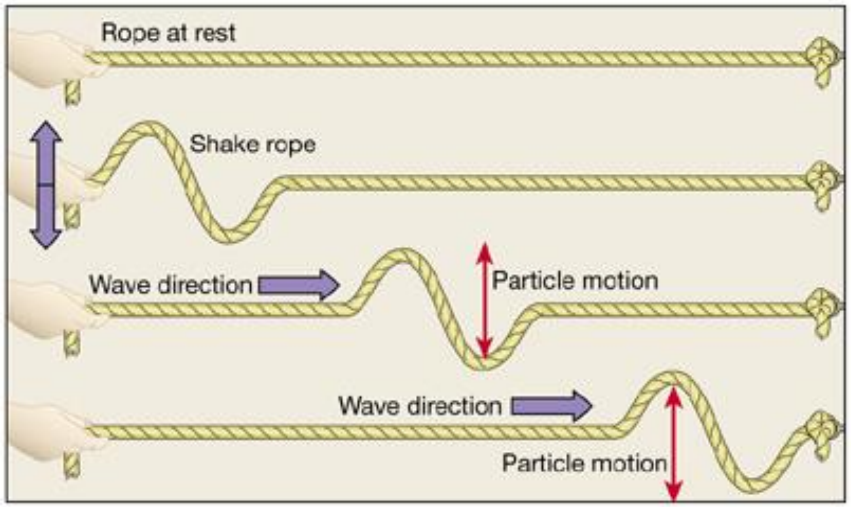
- **Secondary or "S" Wave:**
  - Causes **shearing of rock perpendicular to the direction** of wave propagation (moves the ground up and down or side to side).
  - **Slower than P waves but faster than surface waves.**
  - **Cannot travel through liquids.**

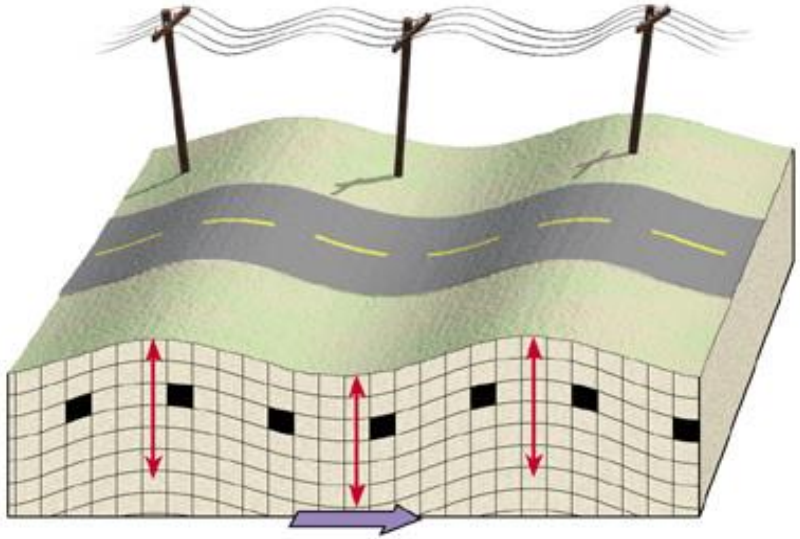
Understanding Body Waves





P wave



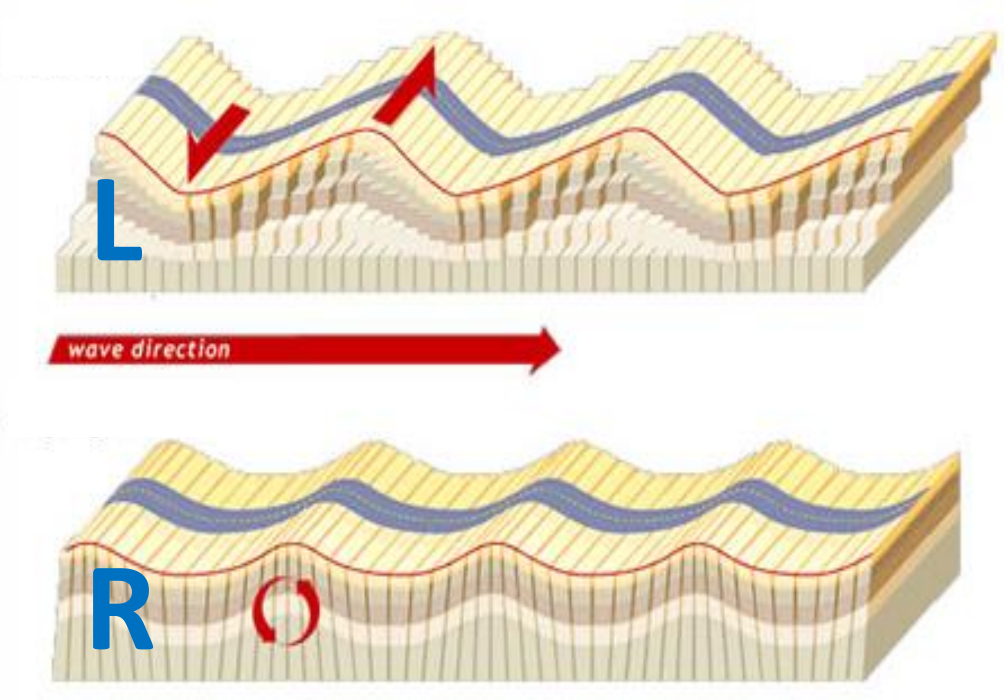


S wave

Seismic Waves: Surface Waves

Move along the Earth's surface, confined to the upper crust. Have lower frequency and travel more slowly than body waves - more destructive.

- **Love or "L" Wave: moves the ground side-to-side in horizontal plane**
- **Rayleigh or "R" Wave: elliptical roll of the ground oriented vertically (both up-down and side-to-side)**

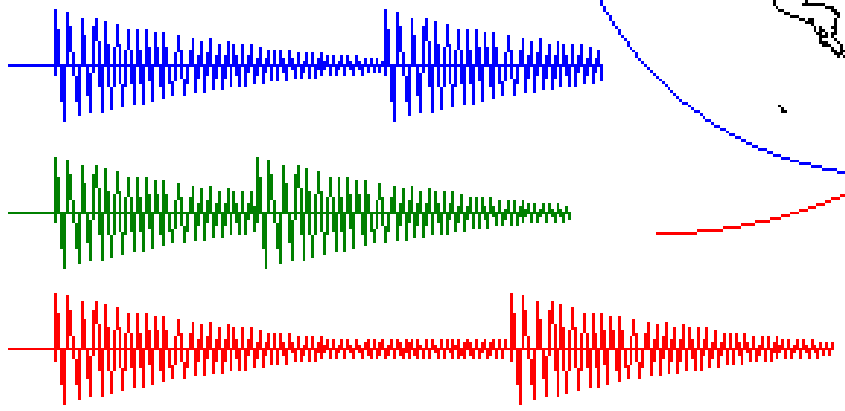


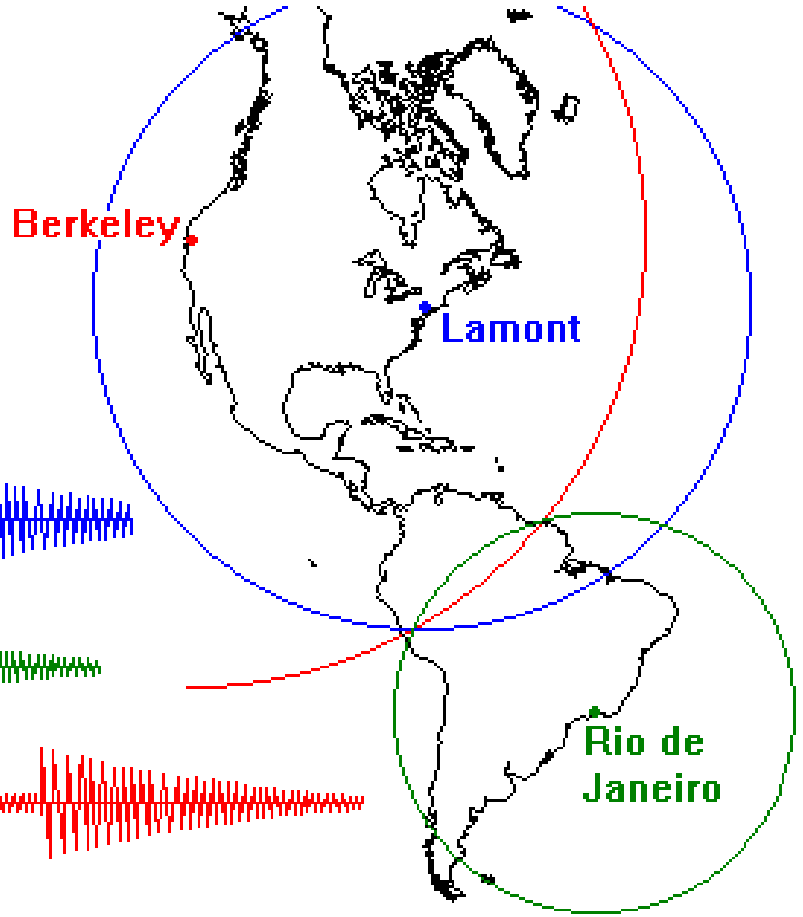
Almost entirely responsible for the damage and destruction associated with earthquakes!

Locating Earthquakes

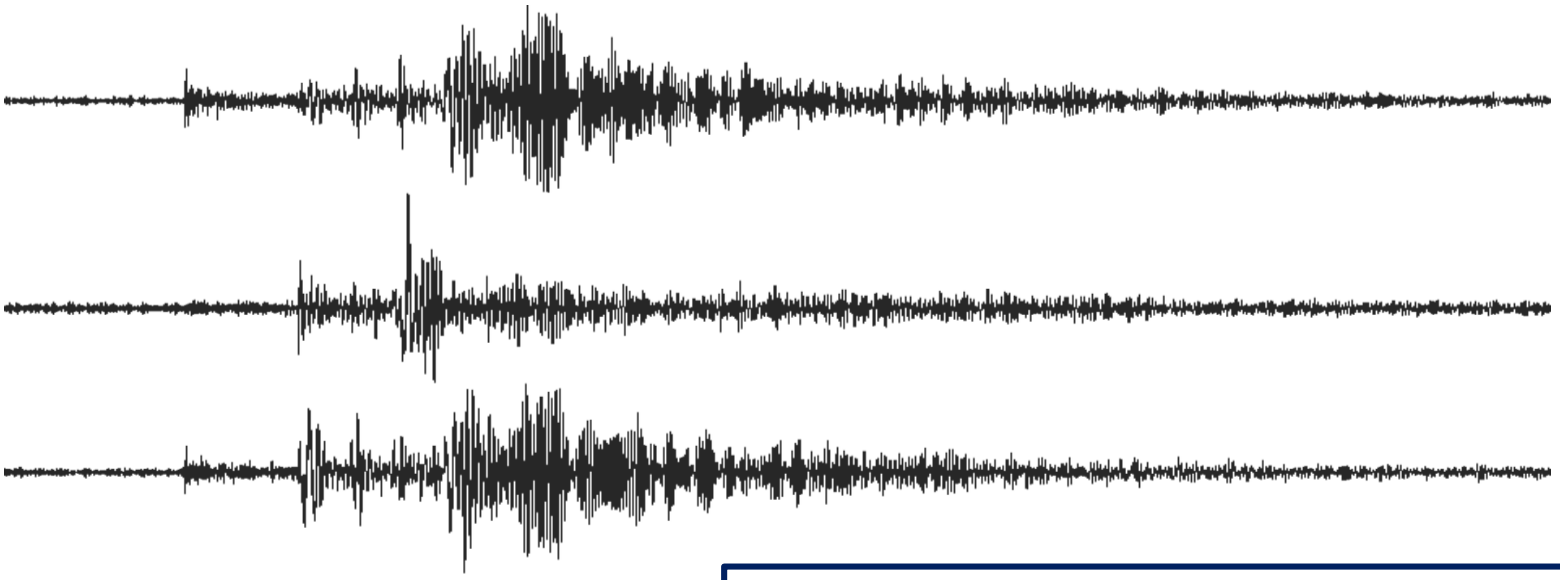
To locate an earthquake source, scientists calculate the difference between arrival times of the P and S waves.

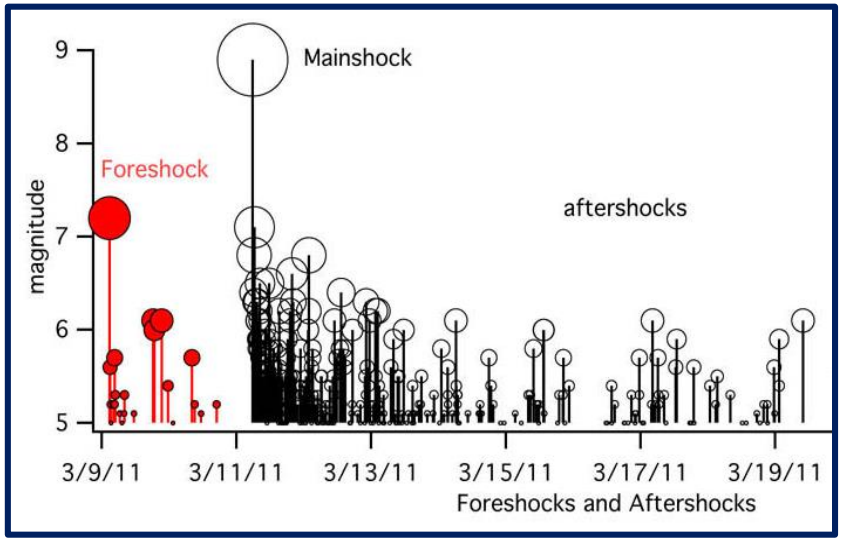
- **Propagation velocity of the seismic waves ranges from ~3 km/s up to 13 km/s, depending on the density and elasticity of the medium.**
- **The further away an earthquake is from the point of detection, the greater the time between the arrival of the P waves and the S waves.**
- **Data from several different (*at least three*) seismic stations is combined to determine the earthquake epicenter location.**

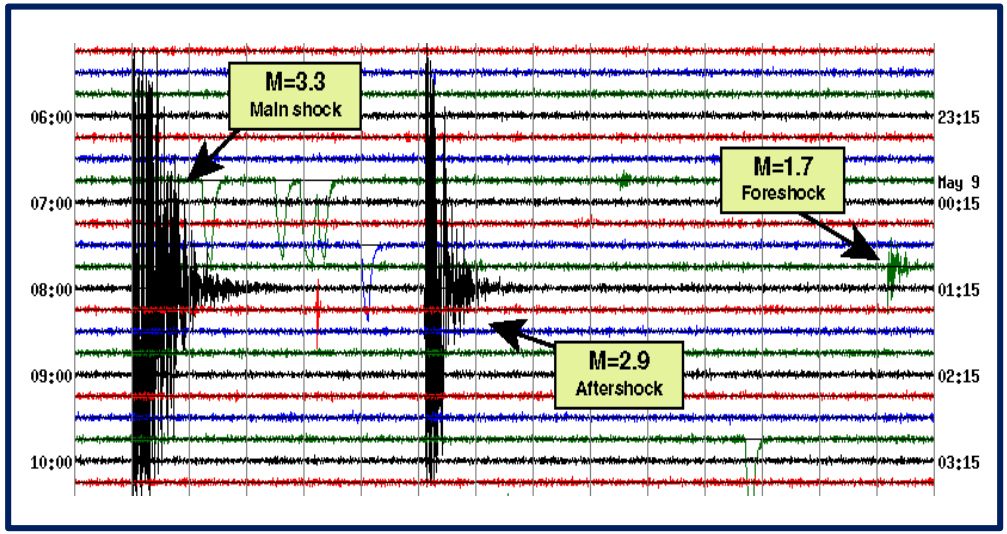




What Real Data Looks Like







How *common* are earthquakes?

- **It is estimated that around 500,000 earthquakes occur each year, detectable with current instrumentation.**
- **About 100,000 of these can be felt (*ground shaking* during a moderate to large earthquake typically lasts about *10 to 30 seconds*).**
- **Minor earthquakes occur nearly constantly around the world; larger earthquakes occur less frequently.**
- **While most earthquakes are caused by movement of the Earth's tectonic plates, the following human activities can also produce earthquakes:**
  - **storing large amounts of water behind a dam**
  - **drilling and injecting liquid into wells**
  - **coal mining and oil drilling**