Earthquakes

Chapter 6
Modern Earth Science

Earthquakes and Plate Tectonics

Section 6.1
Modern Earth Science

Earthquakes and Plate Tectonics

- Earthquakes are the result of stresses in Earth's lithosphere.
- Most earthquakes occur at or near tectonic plate boundaries, where stress on the rock is greatest.
- **earthquake** a movement or trembling of the ground that is caused by a sudden release of energy when rocks along a fault move

Elastic Rebound Theory

elastic rebound the sudden return of elastically deformed rock to its undeformed shape

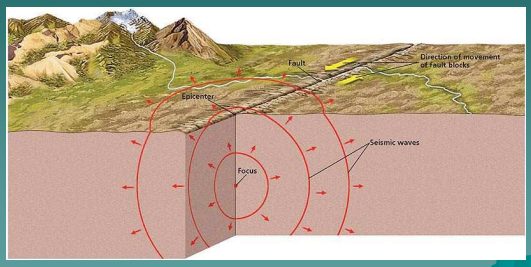
- Earthquakes occur when rocks under stress suddenly shift along a fault.
- A ***fault*** is a break in a body of rock along which one block moves relative to another.

Anatomy of an Earthquake

focus the location within Earth along a fault at which the first motion of an earthquake occurs (underground)

epicenter the point on Earth's surface above an earthquake's starting point, or focus (surface)

aftershocks small tremors that occur after a major earthquake.



Focus Depth

- **Shallow focus:** 70km deep or less. 90% of continental quakes are shallow focus. These cause the most damage.
- **Deep focus:** 300km to 650 km deep
- **Intermediate focus:** 70km to 300 km deep.

- Why are there no earthquakes deeper than 650 km?

Major Earthquake Zones

- 3 major zones

- Pacific Ring of Fire
- Mid-ocean ridges
- Eurasian-Melanesian mountain belt

Major Earthquake Zones

fault zone a region of numerous, closely spaced faults

- Fault zones form at plate boundaries because of the intense stress that results when plates separate, collide, subduct, or slide past each other.

Earthquakes Away from Plate Boundaries

- Not all earthquakes result from movement along plate boundaries.
- In 1811 and 1812 the most widely felt series of earthquakes in United States history occurred in the middle of the continent near New Madrid, Missouri.
- In the late 1970s scientists discovered an ancient fault zone deep within the crust of the Mississippi River region.

Recording Earthquakes

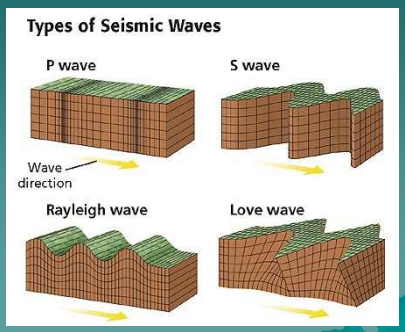
Section 6.2
Modern Earth Science

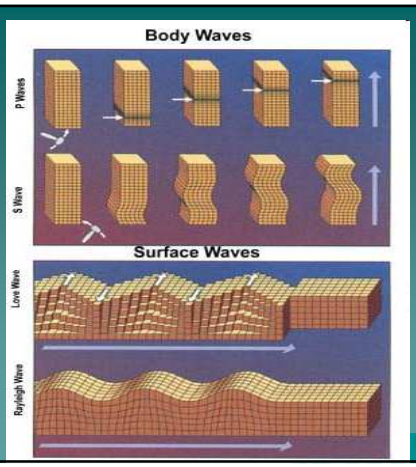
Seismic Waves

- **seismic waves**: when rocks along a fault move, the rocks release energy in the form of vibrations called seismic waves.
- Seismic waves travel outward in all directions from the focus through the surrounding rock.
- Each type of wave travels at a different speed and causes different movements in Earth's crust.

body wave a seismic wave that travels through the body of a medium (P waves & S waves)

surface wave a seismic wave that travels along the surface of a medium and that has a stronger effect near the surface of the medium than it has in the interior





Primary Waves

P wave a primary wave, or compression wave; a seismic wave that causes particles of rock to move in a back-and-forth direction parallel to the direction in which the wave is traveling

- P waves are the fastest seismic waves and can travel through solids, liquids, and gases.
- The more rigid the material is, the faster the P wave travels through it.

Secondary Waves

S wave a secondary wave, or shear wave; a seismic wave that causes particles of rock to move in a side-to-side direction perpendicular to the direction in which the wave is traveling

- S waves are the second-fastest seismic waves and can only travel through solids.

Surface Waves

- **Surface waves** form from motion along a shallow fault or from the conversion of energy when P waves or S waves reach Earth's surface.
- Although surface waves are the slowest-moving seismic waves, they can cause the greatest damage during an earthquake.

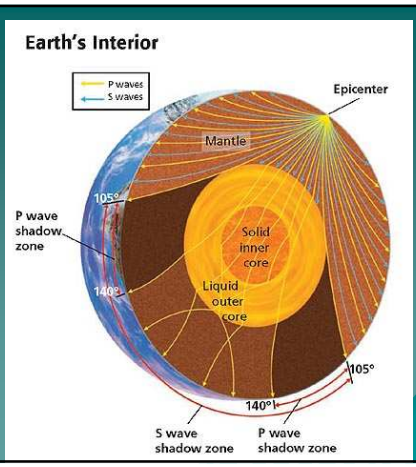
Shadow Zones

shadow zone an area on Earth's surface where no seismic waves can be detected.

- Shadow zones exist because the materials that make up Earth's interior are not uniform in rigidity.

Shadow Zones

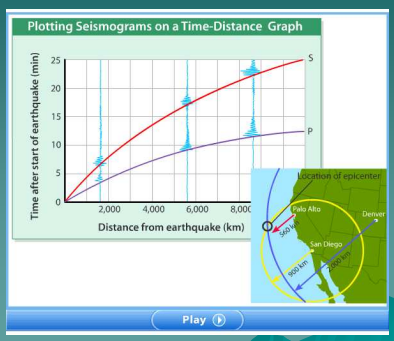
- When seismic waves travel through materials of different rigidity, they change in both speed and direction.
- S waves do not reach the S wave shadow zone because cannot pass through the liquid outer core.
- P waves do not reach the P wave shadow zone because of the way the P waves bend and they travel through Earth's interior.



Measuring Earthquakes

- Magnitude: energy released by an EQ. Also, described as the amount of ground movement.
- Major: 7 or greater
- Moderate: between 6 and 7
- Minor: between 2.5 and 6
- Microquakes: EQs with magnitudes less than 2.5 and are usually not felt by people.

Finding the Epicenter



Mercalli Scale

- Gives intensity of the quake.
- **Intensity** = the amount of damage the quake causes.
- Uses Roman numerals I to XII
- http://www.abag.ca.gov/bayarea/eqmaps/doc/mmi.html

Richter Scale

- Commonly used scale to measure EQs.
- Ranges from 1 (low) to 10 (severe).
- Describes the effect of the EQ

- Also used is the *moment magnitude scale*
- Describes cause of the EQ.

Earthquake Damage

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Earthquake Damage

- Most EQ injuries result from collapsing buildings or from falling objects and flying glass.
- Other dangers: landslides, broken electric/gas lines, and floodwaters.

Destruction to Buildings and Property

- Most buildings are not designed to withstand the swaying motion caused by earthquakes.
- Buildings on loose soil and rock are more likely to be damaged.

Tsunamis

tsunami a giant ocean wave that forms after a volcanic eruption, submarine earthquake, or landslide

- A tsunami may form when the ocean floor suddenly drops or rises because of faulting.
- A tsunami may also be triggered by an underwater landslide caused by an earthquake.

Earthquake Safety

- People who live near active faults should be ready to follow a few simple earthquake safety rules to help prevent death, injury, and property damage. (Like us in SoCal.)

Before an Earthquake

- Be prepared. Keep an adequate supply of food, water, batteries, flashlights and a radio.
- Prepare an earthquake plan and discuss it with your family.
- Learn how to turn off the gas, water, and electricity in your home.

During an Earthquake

- Protect yourself from falling debris by standing in a doorway or crouching under a desk or a table.
- Stay away from windows, heavy furniture, and other objects that might topple over.
- If you are in a car, stop in a place that is away from tall buildings, tunnels, power lines, or bridges and wait until the tremors cease.

After an Earthquake

- Be cautious.
- Check for fire and other hazards.
- Always wear shoes when walking near broken glass.
- Avoid downed power lines and objects touched by downed wires.

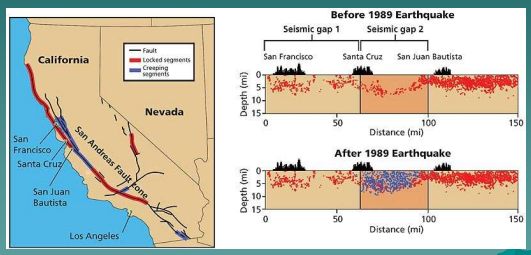
Earthquake Warnings and Forecasts

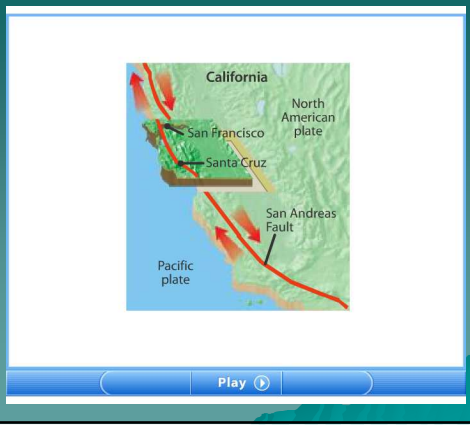
- Scientists study past earthquakes to help them predict where future earthquakes are most likely to occur.
- Using records of past earthquakes, scientists are able to make approximate forecasts of future earthquake risks.
- There is currently no reliable way to predict exactly when or where an earthquake will occur.

Seismic Gaps

Seismic gap an area along a fault where relatively few earthquakes have occurred recently but where strong earthquakes are known to have occurred in the past

- Some scientists think that seismic gaps are likely locations of future earthquakes.
- Several seismic gaps that exist along the San Andreas Fault zone may be sites of major earthquakes in the future.





Foreshocks

- Some earthquakes are preceded by little earthquakes called *foreshocks* that can occur from a few seconds to a few weeks before the main earthquake.
- Only one earthquake has been successfully predicted using foreshocks.

Changes in Rocks

- Scientists use sensors to detect slight tilting of the ground cause by stress that builds up in fault zones.
- When cracks in rock are filled with water, the magnetic and electrical properties of the rock change.
- Scientists also monitor natural gas seepage from rocks that are strained or fractured from seismic activity.
- In the future scientists may be able to use these signals to help predict earthquakes.

Reliability of Earthquake Forecasts

- Not all earthquakes have foreshocks or other precursors, which makes precise earthquake prediction mostly unreliable.
- Scientists continue to study seismic activity so that they may one day make accurate forecasts and save more lives.