Earthquakes

Earthquake - a shaking or vibration of the ground
rapid release of energy.
two blocks on both sides of a fault slip suddenly, setting off ground vibrations.

Focus - point at which slip initiates.
Epicenter - geographic point on Earth's surface directly above focus.
Slip - displacement distance.

The intense vibration of the San Francisco earthquake lasted 40 seconds. Most of the displacement along the fault occurred in less than a minute.

foreshocks - or small earthquakes, often precede a major earthquake by several years.

aftershocks - are smaller earthquakes produced by additional movements and adjustments in the rocks for several days following the main quake.
they can cause damage to already weakened structures.
e.g. Iran

STUDYING EARTHQUAKES - SEISMOLOGY

Seismology - study of earthquake waves.
Seismic waves - recorded with a **seismograph**.

Seismograms - records obtained from seismographs
provide information concerning the behavior of seismic waves.

Seismic waves - elastic energy that radiates out in all directions from the focus.
Two main groups of seismic waves are generated by earthquakes:
1) surface waves - travel along the outer part of the earth.
2) body waves - which travel through earth's interior.

Body waves are divided on the basis of their mode of propagation through intervening material into:
a) primary or **P waves -compressional waves**;
b) secondary or **S waves - shear waves**.

P waves
push (compress) and pull (dilate) rocks in direction of wave travel.
This results in alternating expansion and contraction.
P waves travel through solids and liquids.

S waves
"shake" particles at right angles to direction of travel.
S waves travel only through solids.

When observing a typical seismic record:
1) P waves arrive first at the recording station (primary waves);
2) S waves (secondary waves follow);
3) surface waves arrive last.

This is the consequence of their relative velocities.

In any solid material, P waves travel at 5 km/sec, about 2 times as fast as S waves.

Surface waves have the greates amplitude and are most destructive, followed by S waves and then P waves.

Locating The Epicenter Of An Earthquake

The **epicenter** is the location on the surface directly above the focus.

For shallow earthquakes the difference in velocities of P and S waves provides a method for determining the distance to an earthquake.

1) The greater the interval between the arrival of the first P wave and the first S wave, the greater the distance to the earthquake.
2) Determine this number from a travel-time graph

Earthquake Intensity and Magnitude

Earthquake **intensity** - measure of the effects of an earthquake at a particular locale. **Describes destructiveness.**

Earthquake intensity depends on:
1) the strength of the earthquake;
2) distance from the epicenter;
3) the nature of the surface materials;
4) building design.

In 1902 developed a Mercalli intensity scale - from 1-12
Intensities are assigned after field investigations.

Earthquake **magnitude** - measure of the strength (size) of an earthquake.
amount of energy released during the event.
takes into account ground motion of earthquake.
scale from -2 to 10.
each unit of measure increases by factor of 10. For example, ground motion of magnitude 3 is ten times that of magnitude 2. Energy released changes by an order of 33 for each unit.

Smallest earthquake felt - 3.
Magnitude 4 - Seismic waves from 1000 tons of explosives.

His system determines earthquake magnitudes from the motions measured by seismic instruments.

Today a refined **Richter scale** is used worldwide to describe earthquake magnitude.

Using the Richter scale, the magnitude is determined measuring the amplitude of the largest wave recorded on the seismogram

The largest earthquakes ever recorded have Richter magnitudes near 8.6. Conversely, earthquakes with a Richter magnitude of less than 2.0 are usually not felt by humans.

Destruction Caused by Seismic Vibration

The amount of structural damage attributable to the vibrations depends on several factors:

(1) the intensity and duration of the vibrations;
(2) the nature of the material upon which the structure rests; and
(3) the design of the structure.

For example, in Alaska, steel frame buildings withstood considerable damage, whereas rigid concrete structures were severely damaged.

Soft sediments generally amplify the vibration more than solid bedrock.
In Alaska, buildings above unconsolidated sediments experienced heavy structural damage, while towns located on solid rock (e.g., granite) suffered less damage from the seismic vibrations.

Tsunamis

tsunamis - seismic sea waves.

Earthquake Belts

About 95% of the energy released by earthquakes is concentrated in relatively narrow zones that wind around the globe.
The greatest energy is released along a path located near the outer edge of the Pacific Ocean known as the **circum-Pacific belt**. Included in this zone are regions of great seismic activity such as Japan, the Philippines, Chile, and numerous volcanic islands (e.g., Aleutian Islands).

Most earthquakes occur along faults associated with plate boundaries.