

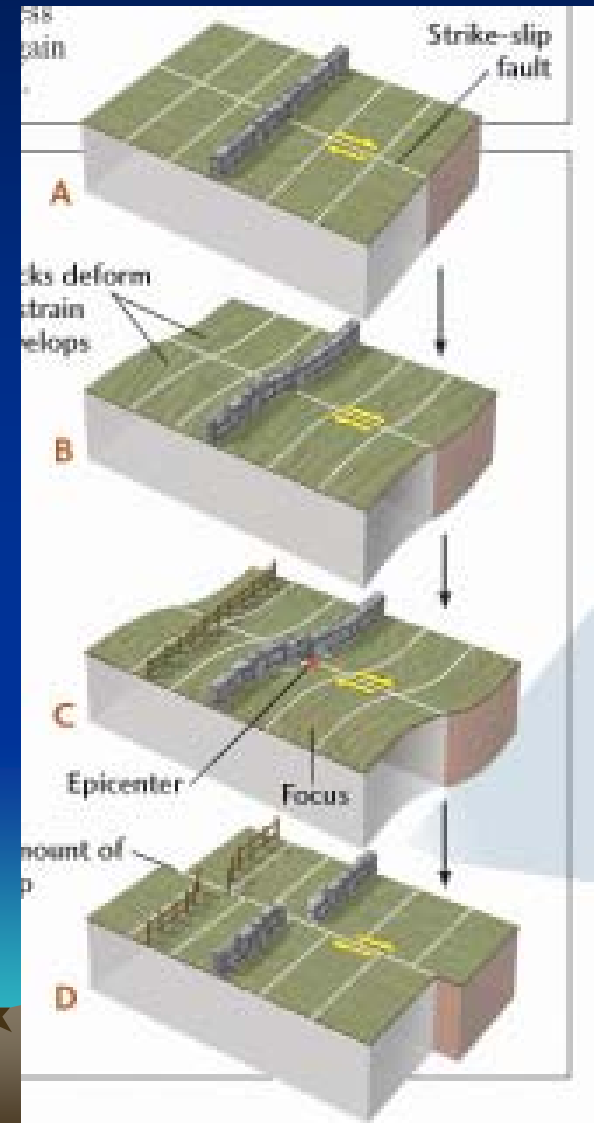
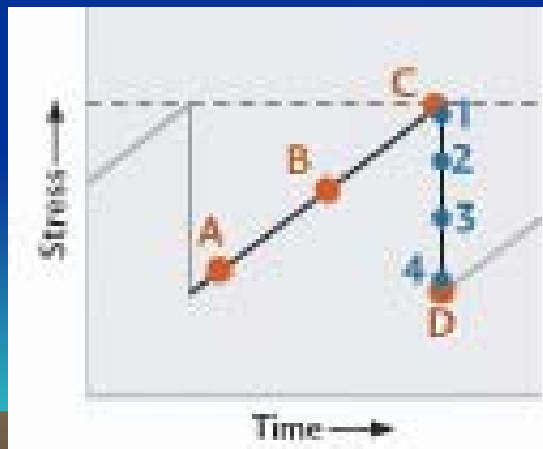
GY111 Introductory Geology

Lecture 10: Earthquakes and Seismic Waves



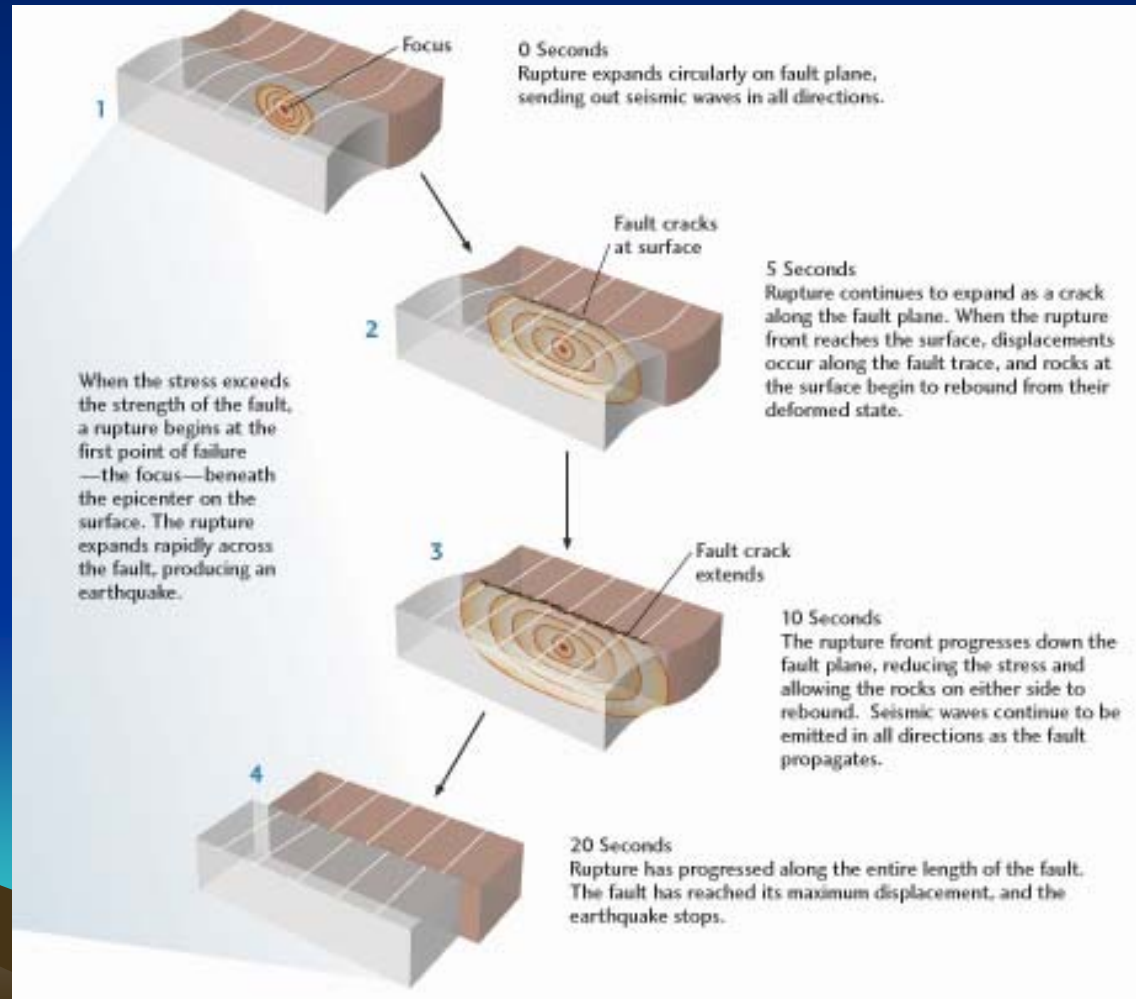
Earthquake Mechanisms

- Brittle Mechanical Model: “stick-slip”
- Focal point: 3D point inside the lithosphere where the seismic event occurs
- Epicenter: projection of focal point to the map surface



Seismic Energy Release

- Radiates from focal point
- P-waves: compressional (fastest)
- S-waves: shear
- Surface waves: move only on surface (slowest); cause damage to structures

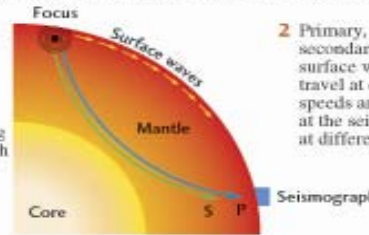


Seismic Wave Mechanics

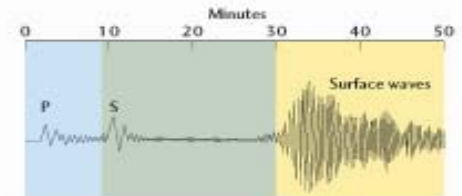
- P-waves always travel faster than S-waves

THE THREE DIFFERENT TYPES OF SEISMIC WAVES MOVE AT DIFFERENT SPEEDS

1 Seismic waves generated at an earthquake's focus travel through Earth and over its surface, arriving at a seismograph far from the earthquake.



2 Primary, secondary, and surface waves travel at different speeds and arrive at the seismograph at different times.



SEISMIC WAVES ARE CHARACTERIZED BY DISTINCT KINDS OF MOTION

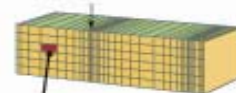
P-wave motion

1 P waves (primary waves) are compressional waves—like sound waves—that travel quickly through rock.

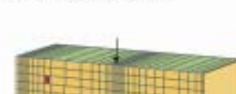
Compressional wave



2 P waves travel as a series of contractions and expansions, pushing and pulling particles in the direction of their path of travel.



3 The red square charts the contraction and expansion of a section of rock.

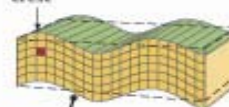


Wave direction

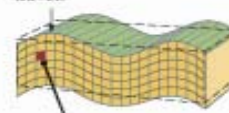
S-wave motion

4 S waves (secondary waves) travel at about half the speed of P waves.

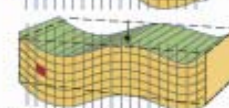
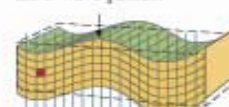
Shear-wave crest



5 S waves are shear waves that push material at right angles to their path of travel.



6 The red square shows how a section of rock shears from a square to a parallelogram as the S wave passes.

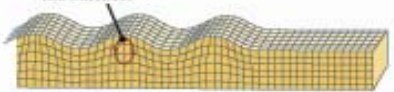


Wave direction

Surface-wave motion

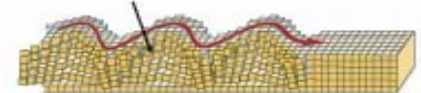
7 Surface waves ripple across Earth's surface, where air above the surface allows free movement. There are two types of surface waves.

8 In one type, the ground surface moves in a rolling, elliptical motion that dies down with depth beneath the surface.



Wave direction

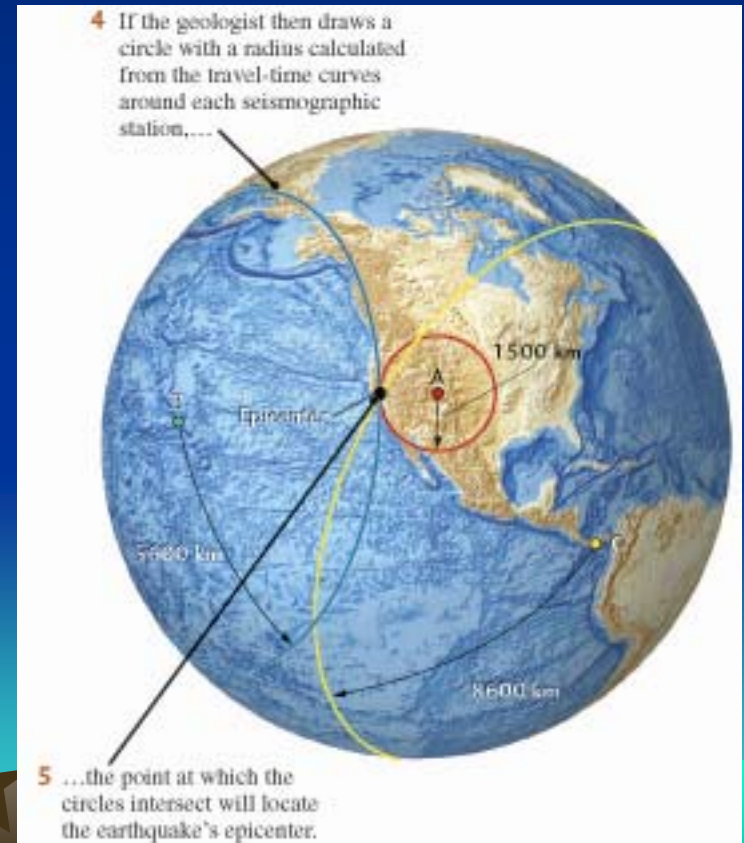
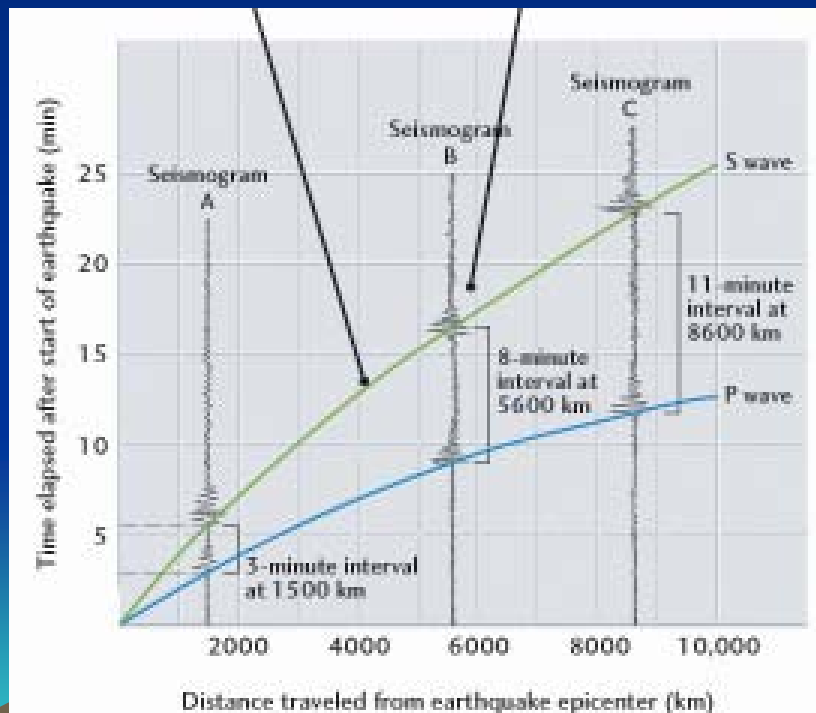
9 In the second type, the ground shakes sideways, with no vertical motion.



Wave direction

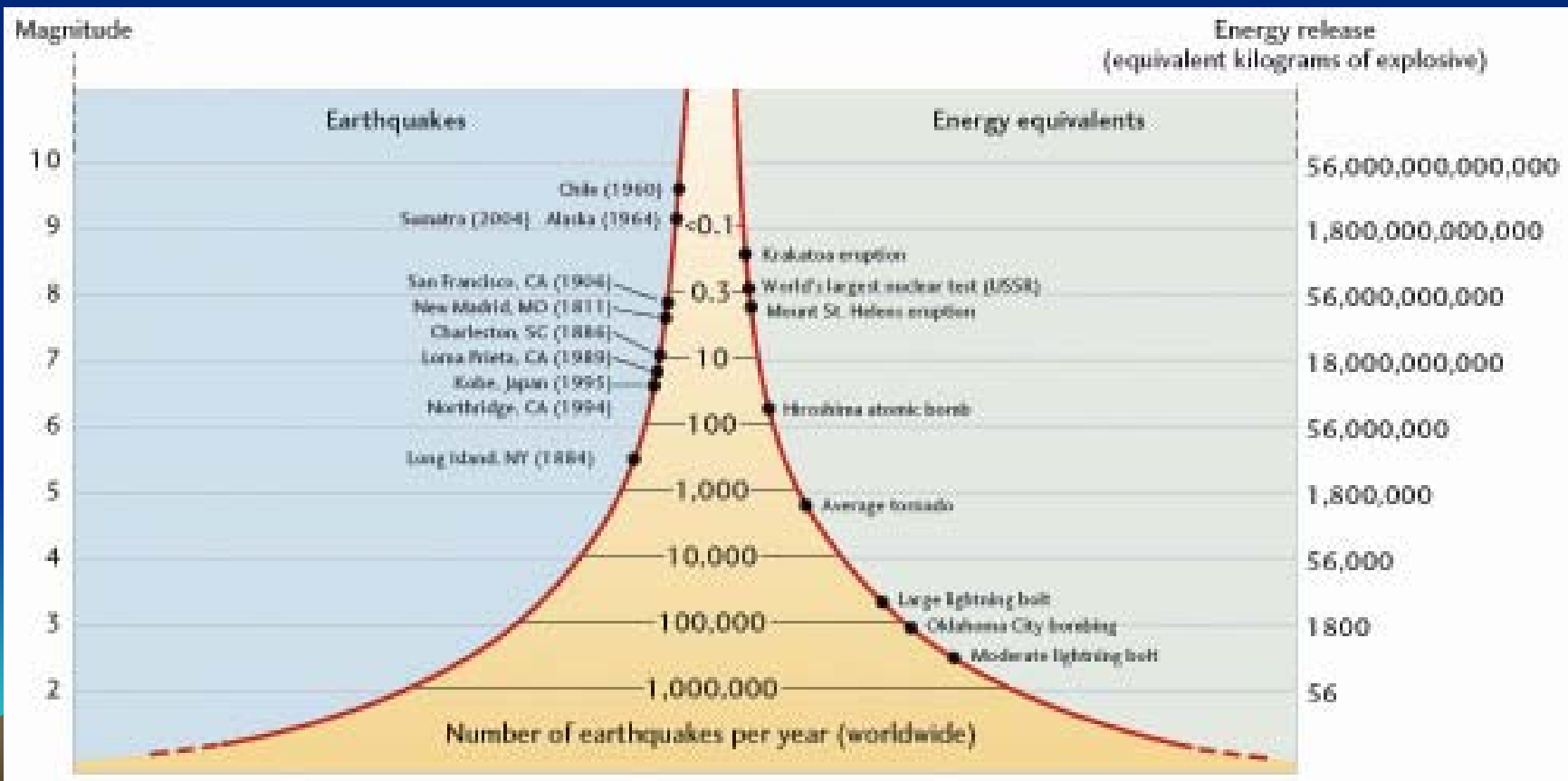
Locating the Epicenter

- Requires readings from 3 seismic stations at 3 different geographic locations



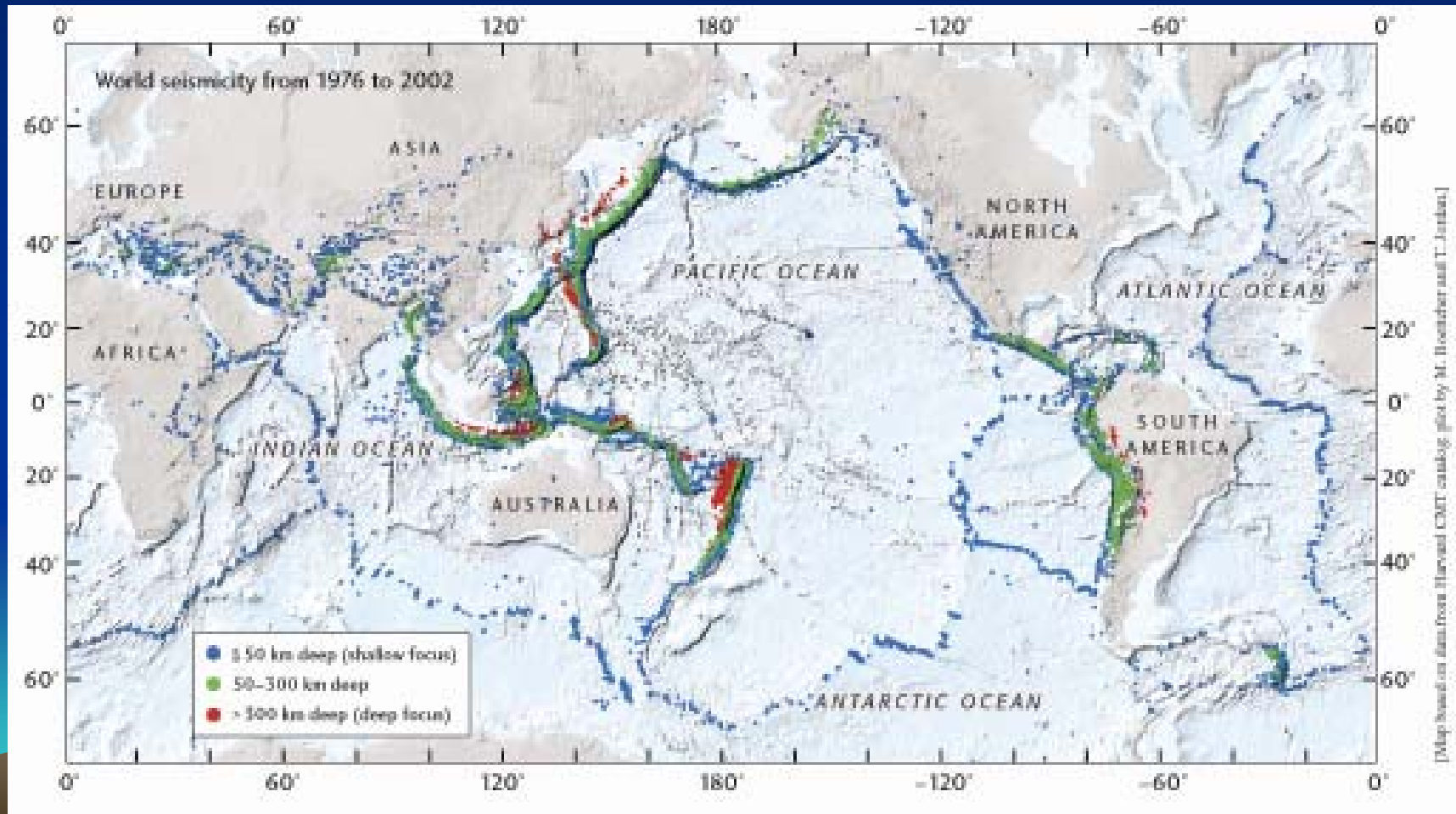
Seismic Moment Magnitude

- Richter scale is similar
- Measured from deflection of pen on seismograph



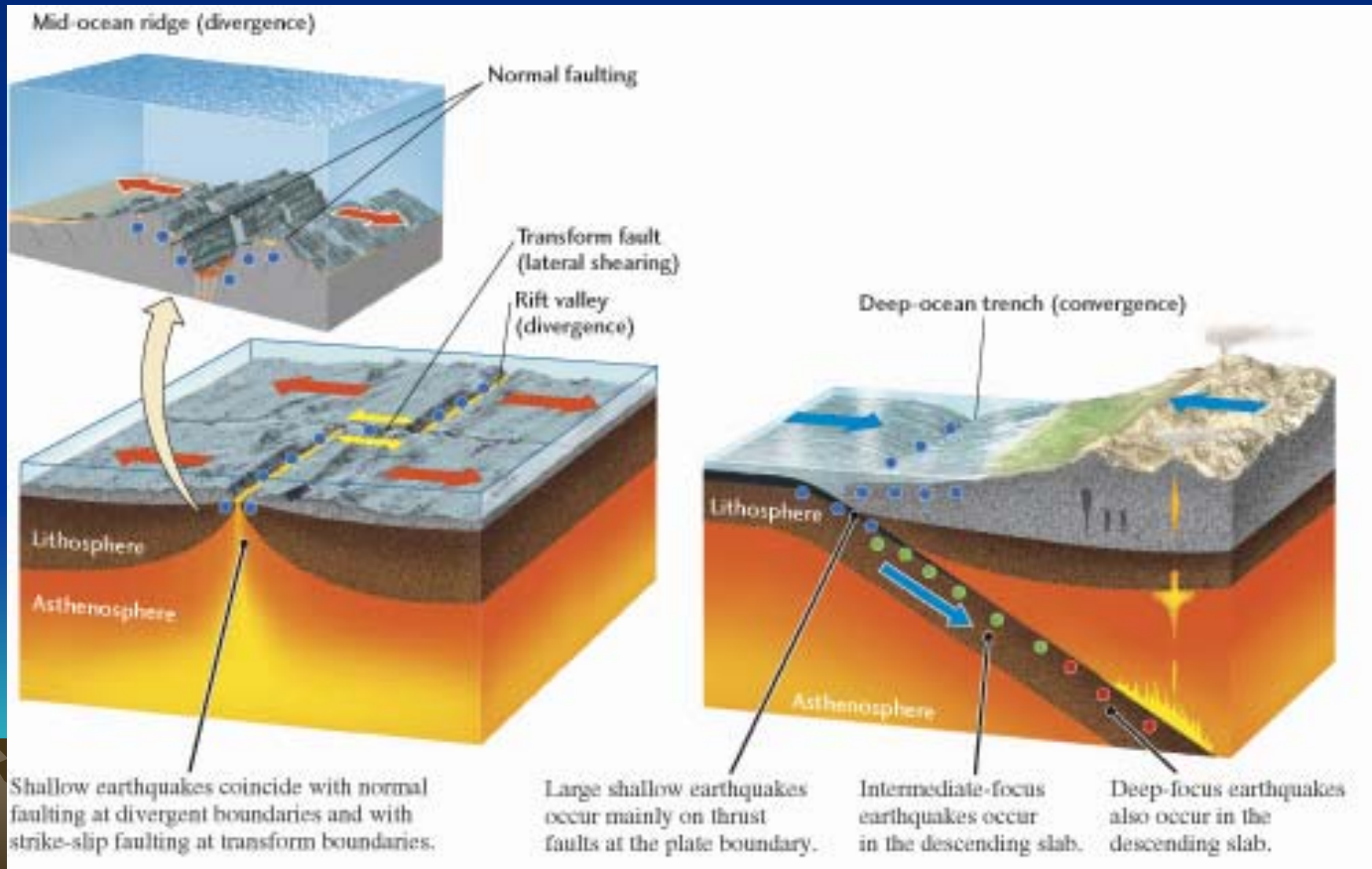
Earthquakes & Plate Tectonics

- Distribution of epicenters outline plate boundaries



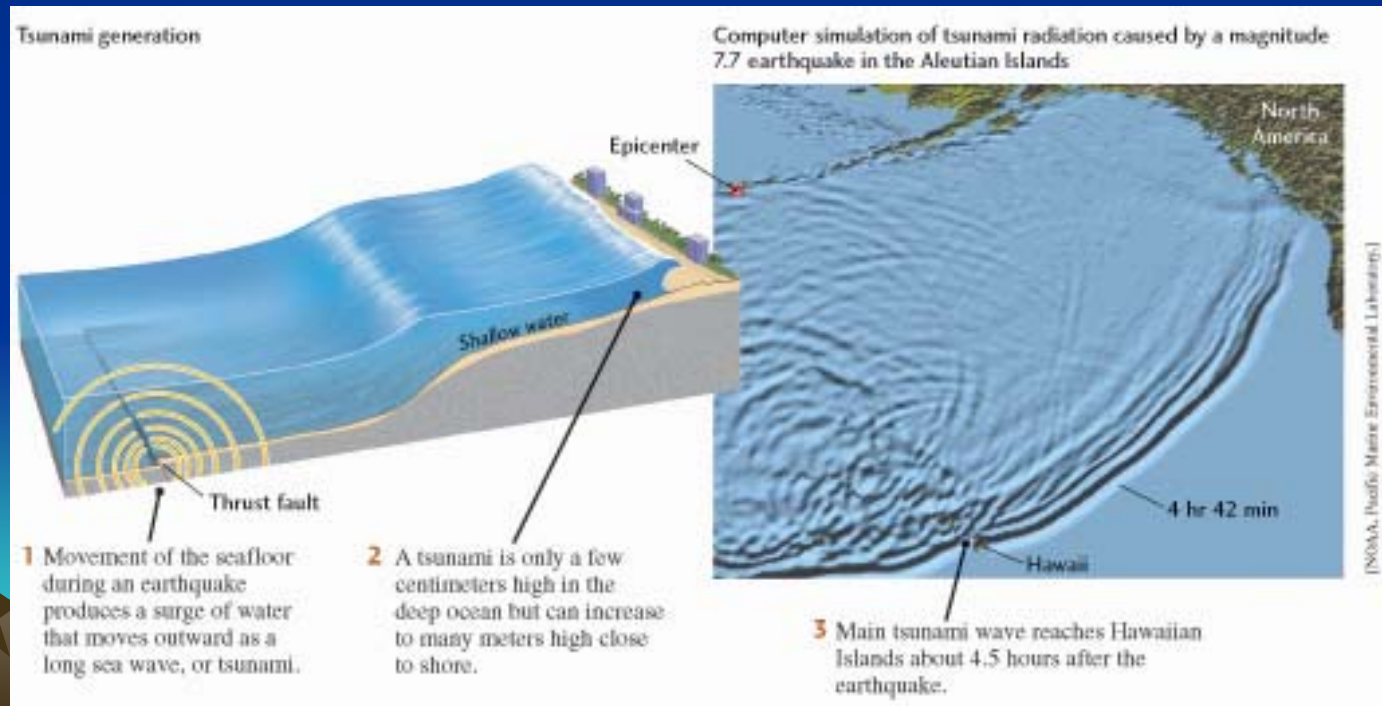
Focal Depth

- Deep focal point earthquakes occur only in subduction zones
- Only shallow focal points are found along divergent ocean ridge systems



Earthquake Damage

- Direct destruction via surface waves
- Landslides and ground failure
- Tsunami
- Fires



Seismic Risk

- Proximity to active fault zones
- Nature of bedrock
- Proximity of populations centers and infrastructure
- Building codes

