The Plate Tectonics and Seismicity
The Earth’s Layers

The Driving Force: Convection Currents

- Lithosphere (100 km)
- Asthenosphere (600 km)

Inner Core (1216 km)
Outer Core (2270 km)
Mantle (2885 km)

- Oceanic Crust (5 km)
- Continental Crust (30-40 km)

- CRUST
  - Upper
  - Lower

- Mantle
  - Solid

- Outer Core
  - Liquid

- Inner Core
  - Solid

(Mg, Fe)
Silicate

D” layer
Fe with Ni, O, S impurities
A cross section illustrating the main types of plate boundaries. Illustration by Jose F. Vigil from This Dynamic Planet -- a wall map produced jointly by the U.S. Geological Survey, the Smithsonian Institution, and the U.S. Naval Research Laboratory.
Figure 1.2-1: Global seismicity, 1963-1995.
0 – 70 km deep

70 - 300 km deep

300 + km deep
Divergent Plate Boundaries: The Oceanic Ridge

Mid-oceanic Ridge

Transform fault

Lithosphere

Oceanic Crust

Asthenosphere

Magma
Causes of intermediate and deep earthquakes

Body forces, with increased resistance caused by lower mantle density increase

variation in negative buoyancy caused by altered depth of phase transitions
Cause of shallow thrust earthquakes

Interseismic:

Fault is locked

Coseismic:

Fault ruptures

Stein & Wysession, 2003
Convergent Plate Boundaries: Continental- Continental

- Wedge of deformed oceanic crust
- Sediments

- Continental Crust

- Lithosphere

- Oceanic Crust

- Asthenosphere
Transform boundaries
The San Andreas Fault System is a Major Transform Fault
South East Asia

COMPLEX PLATE BOUNDARY ZONE
Northward motion of India deforms the region

Eastward motion in China & SE Asia

Many small plates (microplates) and blocks

India subducts beneath Burma microplate

Molnar & Tapponnier,
Partitioning of strain between thrust motion at the trench and strike-slip motion on the Sumatra fault
Regions of compression, tension and shearing stresses – accommodated by faulting
The relationship between faults and earthquakes – Elastic Rebound Theory

- **Time 1**: No strain and no displacement
  - Fault trace

- **Time 2**: Elastic strain begins (rocks begin to bend)
  - Fault trace

- **Time 3**: Elastic strain accumulates (rocks bend)
  - Fault trace

- **Time 4**: Rupture (earthquake) occurs and rocks rebound. Elastic strain (bending) is replaced by horizontal displacement known as fault slip.
  - Fault trace

- **Rock units that cross the fault**
- **Fault showing direction of displacement, in this case, right-lateral strike-slip**
1. Crustal rocks at rest
2. Deformation; dilatancy and development of cracks
3. Instant rupture (earthquake)
4. Sudden drop in stress after earthquake
Classification of faults

A. Normal fault (tensinal)

B. Reverse fault (compressional)

C. Thrust fault (compressional)

D. Strike-slip fault (shear)
Faults occur at many scales
Normal faulting
Ductile
Strike-Slip Fault
Identifying faults - Fault Scarps
Normal and reverse faults both generate scarps.
Block Diagram showing features along a Strike-Slip Fault
Faults at Sea!!
Review

- The Earth lithosphere is broken into numerous plates, which move independently of each other.
- This results in regions of divergence (destructive boundaries), convergence (constructive boundaries) and regions where the plates slide past one another (transform or conservative boundaries).
- The vast majority of earthquakes occur at plate boundaries. The nature of these earthquakes is related to the processes at the boundaries.
- Earthquakes occur when strain built up over many years is released rapidly as brittle failure – Elastic Rebound Theory.
- 3 end members of fault: strike-slip, normal, reverse/thrust.