Plate Tectonics - Earthquakes

The formation of the ocean crust from magma that is upwelled into a pair of spreading centers. Pairs of transform faults bracket the segments of the spreading center. Earthquakes occur in the spreading center valleys. Magnetic stripes mark the age of the different parts of the crust. The collision of these two plates is marked by the subduction of the oceanic crust. Both shallow and deep earthquakes occur in the subduction zone. (LEiO)

Subduction Zones

The collision of these two plates is marked by the subduction of the oceanic crust. Both shallow and deep earthquakes occur in the subduction zone. (LEiO)
Figure 5.2 Convection Drives Plate Tectonics
A schematic diagram of the major plate tectonic features in the upper 450km of the Earth. Convection in the asthenosphere causes the lithospheric parts of the plates to pull apart at the ocean ridges, move across ocean basins, and subduct to great depth in the convergent zone where plates collide. The subducting lithosphere melts at depth and rises as magma to form a volcanic island arc. (ItO)

Figure 5.3 OLD NEWS!
ALASKAN EARTHQUAKE 1964!
Figure 5.4 West Coast Spreading Center & Transform Faults

The North American (NA) plate is overriding the older Pacific Plate spreading center. The famous San Andreas fault is one of the spreading center transform faults. Thus Southern California and the Baja peninsula are moving northwestward relative to the NA plate. Thus in 15 million years or so, Los Angeles will not “fall into the ocean”, but rather will be located west of most of northern California —(Ito)
**Figure 5.5** An area where two moving plates are locked together and where stress builds up until it reaches the breaking point and causes an earthquake. (?)
Figure 5.6 Plate Subduction: NE Pacific Section
Formation of an exotic terrane from the collision of two continents in a subduction zone. Note how the (a) the oceanic plate carries a couple features toward the collision zone; where (b) first the seamount “sticks” to the continental plate; (c) followed by the small continental mass; (d) followed by the re-establishment of the subduction zone to the west. (LEiO)
Figure 5.7 Earthquake Example – Stress Relief!
The series of events that lead to an earthquake in a subduction zone. (top) Two plates lock together, causing uplift in the continental plate as the oceanic plate continues to subduct. (middle) When the stress exceeds the friction between the two plates, the fault ruptures with the continental plate springing forward and the area of uplift subsiding below the original level. (bottom) Over time the sunken area fills with sediment. (SciAmer 12/1995)
Figure 5.8 California Seismic Gap
A large portion of the San Andreas Fault is a seismic gap with stress building up and has the potential to rupture in an earthquake similar to the 1906 one in San Francisco. (ItO)
Figure 5.9 Historic Earthquake Strengths
Locations of seismic gaps and possible future earthquakes related to those gaps. (NH)

Figure 5.10 Earthquakes on Mid Ocean Ridge Transform Faults
The earthquakes (red dots) near mid ocean ridges usually occur in the short transform faults connecting sections of the ridge. A few weak earthquakes do occur within the divergent zone due to the block faulting that occurs as the plates pull apart. (?)
Earthquake Mechanics

- **no stress or deformation**
- **stresses with deformation**
- **catastrophic rupture & slippage along fault**

**EARTHQUAKE!**

Figure 5.11 Earthquake Mechanics
Normally the crust is unstressed (a) but in a region of plate movement, the build up of stress on the crust causes it to deform (b) until the crust ruptures, releasing the energy that had been built up. (?)

Figure 5.12 Other Kinds of Faults
Three different forms of faulting that can occur due to plate movement and earthquakes. (NH)
Figure 5.13 Earthquake Scenario
The epicenter of an earthquake is the location of the earthquake’s source on the surface of the earth while the focus is the three dimensional location.
There are three ways that the ground moves during an earthquake: there are P waves that expand and contract much like the pressure waves that make up sound (b); S waves that move side to side (c); and surface waves that move up and down like waves on water (d).
It is possible to pinpoint the location of the epicenter of an earthquake by compiling the data from seismic recorders to find the P wave shadow zone that is caused by the way seismic waves travel through the earth. (NG 1965)
Figure 6.16 “Seismic Gaps”
While there has been a “fair amount of stress relief due to recent earthquake activity in the northwestern North America collision zone, there are many seismic gaps around the perimeter of the Pacific Basin. A seismic gap is an area along a fault that has not had any activity for an unusually long period of time. Stress continues to builds up until it is released in one unusually large earthquake instead of many smaller ones that would have gradually released the stress.
Figure 5.17 Earthquakes and Plate Boundaries
The location of earthquake epicenters; note silhouettes of ocean spreading ridges and convergent zones. (top) at depths less than 100km below the surface, (bottom) at depths more than 100km-these are usually associated with plate subduction. (ITO)
Figure 5.18 Plate Subduction and Earthquakes
As one plate subducts beneath another, the friction between the two plates causes earthquakes as they slip past each other. Black dots denote earthquake locations. (?)
When two plates collide one of two different things occur. When the edges of the two colliding plates have distinctly different densities such as between a continental plate and a section of ocean crust, the denser one subducts under the other (top). When both plates are of similar density such as when two continents collide, there is minimal subduction and instead the crust that is pushed together rises up and forms a mountain range that continues to grow as long as the two plates continue to move together (bottom). (ItO)