MAR110 LECTURE #6
West Coast Earthquakes & Hot Spots

Figure 6.1 Plate Formation & Subduction Destruction
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)

Figure 6.2 Plate Boundaries
Ocean crust forms from magma along the segmented mid-ocean ridges. Ocean crust is destroyed in the subduction zone (diamonds). (LEiO)
Figure 6.3 Mid-Ocean Ridge Earthquakes
Most of the MOR earthquakes occur along the transverse faults; as illustrated for this section in the South Atlantic. (LEIO)
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 6.5 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 6.6 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 6.7 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)
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 build up until it is released in one unusually large earthquake instead of many smaller ones that would have gradually released the stress.
Figure 6.9 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 6.10 Historic Earthquake Strengths
Locations of seismic gaps and possible future earthquakes related to those gaps. (NH)
Figure 6.11
(top) Locations of larger earthquakes in California since 1769. (bottom) A distribution over time of notable earthquakes in North America. (NH)
Density & Heating

REMINDER - Density of Rocks (or Sea Water)

“Amount of Rock Material in a defined volume”

or

Rock MASS PER UNIT VOLUME

Amount of Rock/Volume is sensitive to temperature change
for example
increased temperature \( \rightarrow \) expansion
and thus
Lower Density \( \rightarrow \) Rock Rises

Figure 6.12 Mantle Convection
Interior heat escape causes convection cells, with hotter rising plumes and the cooler sinking plumes to form. The lithospheric plates at the surface move with the lateral flow that connects the plumes. The movement of the electrically-conducting mantle material in the convection cells creates the earth’s magnetic field (?)
Figure 6.14 Plate Movement and Hot Spot Island Formation
A hotspot is an area under the earth’s crust where an isolated, stationary plume of magma rises to the surface forming a volcanic island. As the plate moves relative to the stationary plume, the volcano is cut off from its source of magma it becomes extinct. A new volcanic island then begins to form – repeating the cycle, thereby building a chain of volcanic islands. (ItO)
Figure 6.15 Hot Spot Island Formation
(A) Stationary hot spots feed magma to new volcanic island (#1) – around which a fringing reef forms. (B) The moving plate drags volcano #1 away from magma chamber rendering it extinct, while forming a new volcanic island (#2). (ItO)
Figure 6.16 Hot Spot Island Formation

(C) The moving plate drags volcano #2 away from magma chamber rendering it extinct, while forming a new volcanic island (#3). (C) The moving plate drags volcano #3 away from magma chamber rendering it extinct, while forming a new volcanic island (#4). (IIO)
Figure 6.17
The Hawaiian Ridge is formed from a hot spot-generated volcanic island chain. Note the increasing age of the islands furthest away from the newest Hawaiian island. Also note that the direction of plate movement probably changed radically about 40 MYBP (ltO)

(c) KILAUEA, HAWAII

Figure 6.18 Kilauea Volcanism Associated with the Hawaiian Hot Spot(?)