Introduction to Plate Tectonics

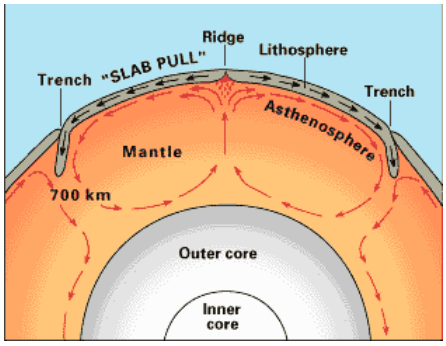
Oceanography EPSS 15

Spring 2017

Review from Lab 2

Cool, rigid lithospheric plates "*float*" on hotter, more plastic region of the upper mantle, called asthenosphere

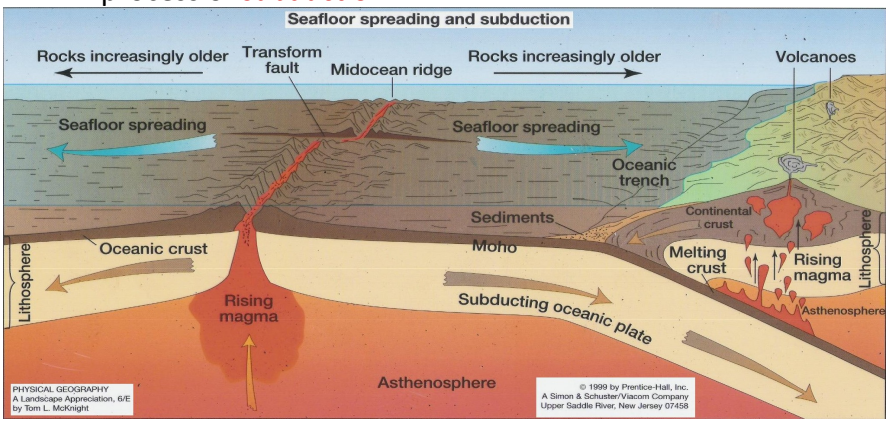
These plates are in constant motion driven by forces deep within the Earth



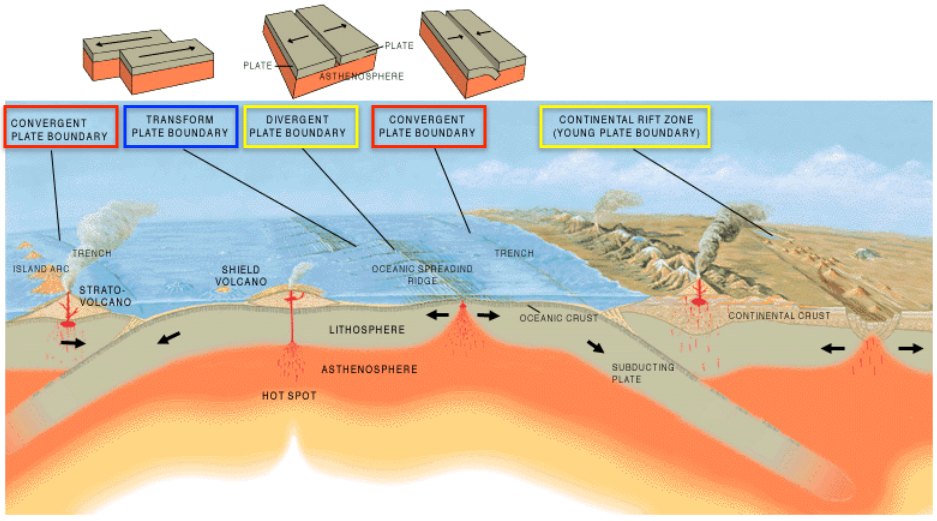
Basics of Plate Tectonics

The Earth's crust is constantly being recycled

- New lithospheric material is created at mid-ocean ridges where it moves outwards due to sea-floor spreading
- Lithospheric material is ultimately destroyed by the process of subduction

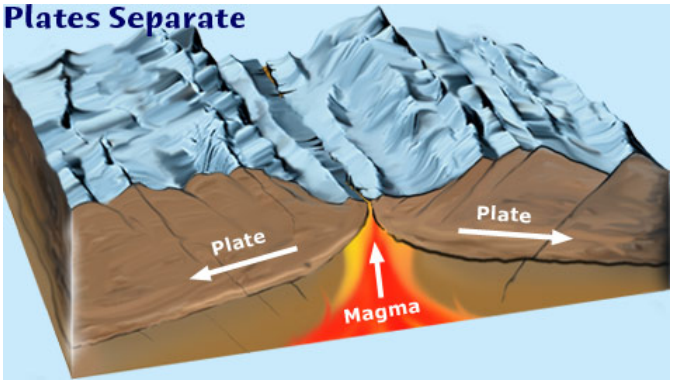


Different Types of Plate Boundaries



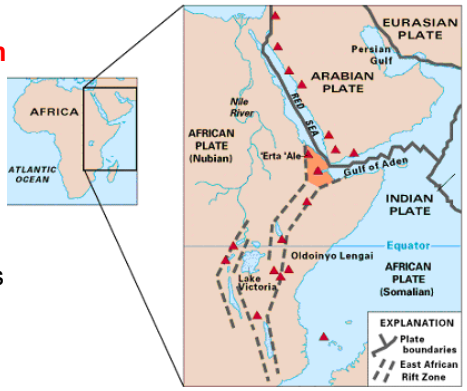
Divergent Plate Boundary

- Two plates move away from each other (e.g., MOR, Gulf of California)
- Rising asthenosphere pushes ridges apart (sea-floor spreading)
- New basaltic crust is being created



Types of Divergent Plate Boundaries

Oceanic Ridge and Rise System
•Shallow earthquakes
•High heat flow, volcanic activity
•*e.g., Mid-Atlantic Ridge, East Pacific Rise*

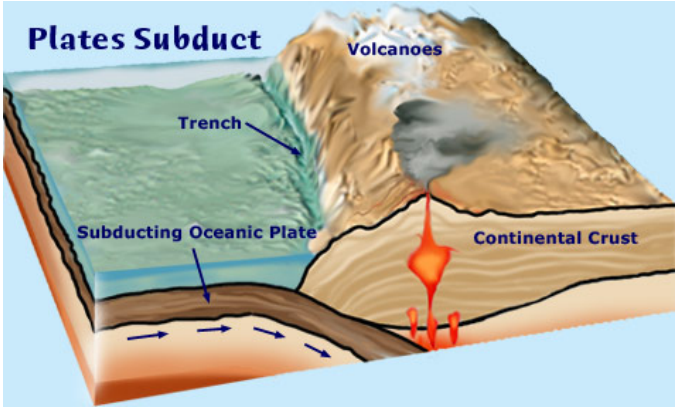


Young (Juvenile) Ocean Basins
•Very young rift and ridge systems
e.g., Gulf of California, Red Sea

On-land Rifting
•Continents that are spreading apart may become ocean basins
•High heat flow, volcanic activity
e.g., East African Rift Valley, Rio Grande Rift

Convergent Plate Boundary

- Boundary where two plates move towards each other
- Subduction occurs (most cases)
  - Denser plate sinks (subducts) beneath less dense plate
  - Generation of magmatic arcs, parallel to trenches



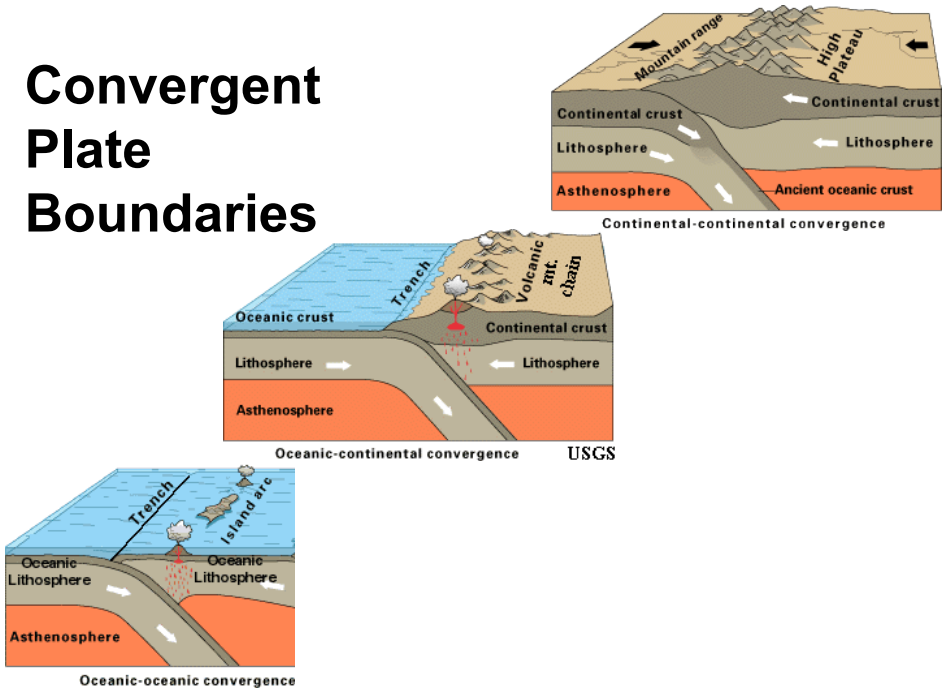
Types of Convergent Plate Boundaries

Ocean-Ocean Convergence
•Subduction of one oceanic plate beneath another
•Older, colder plate is subducted under younger, warmer one
•Associated with deep trenches and volcanic island arcs that are parallel to the trench
e.g., Tonga, Aleutians

Ocean-Continent Convergence
•Subduction of more dense oceanic plate beneath continental plate
•Associated with deep ocean trenches near continental volcanic arcs
e.g., Andes, Cascades

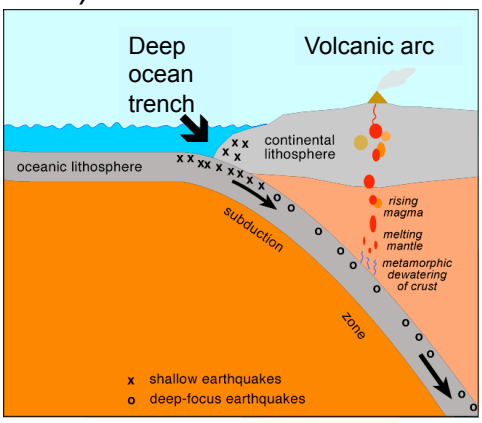
Continent-Continent Convergence
•Since both continental plates are low-density, neither is forced into asthenosphere; instead plates are pushed up
•Mountain building occurs, crust becomes highly deformed
e.g., Himalayas, Alps

Convergent Plate Boundaries



Additional Information

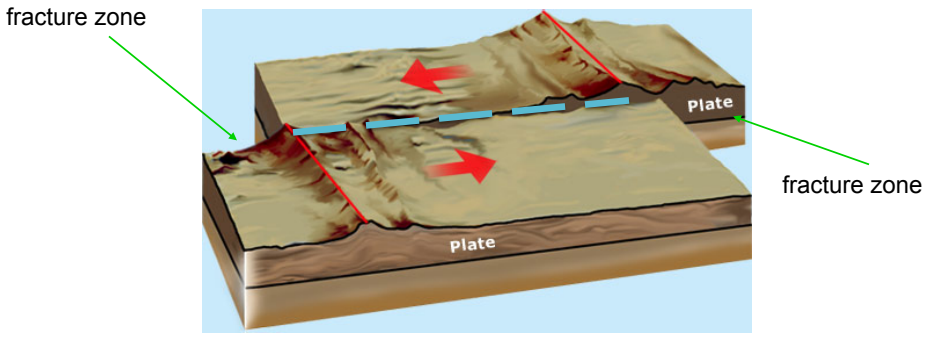
- Earthquakes at convergent boundaries:
  - Shallow (0-30 km)
  - Intermediate (30-400 km)
  - Deep (400-700 km)
- Heat flow is **low** at trenches and **high** at volcanic arcs!
  - Why???



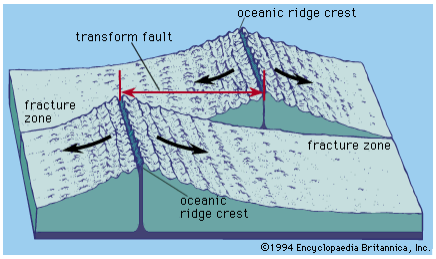
Transform Plate Boundaries

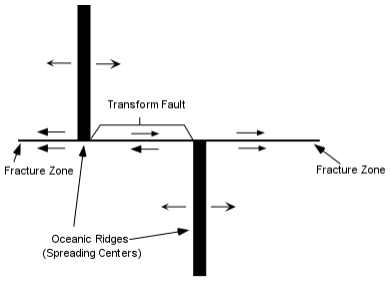
- Boundary where two plates are moving in parallel, but opposing directions
- Low heat flow, shallow earthquakes
- Right-lateral or left-lateral

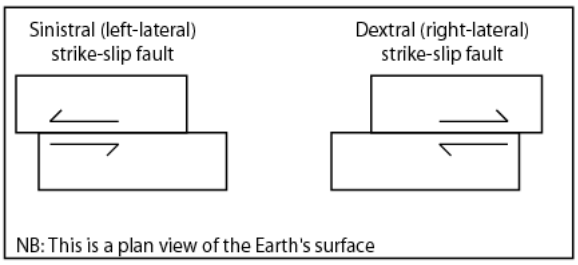
  e.g., San Andreas fault



Transform Plate Boundaries

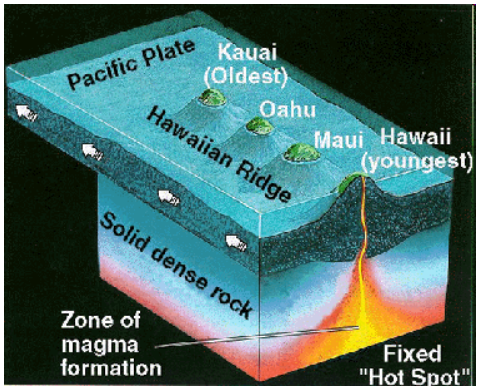




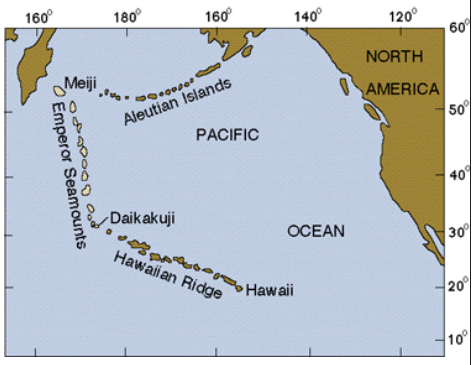


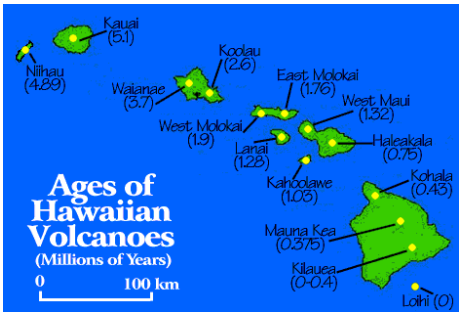
Intraplate Regions and Hotspots

- Stationary plumes of magma erupt through a plate that is moving over it
- Forms chains of extinct volcanic islands terminating at the active (youngest) volcanic island
- e.g., Hawaiian islands, Emperor Seamounts

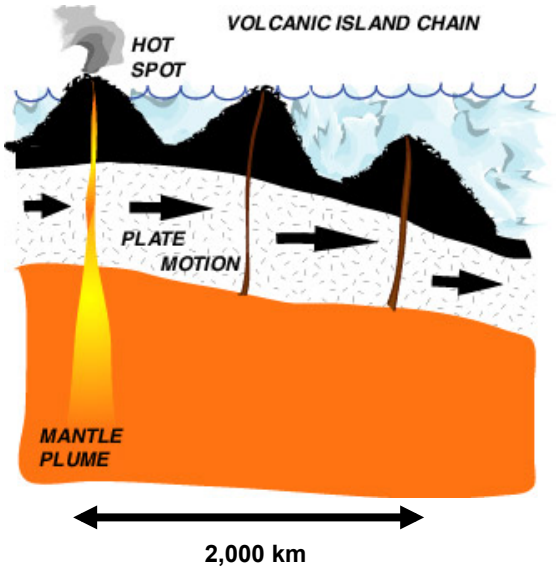


Pacific Plate Motion





Hot Spot Motion



Moving Rate - Sample calculation:

Distance between oldest and youngest volcano: 2,000 km

Time period: 20 Ma

Moving rate (cm/year) = 2,000 km / 20 Ma = 10 cm/year