Plate Tectonics: the major plates
Seven major plates:

One for each continent

North America
South America
Africa
Eurasia
Antarctica

One with two smaller continents

Indo-Australian

And one that’s all ocean

Pacific
Continental fit

Some of the original evidence

Proposed by Alfred Wegener in 1912
Three types of plate boundaries

Divergent

Convergent

Transform
All the tectonic pieces

Two types of crust: Oceanic Continental
Three combinations of crust interactions:

Oceanic - Oceanic

Oceanic - Continental

Continental - Continental
Divergent plate boundary – mid-ocean ridge system

New oceanic crust is being created

Magma chamber beneath rift
Divergent boundary – Rifting of a continent

Rift valley

Continental crust

Mantle plume beneath rift
Convergent boundary – subduction system
Benioff zone

an inclined plane of earthquakes dipping landward away from a submarine trench
Convergent boundary – continental collision

Produces a double thickness of continental crust
Transform Plate Boundary

Modern example:

San Andreas Fault System
San Andreas fault zone

A whole system of faults

Most of the movement is SSE to NNW
San Francisco area
San Francisco Bay is bounded by two major faults
San Andreas Hayward
Example: Juan de Fuca Ridge

All 3 types of boundaries:

Divergent

Convergent

Transform
Plates on the globe

A plate has both types of crust
Plate boundaries defined by earthquakes
Pacific Plate

The Ring of Fire
Relative Motion of Plates
Different depths for earthquakes

MOR shallow earthquakes
Subduction zones shallow/intermed/deep

Depth of Earthquake
- Red: 0–70 km
- Green: 70–300 km
- Blue: > 300 km
What drives plate tectonics?

Mantle convection
Tectonic plates on a sphere

Plates moving across the curved surface of the planet *must* interact with other plates.
Tectonic plates on a sphere

- **Plate A**: Overlap: convergent plate boundary
- **Plate B**: Sliding: transform plate boundary
- **Plate C**: Gap: divergent plate boundary

1. **Overlap**: convergent plate boundary
2. **Gap**: divergent plate boundary
3. **Sliding**: transform plate boundary
Types of plate boundaries

- Convergent boundary (destructive)
- Trench
- Divergent boundary (constructive)
- Transform boundary (conservative)
- Rising magma
- Asthenosphere
A rigid plate moving across a curved surface

Something’s got to give
Ridge offsets

Adjacent sections here move in same direction

Sections here move in opposite directions

Adjacent sections here move in same direction

Fracture zone (inactive)

Transform fault (active part of fracture zone)

Fracture zone (inactive)

Plate boundary

Oceanic ridge

Lithosphere

Asthenosphere
Mid-ocean ridge system
Seeing inside the Earth: Mantle tomography

Cross section of mantle velocity
$\Delta v/v = +0.6\%$
Mantle tomography

CENTRAL AMERICA

Trench

Core-mantle boundary
Convergent margin – oceanic to continental

- Oceanic lithosphere
- Peru-Chile Trench
- Andes: Volcanic mountains
- South America: Continental lithosphere

Gently descending slab
Mantle tomography
Convergent margin – oceanic to oceanic
The Hawaiian hot spot
The Hawaiian hot spot
A single seamount
The Hawaiian hot spot as a mantle plume