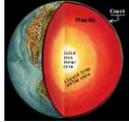


Plate tectonics

GS106



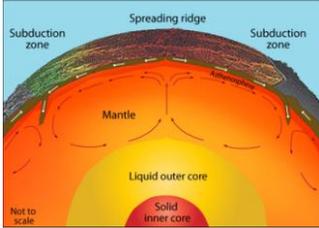
Earth vs. Egg



Earth radius = 6370 km
 Lithosphere (plate) thickness = 100 km
 What % of Earth radius is lithosphere? ~2%
 Egg radius = 0.75 inch
 Egg shell thickness = 0.015 inch
 What % of egg radius is shell? ~2%
 How do these compare?

Plate tectonics

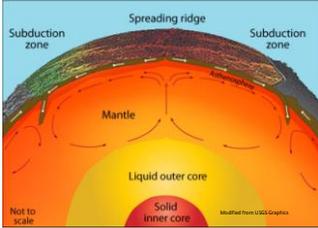
Plates are driven by cooling of Earth.
Gravity provides additional force to move plates.



Convection is like a boiling pot.

Plate tectonics

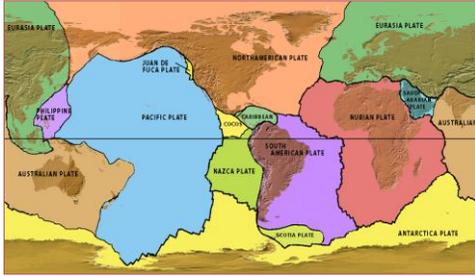
Convection in Earth's interior is like a boiling pot.




Tectonics Plates

There are a dozen large lithospheric plates (smaller plates not shown). Some plates have continents; some don't. All are in motion.

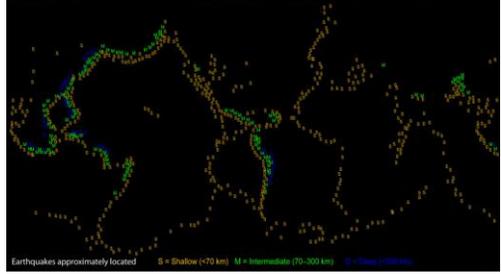
Question: What evidence is there for these plate boundaries?



Seismicity & Distribution of Earthquakes

There are thousands of small earthquakes every day. "Strong" earthquakes (~M7) occur once a month. >M8 occur about once/year.

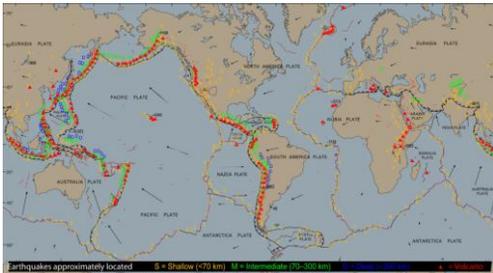
Where are the deepest earthquakes?



For earthquakes of the past 2 weeks, go to <http://www.iris.edu/seismon/>

Seismicity, Tectonics & Volcanoes

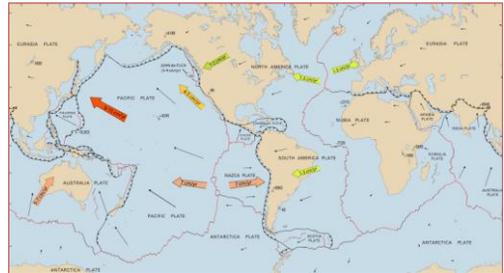
The Earth is divided into relatively stable regions bounded by linear zones of earthquakes and volcanoes



Tectonics Plates

How fast are the plates moving?

Plates move 1-10 centimeters per year (≈ rate of fingernail growth).



Tectonics Plates

What is the motion of the plates relative to the North American Plate?
(remember...the map is flat, the globe is not.)

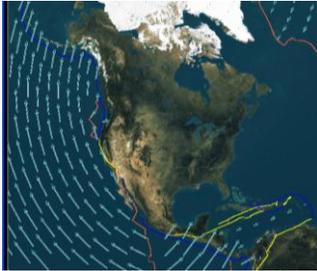
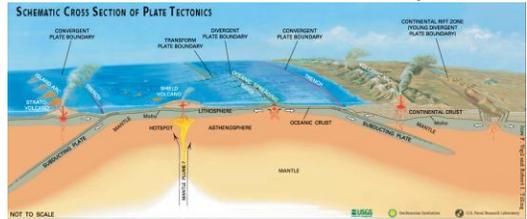


Image from EarthScope Voyager, Jr.
<http://jules.unavco.org/VoyagerInEarthScope>

Next slide: What are these tectonic plates?

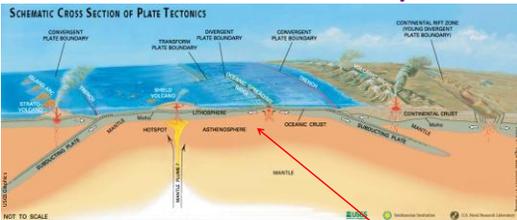
What are the tectonic plates?



Lithosphere

- Is the ~100-km-thick surface of Earth;
- Contains crust and upper mantle;
- Is rigid and brittle;
- Fractures to produce earthquakes.

What is the asthenosphere?



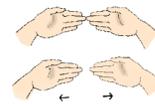
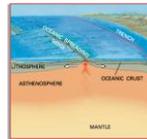
Asthenosphere:

- Is the hotter upper mantle below the lithospheric plate;
- Can flow like silly putty; and
- Is a viscoelastic solid, NOT liquid!!

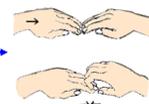
Three Basic Types of Plate Boundaries

Using hands to show relative motion

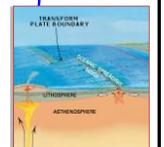
Divergent



Convergent



Transform



Three Basic Types of Plate Boundaries

Divergent

Transform

Convergent

USGS Graphics

Divergent boundaries

- New crust is generated as the plates pull apart;
- Occur on ocean floors and continental interiors;
- Earthquakes are shallow and small.

USGS Graphics

Example:

- East Pacific Rise (moving apart at about 15 cm/year)

Examples:

- Atlantic mid-ocean ridge
- Basin and Range, USA
- African Rift Valley
- Northern Red Sea

Convergent Plate Boundaries

Plates push together.

- A) The denser plate subducts,
- or
- B) two continental plates crunch together and form high mountains

Ocean /Ocean convergence (Marianas)

Ocean /Continent convergence (Cascades)

Continent/Continent Collision (Himalayas)

USGS Graphics

Earthquakes along Convergent Zones with Subducting Oceanic Lithosphere

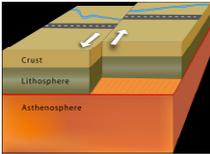
Shallow earthquakes:
The most destructive of these occur between the plates at the plate boundary.

Intermediate and Deep:
Occur only within the subducting oceanic lithosphere.

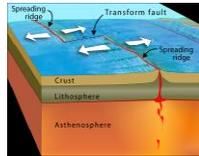
USGS Graphics

Transform Boundaries

Lithosphere is neither produced nor destroyed as the plates slide horizontally past each other.



Strike-slip fault



Strike-slip fault between two spreading ridges allows the two plates to move apart.

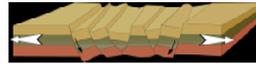
Next slide: What is stress?

Deforming Earth's Crust

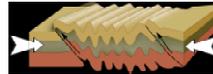
Types of stress: Extension, Compression, Shear



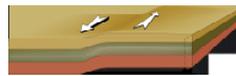
Undeformed beds: no stress applied.



Extension makes faults and regional thinning. (Ex., Basin & Range.)



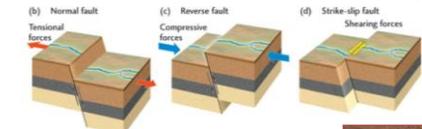
Compression makes faults and folds. (Ex., Rocky Mountains.)



Shearing displaces layers horizontally and can result in strike-slip faulting. (Ex., San Andreas Fault, California.)

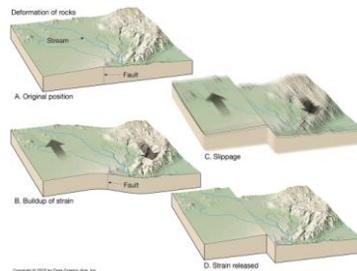
Types of Faults

Normal Reverse Strike-slip



Elastic Rebound Theory—Stick-slip

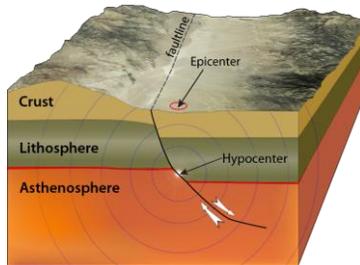
Jerky motions on faults produce EQs



Three Fs of earthquakes: Forces, Faults, and Friction.

Epicenter & Focus of Earthquakes

Epicenter—Location directly *above* EQ *on* Earth's surface.



Focus:

or hypocenter; point *within* Earth where the EQ occurred.