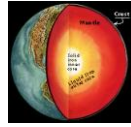


## Plate tectonics

GS106



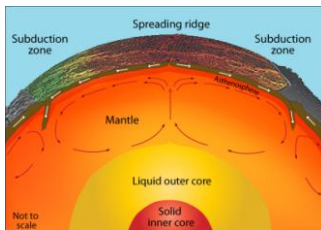
Earth  
vs.  
Egg



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

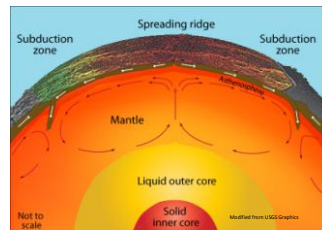
Plates are driven by cooling of Earth.  
 Gravity provides additional force to move plates.



Convection is like a boiling pot.

## Plate tectonics

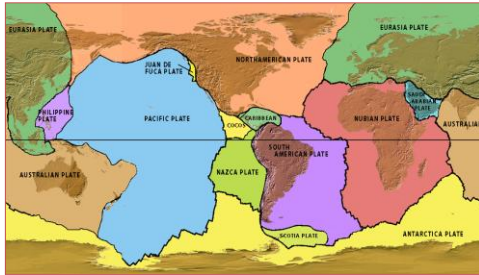
Convection in Earth's interior is like a boiling pot.



## Tectonics Plates

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

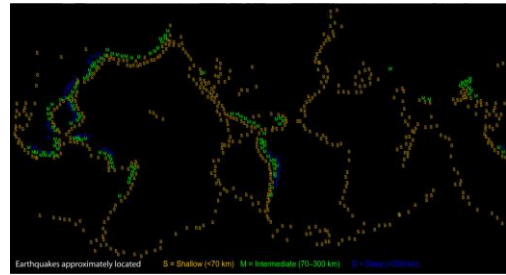
Question: What evidence is there for these plate boundaries?



## Seismicity & Distribution of Earthquakes

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

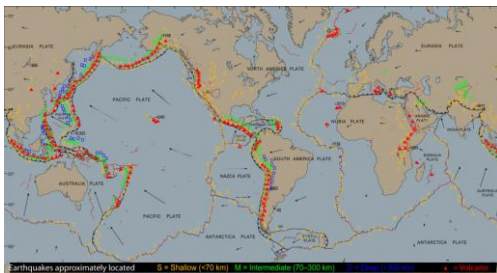
Where are the deepest earthquakes?



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

## Seismicity, Tectonics & Volcanoes

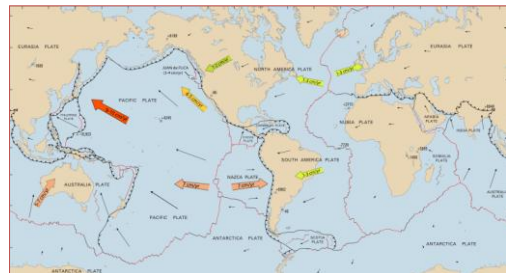
The Earth is divided into relatively stable regions  
bounded by linear zones of earthquakes and volcanoes



## Tectonics Plates

How fast are the plates moving?

Plates move 1-10 centimeters per year ( $\approx$  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.

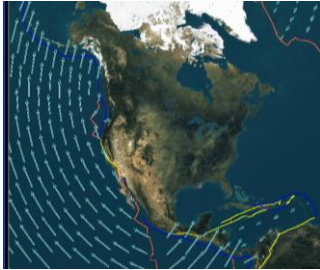
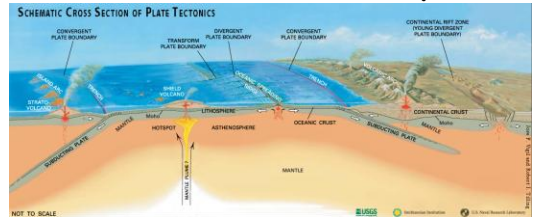


Image from  
EarthScope  
Voyager, Jr.  
<http://jules.unavco.org/Voyager/EarthScope>

Next slide: What are these tectonic plates?

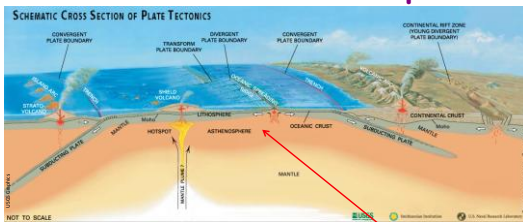
## What are the tectonic plates?



### 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?



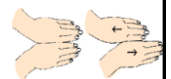
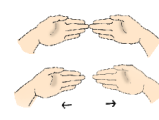
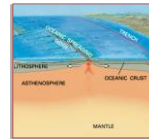
### Asthenosphere:

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

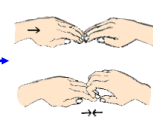
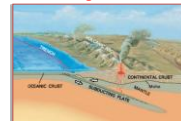
## Three Basic Types of Plate Boundaries

Using hands to show relative motion

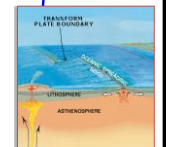
### Divergent



### Convergent

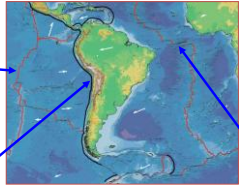
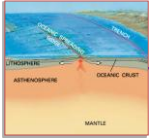


### Transform

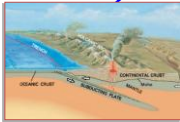


## Three Basic Types of Plate Boundaries

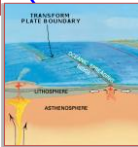
### Divergent



### Convergent



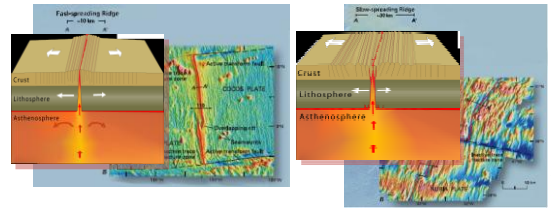
### Transform



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.



### Example:

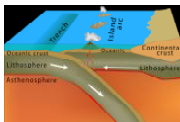
- East Pacific Rise (moving apart at about 15 cm/year)

### Examples:

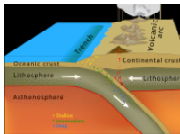
- Atlantic mid-ocean ridge
- Basin and Range, USA
- African Rift Valley
- Northern Red Sea

USGS Graphics

## Convergent Plate Boundaries



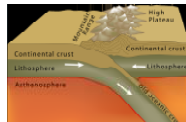
Ocean /Ocean convergence (Marianas)



Ocean /Continent convergence (Cascades)

Plates push together.

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



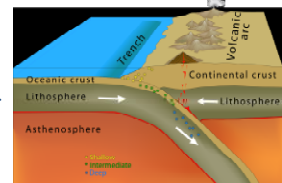
Continent/Continent Collision (Himalayas)

Now slide, 100% and where would earthquakes occur for convergent boundaries?

## Earthquakes along Convergent Zones with Subducting Oceanic Lithosphere

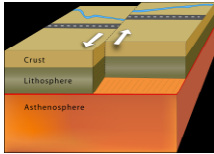
Shallow earthquakes:  
The most destructive of these occur between the plates on the plate boundary.

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

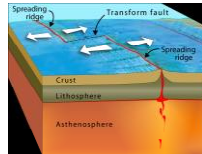


## Transform Boundaries

**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

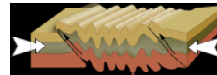
**Types of stress: Extension, Compression, Shear**



Undeformed beds: no stress applied.



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



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



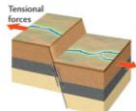
Shearing displaces layers horizontally and can result in strike-slip faulting. (Ex., San Andreas Fault, California.)

## Types of Faults

**Normal**

(b) Normal fault

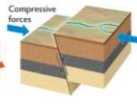
Tensional forces



**Reverse**

(c) Reverse fault

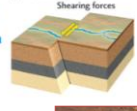
Compressive forces



**Strike-slip**

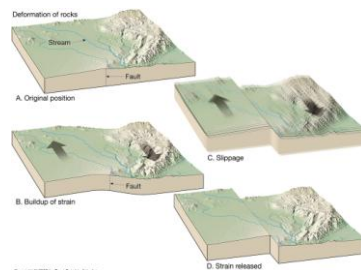
(d) Strike-slip fault

Shearing forces



## Elastic Rebound Theory—Stick-slip

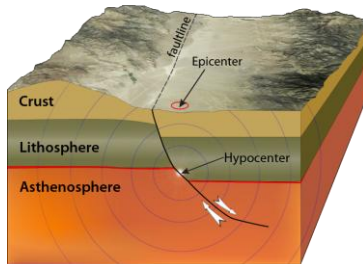
Jerky motions on faults produce EQs



**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.