Continental Drift to Plate Tectonics: From Hypothesis to Theory

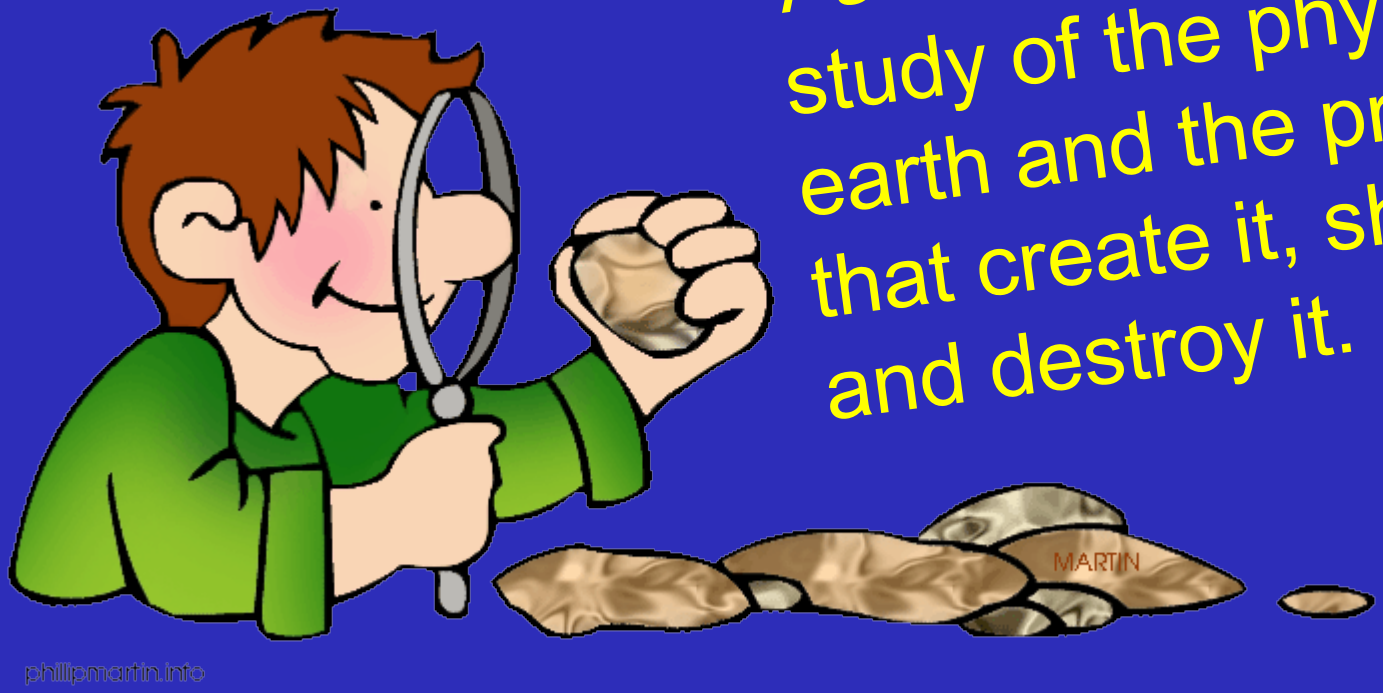
Key Understandings

- Internal structure of the earth/structure of the crust.
- Difference between continental drift & plate tectonics.
- Evidence used to support plate tectonics.
- Earth's **oceanic crust** is broken into 7 large (& several smaller) pieces or **"plates";** pieces of continental crust **"ride"** on some of these plates
- **Convection cells (currents)** under the crust (asthenosphere) cause the plates to move.
- 3 basic plates movements: **divergent, convergent, transform**
- Different **physical features** (**mountains, ridges, trenches, valleys**) are created at different boundaries, depending on the plate movement

Things That Make You Go..hmmmm

Wegener's hypothesis of **continental drift** *(also known as sea floor spreading)* was missing a **geological** mechanism to explain how the continents could drift across the earth's surface.

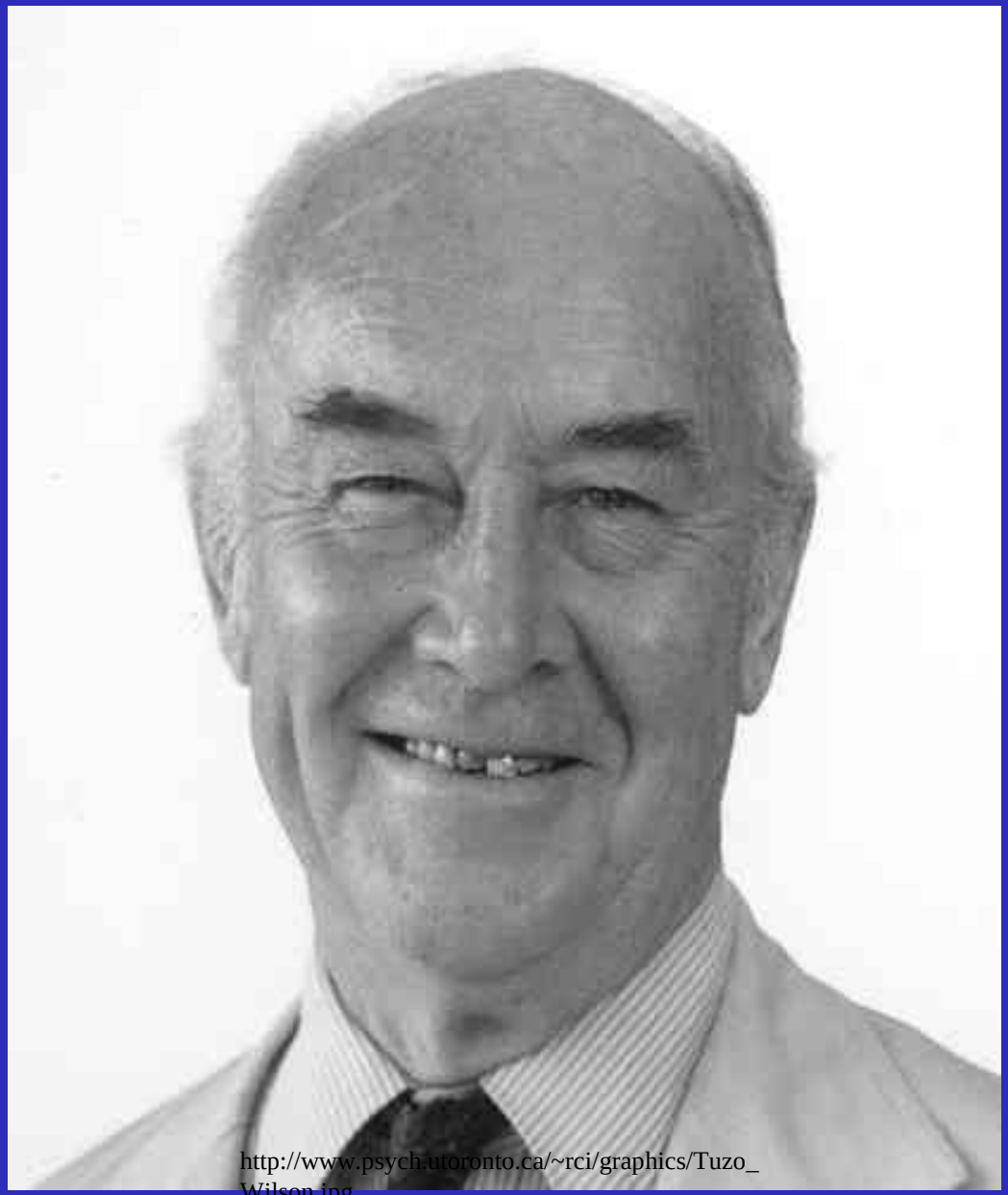
He knew they moved, but could never prove HOW they moved!



*Psst…*Geology is the study of the physical earth and the process that create it, shape it, and destroy it.

- It wasn't until the 1960s that the theory of *plate tectonics* was advanced to explain how the continents could separate.

- A Canadian by the name of J. Tuzo Wilson played an important part in the development of this theory.

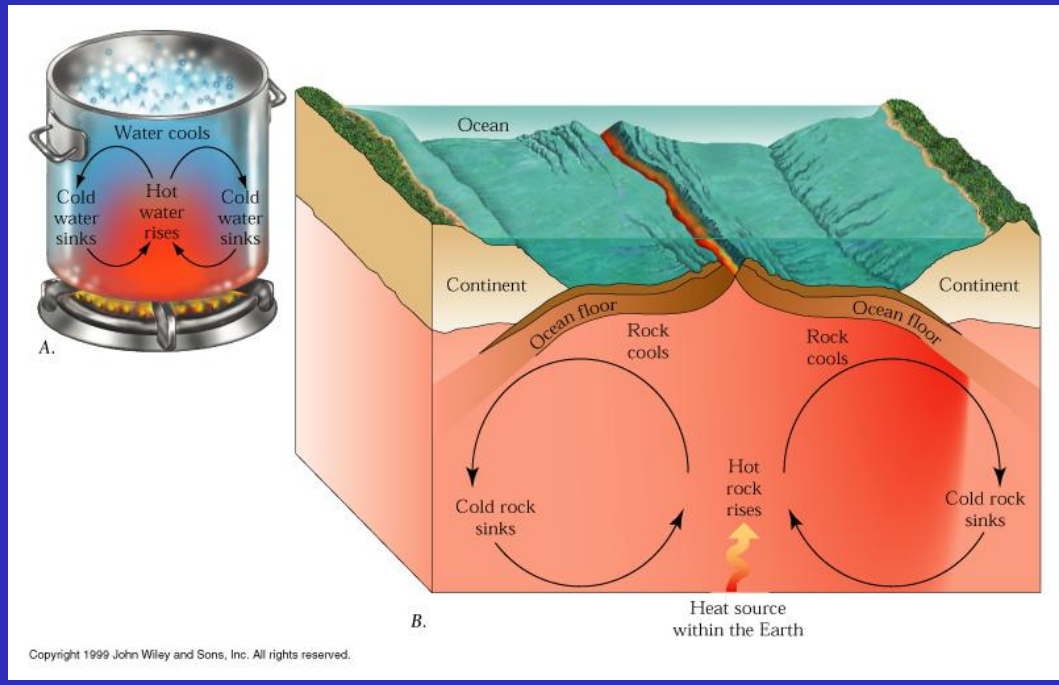


http://www.psych.utoronto.ca/~rci/graphics/Tuzo_Wilson.jpg

- Companion of the Order of Canada.
- First Director General of the Ontario Science Centre.

So…we know that Wegner could not explain HOW the plates moved…

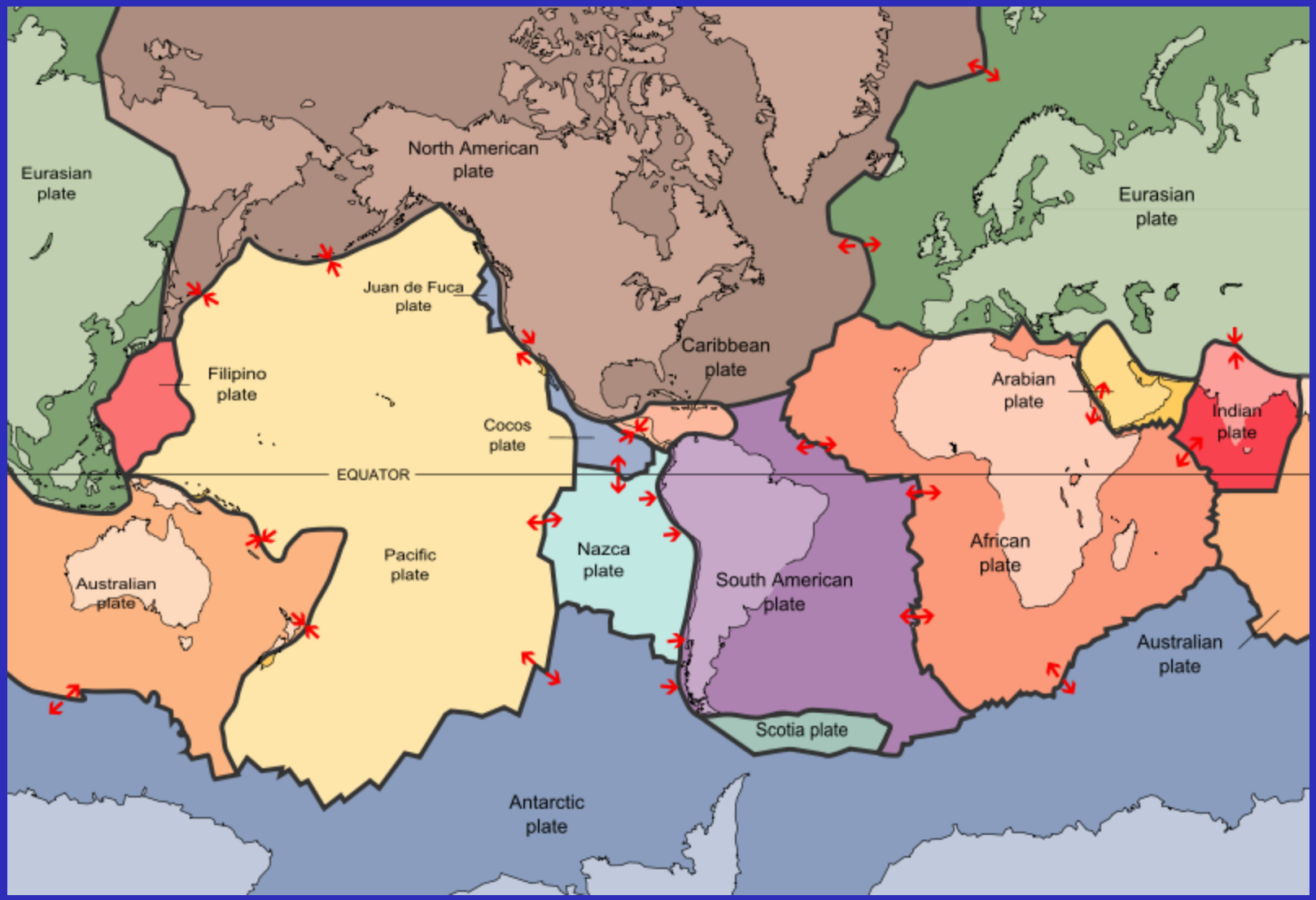
Wilson's Theory of Plate Tectonics discovered that the plates are floating on the mantle (magma) and different **convection currents** moves the plates around (think boiling water moving the lid…)



So, what's happening?

The outer surface of the Earth is a thin crust of fragile rock, fractured like the cracked shell of an egg.

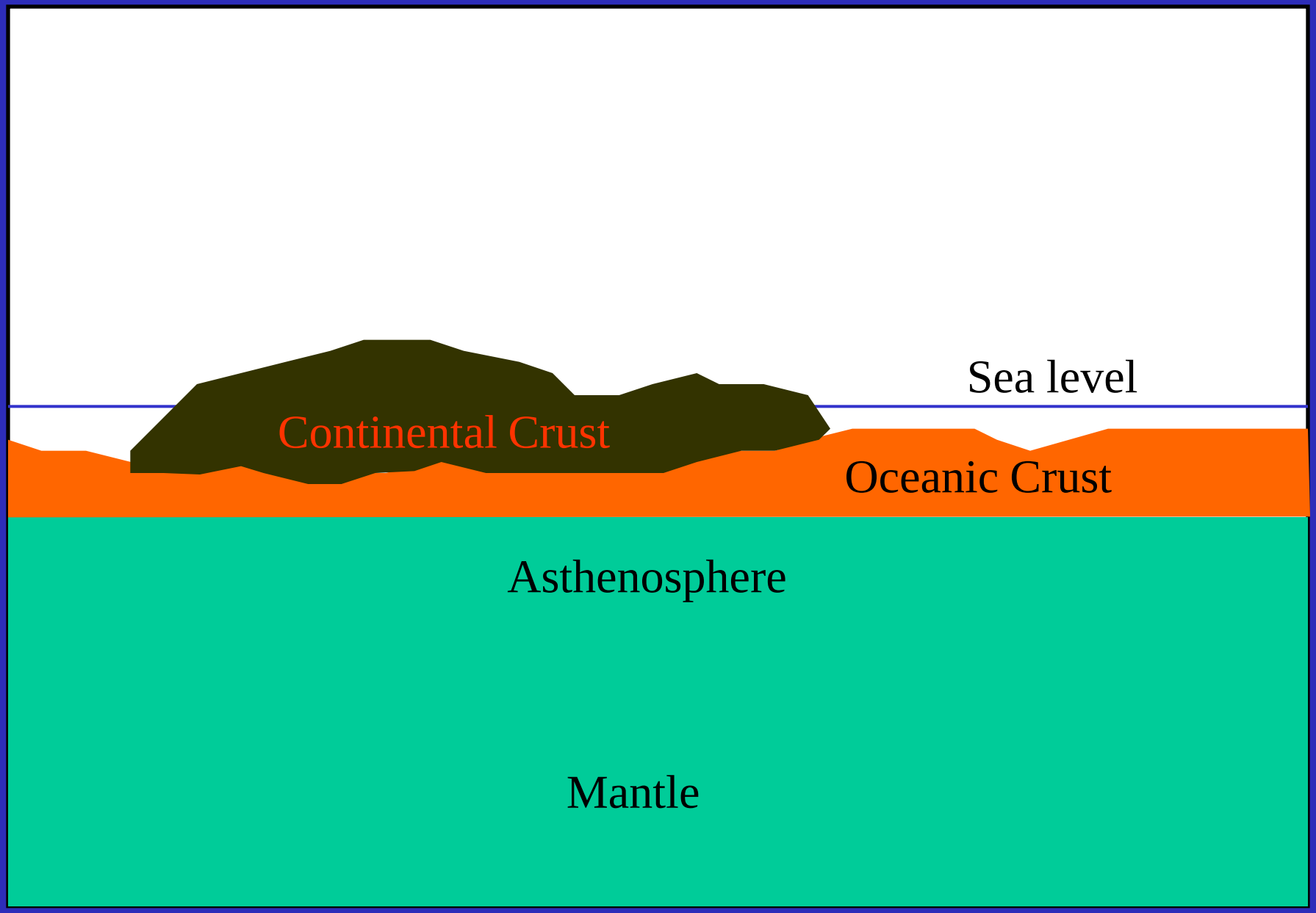
The pieces of the crust are Earth's tectonic plates -- there are 12 major ones -- and they float along on vast convection currents in the upper layer of the mantle called the asthenosphere.



http://en.wikipedia.org/wiki/File:Plates_tect2_en.svg

Remember, there are two types of crust:

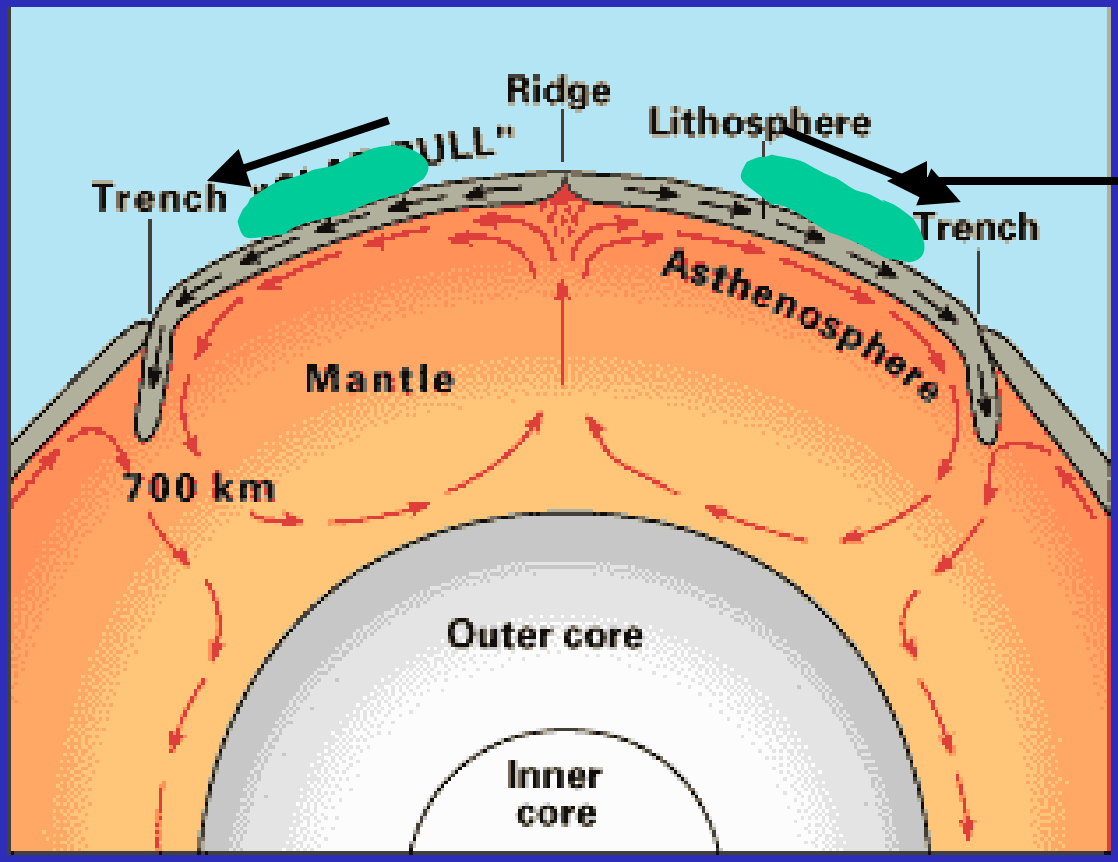
1. **Oceanic crust**, which extends all over the earth and is broken into the 12 large and many smaller plates; and,
2. **Continental crust**, which "rides around" on top of the oceanic crustal plates


Sea level
Continental Crust
Oceanic Crust
Asthenosphere
Mantle

These plates are continually moving, spreading from the center, sinking at the edges, and being regenerated.

Convection currents in the **asthenosphere** beneath the plates move the crustal plates in different directions.

The source of heat driving the convection currents is radioactivity deep in Earth's mantle.



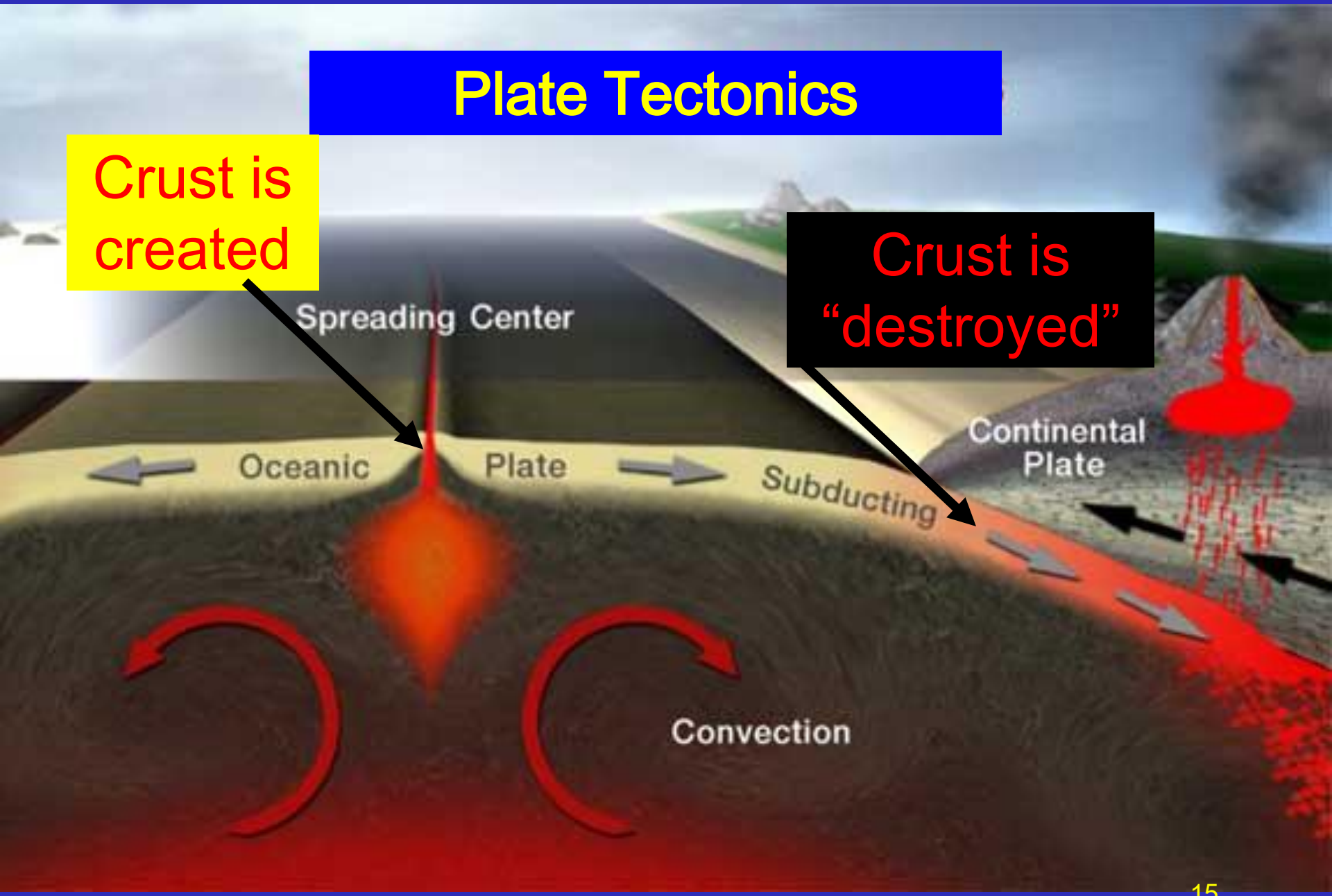
http://geog.ouc.bc.ca/physgeog/contents/10i.html

Convection currents power the plate movements. Convection currents rise up from the radioactive core, carrying heat to the thin crust of the earth.

At the mid ocean ridges, **magma erupts between the two plates, forcing the two plates apart and creating mid-oceanic mountain ridges** as it cools and solidifies. At the mid-oceanic ridges new crust is created.

But Earth's crust is in balance, so that as new crustal material is created, old crust is "removed". **This happens at the trenches, where one plate slides down towards the mantle.** The plate melts back into the mantle.

Plate Tectonics



http://geothermal.marin.org/GEOpresentation/images/img007.jpg

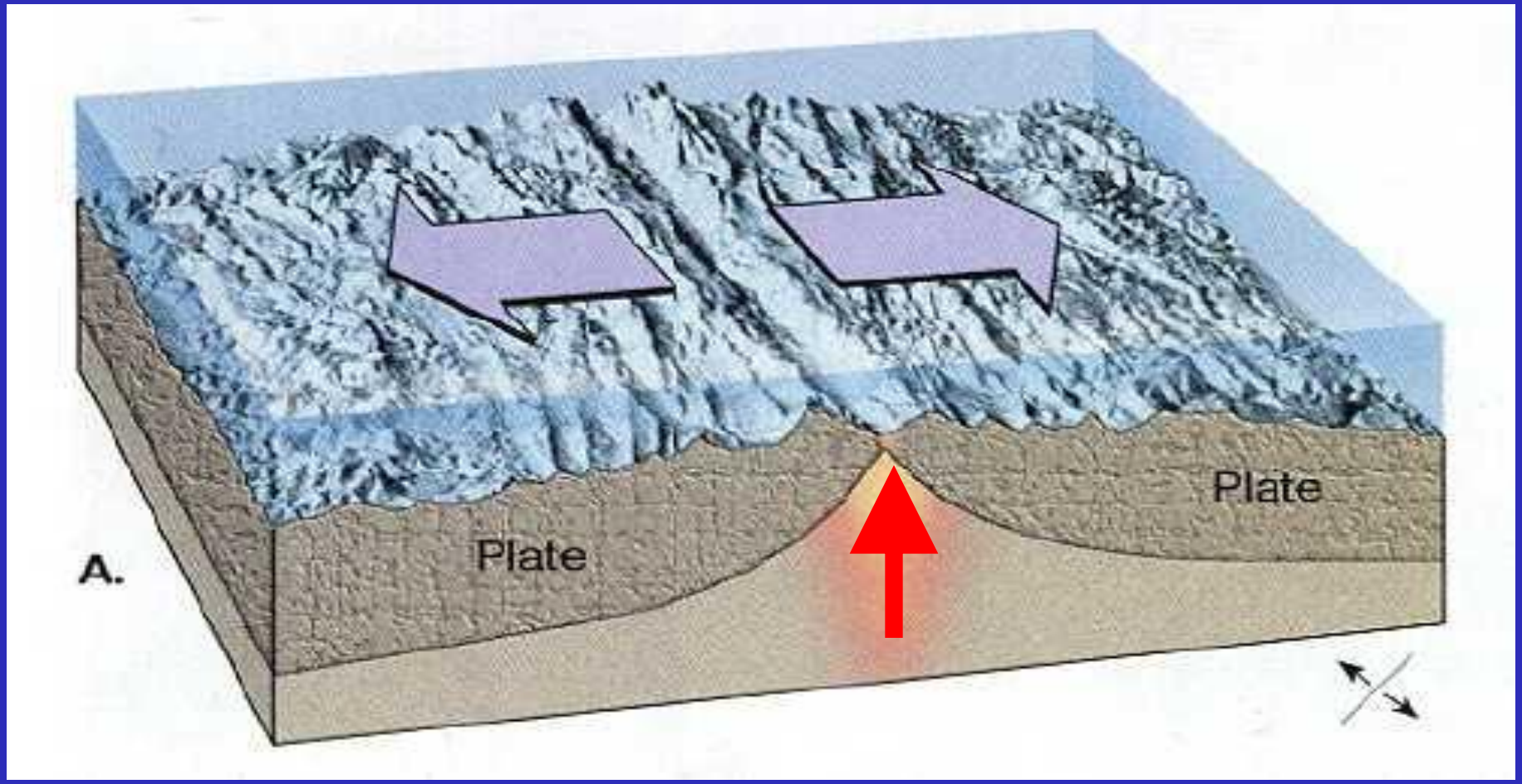
There are **three** basic plate movements or boundaries.

1. **Divergent:**

- **the plates move apart**
- new magma wells up to the surface forming new crust (a ridge)
- the Mid-Atlantic ridge is a prime example.

http://homework.uoregon.edu/pub/class/121/earthd.html

Divergent Boundary plates move away from each other

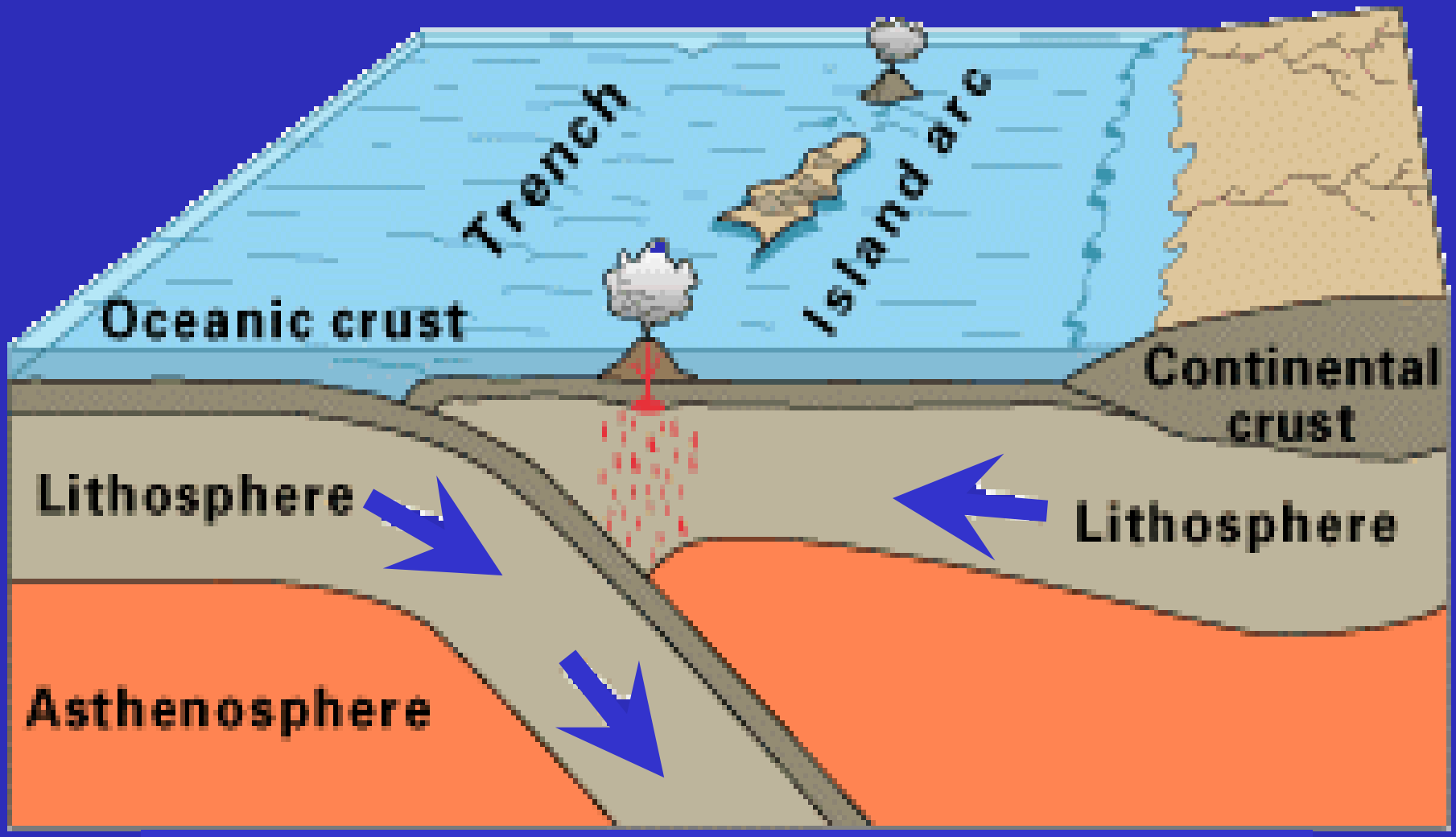


http://www.geo.lsa.umich.edu/~crlb/COURSES/117/Lec17div.jpeg

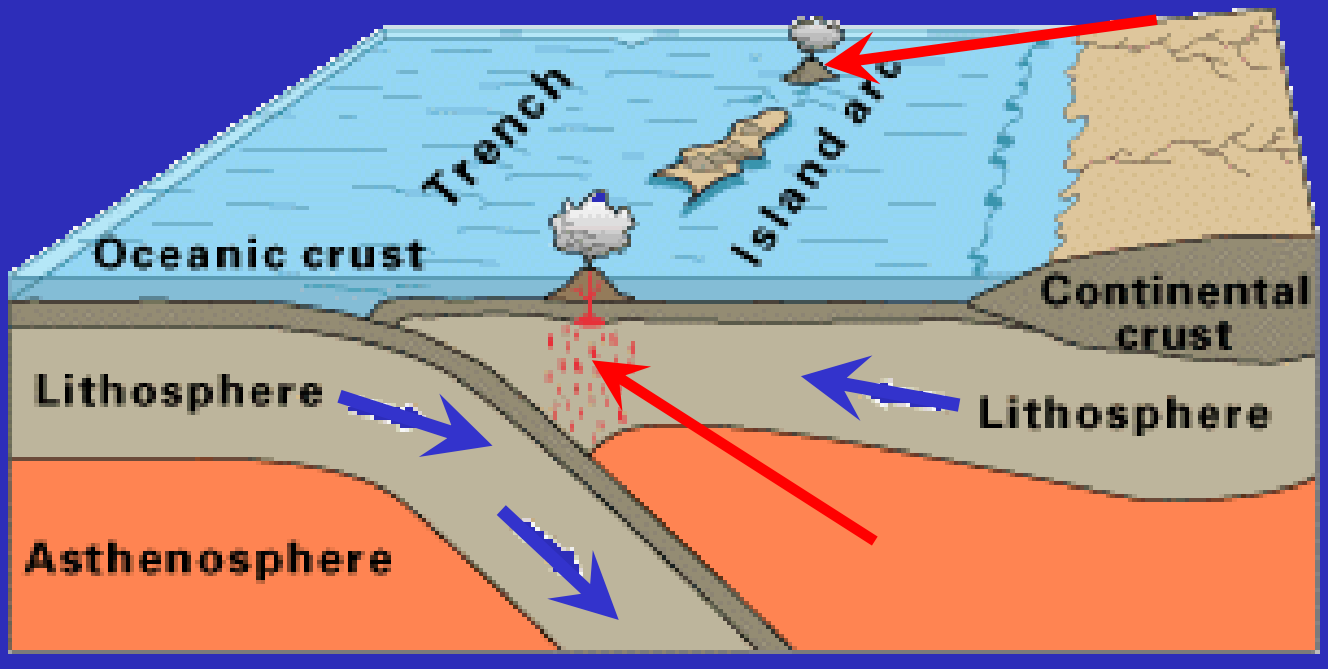
2. Convergent:

- two plates come together
- one plate subducts (goes under) the other plate, creating a subduction zone
- the crust at the leading edge of the subducting plate melts back into the mantle
- the Pacific Rim of Fire is a good example of this

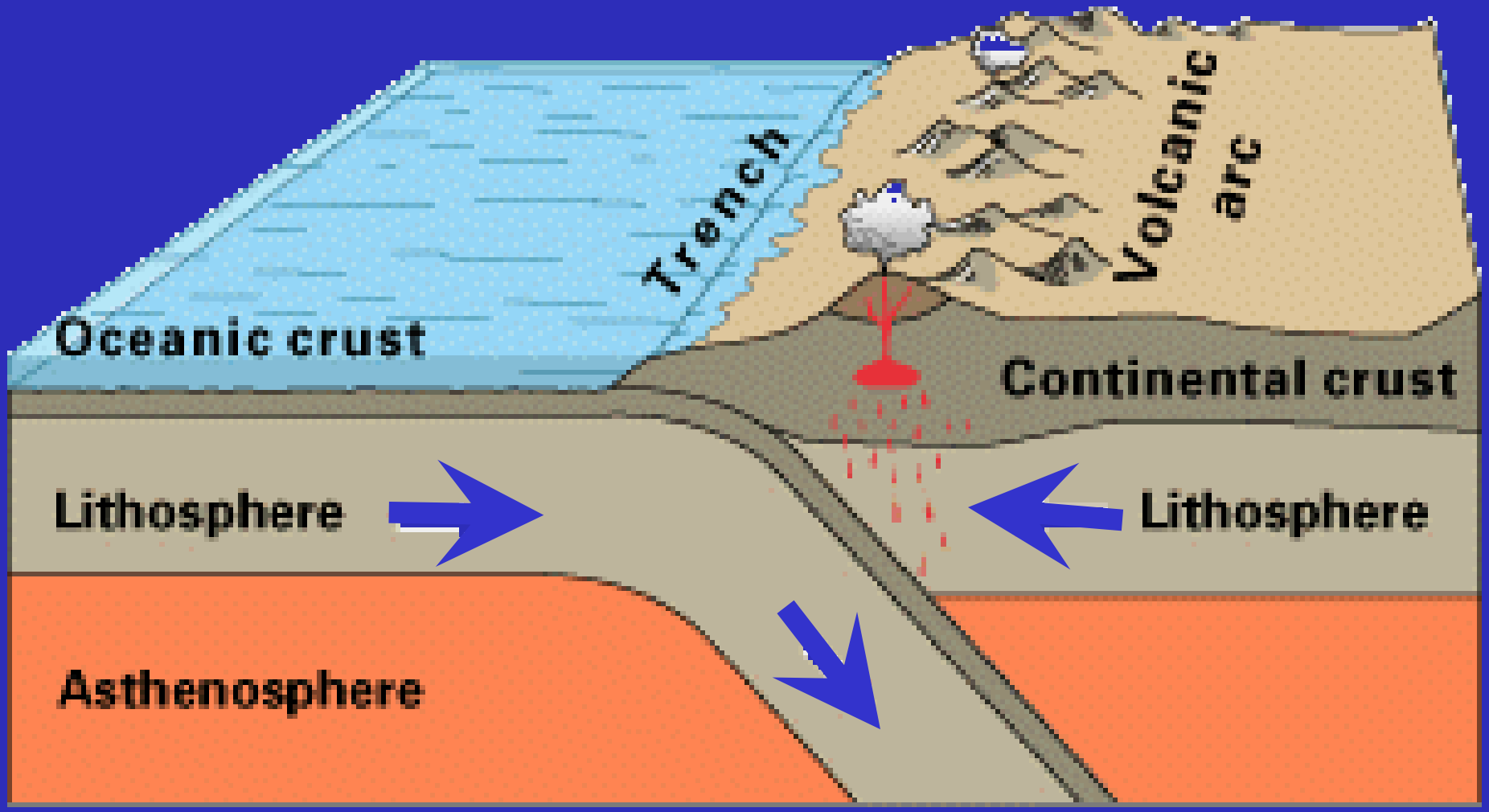
http://www.universetoday.com/59341/pacific-ring-of-fire/



A. Mid Ocean Convergence Zone: Oceanic Crust to Oceanic Crust



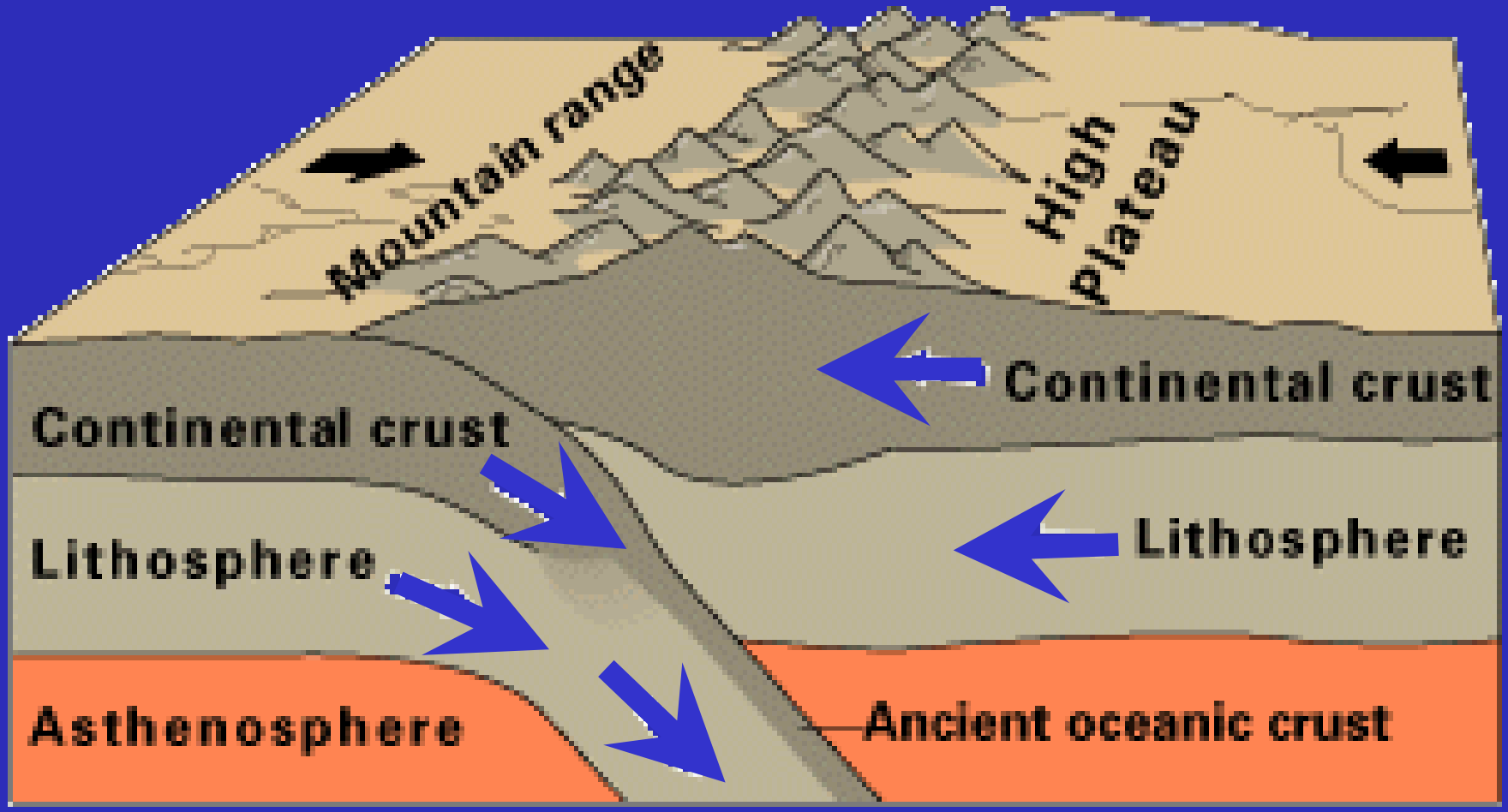
Less dense material that has accumulated on the surface of the crust melts as it goes down into the mantle. Because it is less dense, it rises back up as liquid rock, and creates volcanoes and volcanic islands beside the trench. Japan is a good example of this.



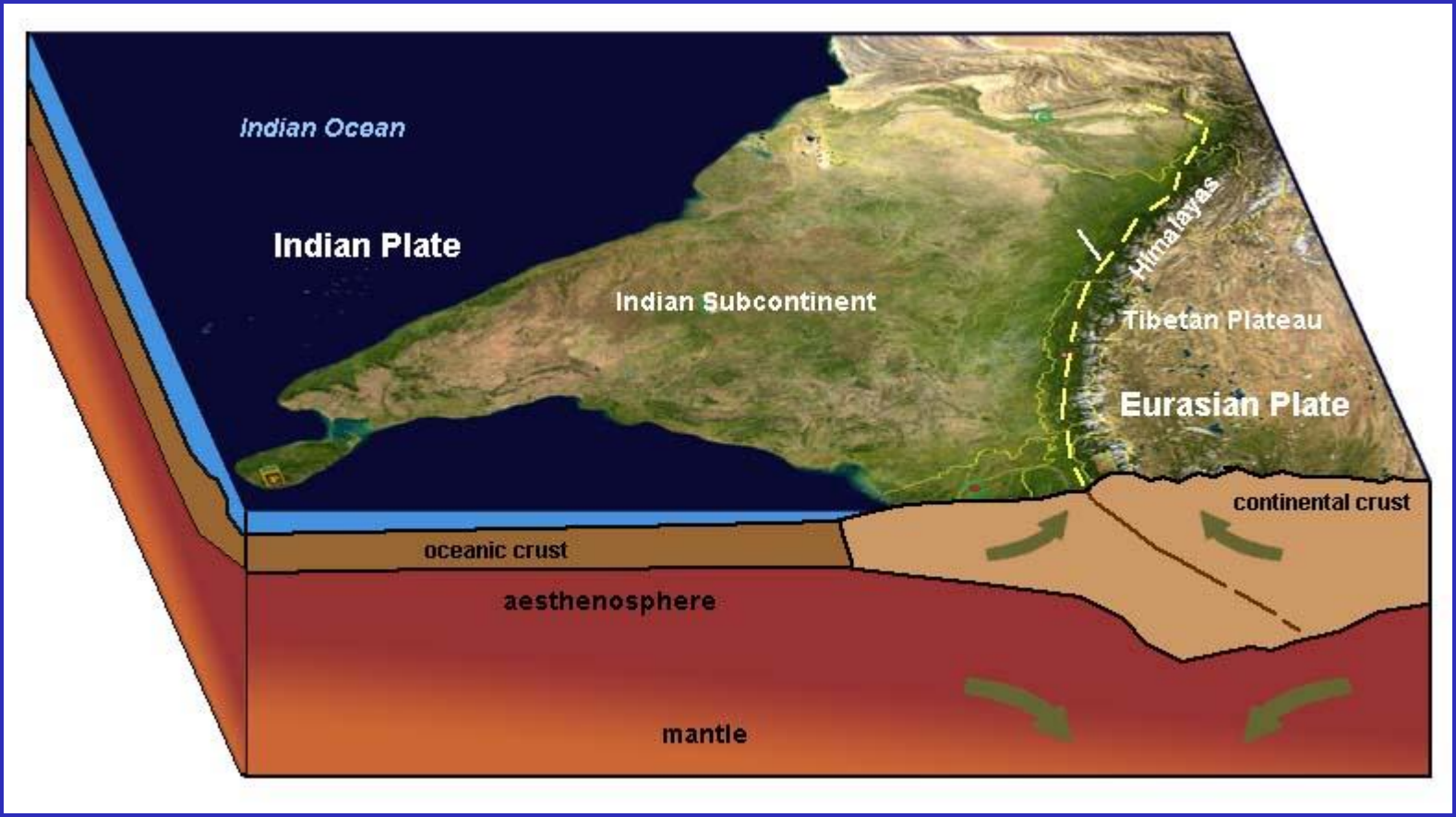
B. Convergence Zone: Oceanic Crust and Continental Crust

Mount St. Helens
(Washington State)

http://en.wikipedia.org/wiki/Image:Sthelens3.jpg



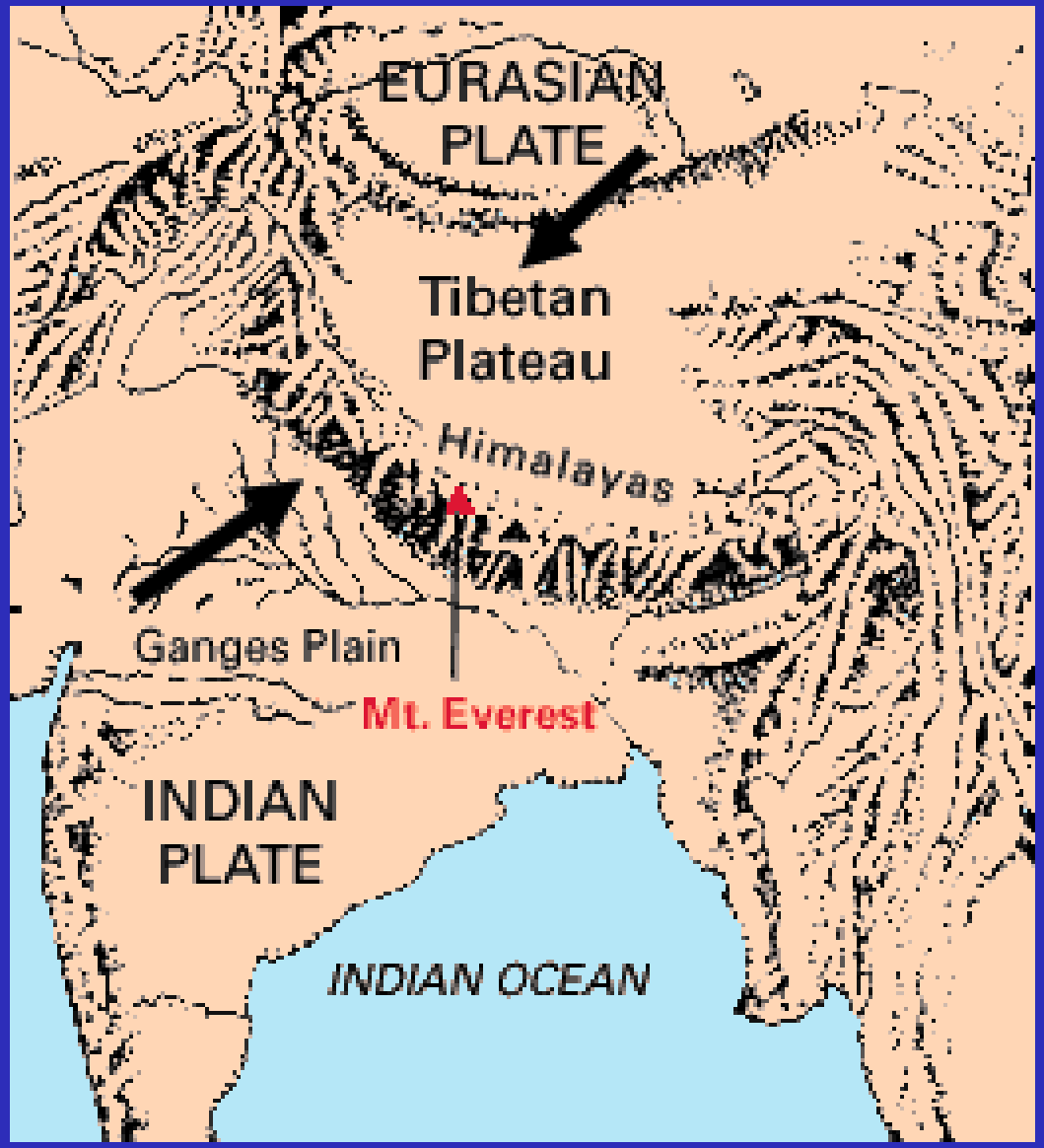
C. Convergence Zone: Continental Crust to Continental Crust



http://www.geologycafe.com/class/chapter3.html

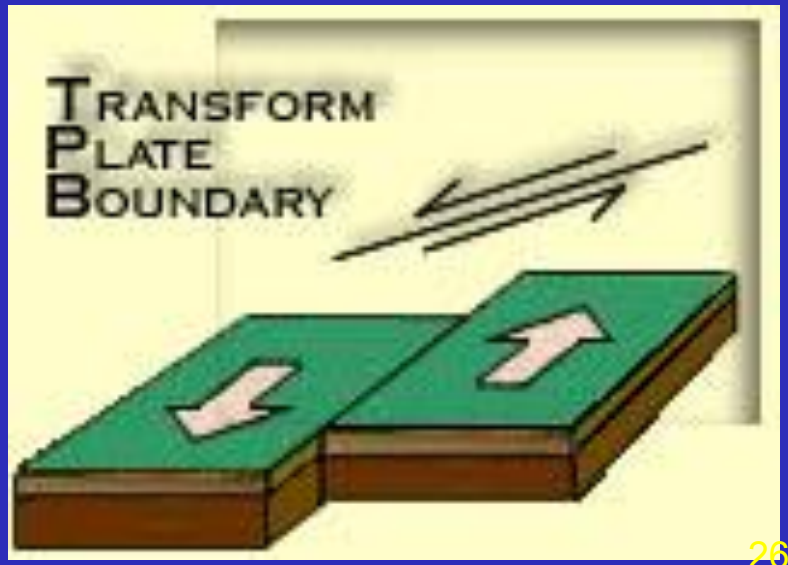
The formation of the Himalayas is an excellent example of this.

The result: the Himalayas and Mt. Everest



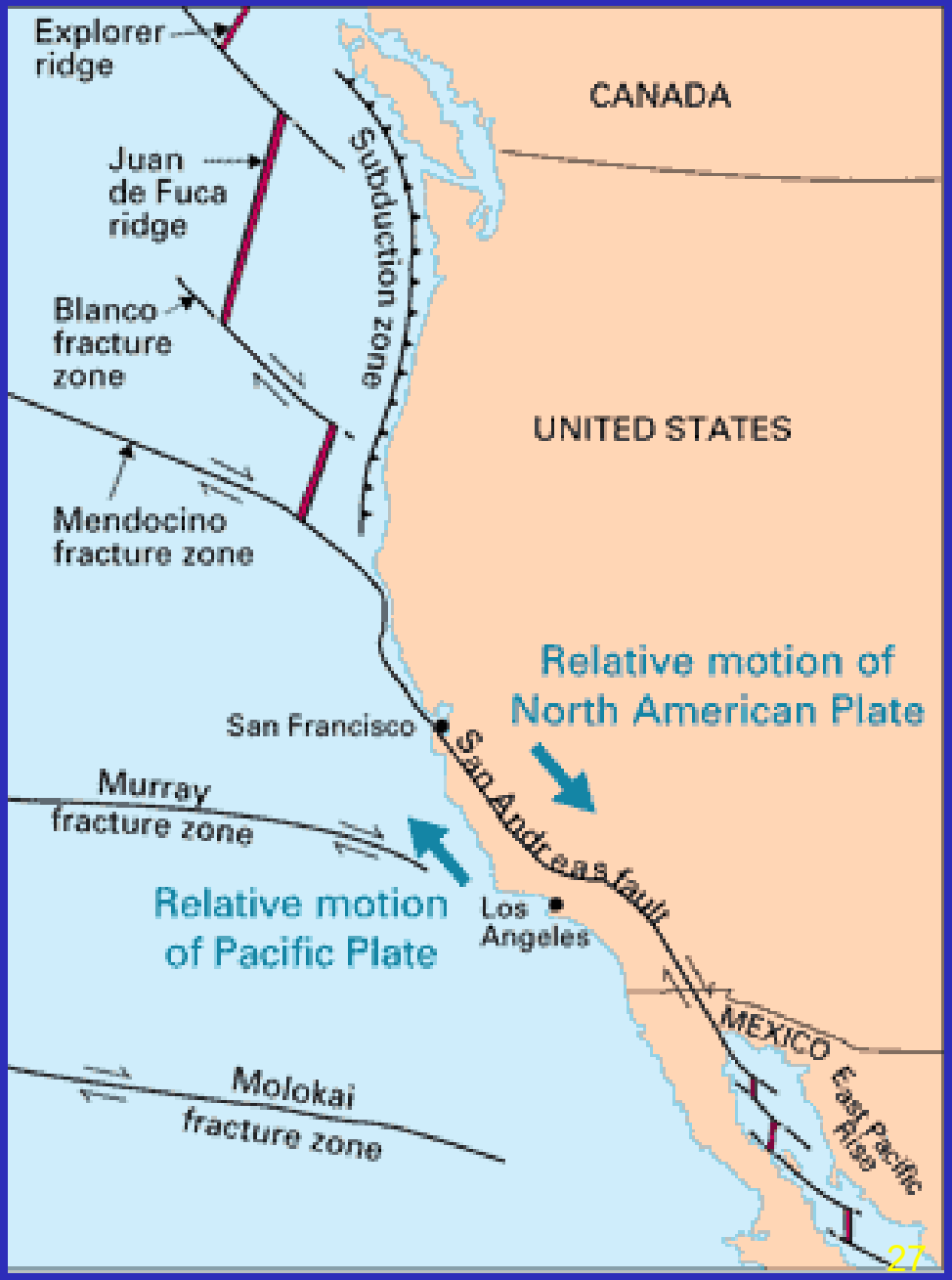
3. Transform Boundaries:

- *two plates slide past each other*
- this can create tremendous friction, which may be eventually released in the form of violent earthquakes
- Example: the San Andreas Fault (California) is a transform boundary

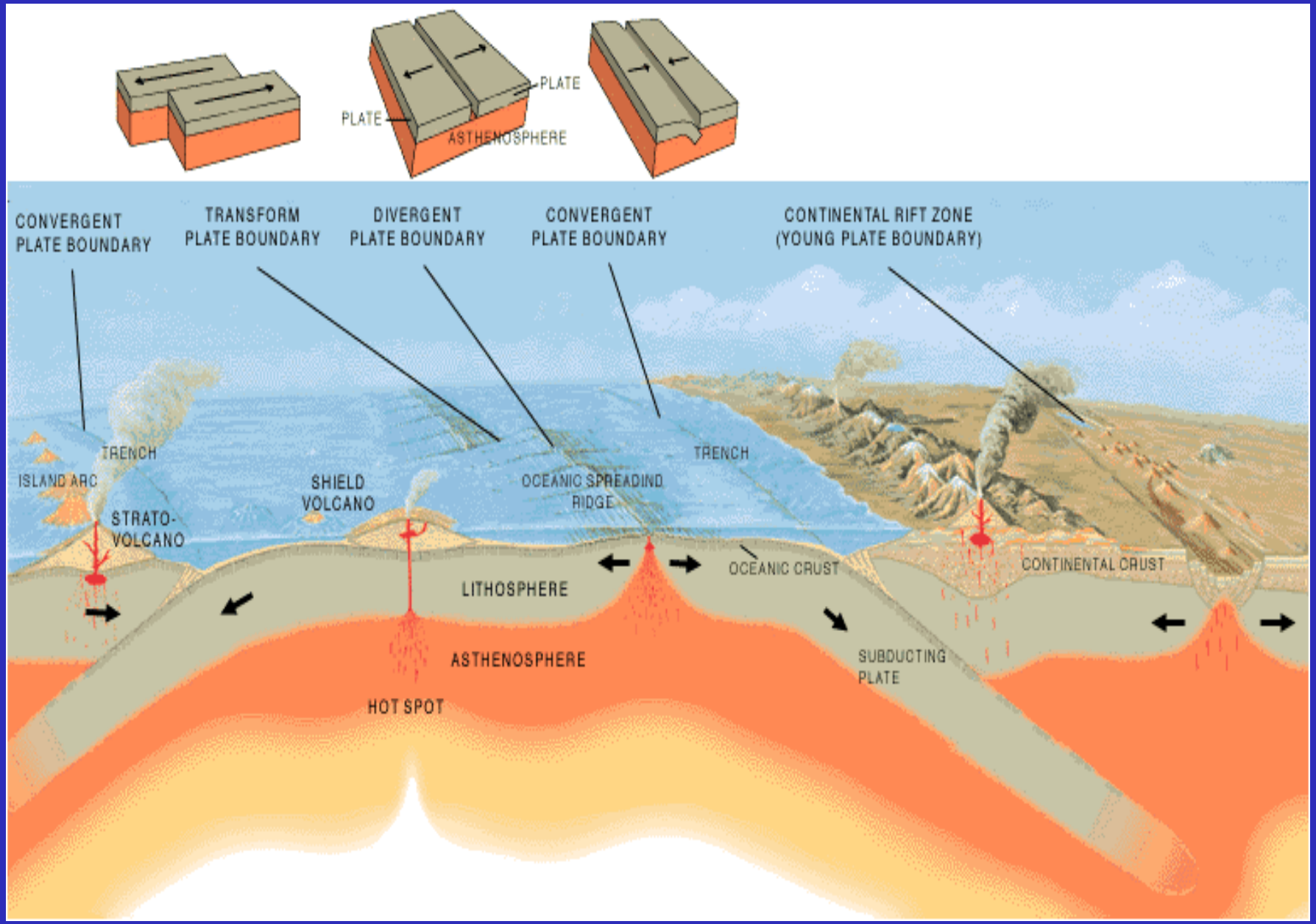


http://observe.arc.nasa.gov/nasa/earth/tectonics/graphics/Image43.jpg

Transform plate margins: where two plates slip past one another.

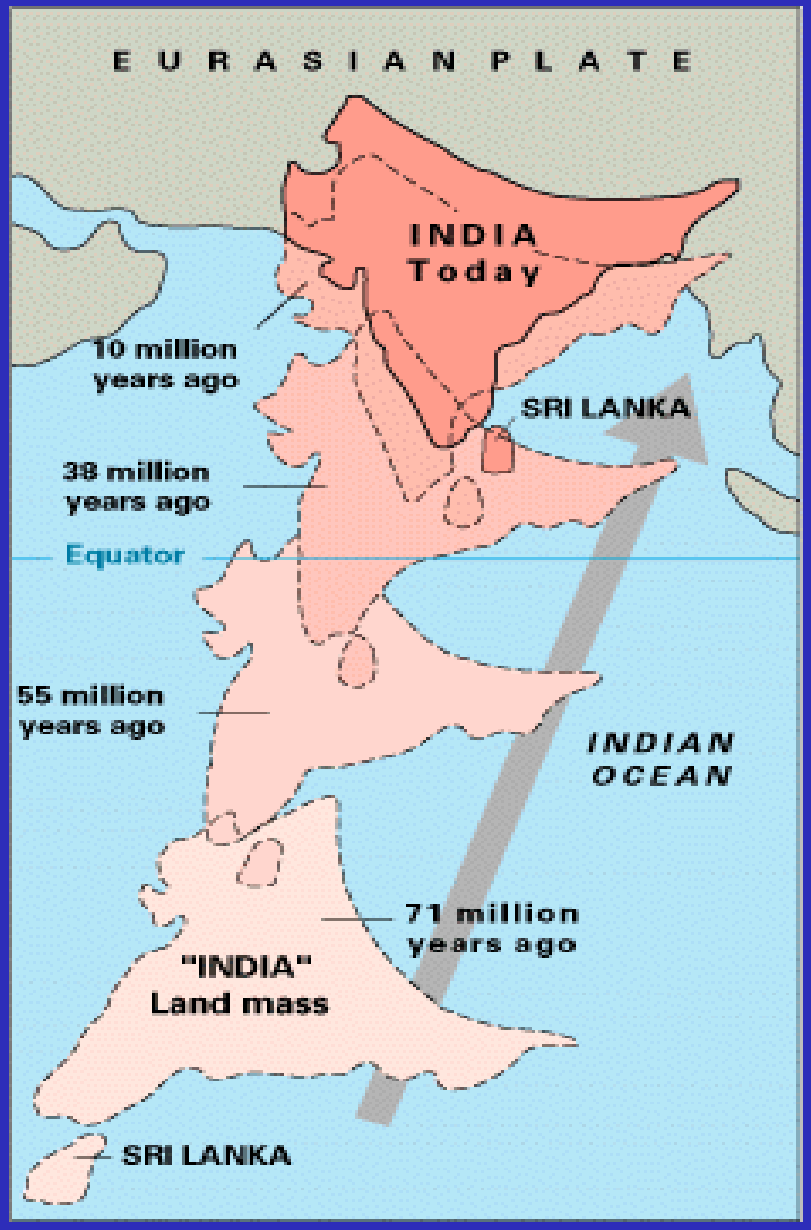


The San Andreas Fault, California

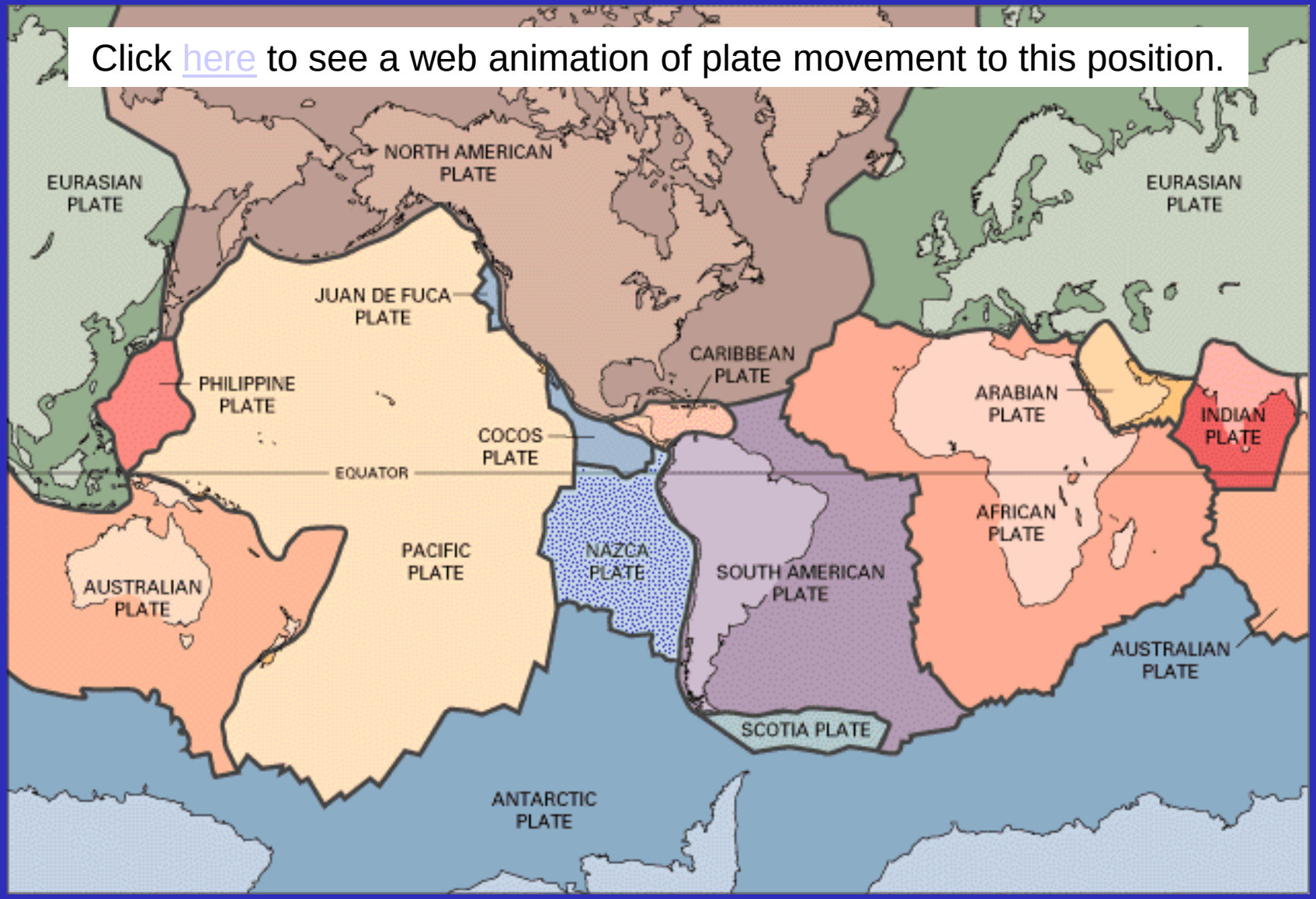


The main types of plate boundaries.

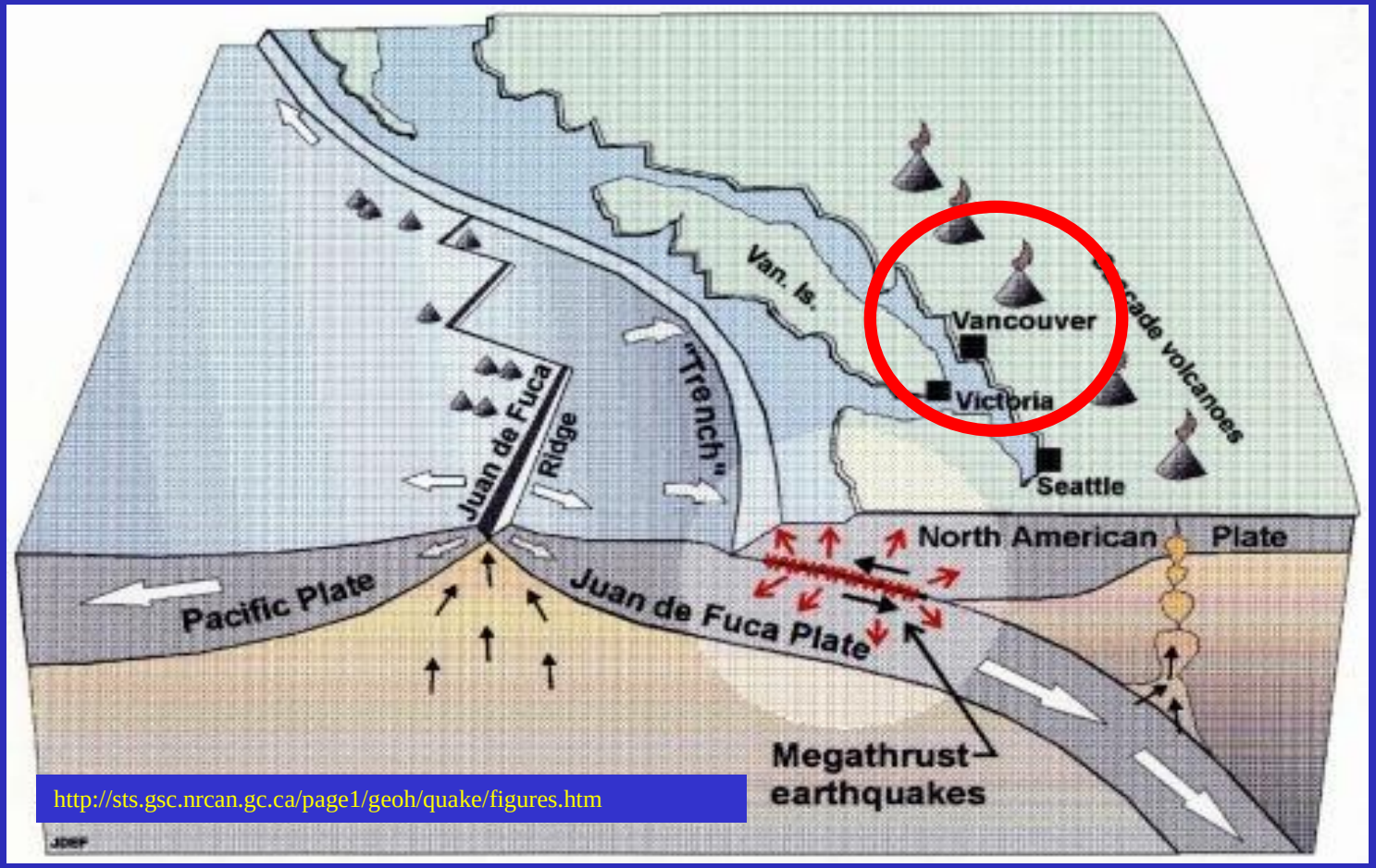
Indian Plate collides with Eurasian Plate



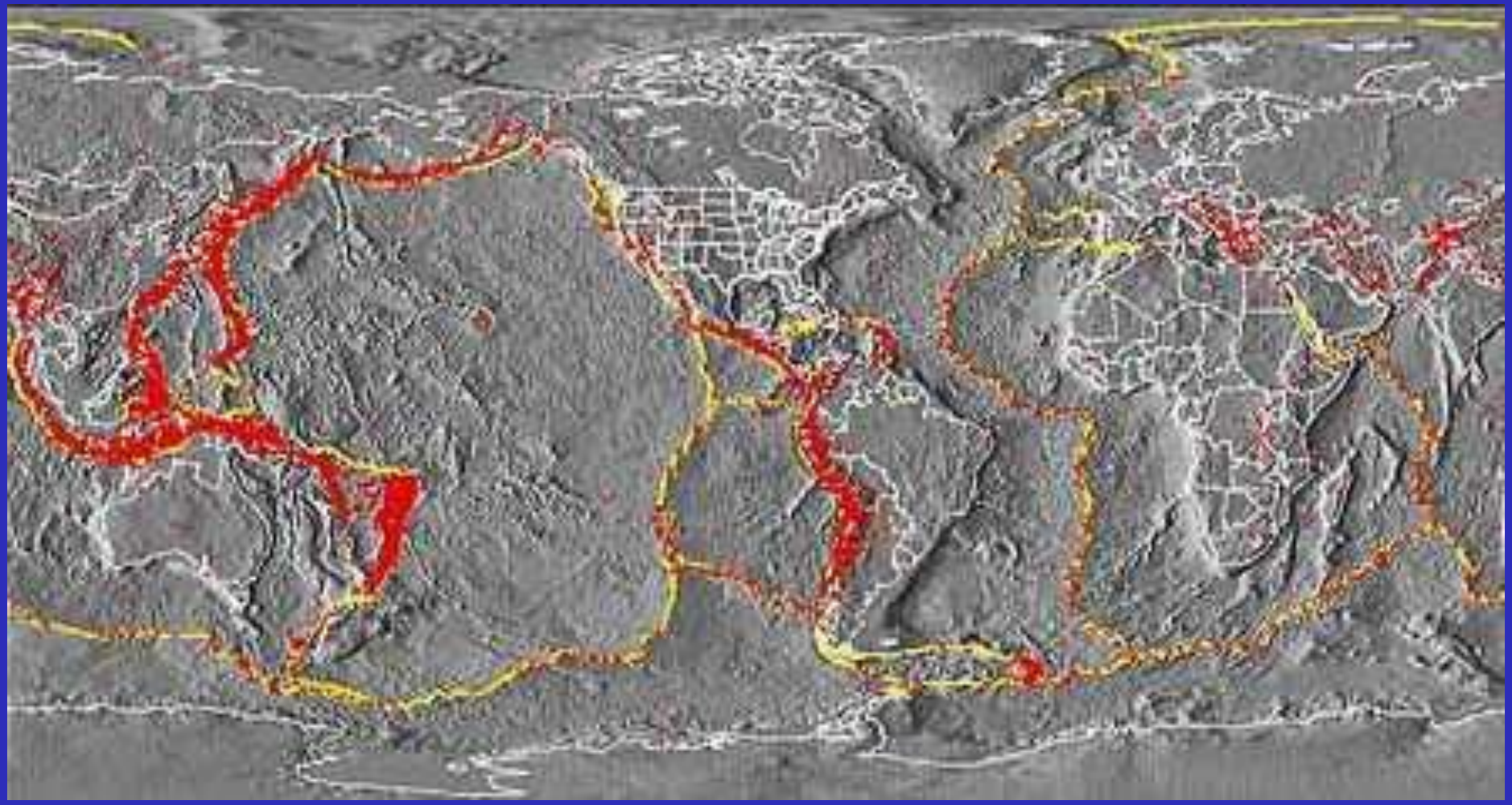
Click here to see a web animation of plate movement to this position.



earthquake.usgs.gov/ faq/plates.html



Tectonic setting of western British Columbia and Washington state. The oceanic Juan de Fuca plate is moving beneath the continental North America plate at a rate of about 4 cm/year. Earthquakes occur along parts of the boundary between the two plates.



This map, which shows 20th-century earthquakes in red, illustrates how they cluster on the edges of the major tectonic plates (outlined in yellow).

http://www.pbs.org/wnet/savageearth/hellscrust/index.html