Earths Dynamic Crust and Interior (Tectonics)

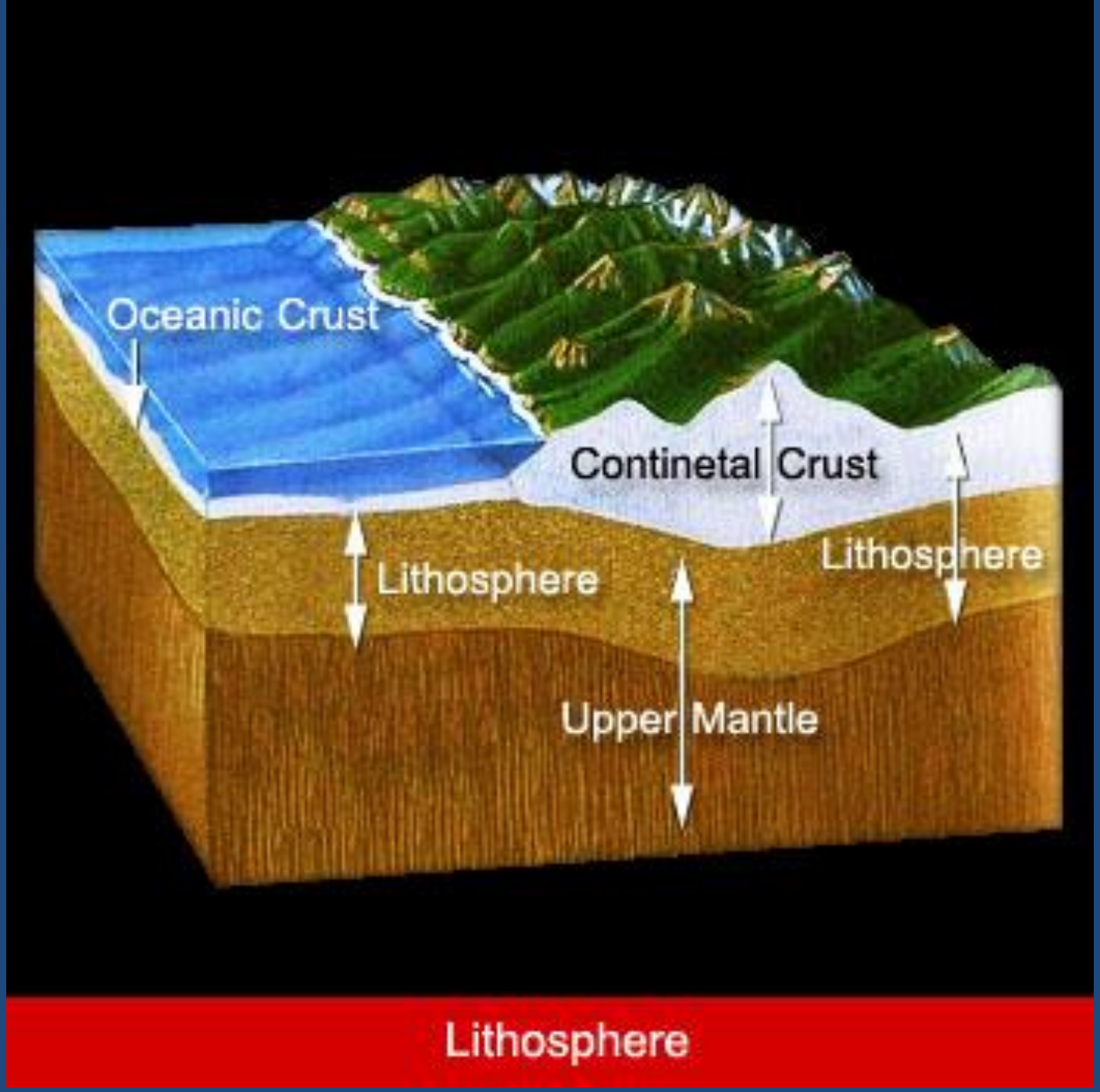
- Earths Interior
-Small Scale Crustal Changes
- Earthquakes and Igneous Activity Including Volcanoes
- Plate Tectonics

Small Scale Crustal Changes

- Earths Crust in constantly undergoing change!

Lithosphere : The layer of rock that forms the outer shell at the top of the Earth's interior

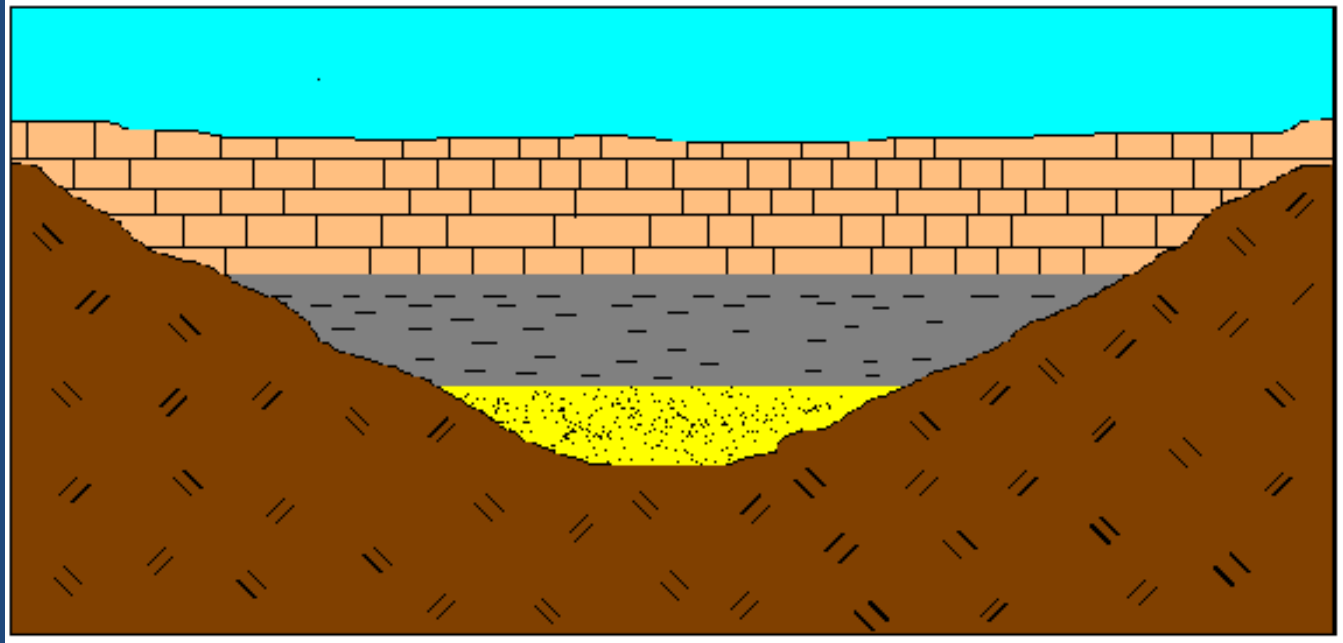
Crust: The upper portion of the lithosphere


Oceanic Crust
Continetal Crust
Lithosphere
Lithosphere
Upper Mantle
Lithosphere

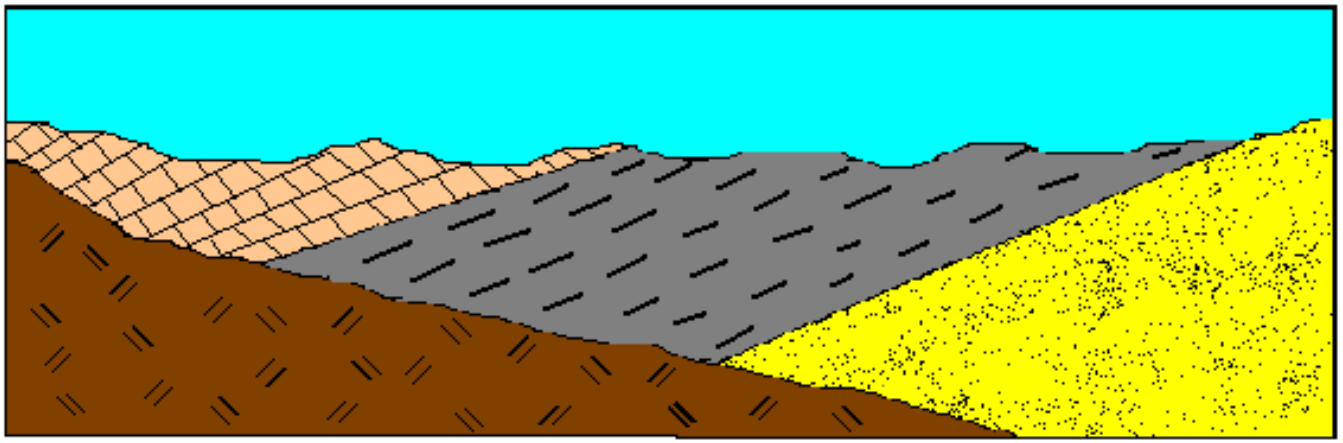
Evidence for past movement of earths crust is based on the concept of ***Original Horizontality***

Original Horizontality : assumes that most rock layers (often called strata) form in horizontal layers.

Therefore strata found in positions other then horizontal have been deformed by crustal movement.



Original Horizontal Strata



Tilted Strata

Deformed Rock Layers

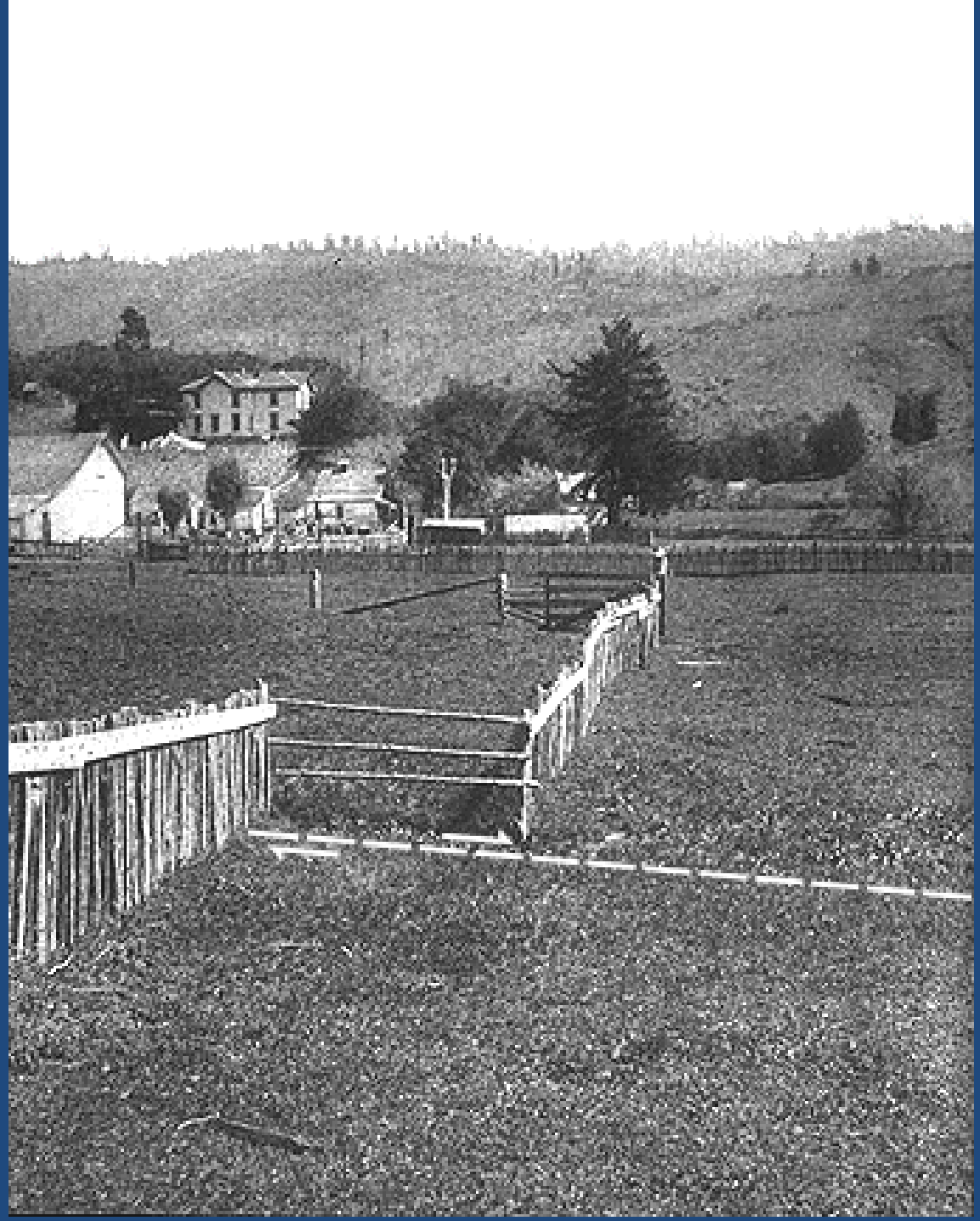
1) Folded
2) Uplifted
3) Faulted

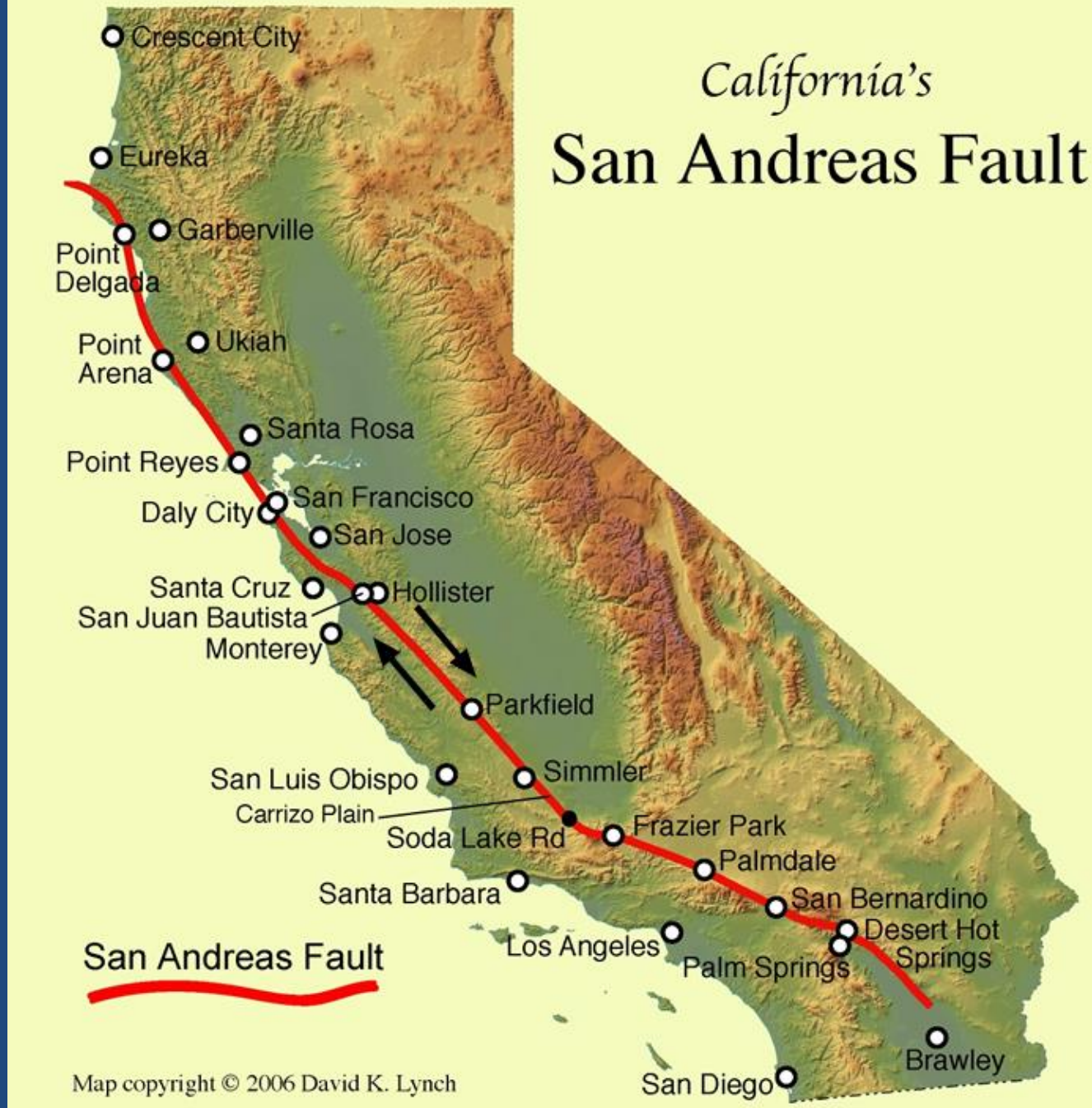
Folded Rock Layers : are bent or curved

Uplifted Rock Layers : indicate that land has been raised up or lifted to its present location

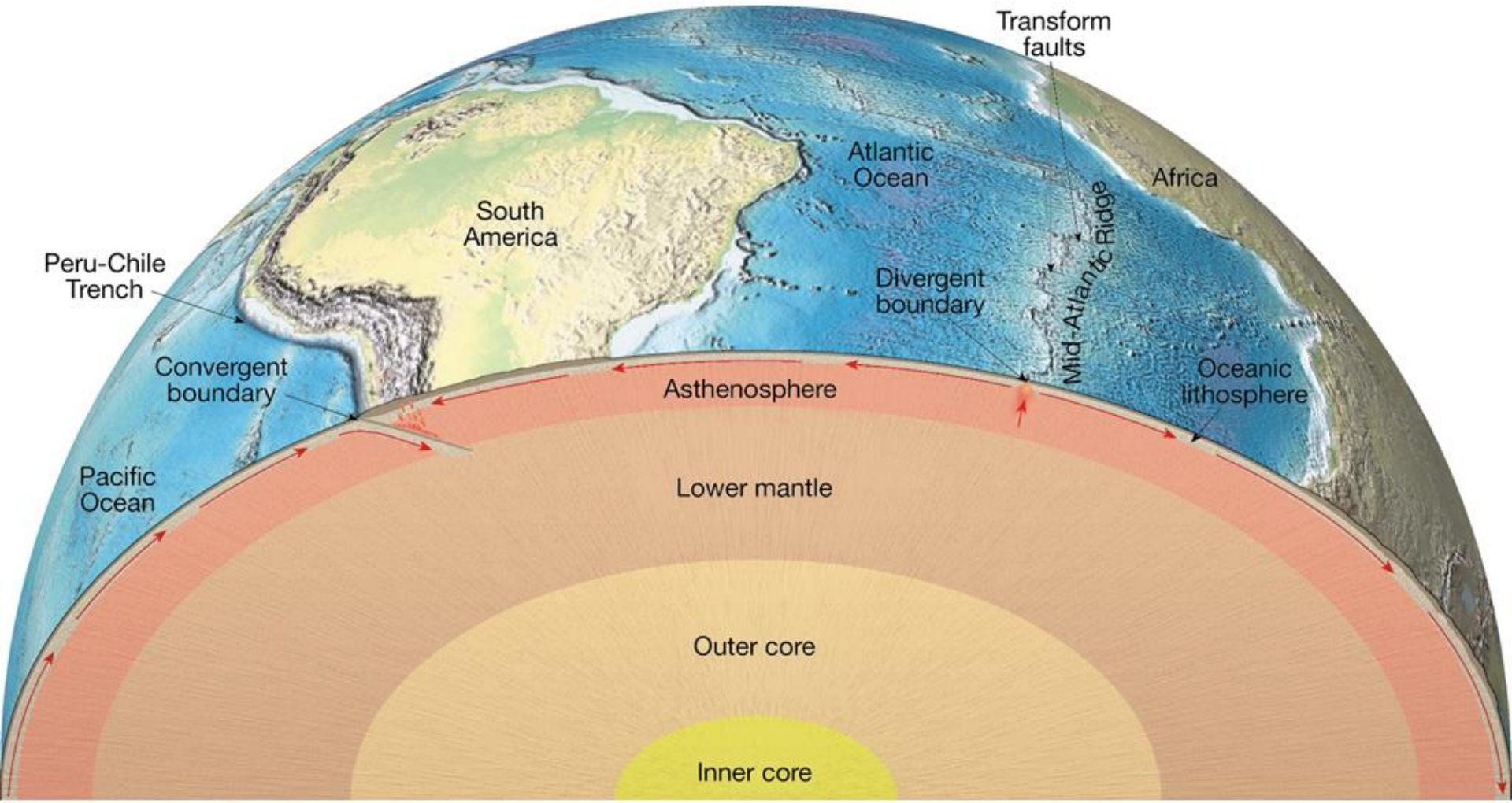
Example are fossils on top of Mount Everest

Faulted Rock Layers : are displaced or offset along a crack called a fault.




California's
San Andreas Fault
Crescent City
Eureka
Garberville
Point Delgada
Point Arena
Ukiah
Santa Rosa
Point Reyes
San Francisco
Daly City
San Jose
Santa Cruz
Hollister
San Juan Bautista
Monterey
Parkfield
San Luis Obispo
Simmler
Carrizo Plain
Soda Lake Rd
Frazier Park
Palmdale
Santa Barbara
San Bernardino
Desert Hot Springs
Los Angeles
Palm Springs
Brawley
San Diego
San Andreas Fault
Map copyright © 2006 David K. Lynch

Earths Interior



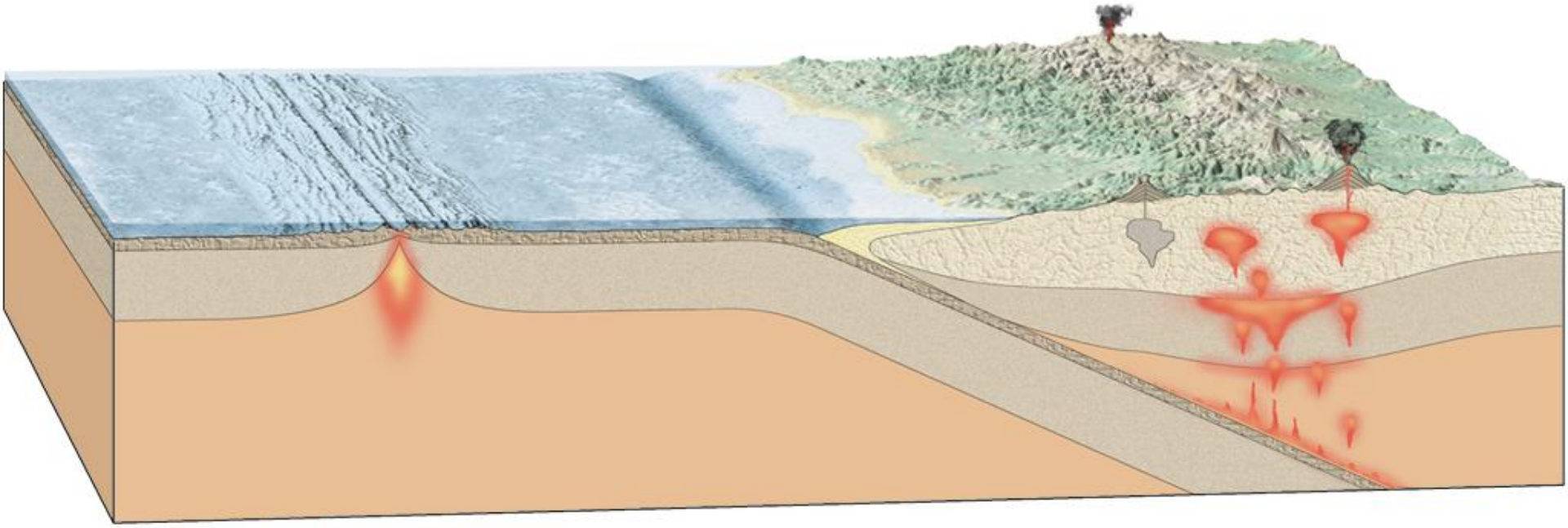
Properties of Earth's Interior

Lithosphere - The solid most outer part of Earth

Crust - The rocky solid shell that "floats" on the asthenosphere

Asthenosphere - Plastic mantle (made of molten material)

* Convection current found in Asthenosphere



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Stiffer Mantle - Rocky part of mantle, takes up the majority of it

Sliding Plate over the Asthenosphere

Properties of Earth's Interior

Lithosphere - The solid most outer part of Earth

Crust - The rocky solid shell that "floats" on the asthenosphere

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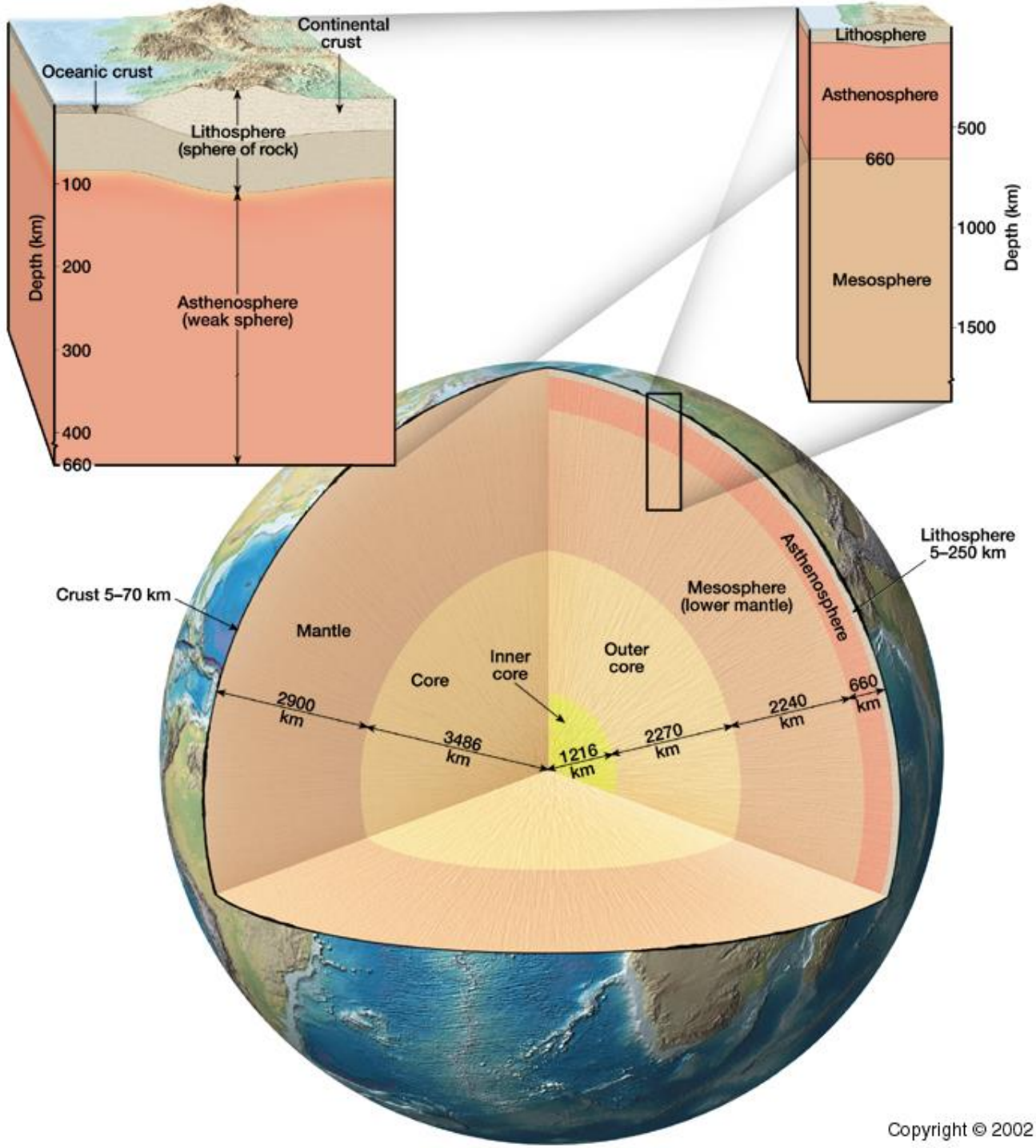
Stiffer Mantle - Rocky part of mantle, takes up the majority of it

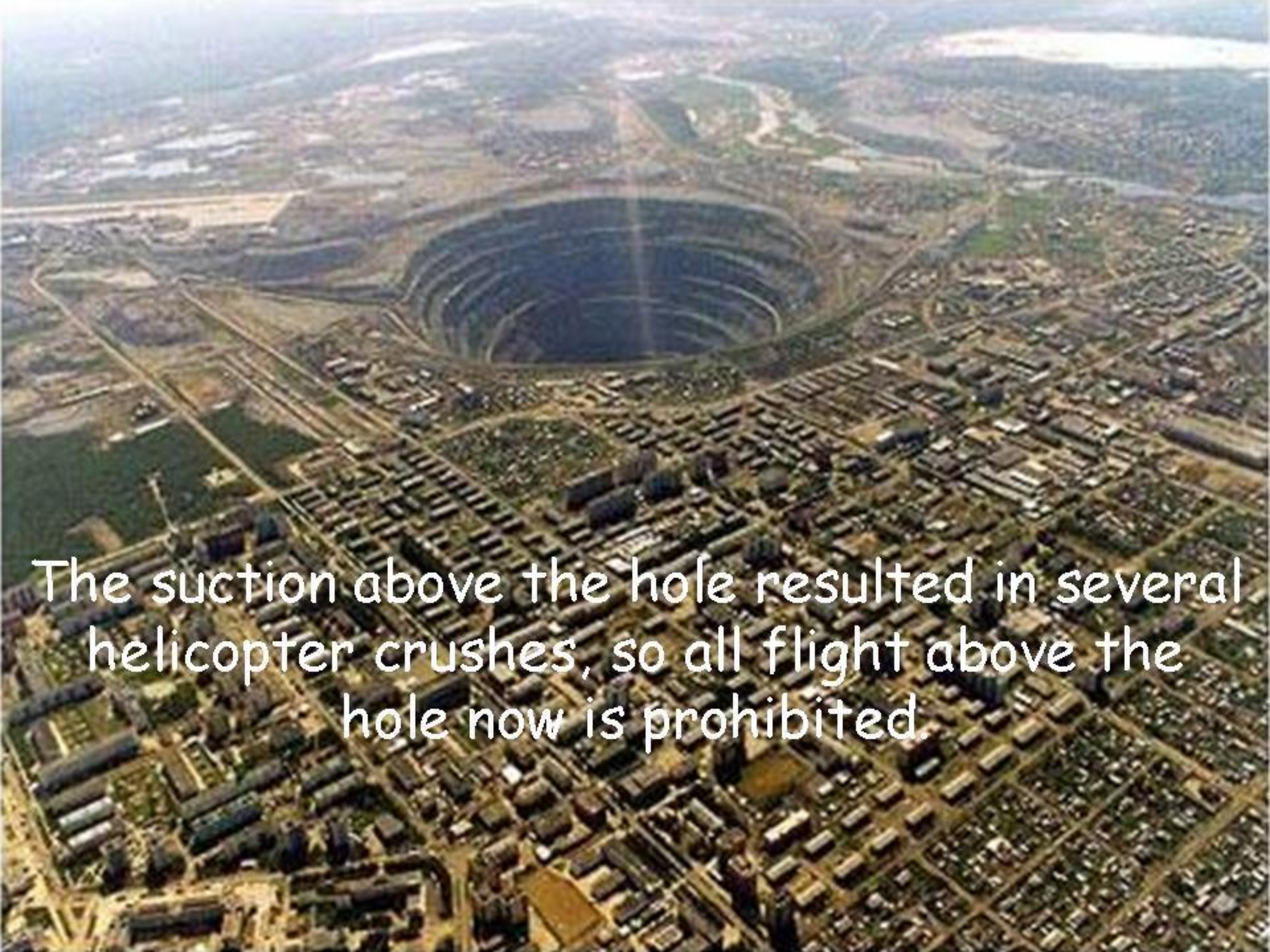
Outer Core - Liquid Metal

Inner Core - Solid Nickel and Iron



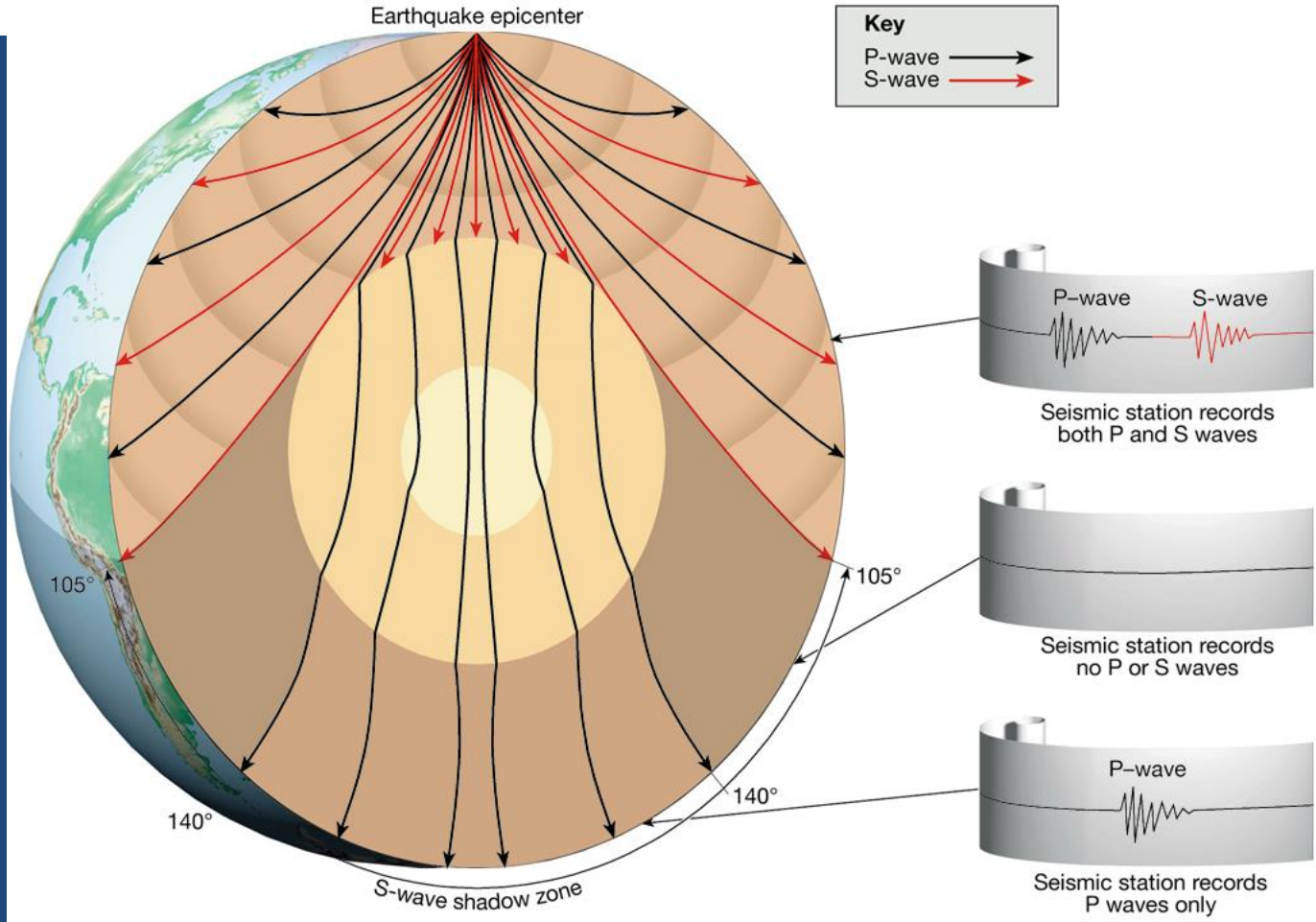
How do we know what is down there?

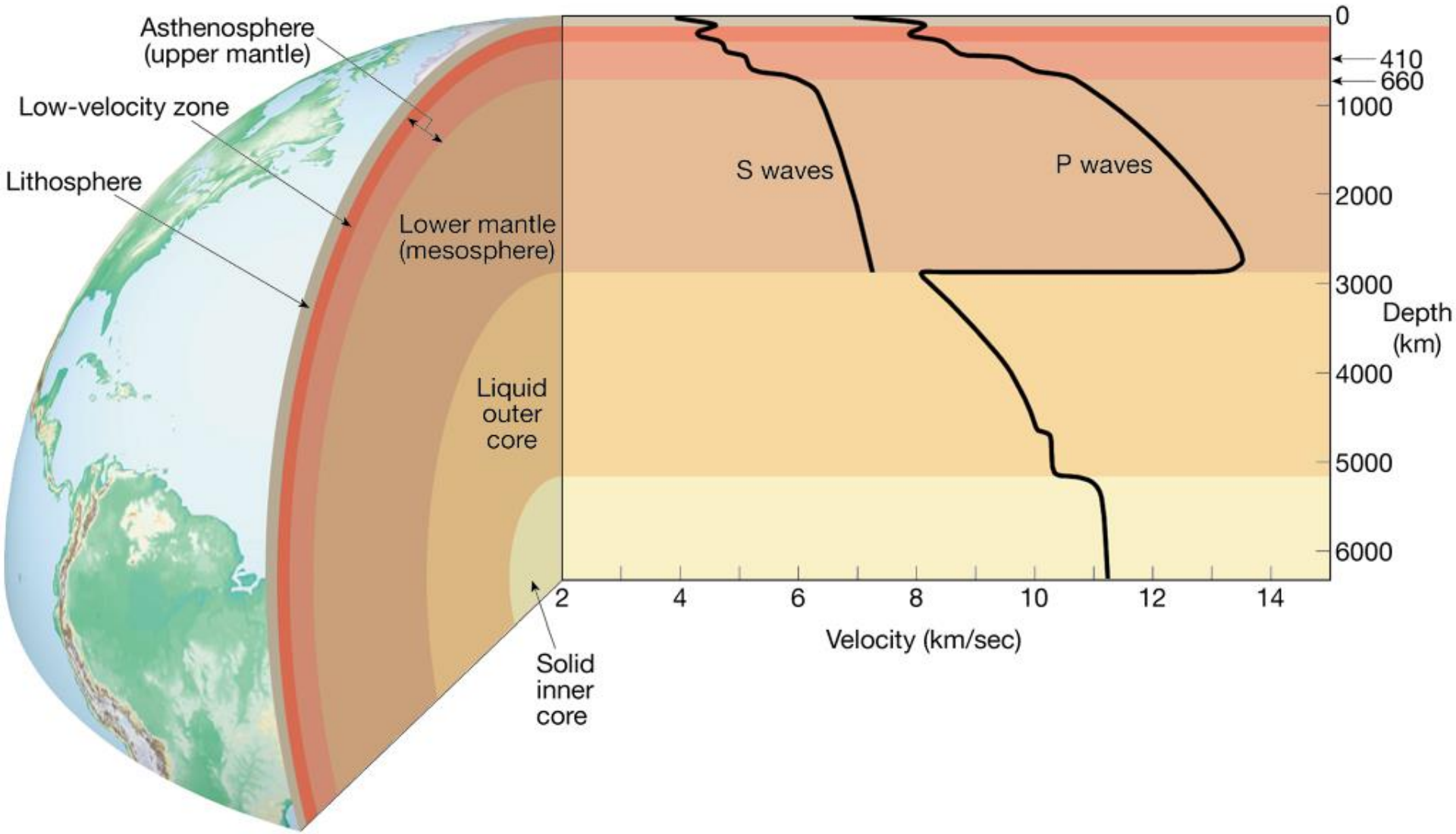
The deepest mine in the world is only 3.3 km deep, and nobody has ever been able to drill down further than 15 km


The suction above the hole resulted in several helicopter crushes, so all flight above the hole now is prohibited.

Earth's interior — Layers of earth inferred by earthquake waves

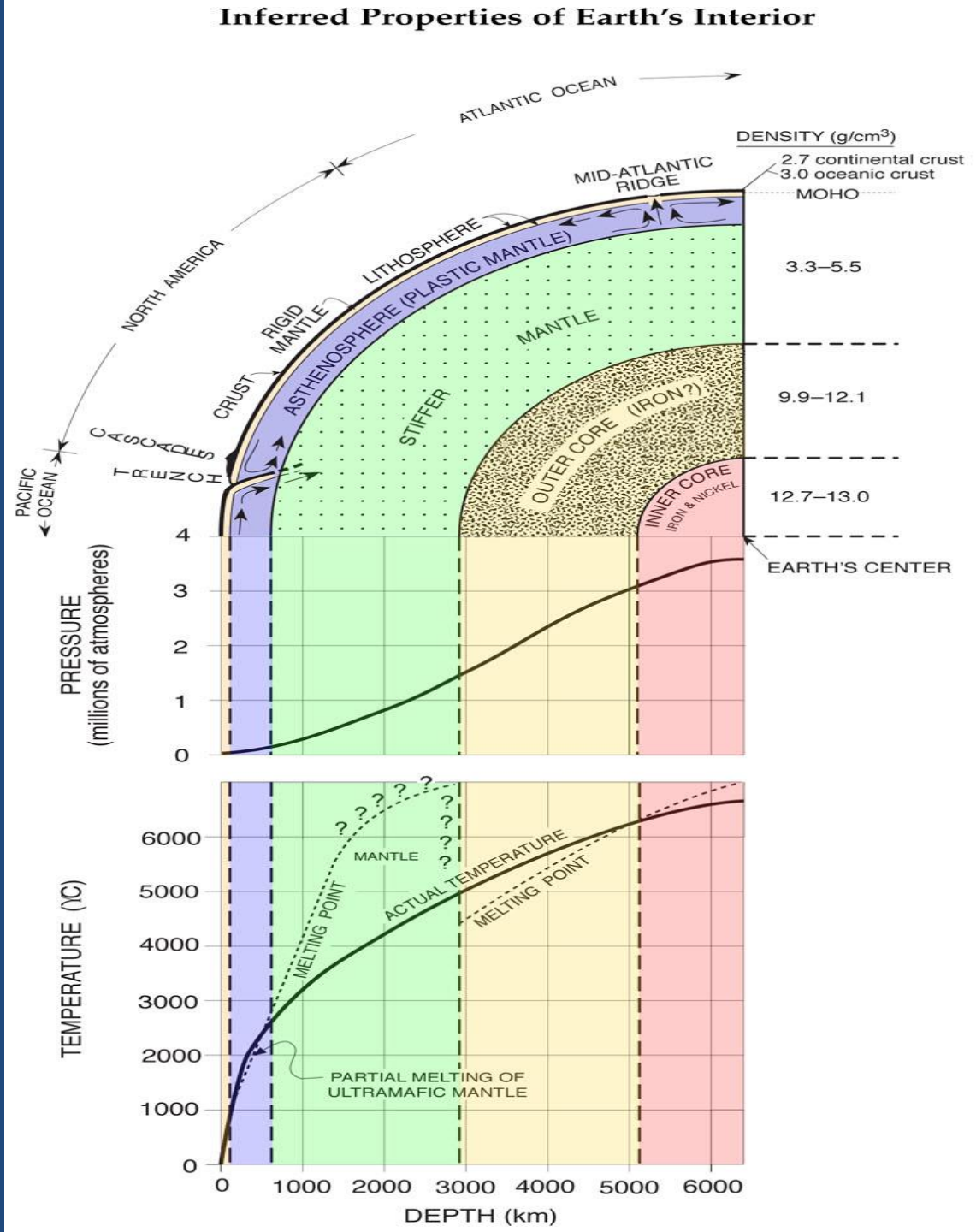
ESRT page **10**





Earth's Interior

Reference Table pg 10



Complete page 4 and 5 in note packet

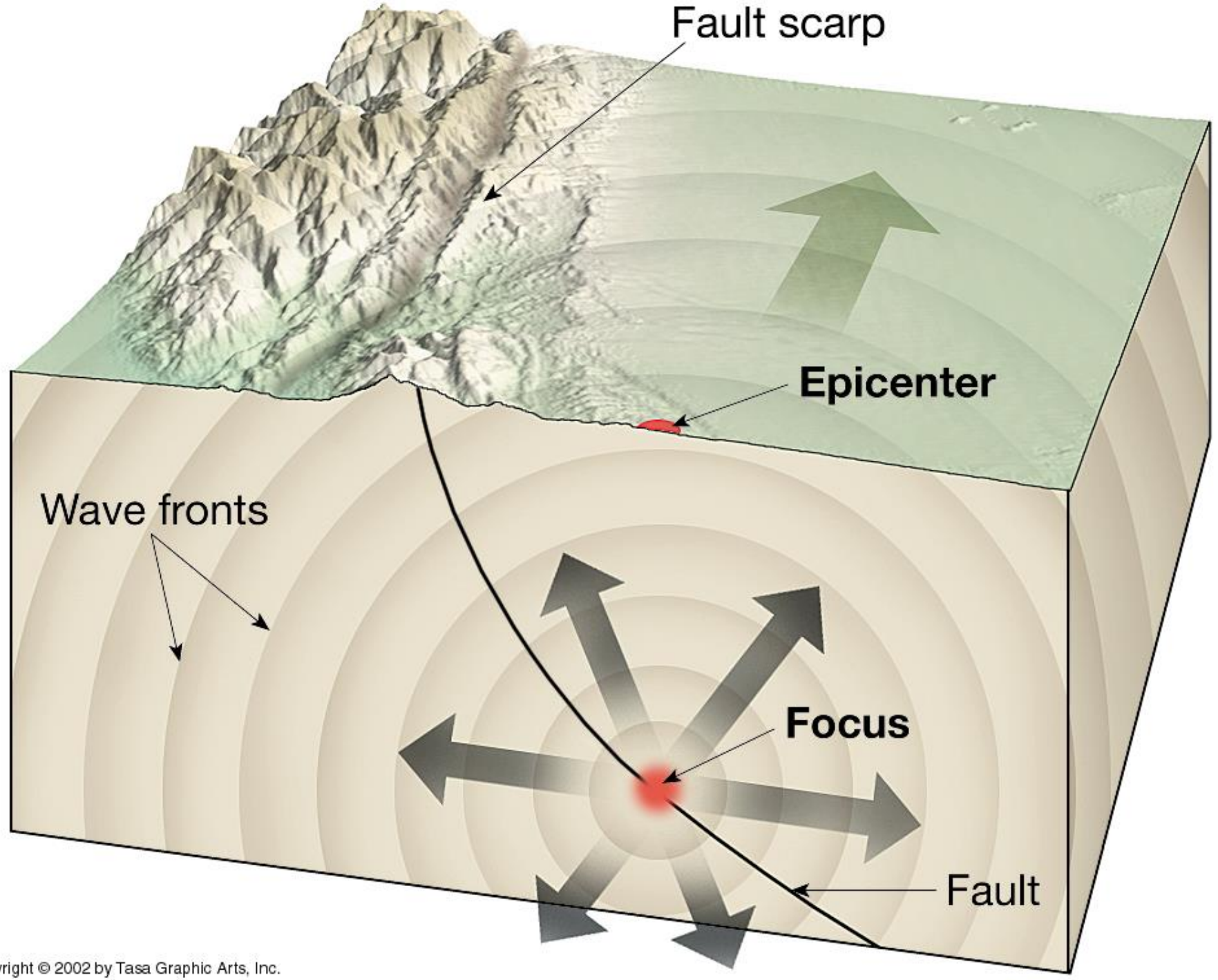
Earthquakes

1. What is an earthquake? **Shaking of the Earths crust caused by a release of energy**

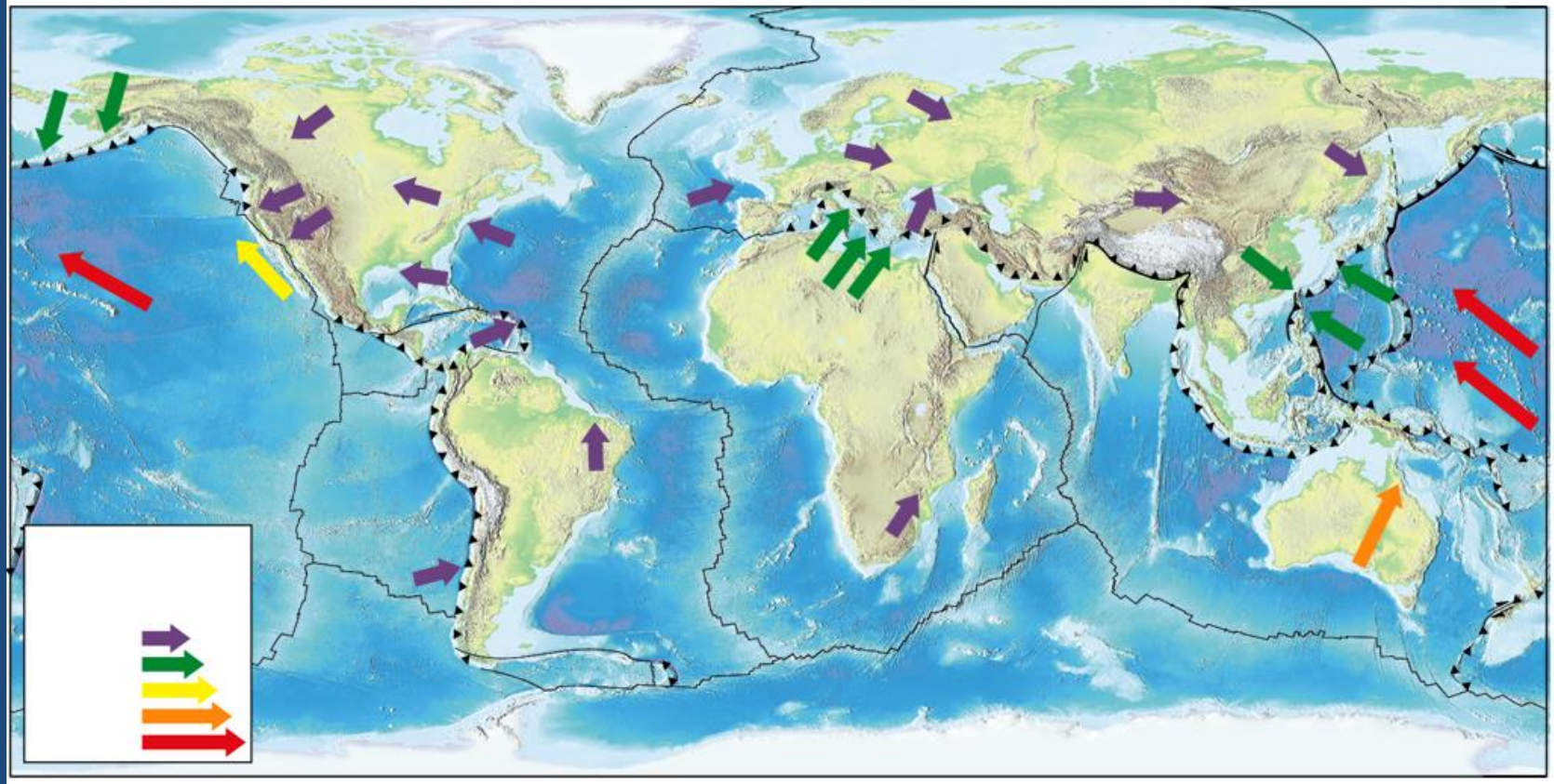
2. Possible causes? **Interaction between lithospheric plates**

3. Damages

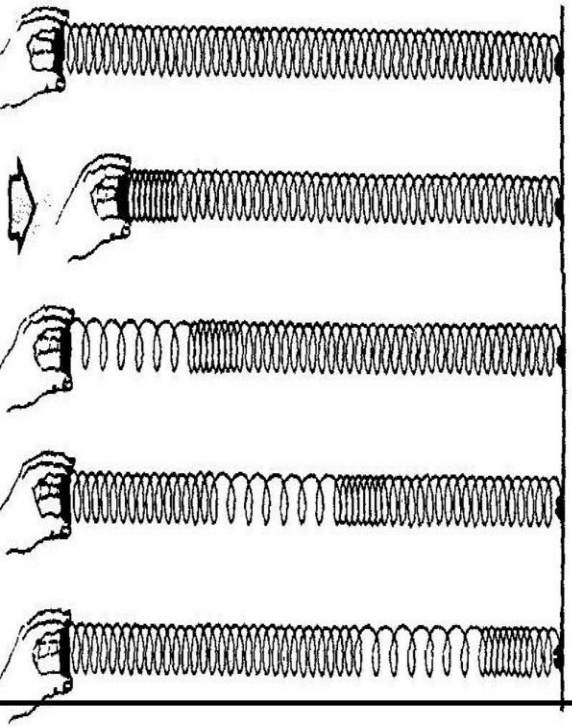
Building and bridge collapses, fires, water shortage



6. Most earthquakes and volcanoes occur at or near **Plate Boundaries**



Two Main Types of Earthquake Waves



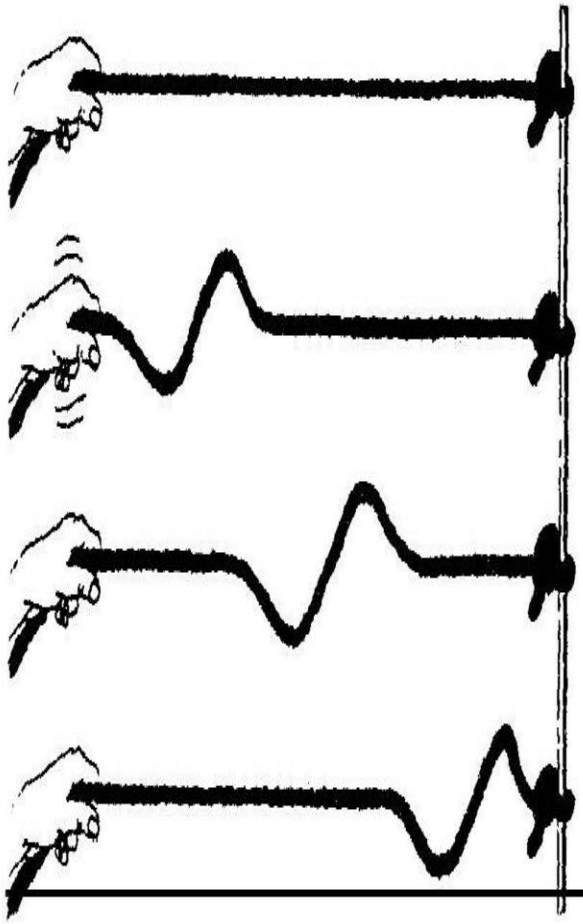
P – waves: **Compression / Primary Waves**

(1) **Back and Forth motion**

(2) **Travels the fastest**

(3) **Goes through everything (solid, liquid and gas)**

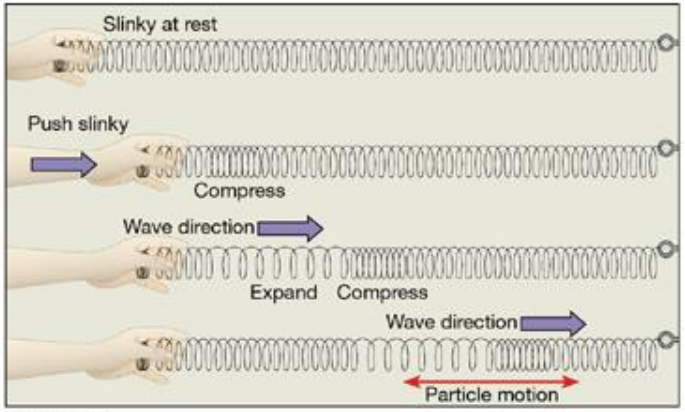
S – waves: **Shear / Secondary Waves**



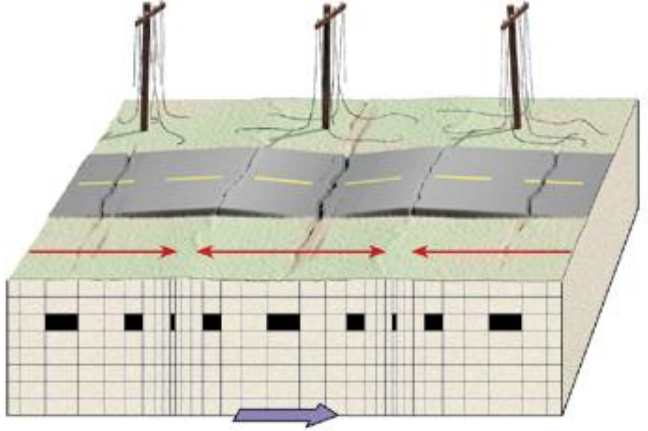
(1) **Travel perpendicular to direction of movement**

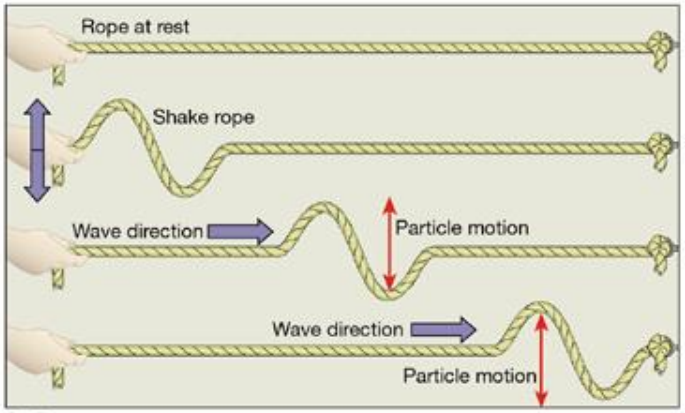
(2) **Slower then P-Waves**

(3) **Only goes through solids**

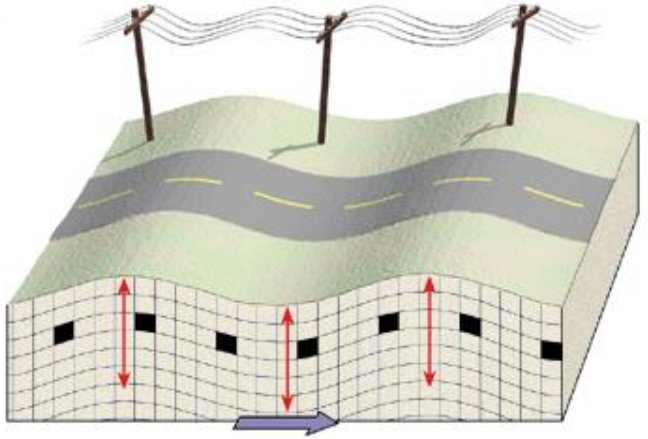


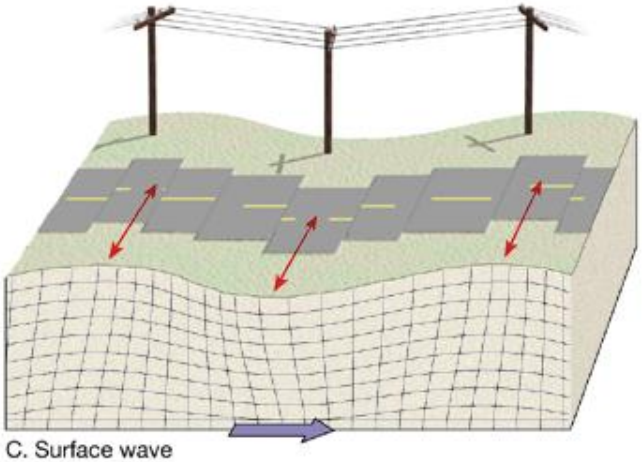
A. P wave



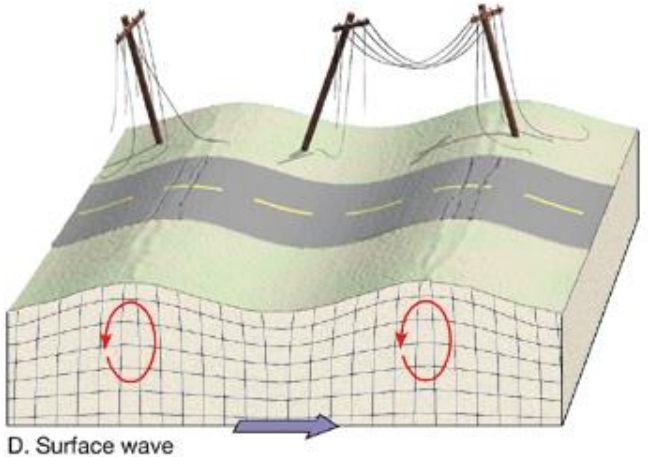


B. S wave





C. Surface wave



D. Surface wave

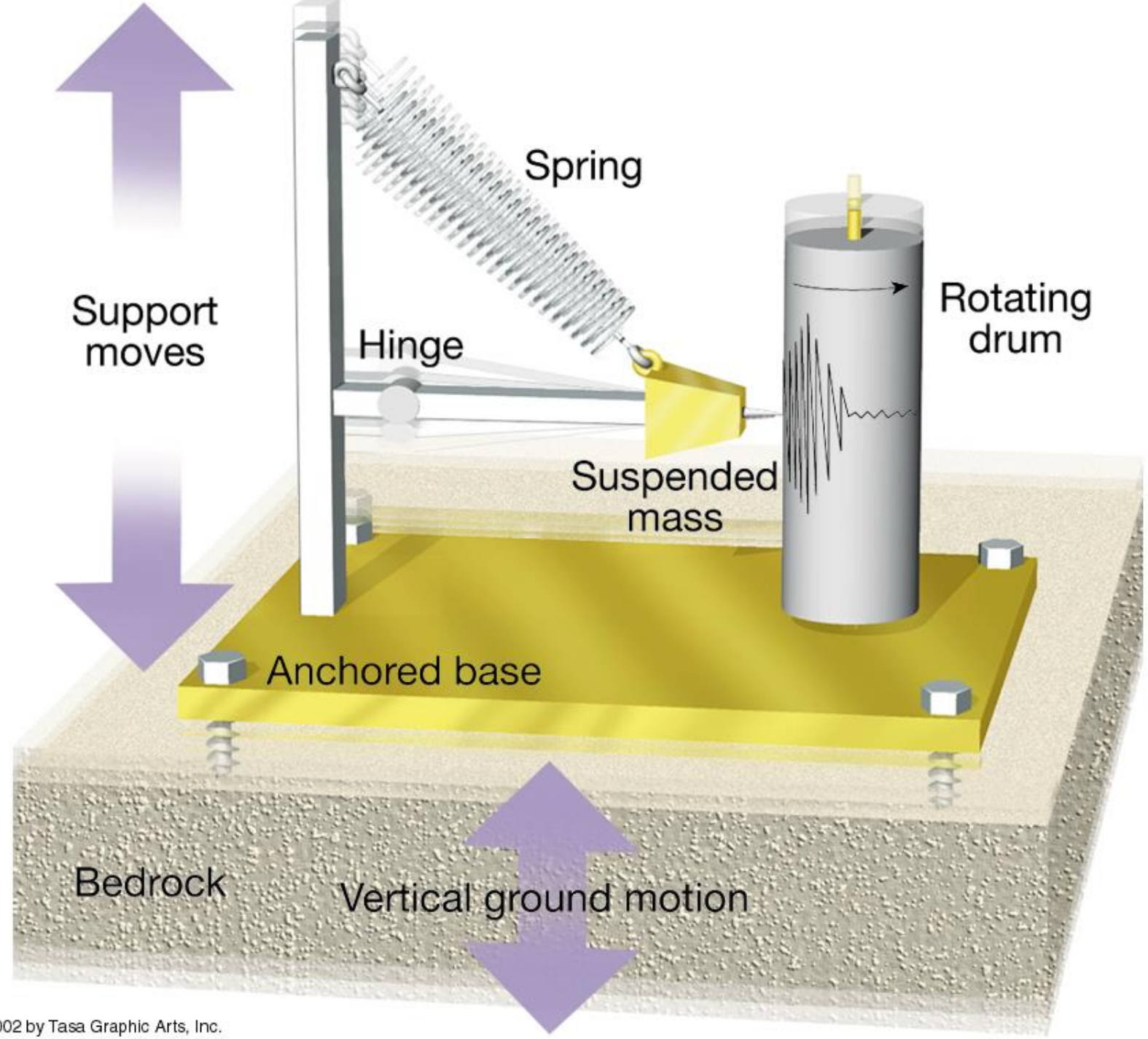
Measuring an Earthquake

Richter scale - **Measures an earthquakes magnitude**

- Uses seismograms

- Each successive number is 10x greater then the previous

Richter number	Increase in Magnitude
1	1
2	10
3	100
4	1,000
5	10,000
6	100,000
7	1,000,000
8	10,000,000
9	100,000,000



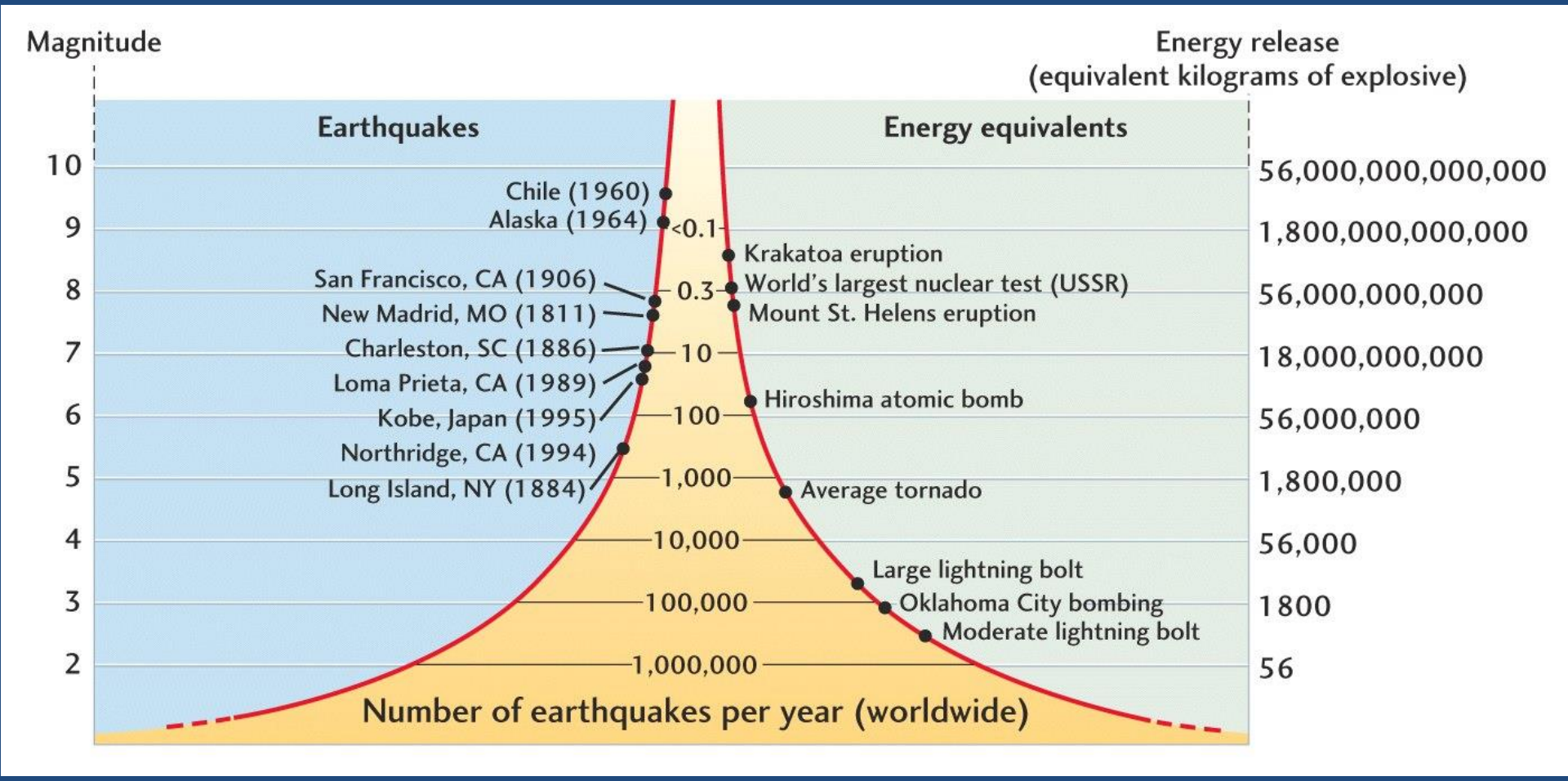
Mercalli Scale -

Measures an earthquakes intensity

- Based on reports from people who experienced the event

* It is subjective

Earthquake Magnitude Scale



Magnitude 6.7

Magnitude 6.9

Magnitude 6.9

Magnitude 7.4

Magnitude 8.5

Determining the arrival time differences between P-waves and S-waves using the chart:

1. Find the distance on the bottom of the chart

2. Place a piece of scrap paper vertically (up and down) for that distance

3. Mark the scrap paper where the S-wave and P-wave touch it

4. Move the scrap paper to the left of the chart. Place one mark at zero and read the time using the mark above it.

Complete bottom of page 7 in notes packet

Determining distance of an earthquake by using differences in P-wave and S-wave arrival times.

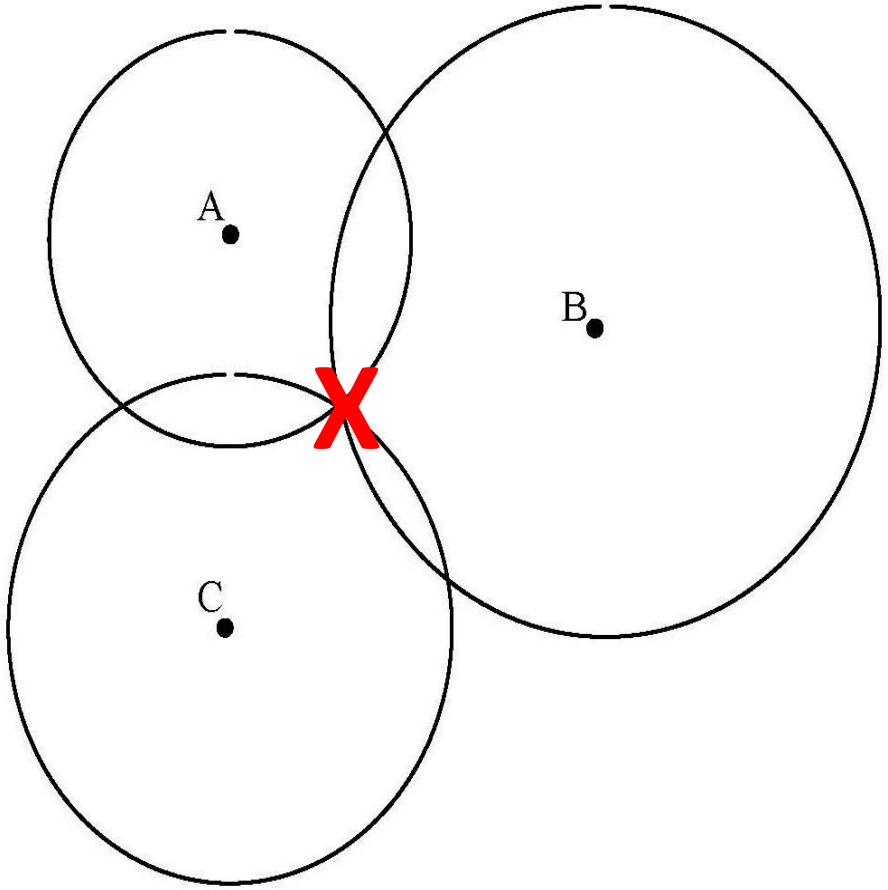
1. Place a piece of scrap paper on the left side of the chart
2. Mark the zero and the arrival time difference on the scrap paper
3. Keep the scrap paper vertical and move it to the right until the top mark is touching the S-wave line and the zero mark is touching the P-wave line
4. Follow the paper down and read the chart to determine the distance

Complete page 8 and 9 in notes packet

Locating the Epicenter

A minimum of 3 seismic stations are needed to locate an earthquake epicenter.

- One seismic station gives you distance only, and not direction
- Two stations may give you 2 possible locations where the two circles intersect
- When 3 stations are used, the epicenter is where they all intersect



a. Which seismic station is closest to the epicenter? A

How can you tell by the diagram?

The smallest circle

b. Which seismic station is farthest away from the epicenter? B

How can you tell by the diagram?

The largest circle

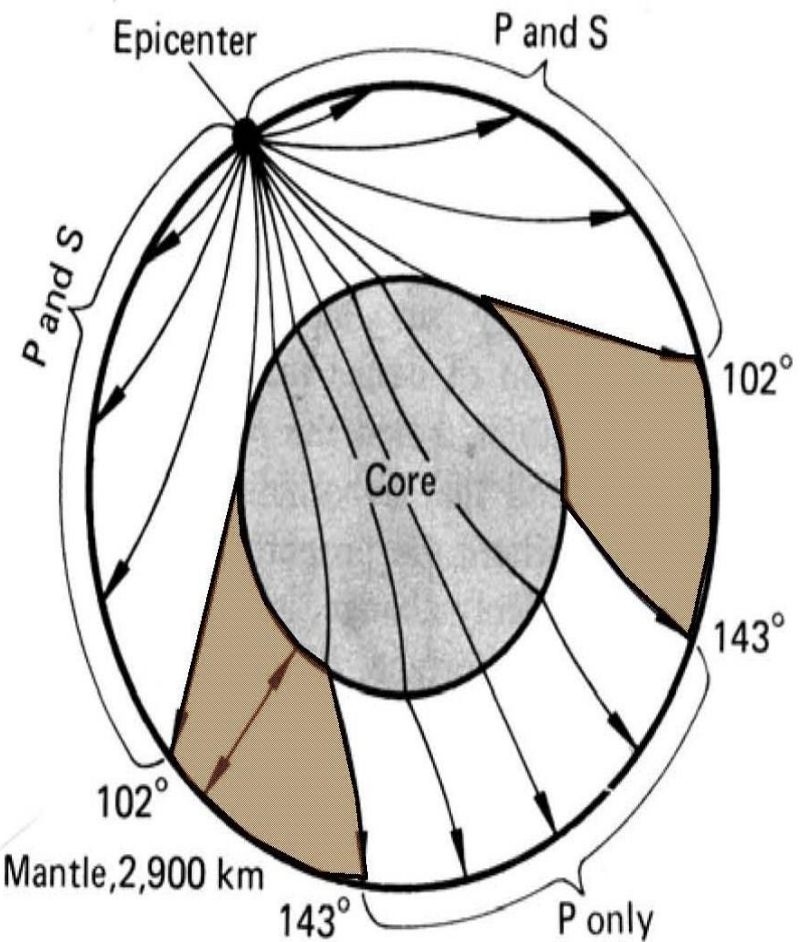
c. Describe where the epicenter is.

Where all 3 circles intersect

d. Place an "X" at the epicenter.

Shadow Zone Diagram

As P-waves and S-waves pass through different layers within Earth's interior they are **refracted (bent)** due to differences in **density**



Some areas on Earth's surface only receive P-waves, because S-waves can only travel through **solids** and the **outer core** is liquid.

Other sections on Earth's surface receive no earthquake waves because of the way the waves **bend** within the Earth

These areas are known as the **shadow zone**

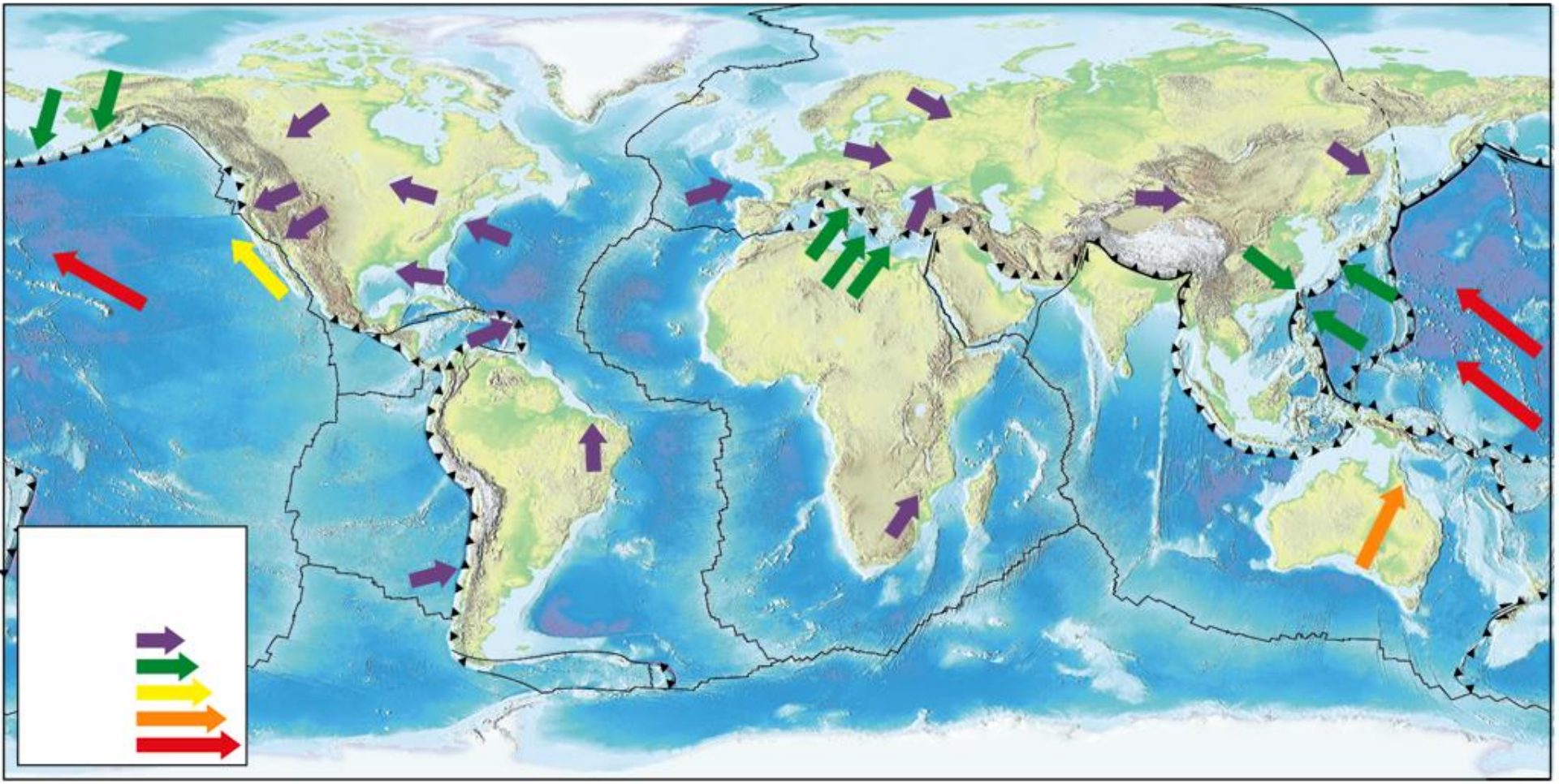
Complete Epicenter Practice, Lab, then pages 11 – 15 in notes packet

Plate Tectonics

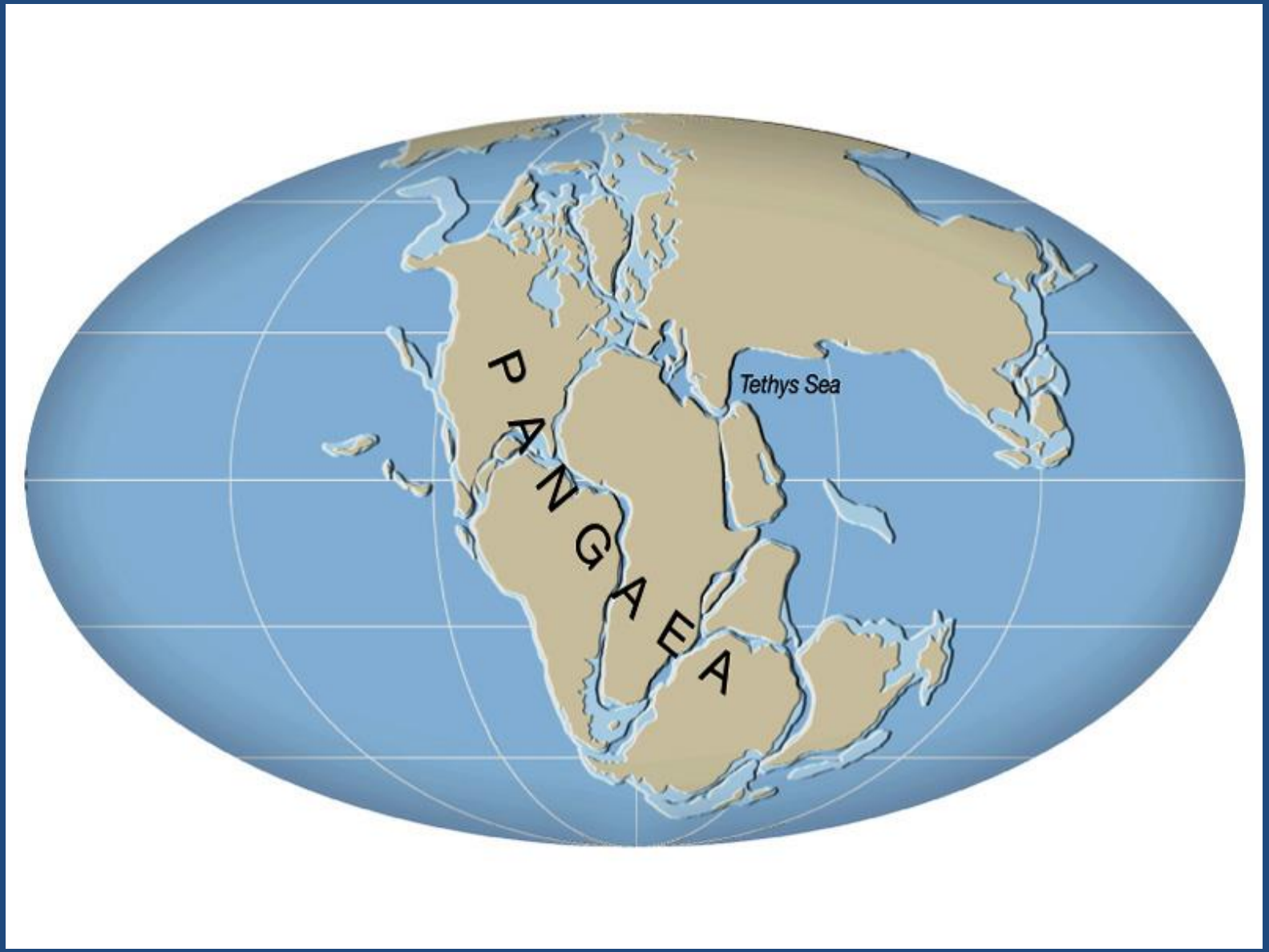
Continental Drift: - The theory that Earth's crust is floating on a fluid-like material that allows it to move.

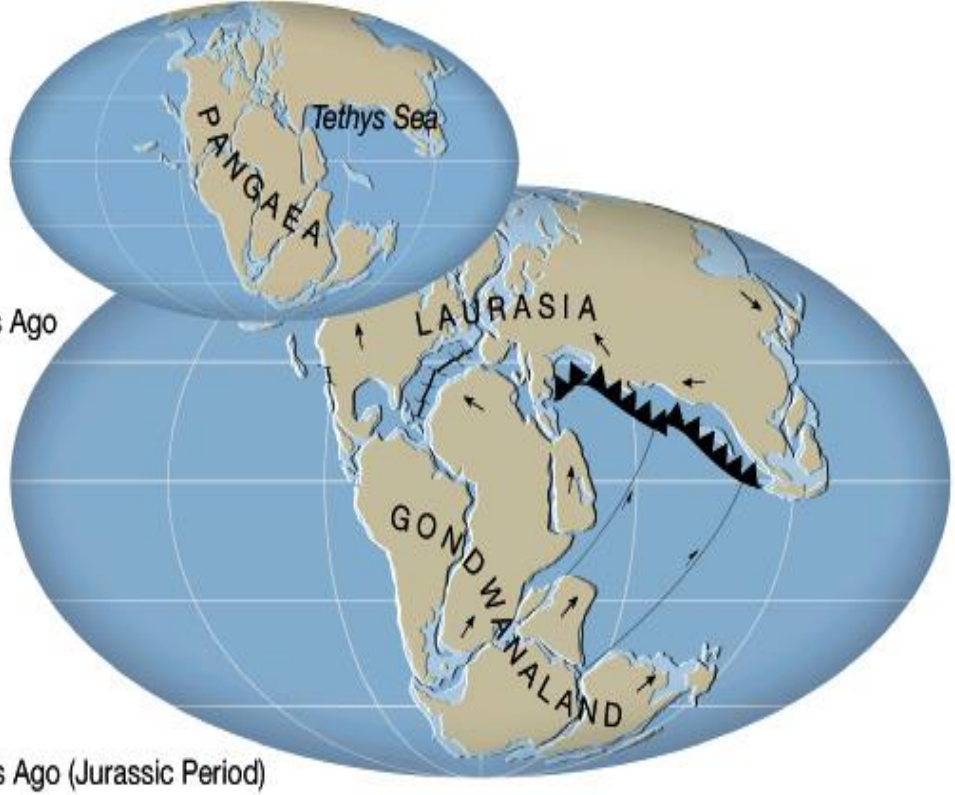
- The crust is broken up into pieces called plates that move relative to each other.

Pangea Supercontinent – one large land mass



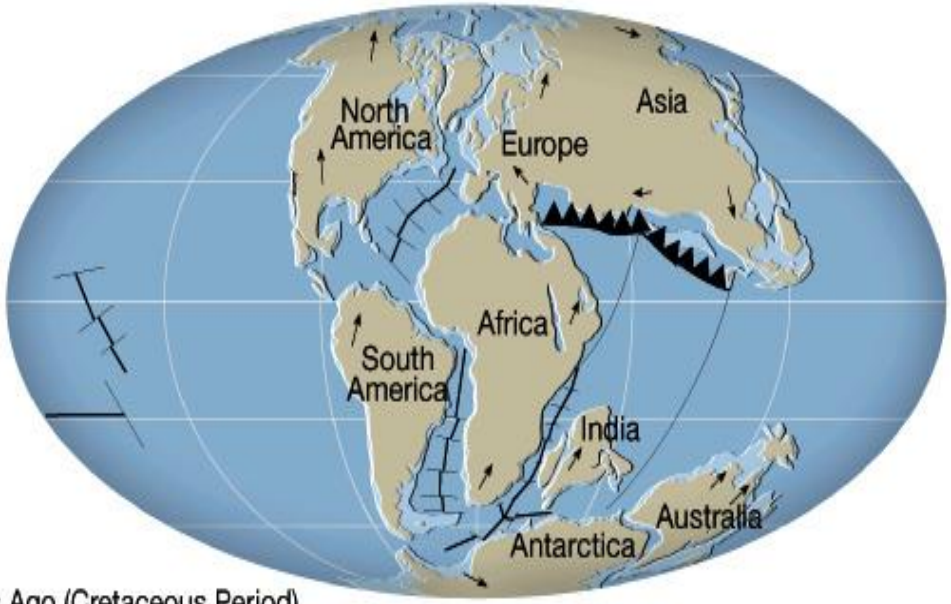
Pangaea: Supercontinent – one large land mass





A. 200 Million Years Ago

B. 150 Million Years Ago (Jurassic Period)



C. 100 Million Years Ago (Cretaceous Period)

Evidence for Continental Drift

Shape of Coastline

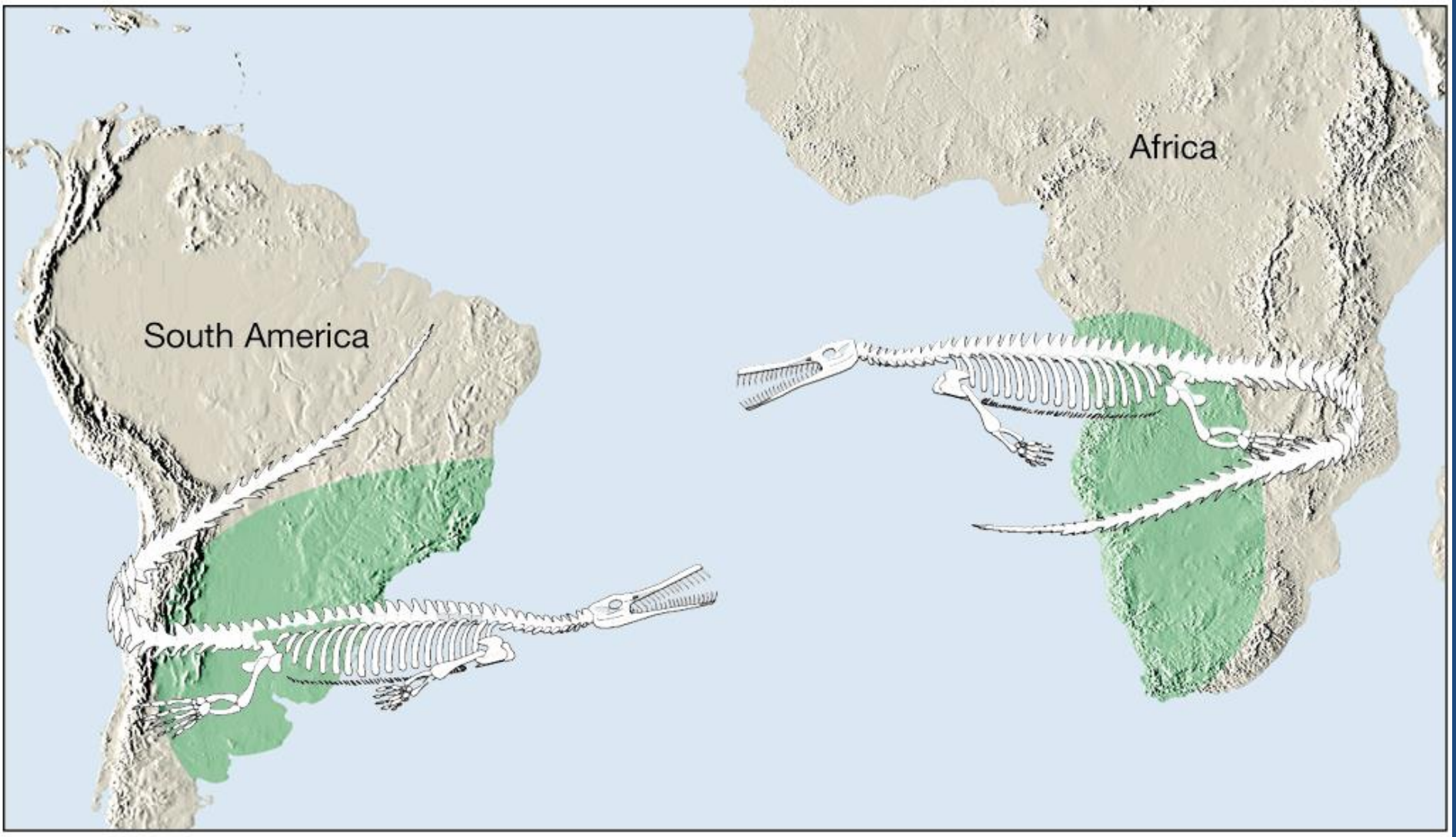
Continents fit together like a jigsaw puzzle

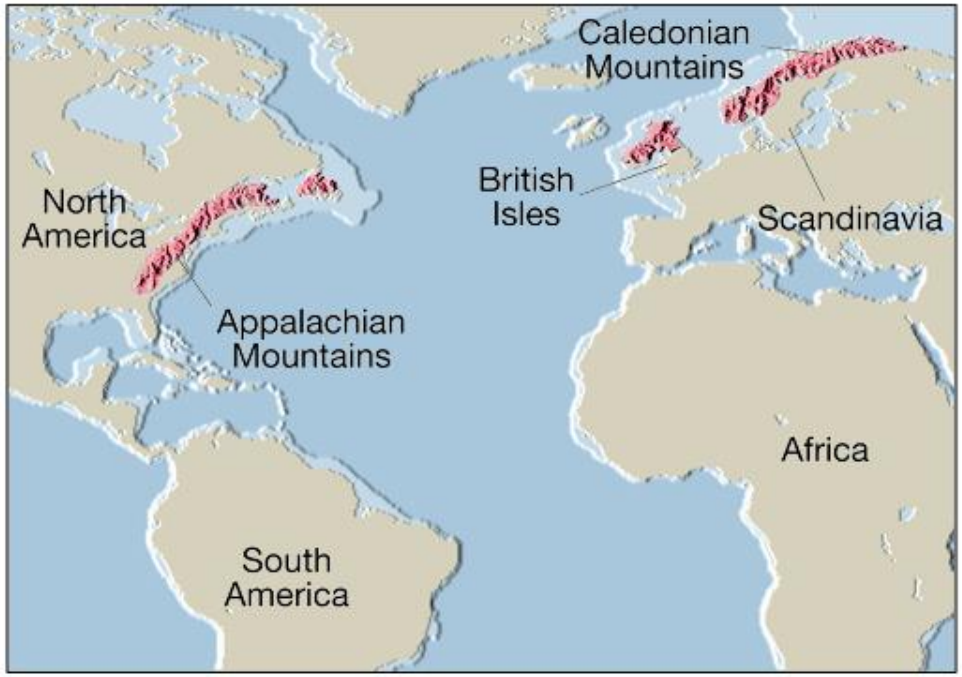
Correlations

Fossils and Rocks match across oceans

Climate Changes

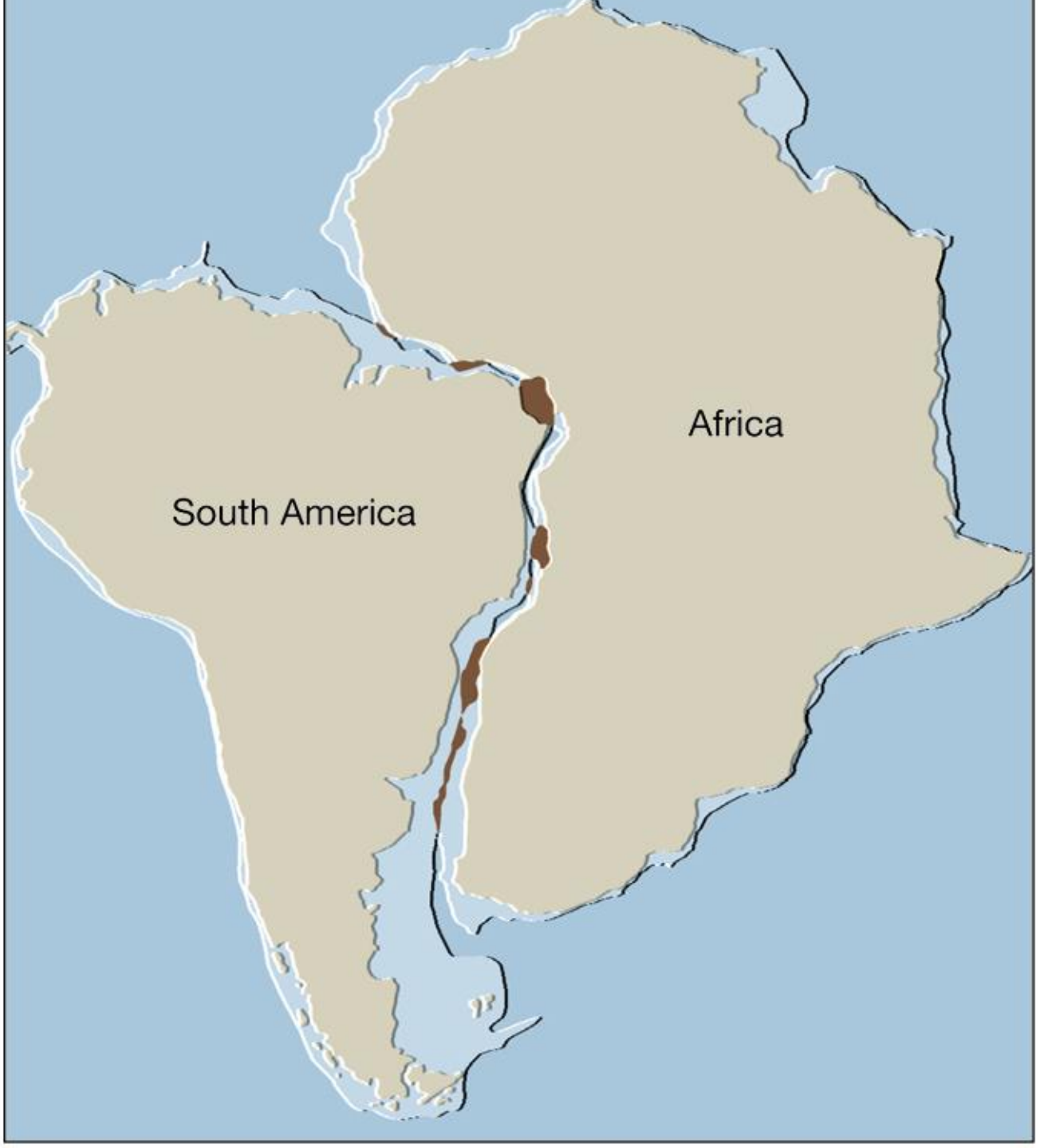
Coal found in Antarctica, glacier striations in Australia and Africa

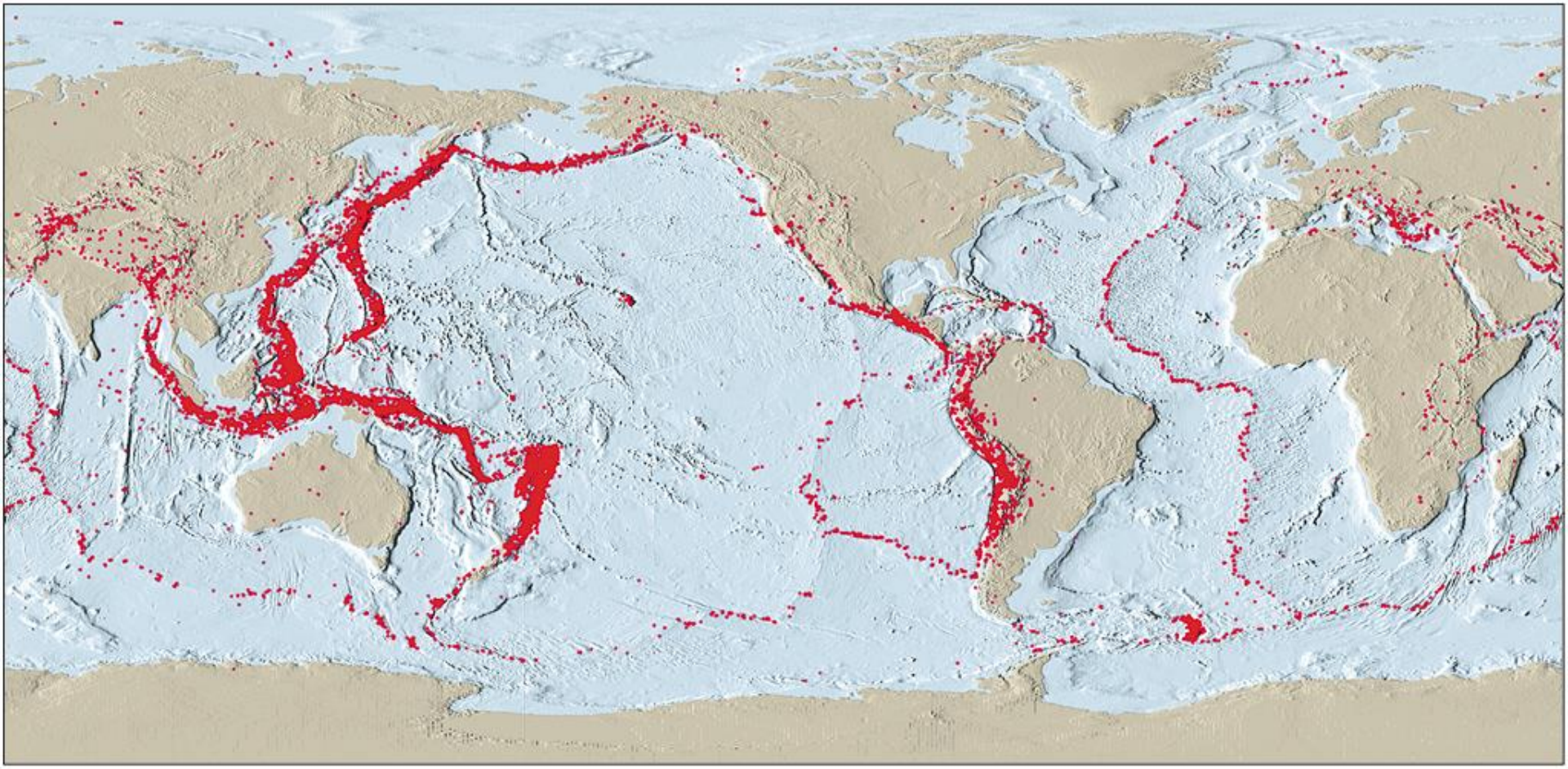


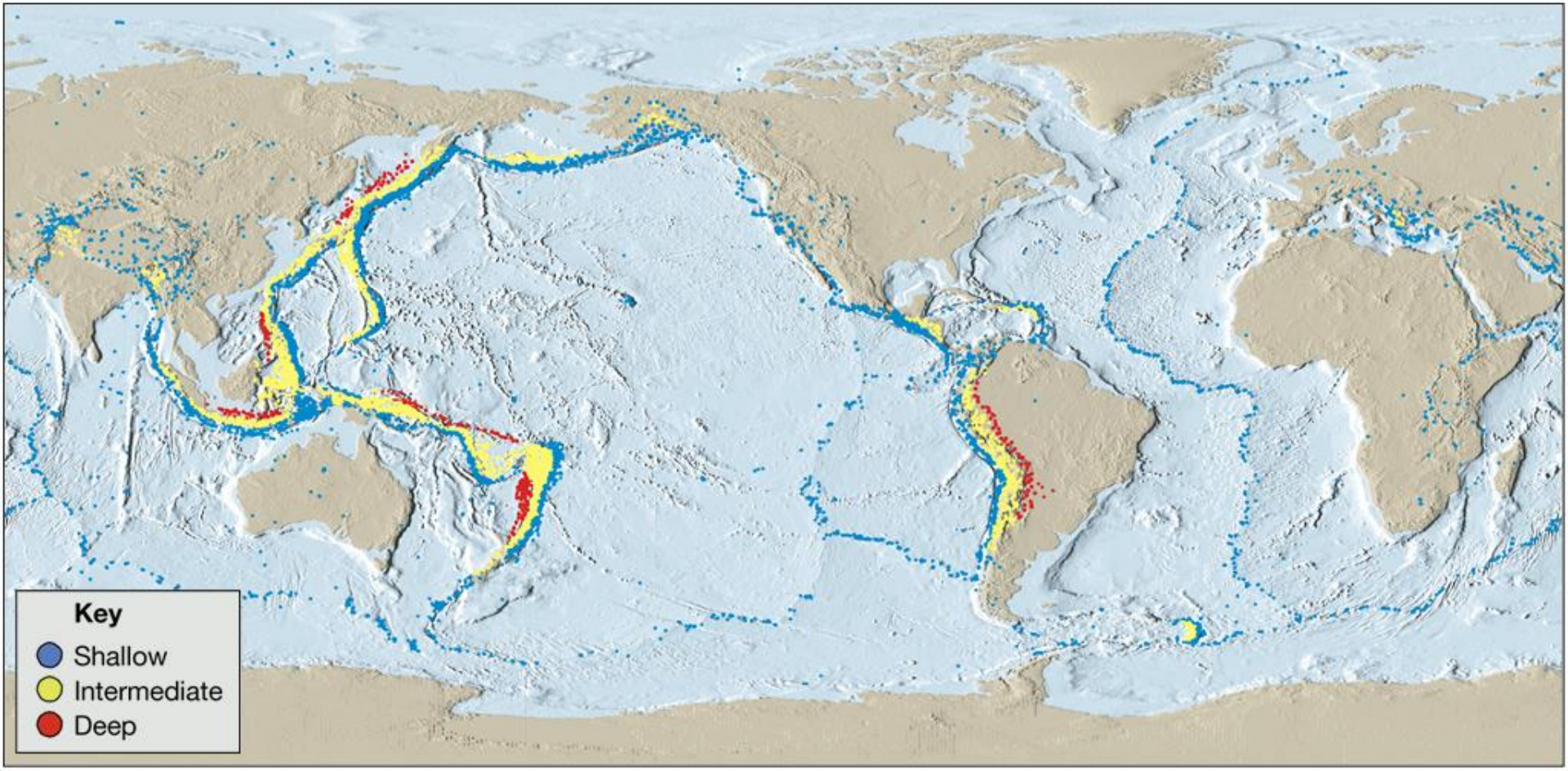


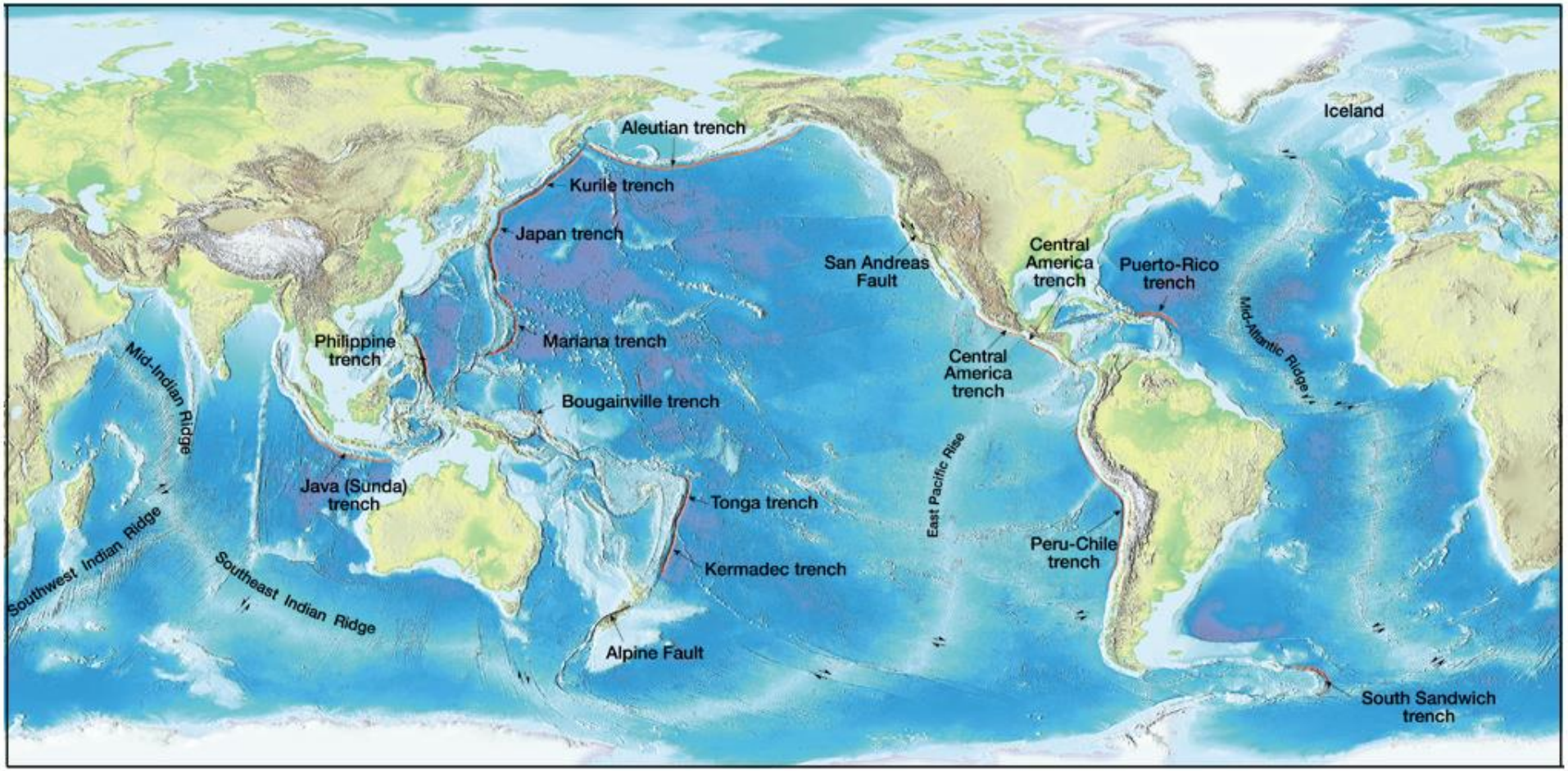
A.

B.





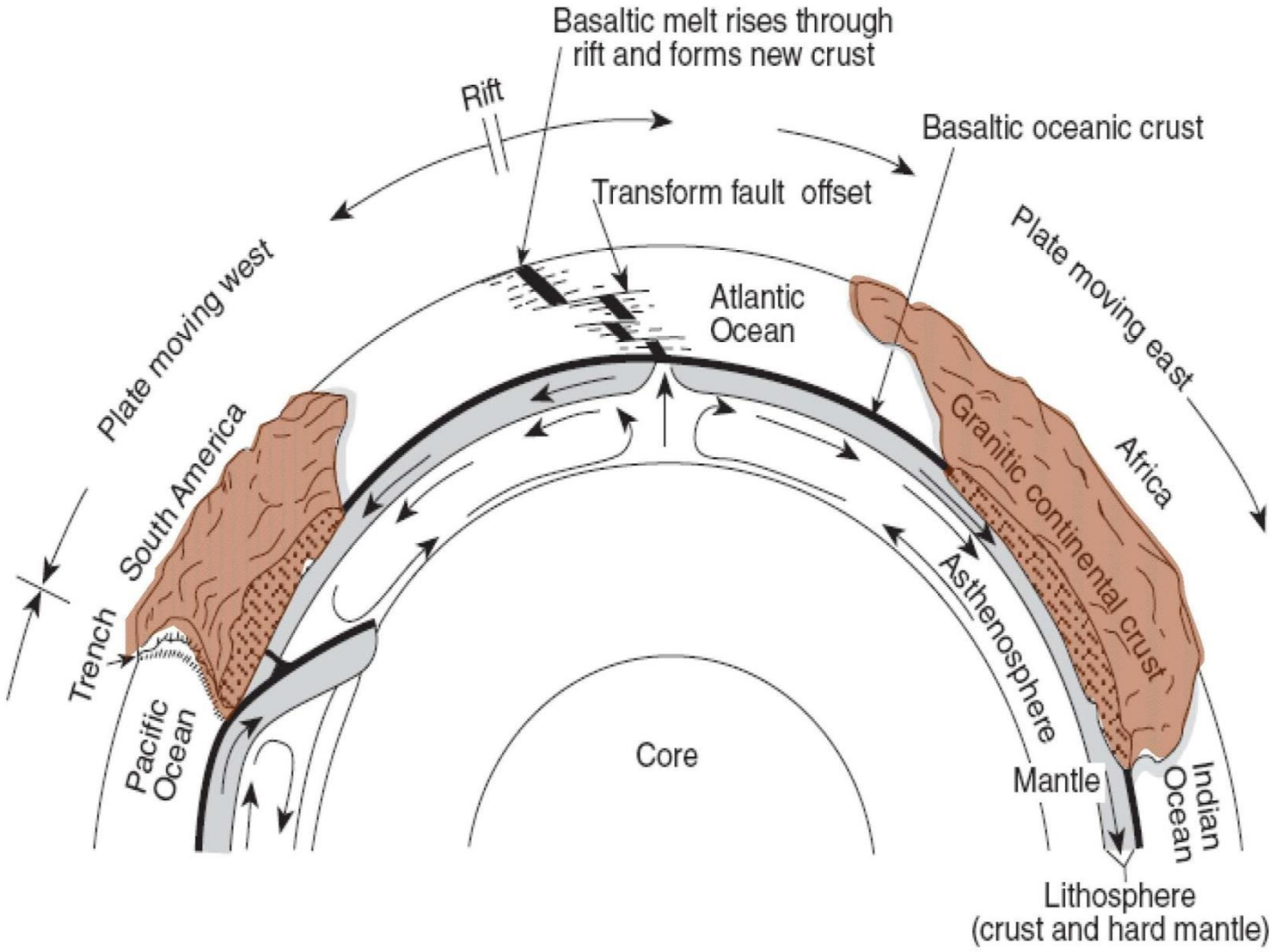


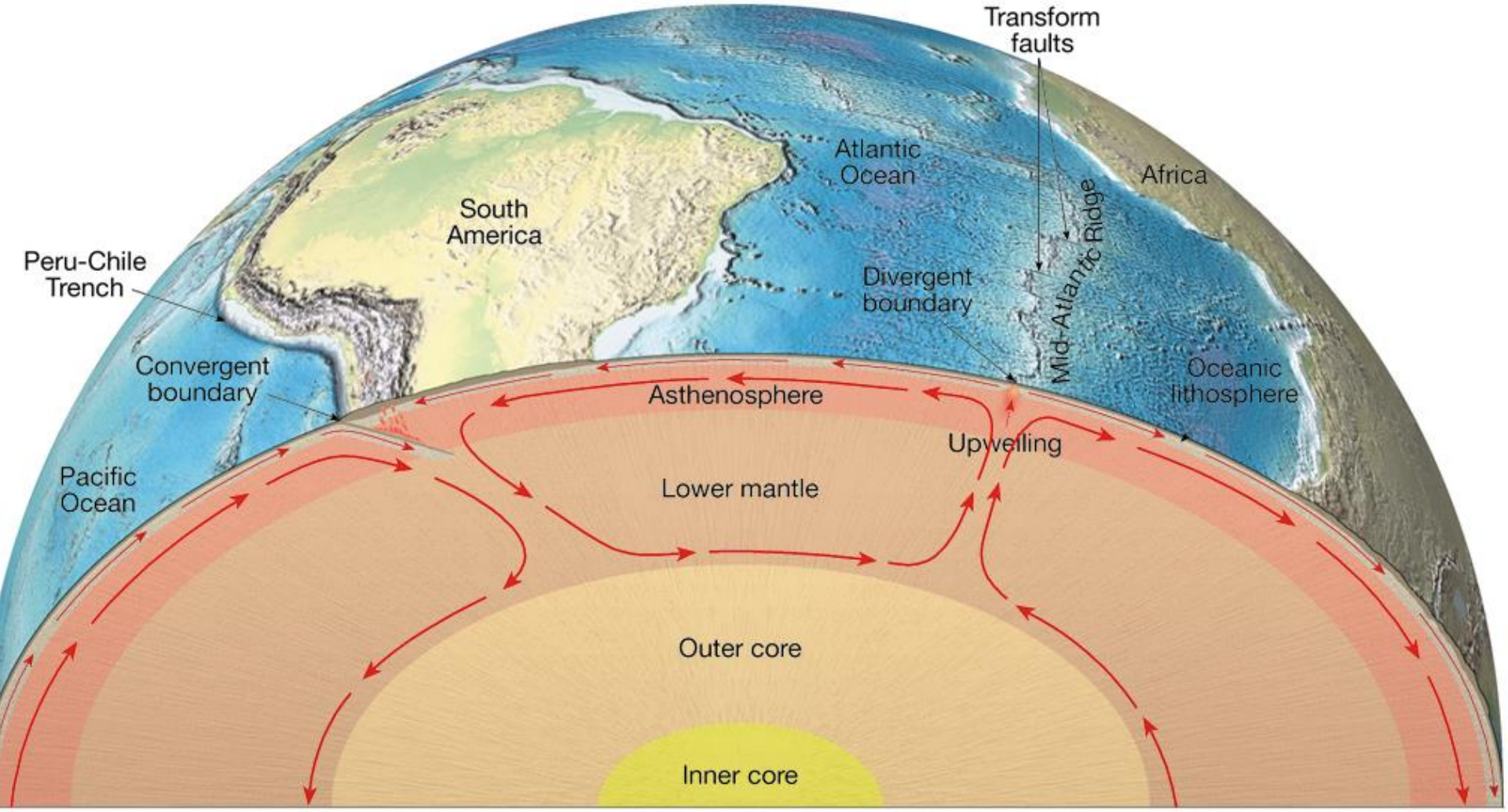


Fact(s) to memorize: 13, 14, & 15

Movement of Plates

Convection currents in the asthenosphere move the plates that rest on top of it.





Convection currents — Currents that drive plate movement due to differences in density

Rising currents
- Hot, less dense rock rises
- Causes plates to move apart
- Divergent plate boundaries

Falling currents
- Cold, more dense rocks sink
- Causes plates to come together
- Convergent plate boundaries

	Continental Crust	Oceanic Crust
Composition	Granite	Basalt
Density	2.7 g/cm3	3.0 g/cm3
Thickness	Thicker	Thinner

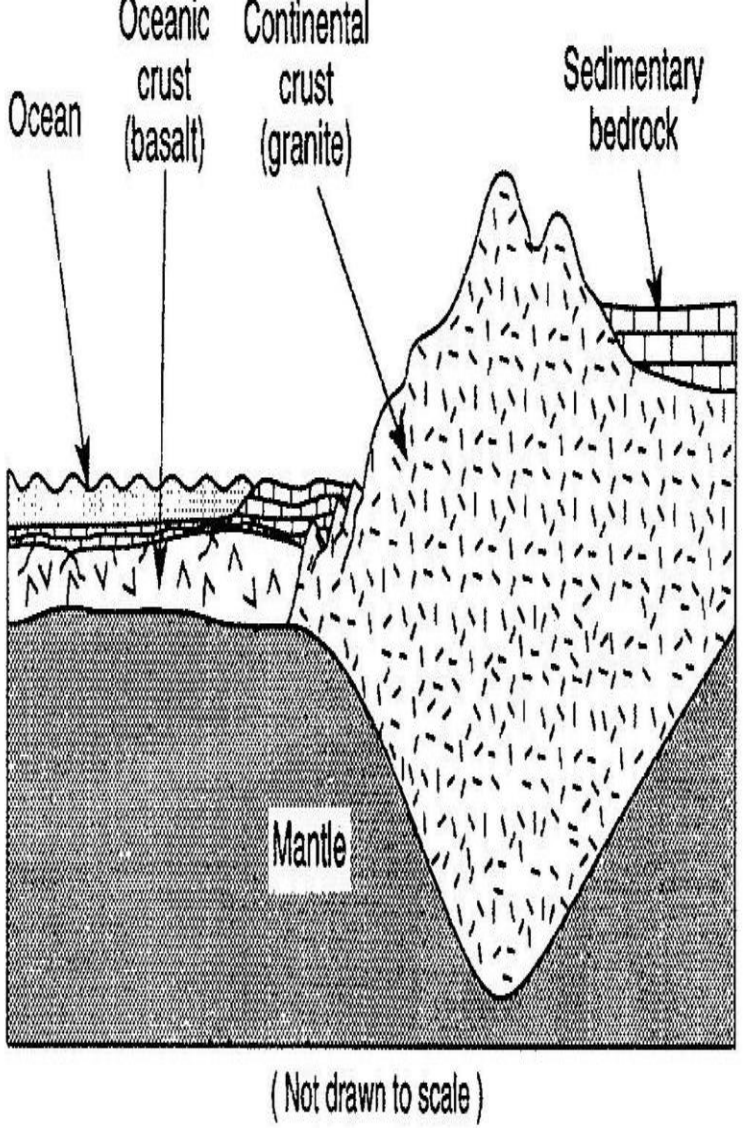


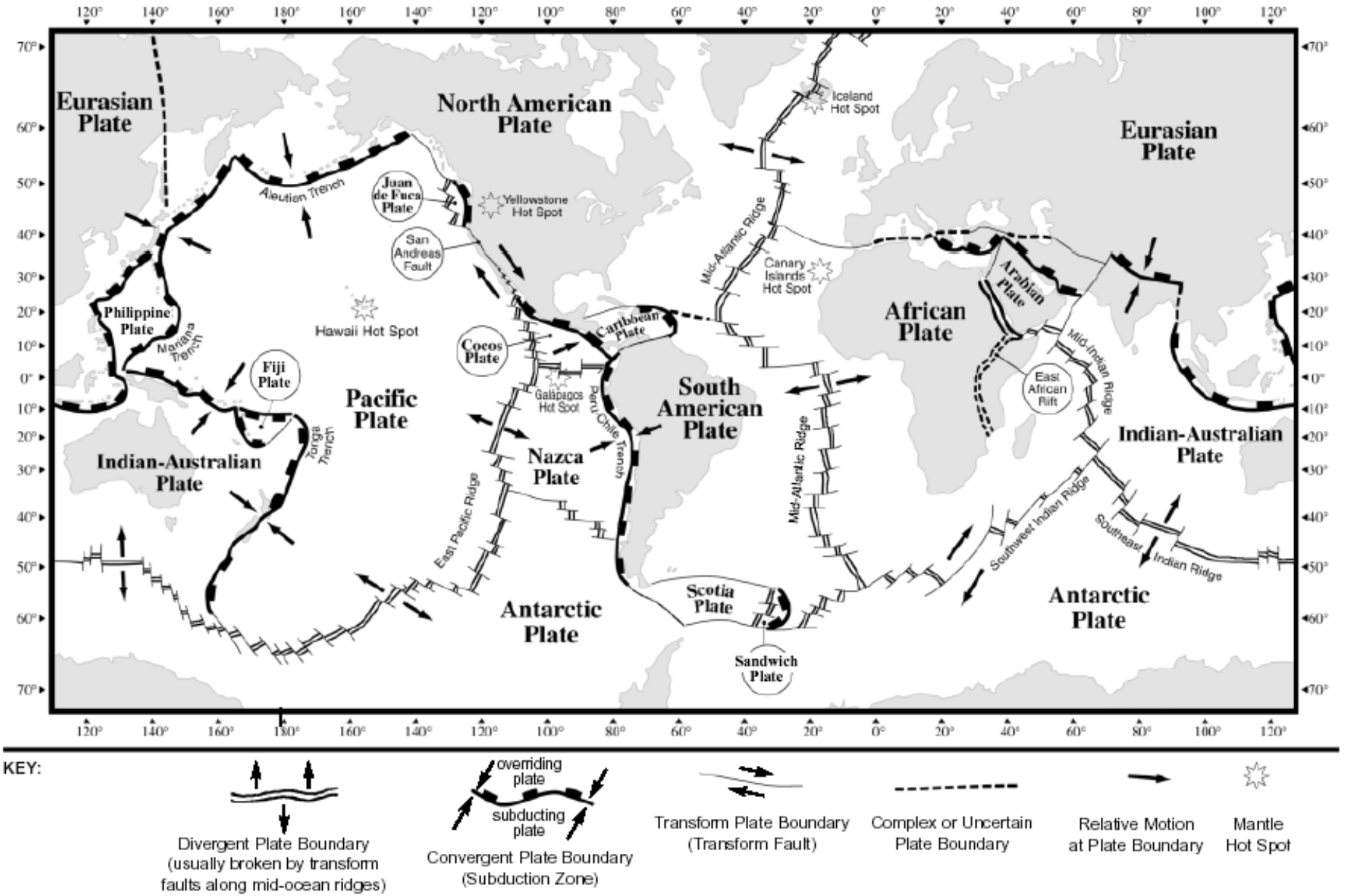
Plate Boundaries

When plates move they can:

1)Separate
2)Collide
3)Slide by each other

*Earthquakes, Volcanoes, and Mountain Building occur on Plate Boundaries

Tectonic Plates



KEY:

Divergent Plate Boundary (usually broken by transform faults along mid-ocean ridges)

overriding plate

subducting plate

Convergent Plate Boundary (Subduction Zone)

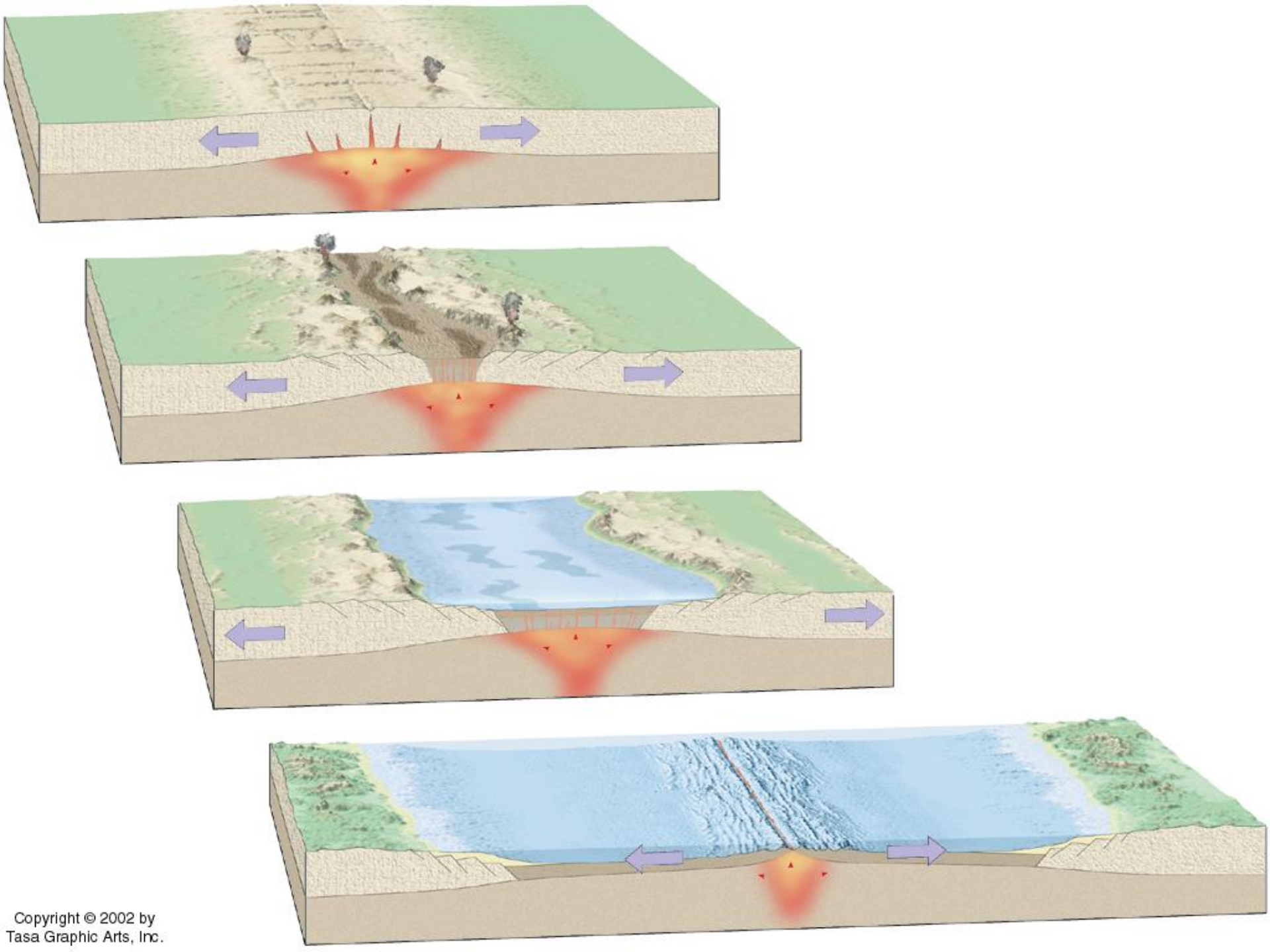
Transform Plate Boundary (Transform Fault)

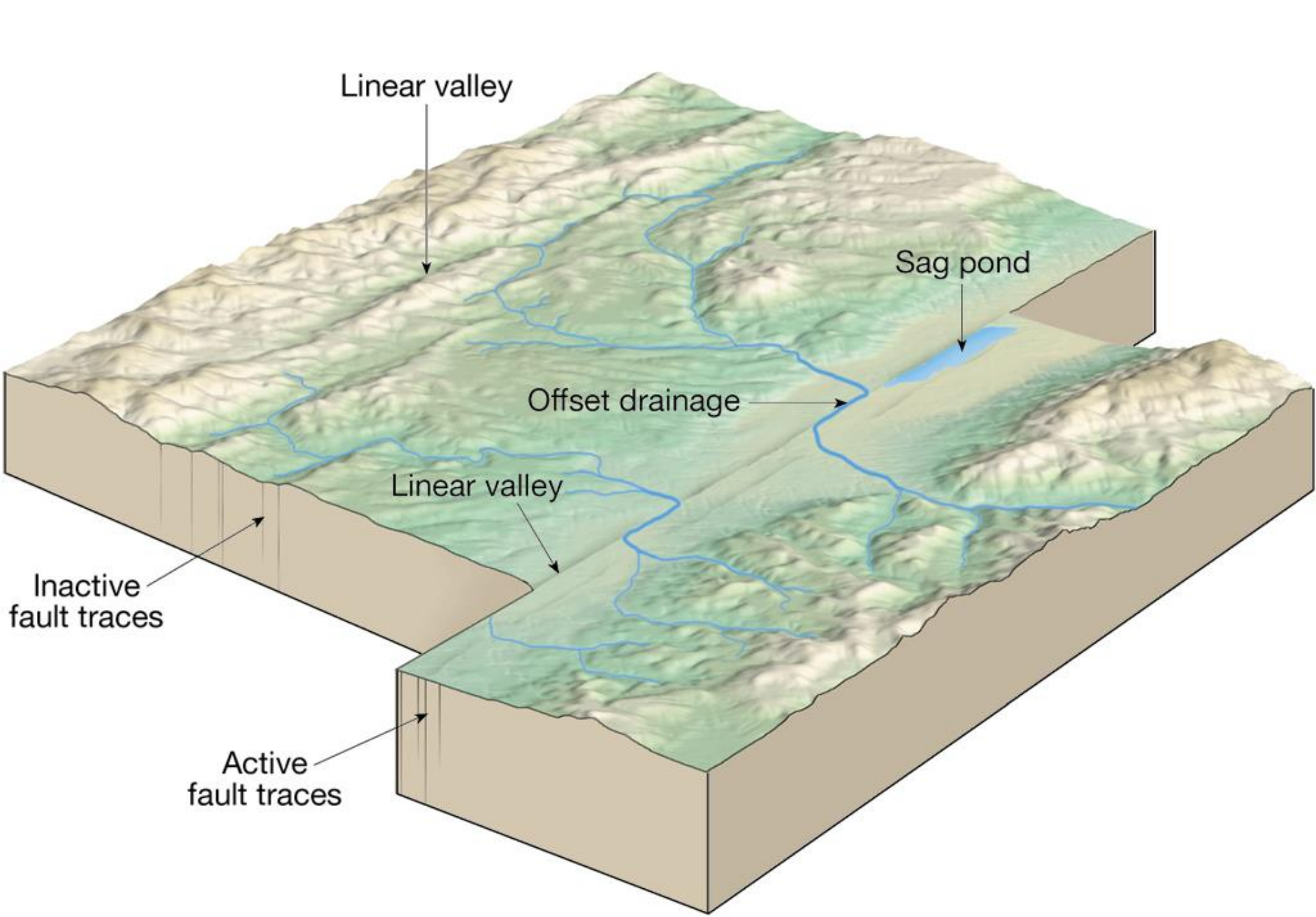
Complex or Uncertain Plate Boundary

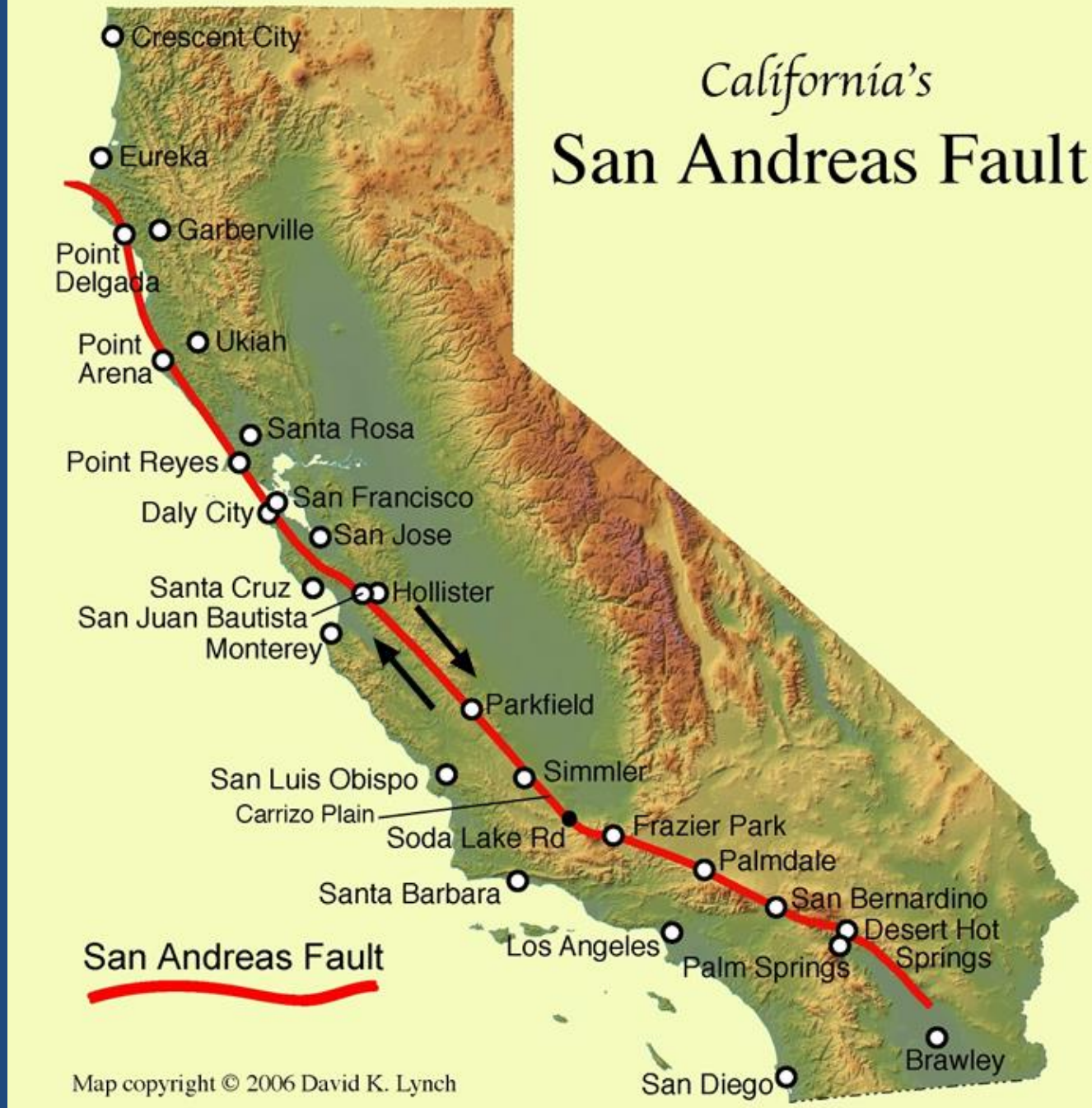
Relative Motion at Plate Boundary

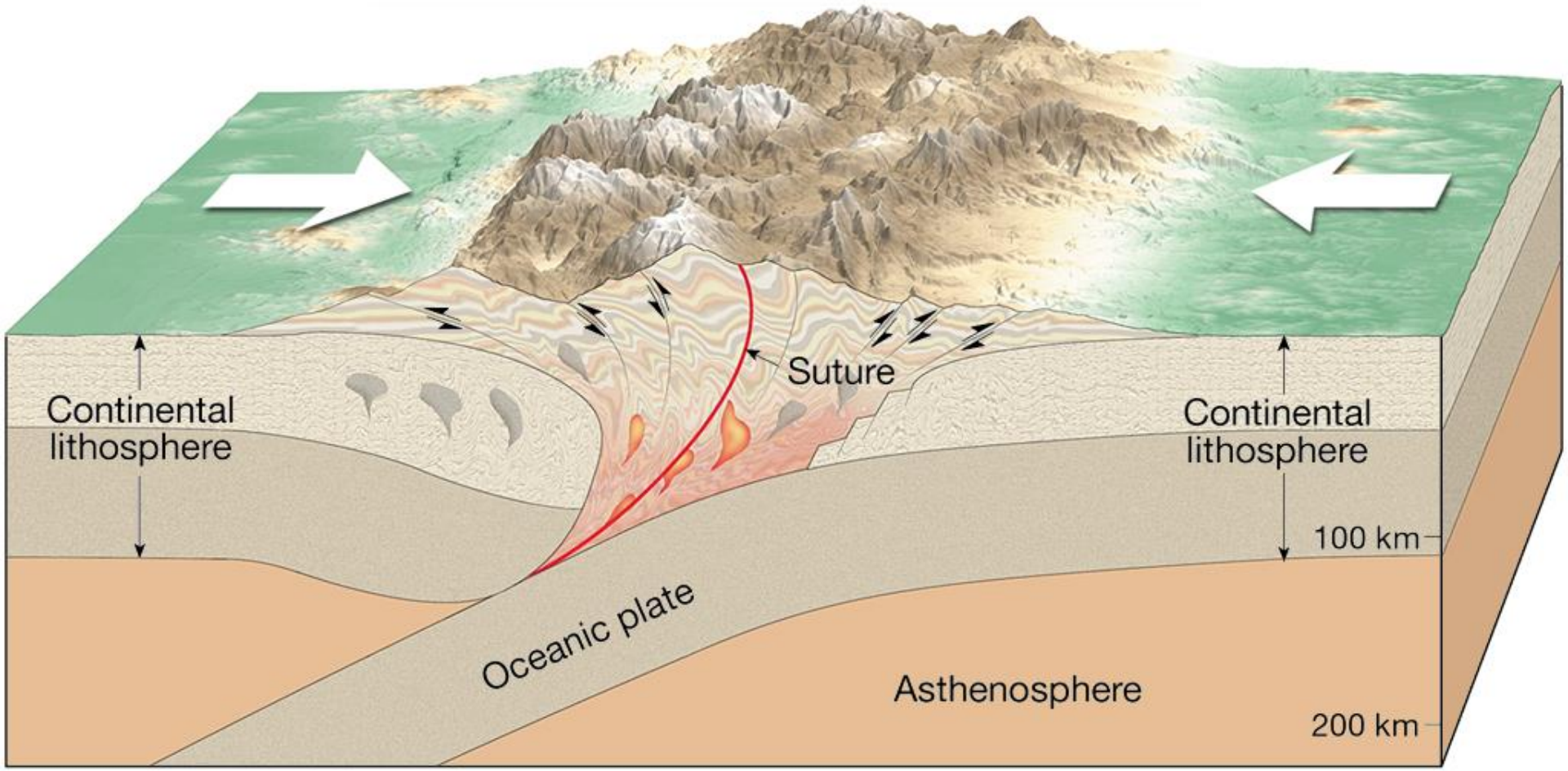
Mantle Hot Spot

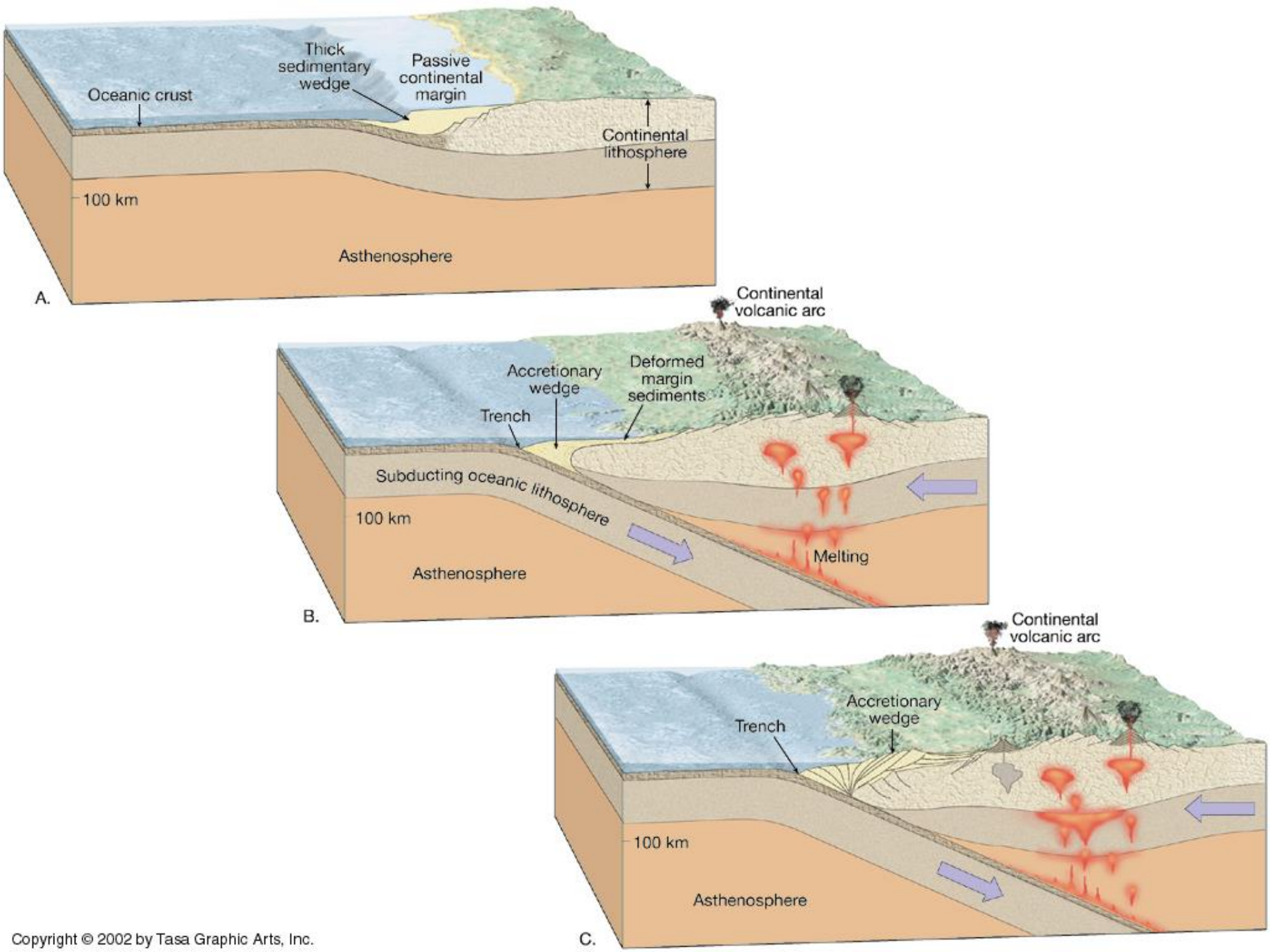
Fill in page 17 in notes

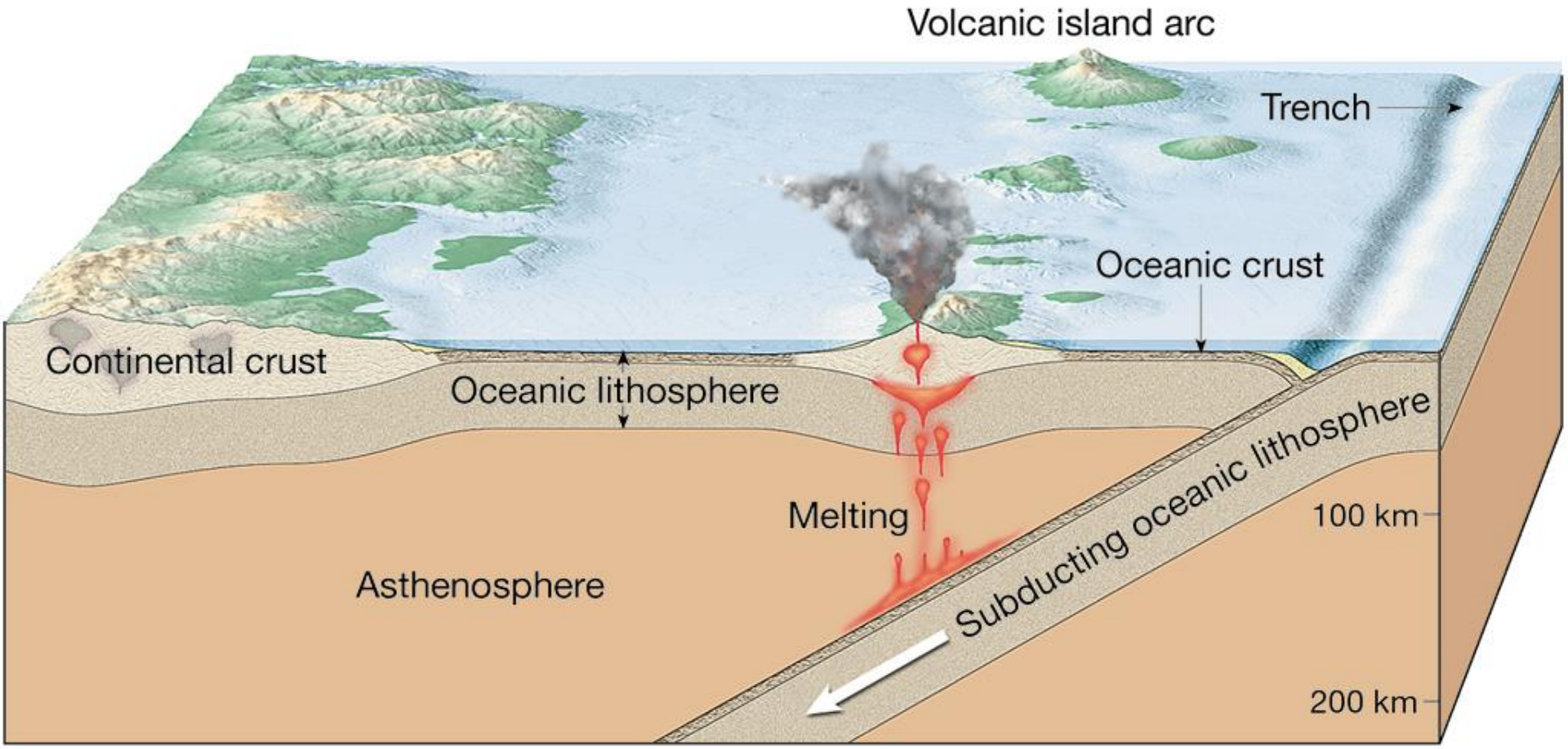


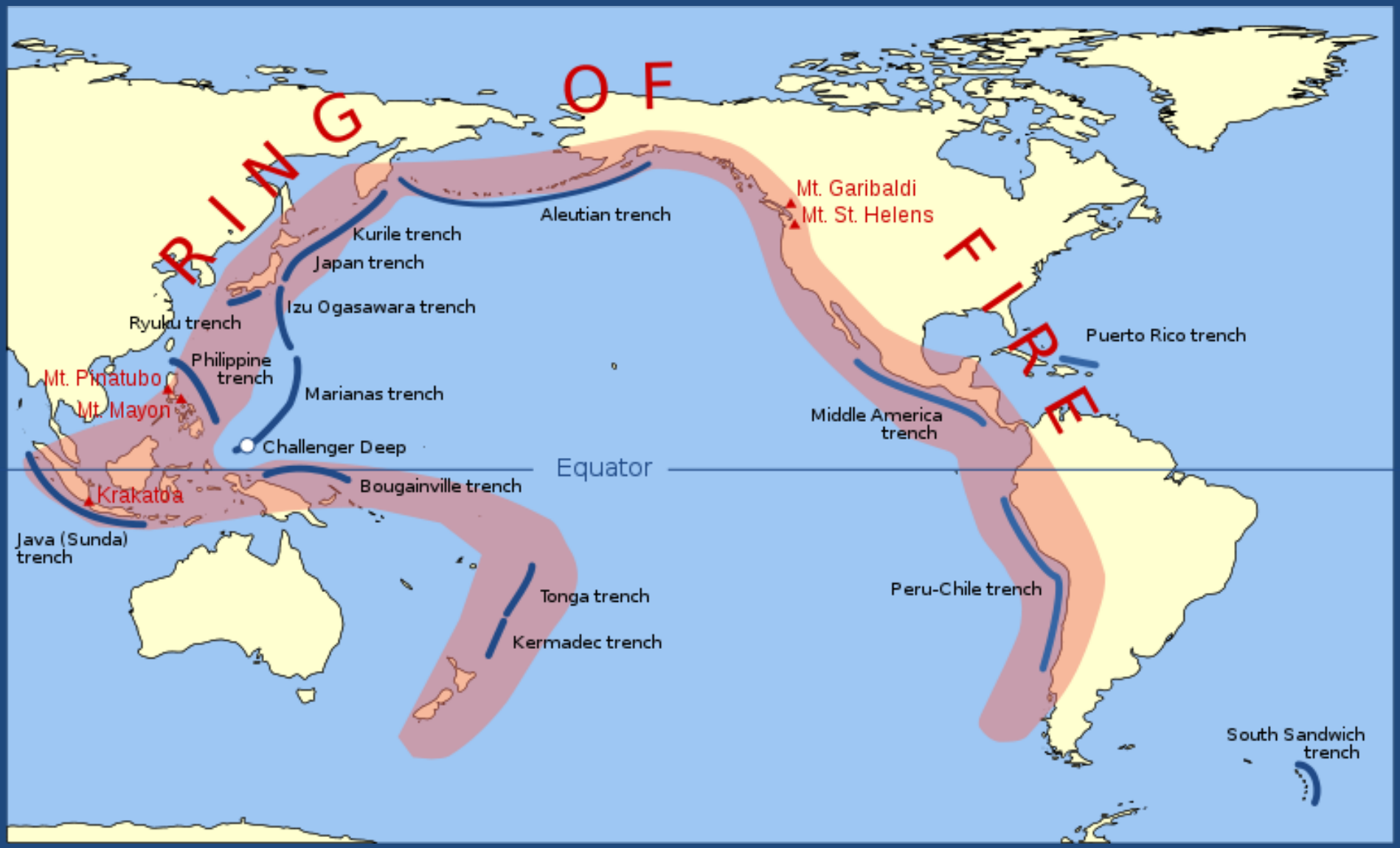



California's
San Andreas Fault
Crescent City
Eureka
Garberville
Point Delgada
Point Arena
Ukiah
Santa Rosa
Point Reyes
San Francisco
Daly City
San Jose
Santa Cruz
Hollister
San Juan Bautista
Monterey
Parkfield
San Luis Obispo
Simmler
Carrizo Plain
Soda Lake Rd
Frazier Park
Palmdale
Santa Barbara
San Bernardino
Desert Hot Springs
Los Angeles
Palm Springs
Brawley
San Diego
San Andreas Fault
Map copyright © 2006 David K. Lynch







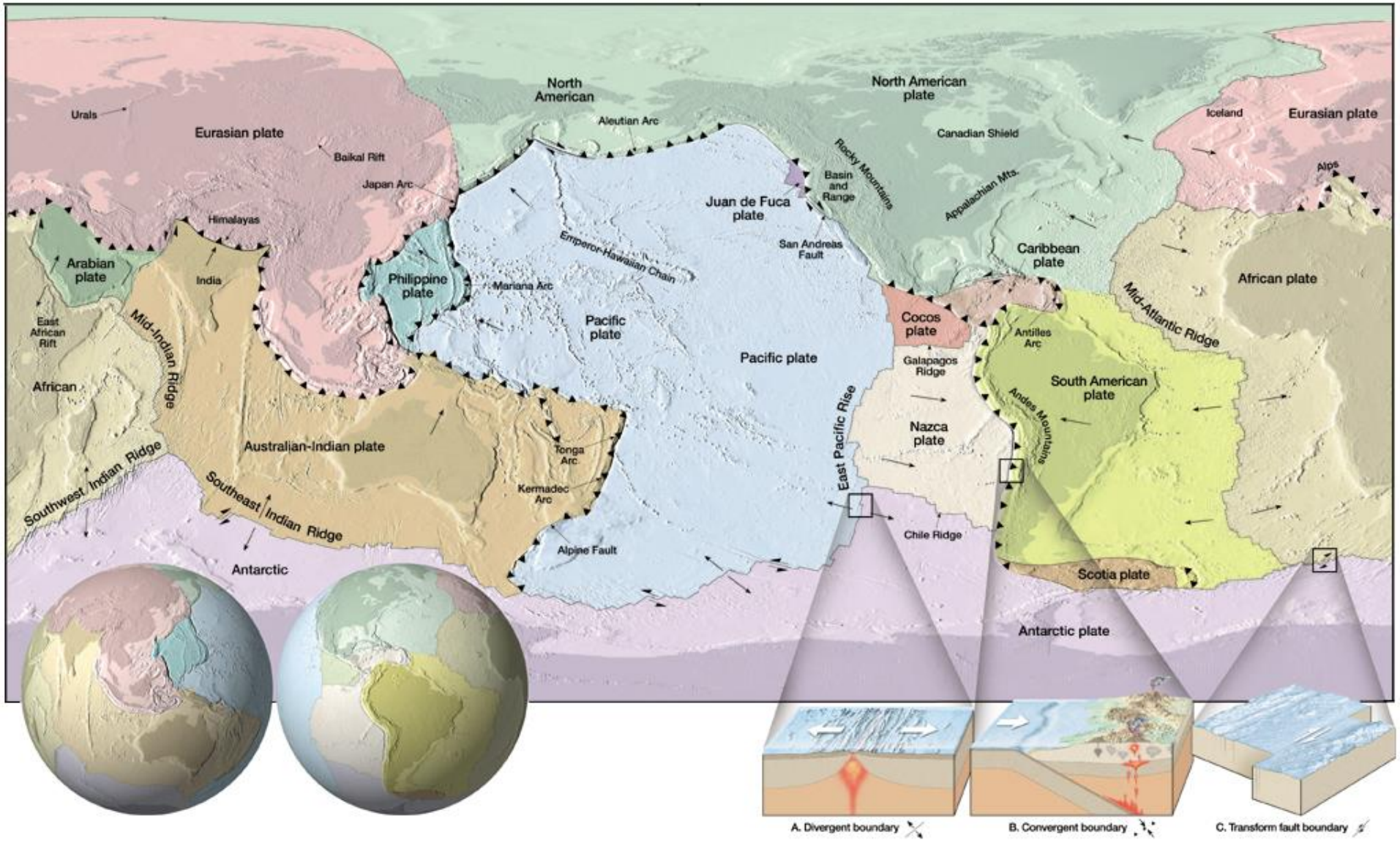

RING OF FIRE
Aleutian trench
Kurile trench
Japan trench
Izu Ogasawara trench
Ryuku trench
Philippine trench
Marianas trench
Challenger Deep
Bougainville trench
Mt. Pinatubo
Mt. Mayon
Krakatoa
Java (Sunda) trench
Tonga trench
Kermadec trench
Mt. Garibaldi
Mt. St. Helens
Puerto Rico trench
Middle America trench
Peru-Chile trench
South Sandwich trench
Equator

Observe an animation of volcanism at a subduction zone.

- http://www.classzone.com/books/earth_science/terc/content/visualizations/es0902/es0902page01.cfm?chapter_no=09

Observe animations of processes that occur along plate boundaries.

- http://www.classzone.com/books/earth_science/terc/content/visualizations/es0804/es0804page01.cfm?chapter_no=08

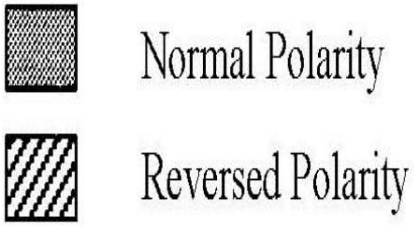


Evidence that pates are moving apart:

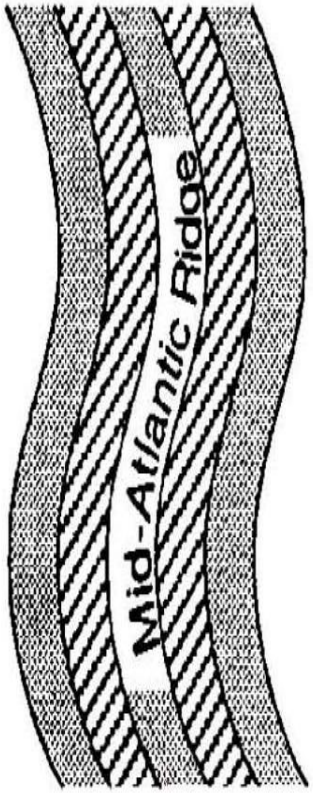
- Ocean floor is generally younger than the continents.

- Rocks continually form at Mid-ocean ridges

- Magnetic reversal



- Some igneous rocks contain minerals that are magnetic.



- Bands of igneous rocks on the ocean floor show that Earth's magnetic orientation has been reversed in the past.

MORE Evidence for crustal movement:

Fact(s) to memorize: 21 & 22

Bench Marks - Locations labeled with the exact elevation

- Scientists can determine change in elevation

Uplift of fossils

Subsidence of fossils


U.S. COAST & GEODETIC SURVEY
REFERENCE MARK
1931

MORE Evidence for crustal movement:

Fact(s) to memorize: 21 & 22

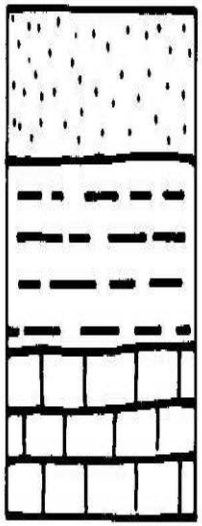
Bench Marks - Locations labeled with the exact elevation

- Scientists can determine change in elevation

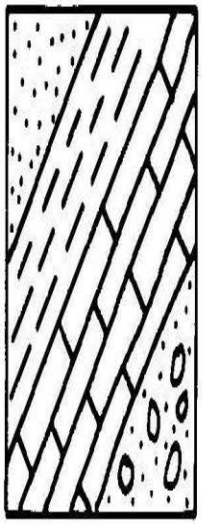
Uplift of fossils - Fish and marine fossils found on mountain tops

Subsidence of fossils - Shallow water fish buried deep in the ocean floor

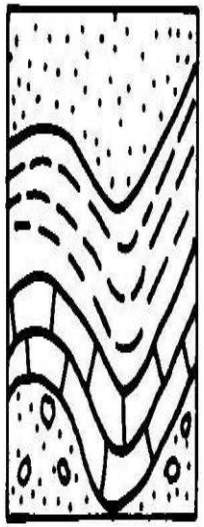
Looking at Rock Strata



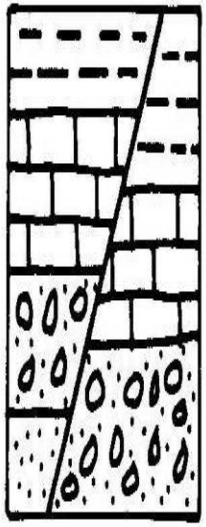
Undisturbed



Tilted



Folded



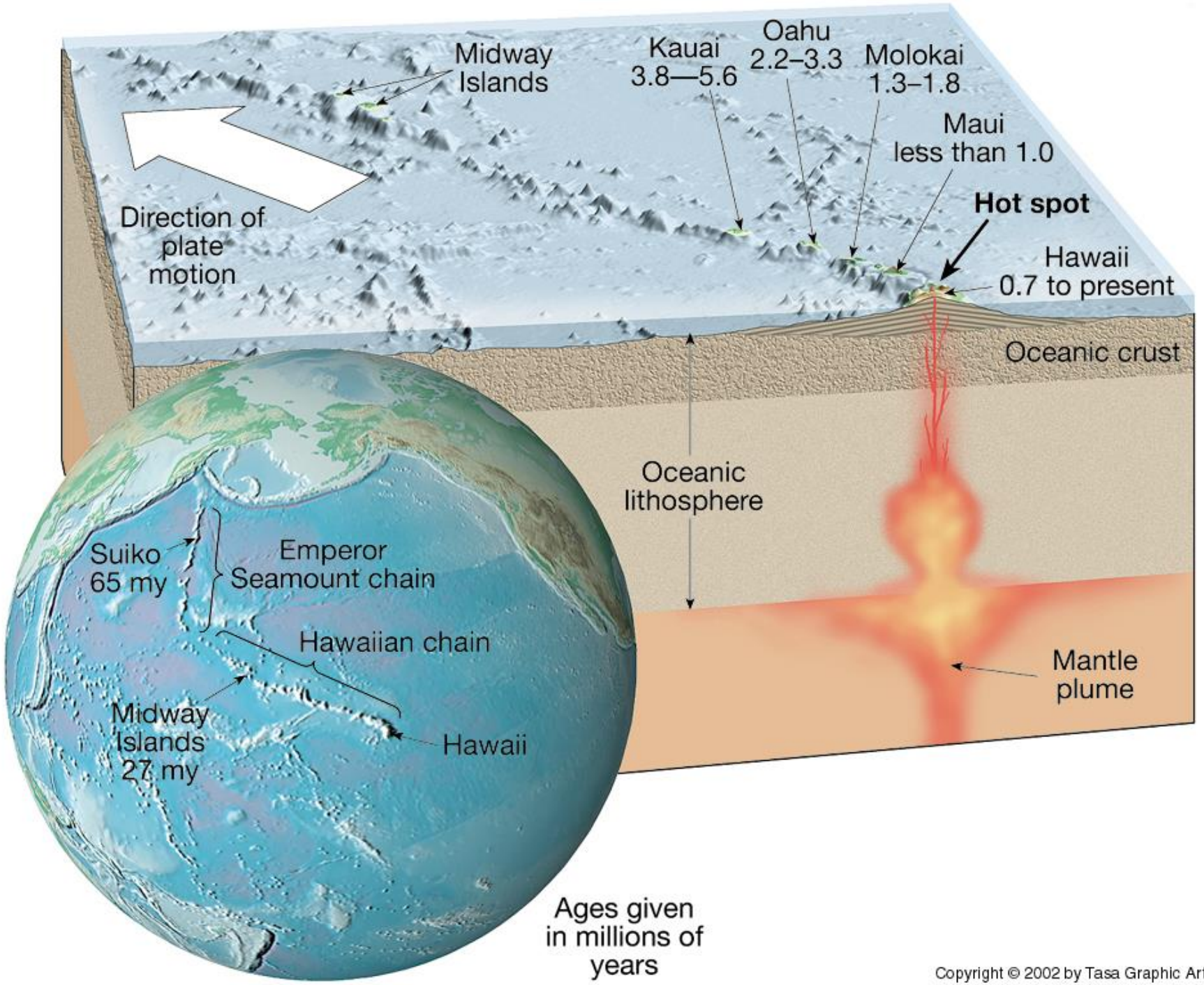
Faulted

Hot spot:

A place where magma is coming up through a weak spot in Earth's crust

Forms a volcanic island chain, island over the hotspot is the youngest

Ex: Hawaii



Observe an animation of volcanic islands forming over a hot spot.

- http://www.classzone.com/books/earth_science/terc/content/visualizations/es0904/es0904page01.cfm?chapter_no=09

- https://www.youtube.com/watch?v=HKZxElErt-I&t=1142s