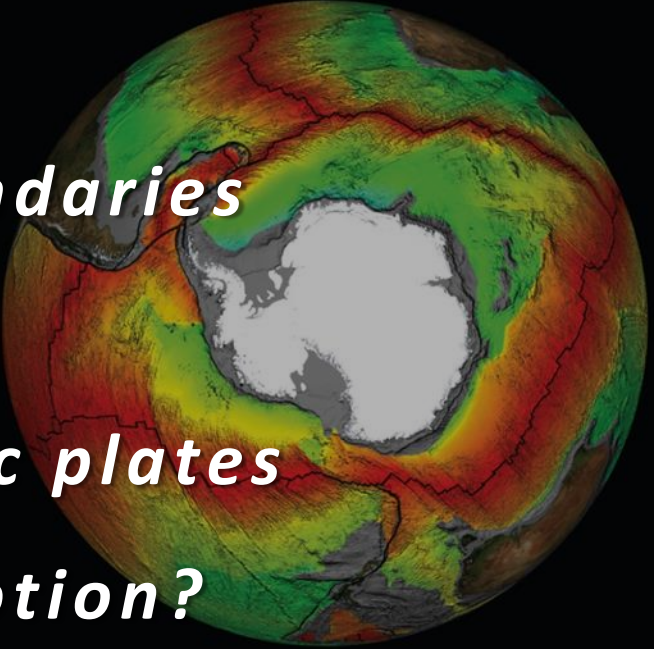
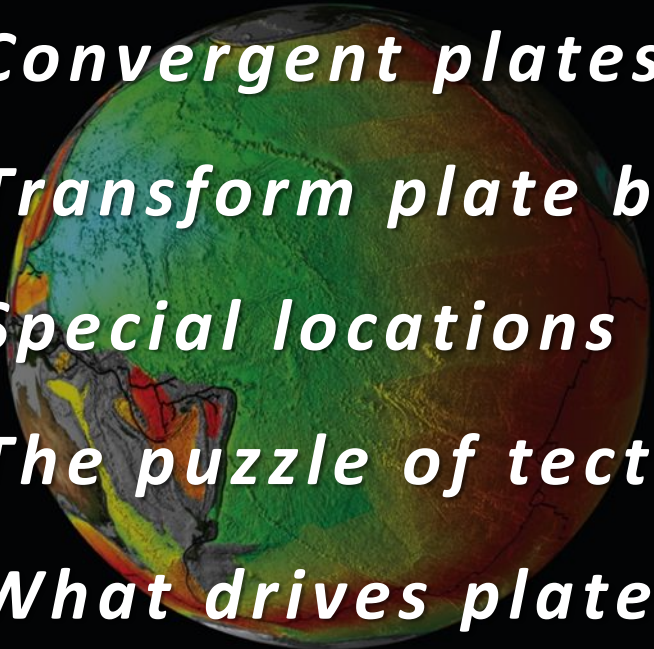
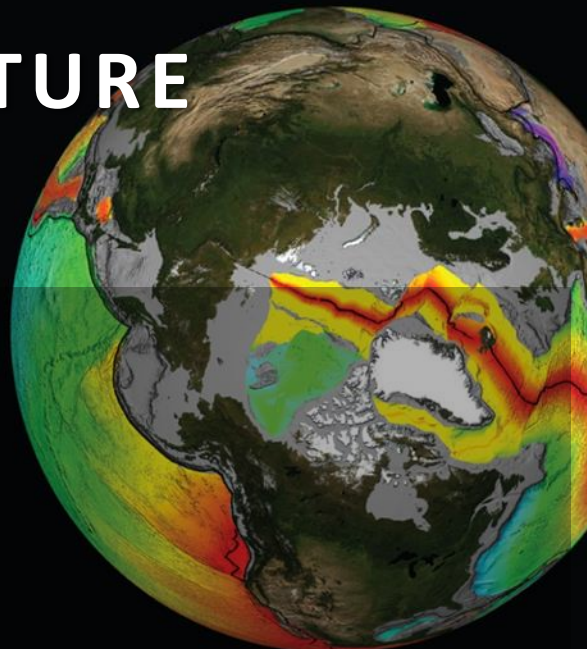
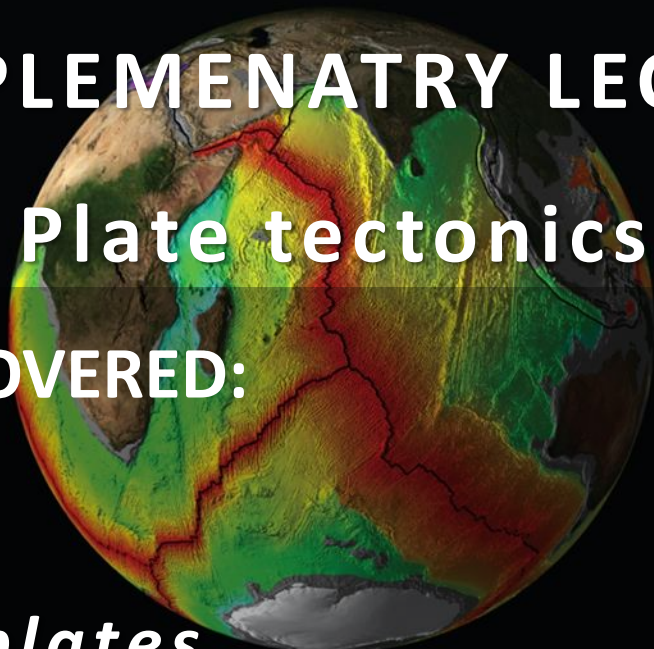


COMPLEMENTARY LECTURE

Plate tectonics

TOPICS TO BE COVERED:

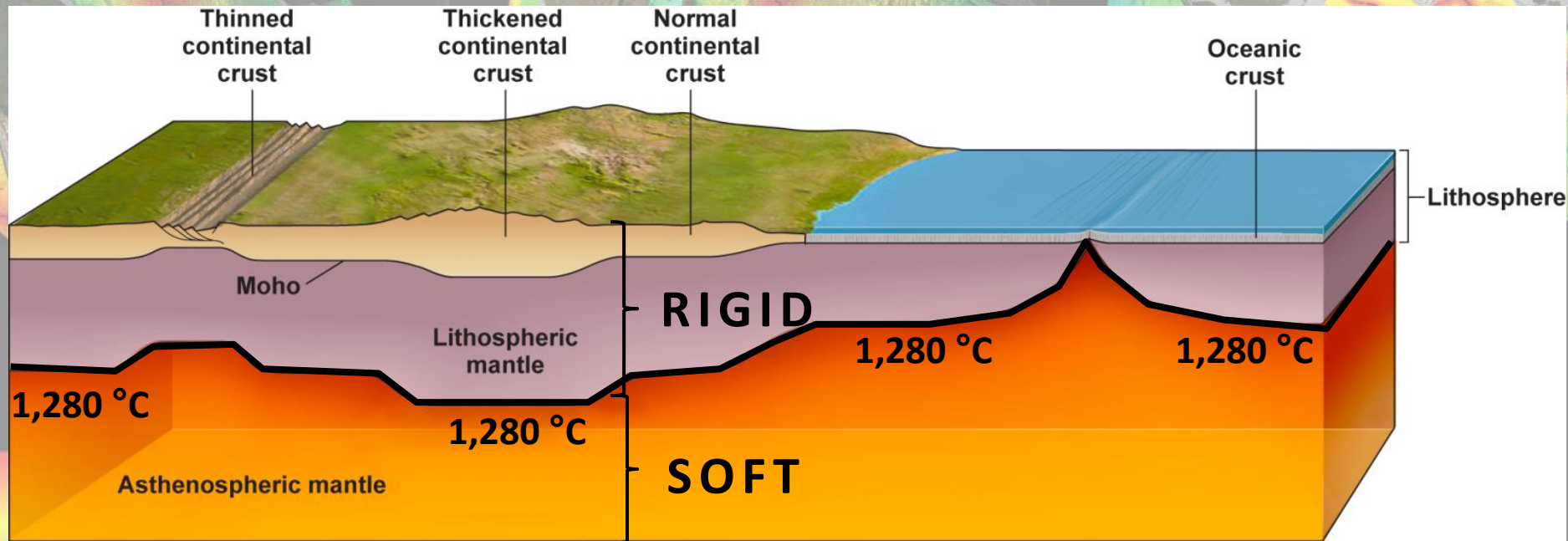
- *Principles*
- *Divergent plates*
- *Convergent plates*
- *Transform plate boundaries*
- *Special locations*
- *The puzzle of tectonic plates*
- *What drives plate motion?*



8. The Continental Drift

Principles of the plate tectonics

CONCEPTS: Lithosphere and Asthenosphere



Lithosphere RIGID or BRITTLE is 100-150 thick → CRUST + LITHOSPHERIC MANTLE

Asthenosphere SOFT or PLASTIC

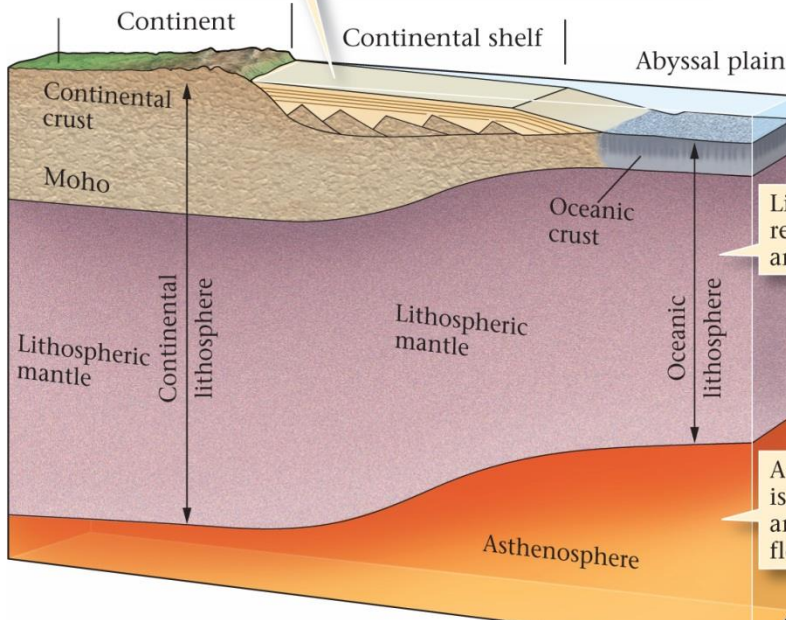
The boundary between Lithosphere and Asthenosphere where $T = 1,280\text{ °C}$

8. The Continental Drift

Principles of the plate tectonics

CONCEPTS: Lithosphere and Asthenosphere

The continental shelf is the top surface of a passive-margin basin. The sediment of the basin overlies stretched lithosphere.

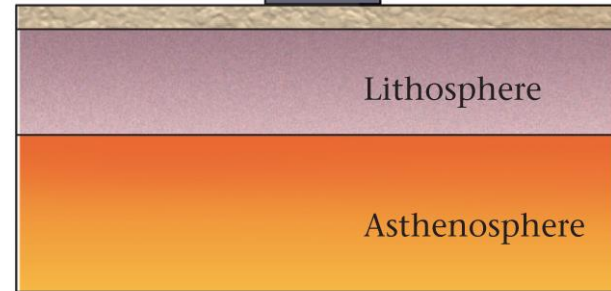


Lithosphere is relatively rigid and cannot flow.

Asthenosphere is relatively soft and able to flow.

A load is placed on the surface of the Earth.

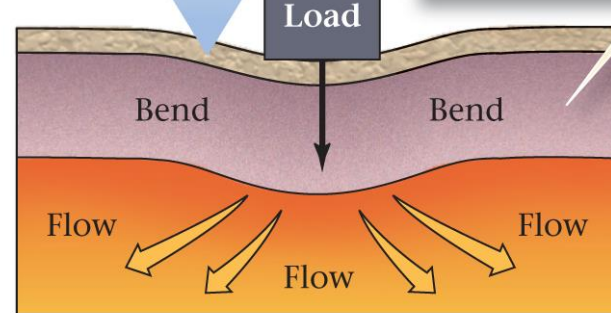
(Not to scale)



Time 1

Time

Lithosphere bends while asthenosphere flows.



Time 2

8. The Continental Drift

Principles of the plate tectonics

CONCEPTS: Lithosphere and Asthenosphere

Low-density felsic rocks

Continental lithosphere (thicker)

Oceanic lithosphere (thinner)

Crust

Moho

Lithosphere

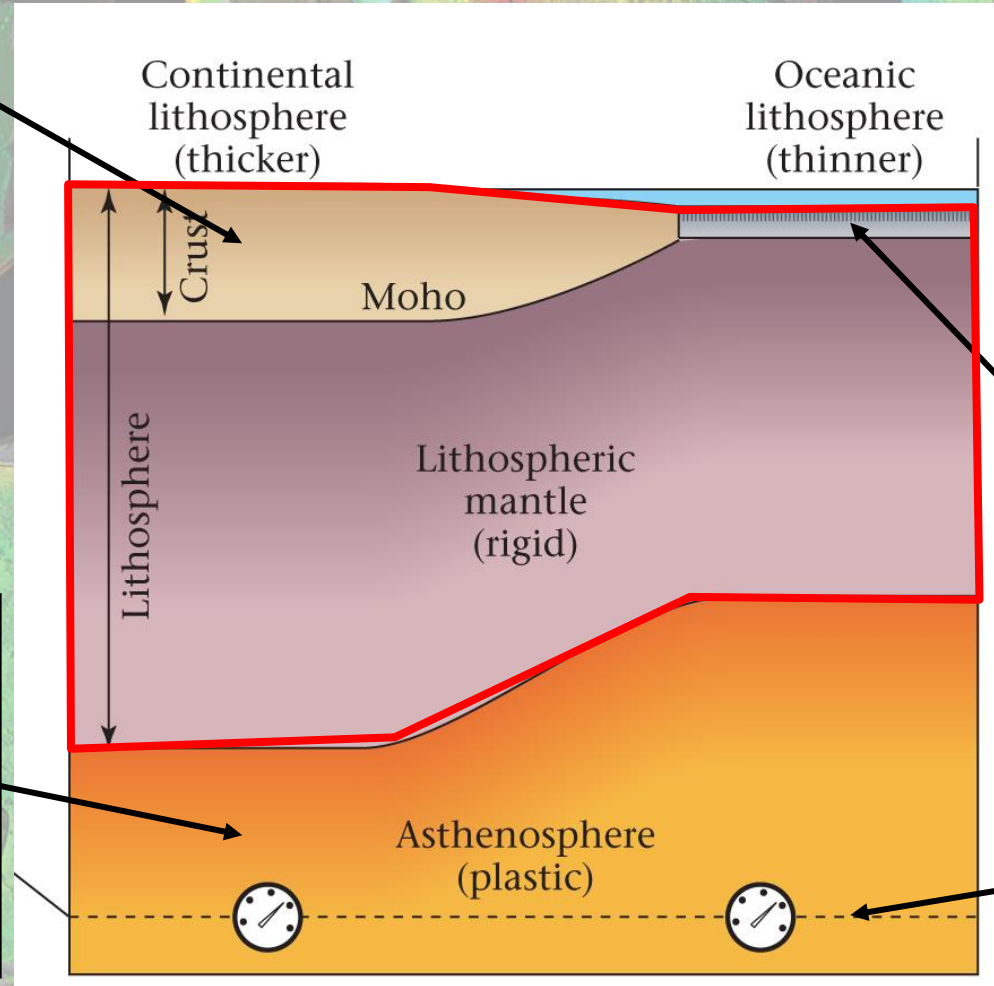
Lithospheric mantle (rigid)

High-density mafic rocks

Very high-density ultramafic rocks

Asthenosphere (plastic)

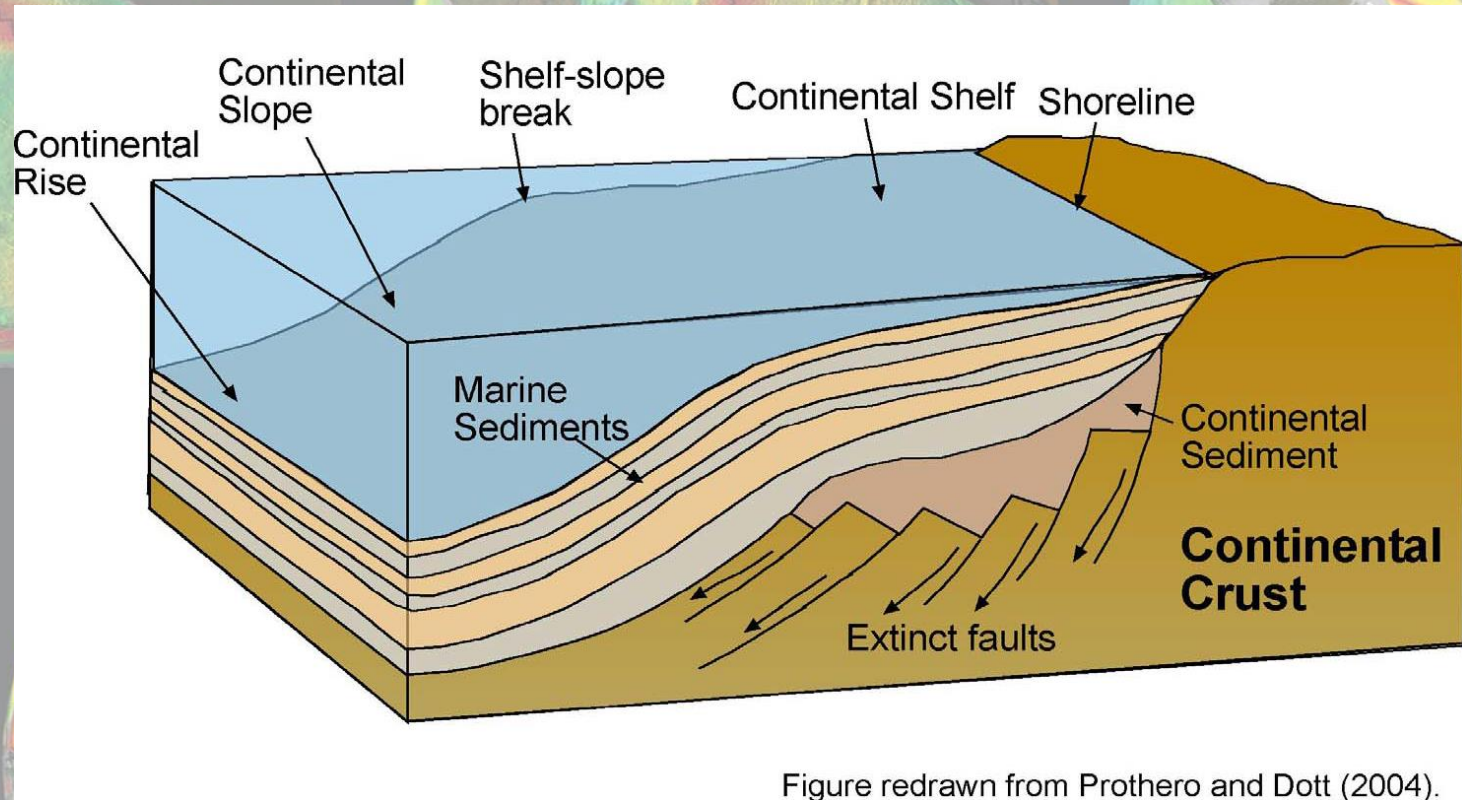
Constant pressure



8. The Continental Drift

Principles of the plate tectonics

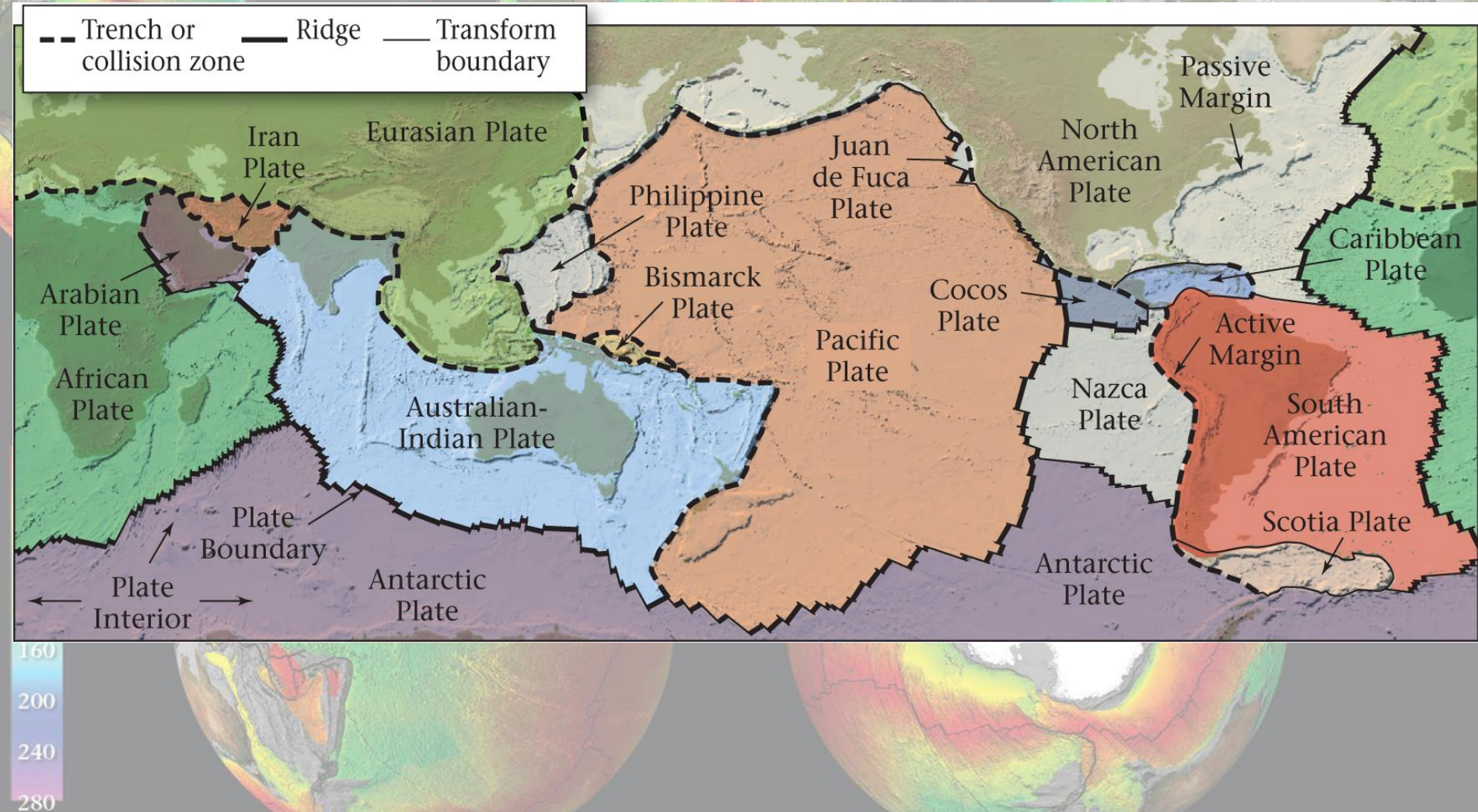
CONCEPTS: passive margins



A passive margin is a boundary between a continent and an ocean but is not a plate boundary!

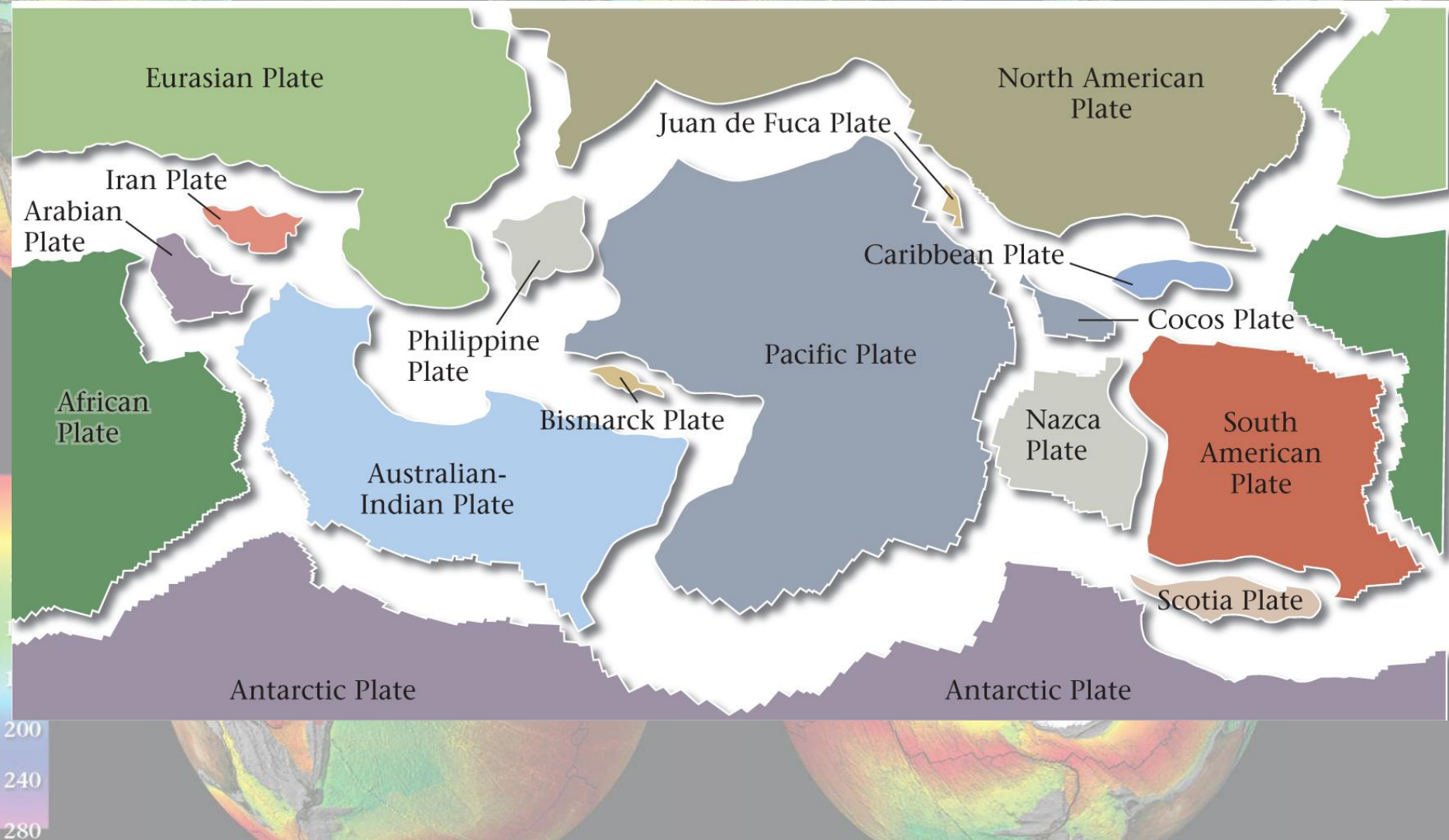
8. The Continental Drift

Principles of the plate tectonics



8. The Continental Drift

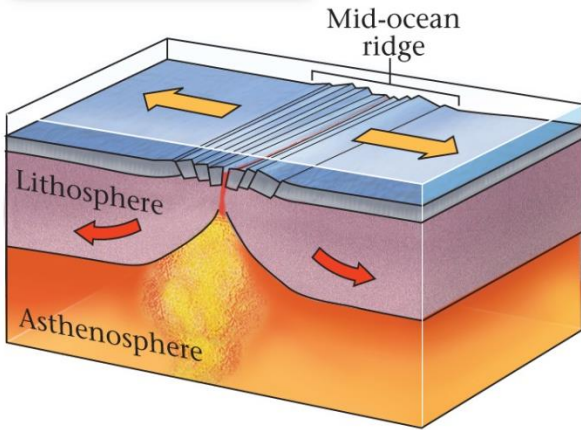
Principles of the plate tectonics



8. The Continental Drift

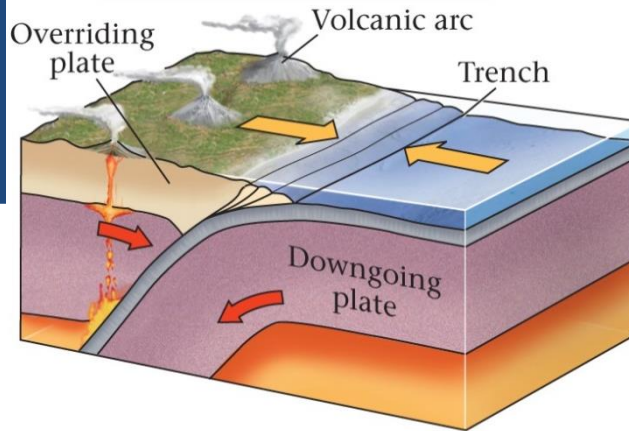
Principles of the plate tectonics

Lithosphere thickens away from the axis.



DIVERGENT

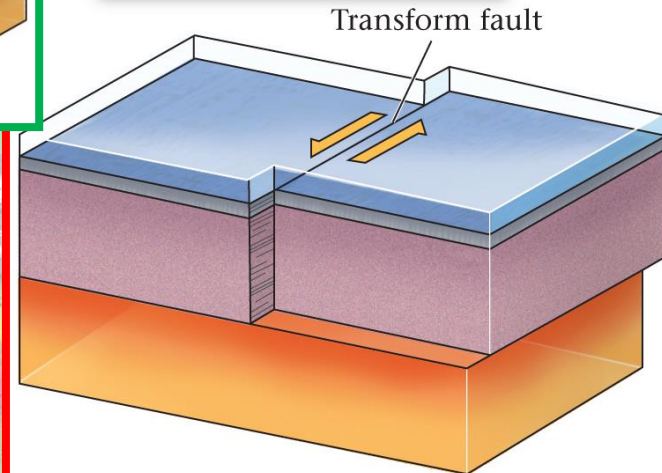
The process of consuming a plate is called subduction.



CONVERGENT

TRANSFORM

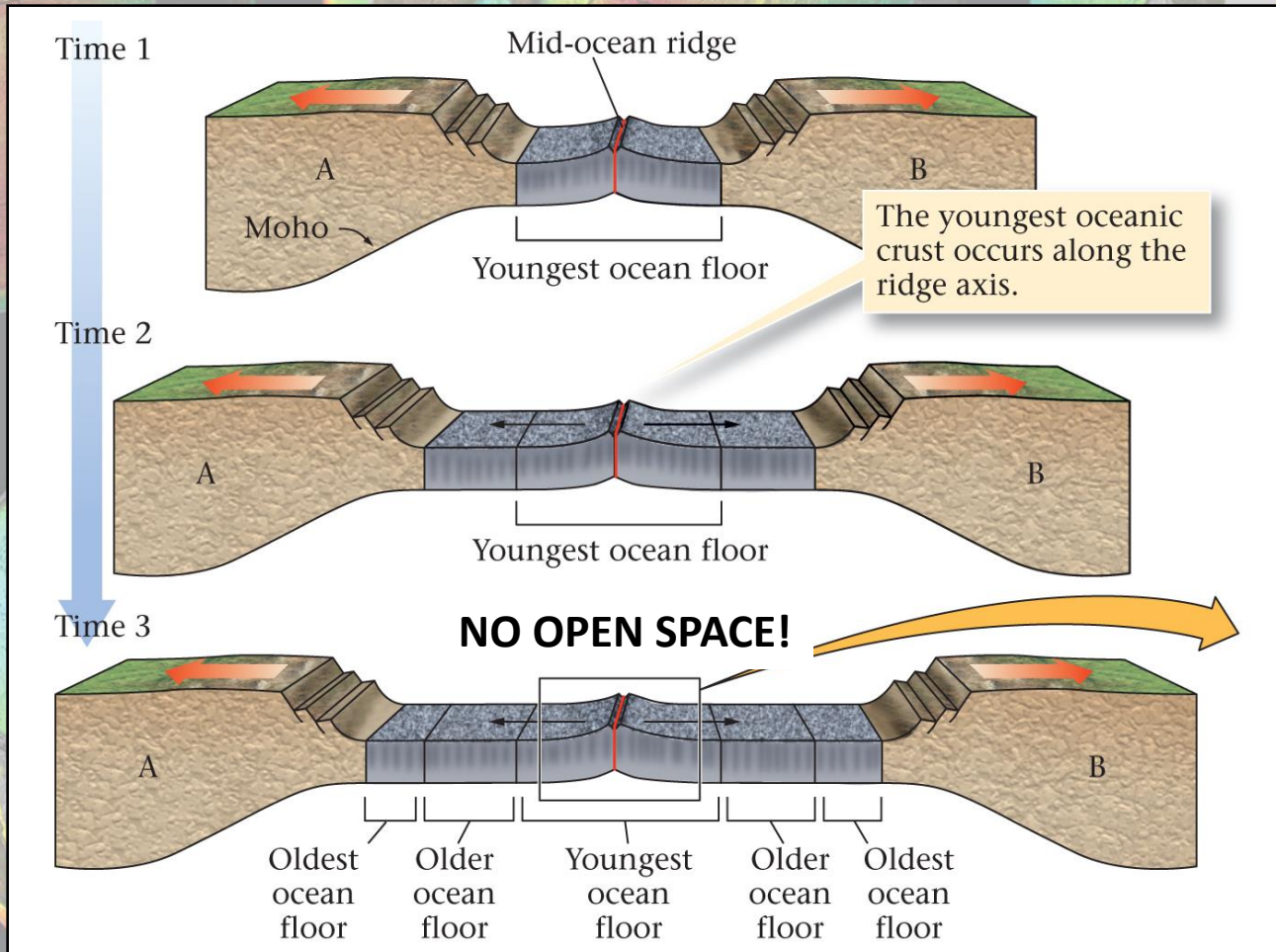
No new plate forms, and no old plate is consumed.



8. The Continental Drift

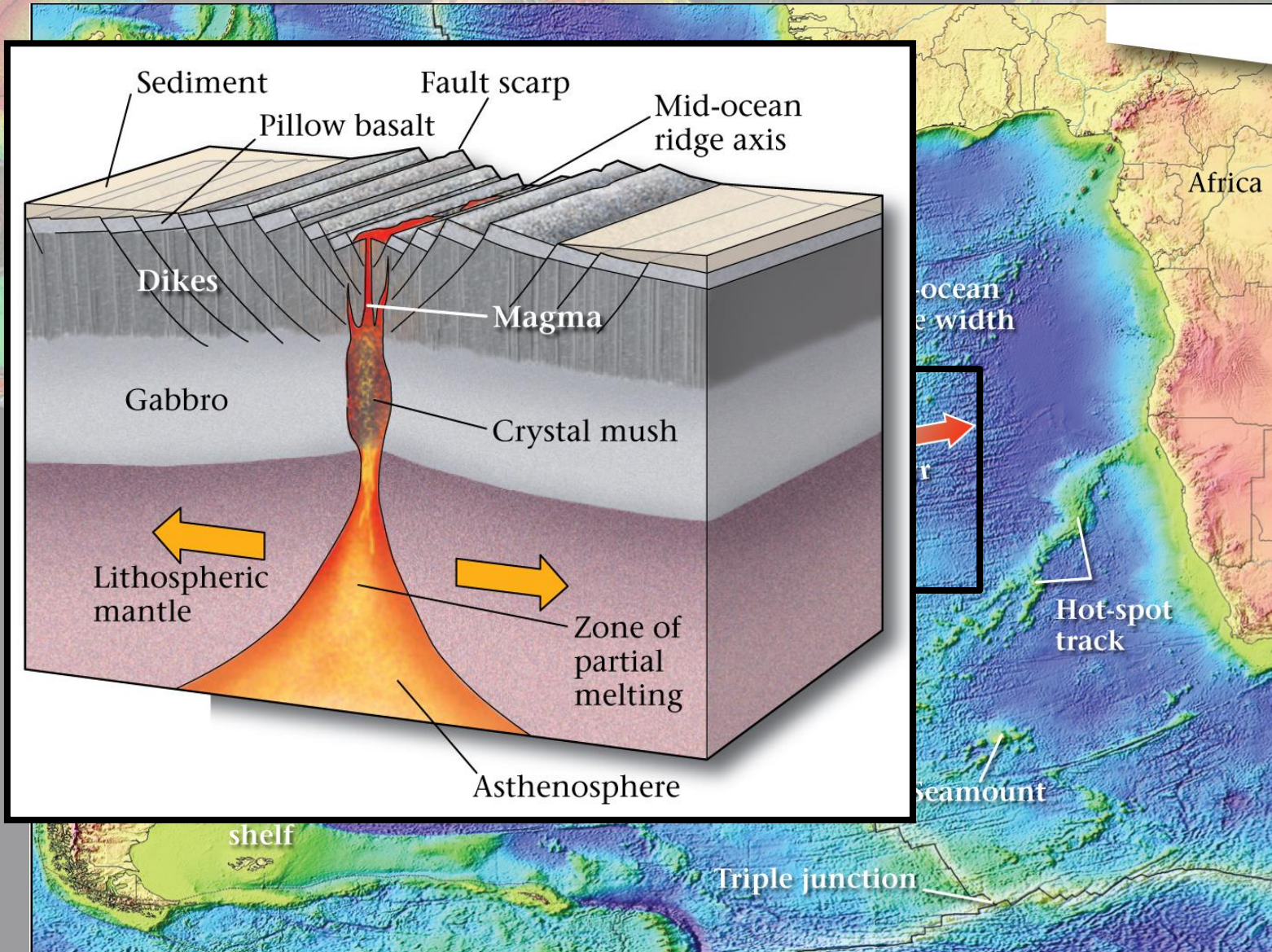
Divergent plates

Divergent plates = SEA-FLOOR SPREADING



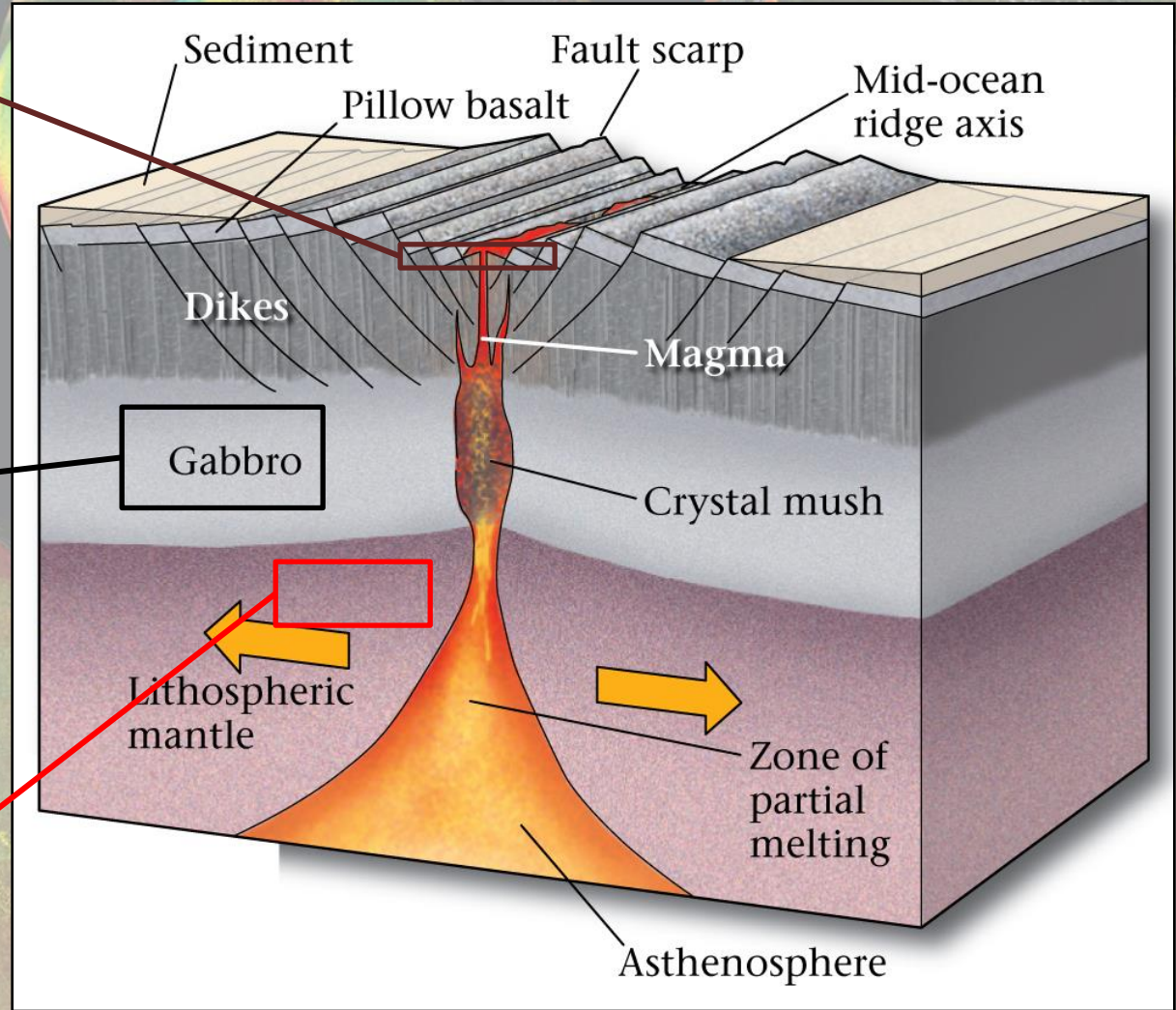
8. The Continental Drift

Divergent plates



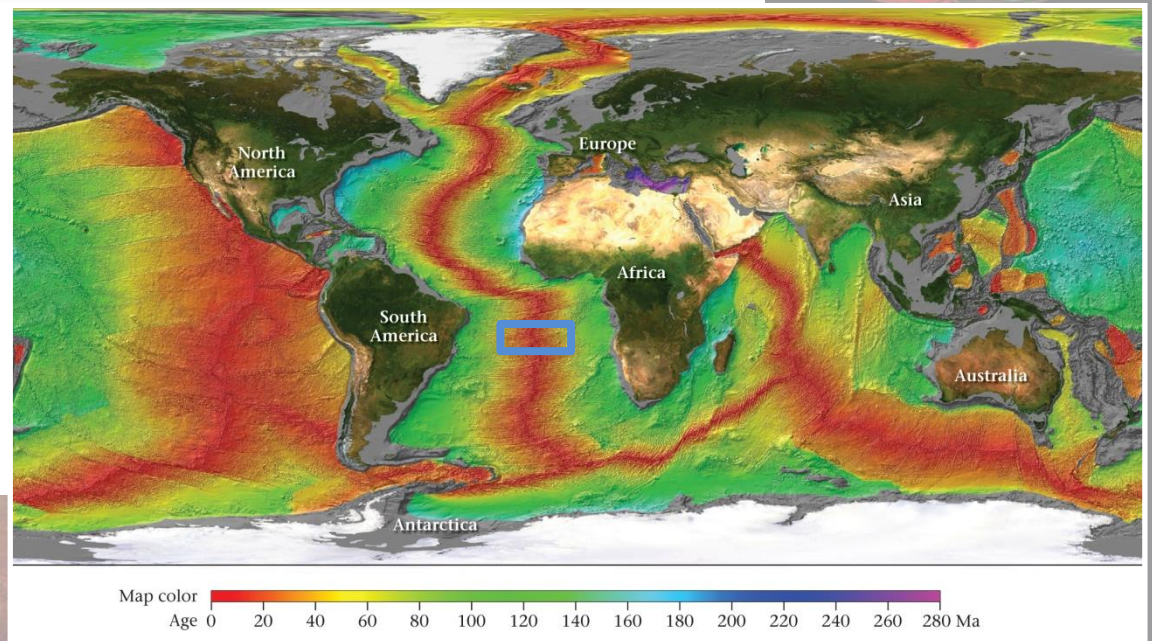
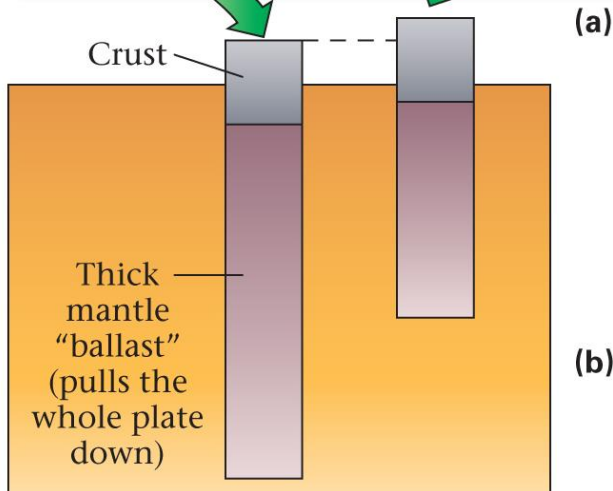
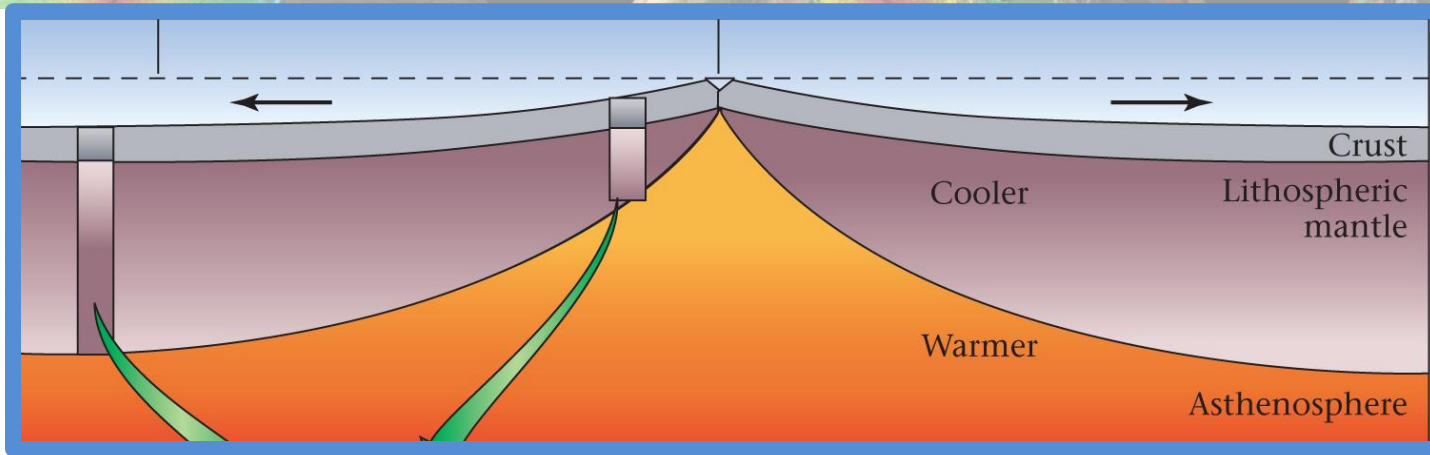
8. The Continental Drift

Divergent plates



8. The Continental Drift

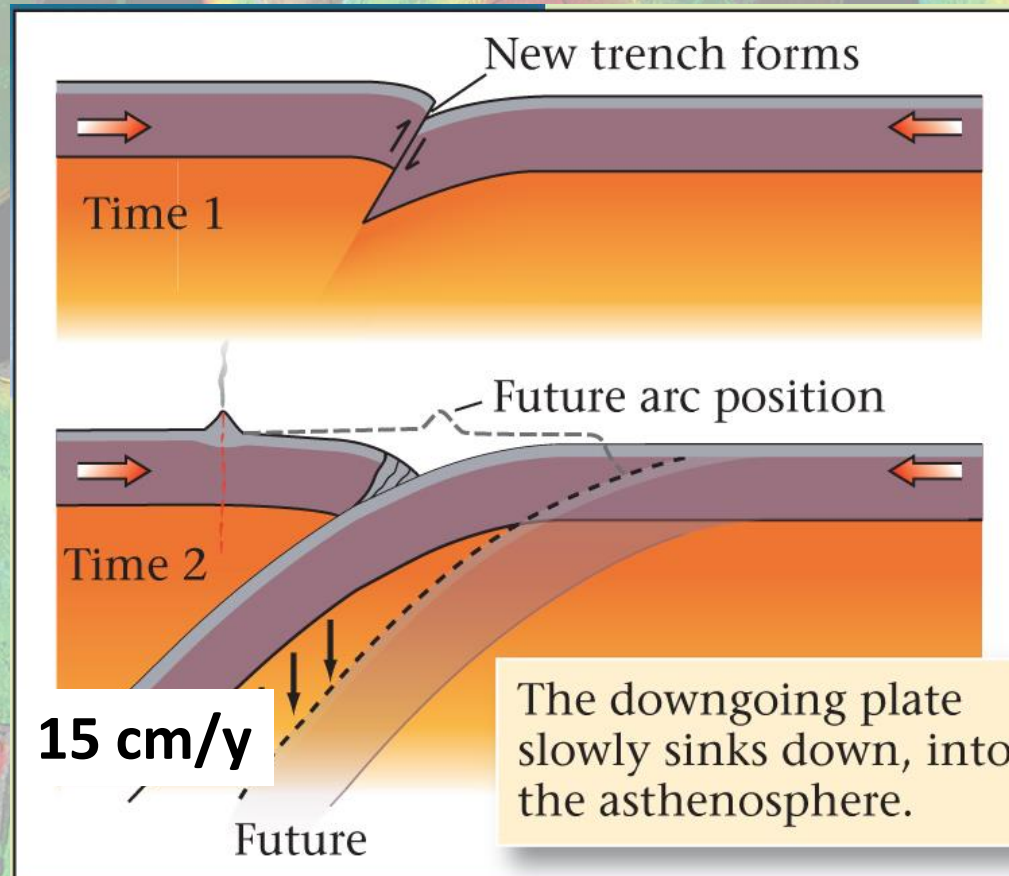
Divergent plates



8. The Continental Drift

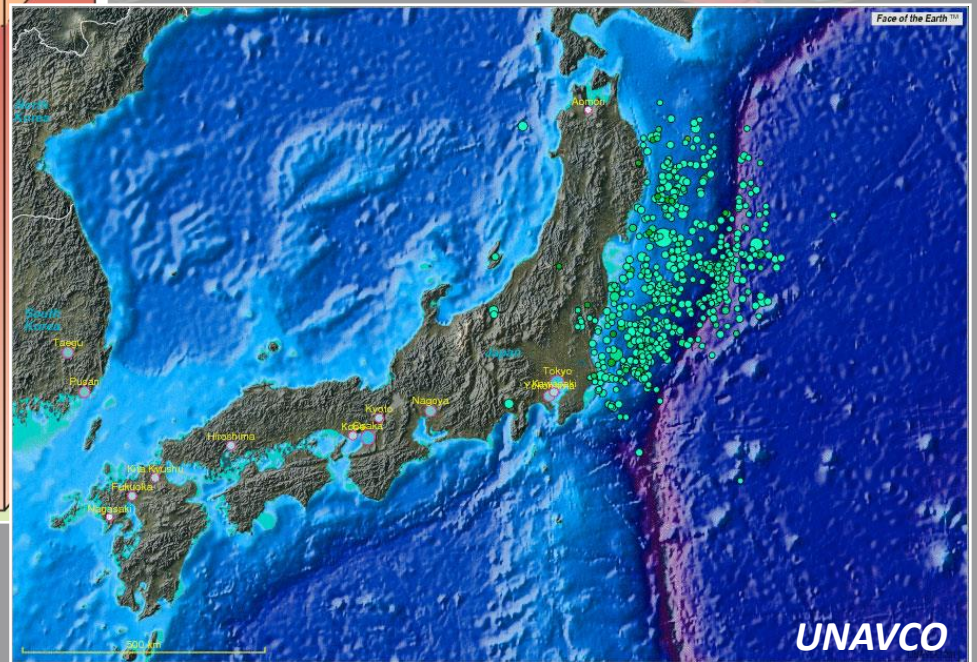
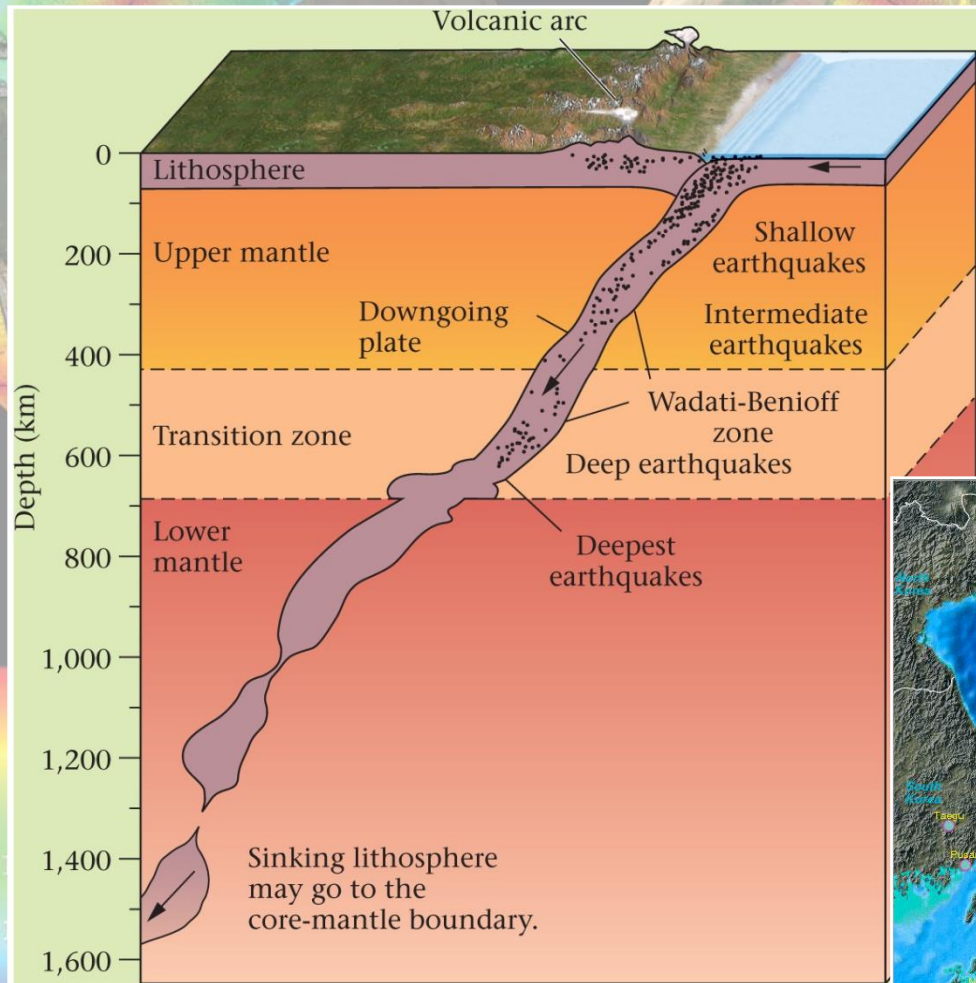
Convergent plates

CONCEPT: Subduction, is the sinking process of a plate under another.



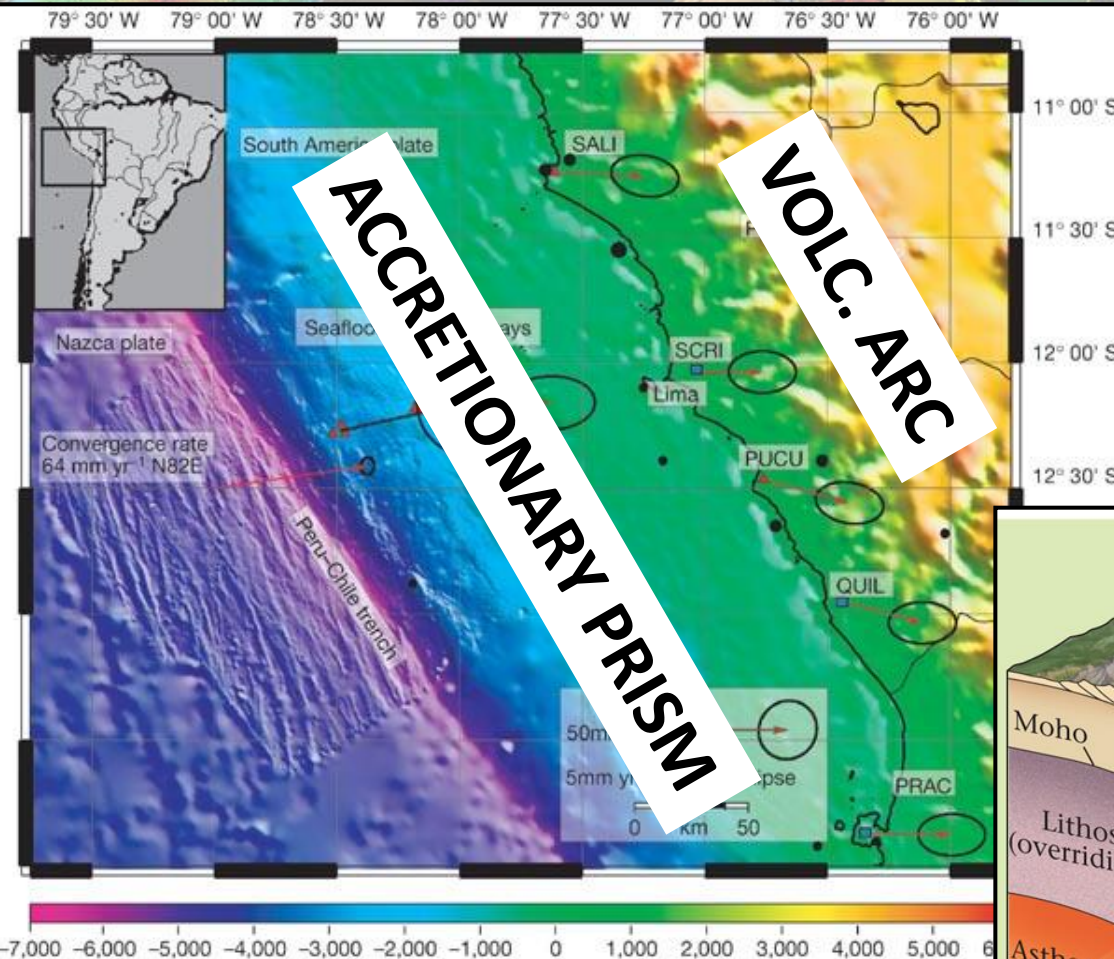
8. The Continental Drift

Convergent plates



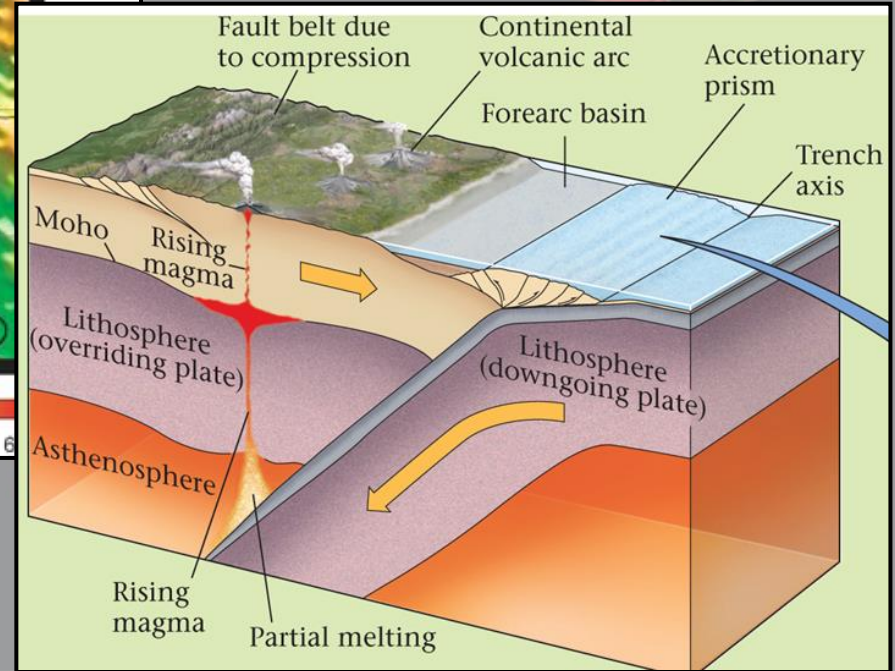
8. The Continental Drift

Convergent plates



Marine sediments get scraped into a wedge-shaped **accretionary prism**.

Melting of subducting lithosphere induce the formation of a **volcanic arc**.

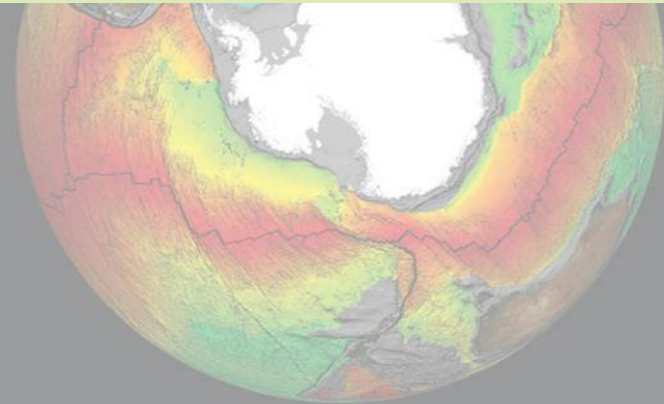
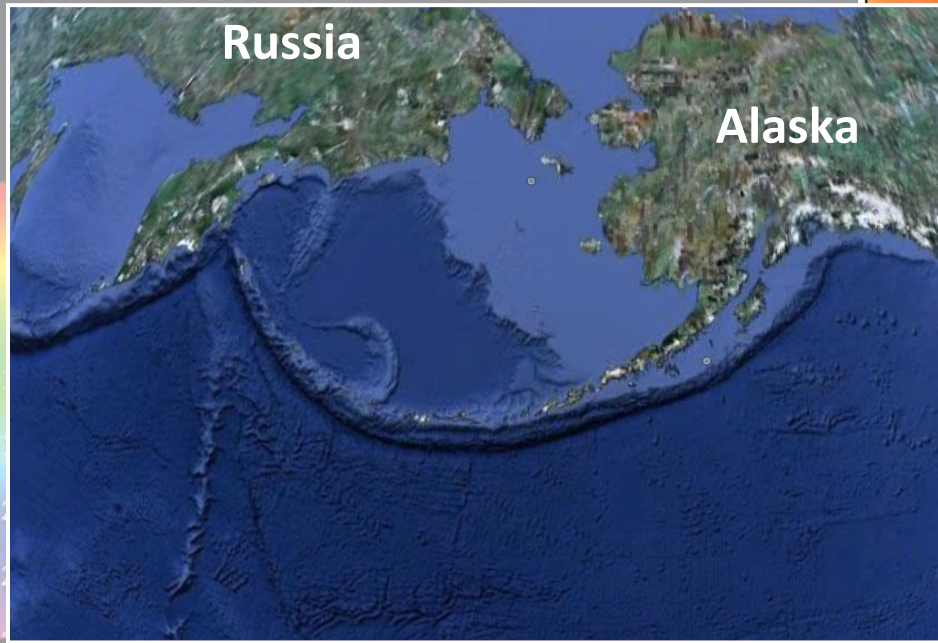
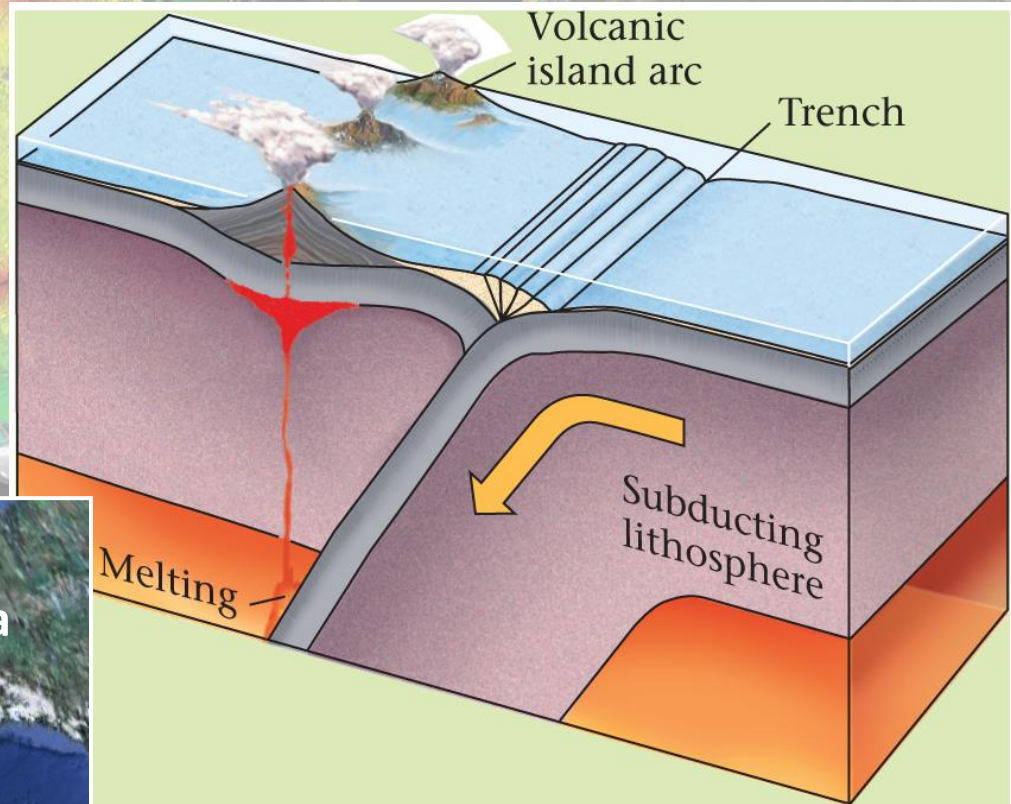
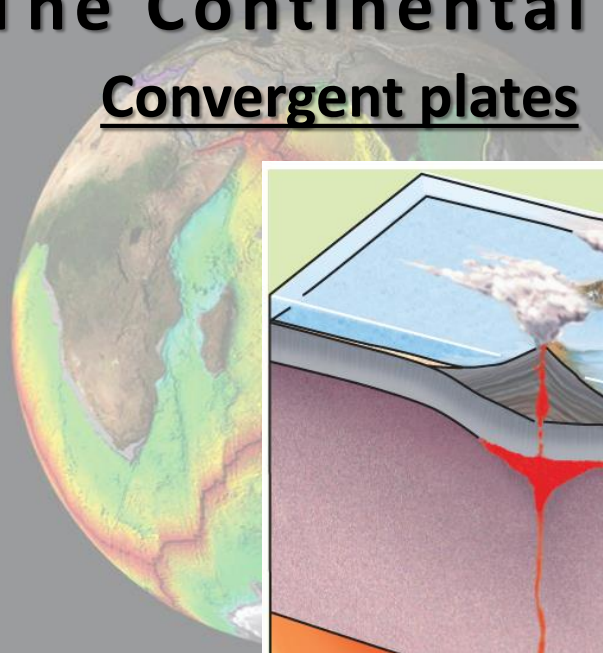
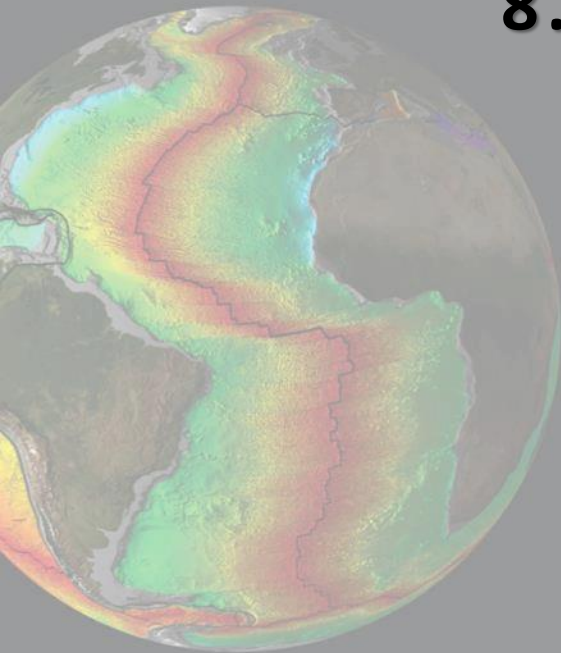


Gagnon et al., 2005

200
240
280

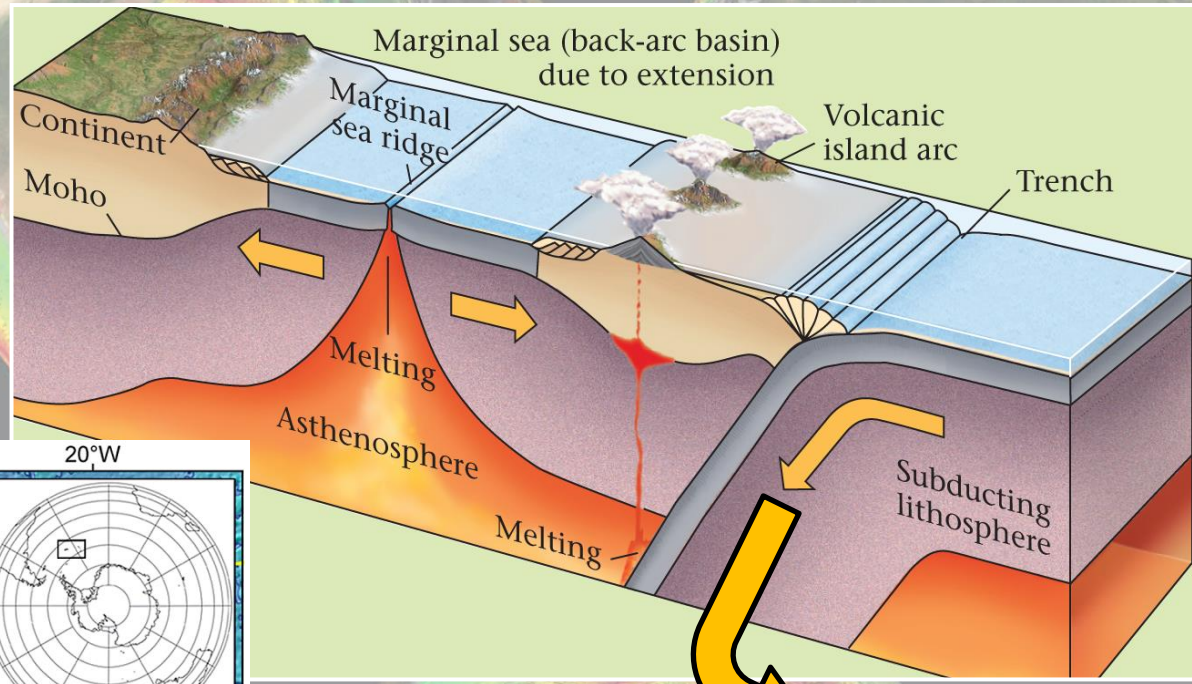
8. The Continental Drift

Convergent plates

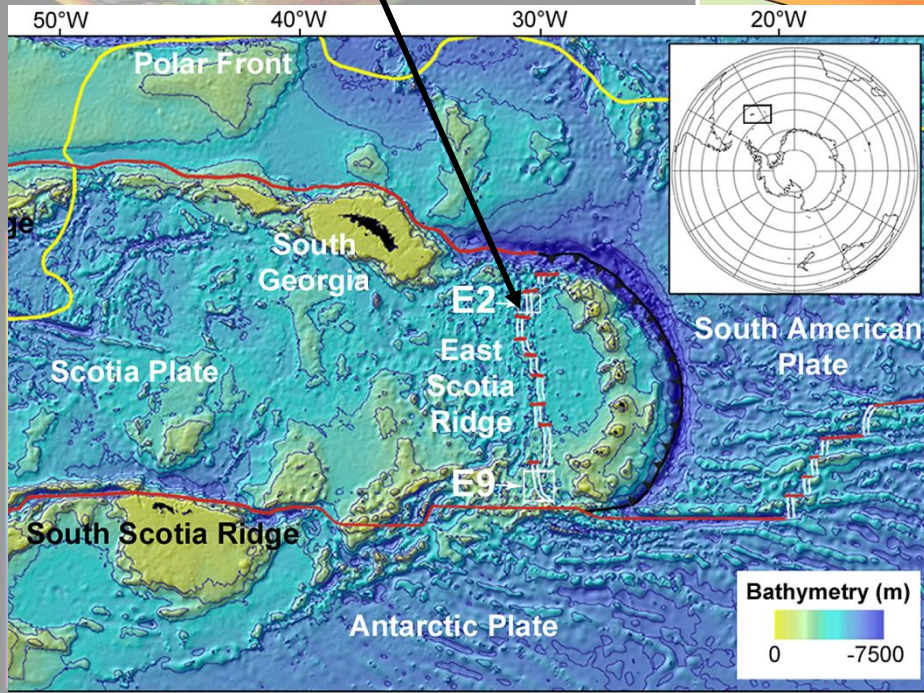


8. The Continental Drift

Convergent plates



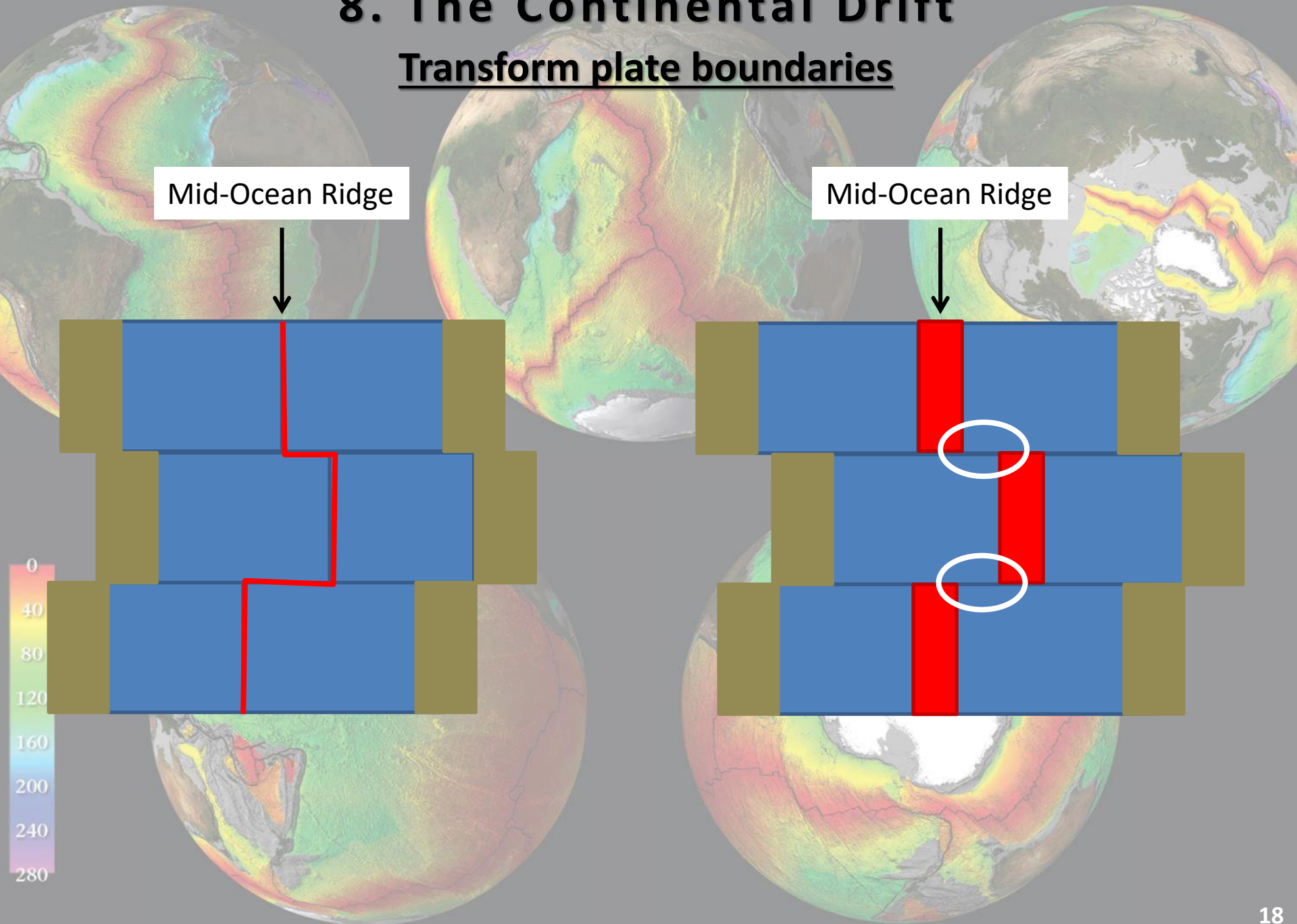
**Back-arc Basin
(sea-floor spreading)**



Subducting plates “drags” the overriding plate inducing extensional stress in the back-arc basin with the consequent sea-floor spreading.

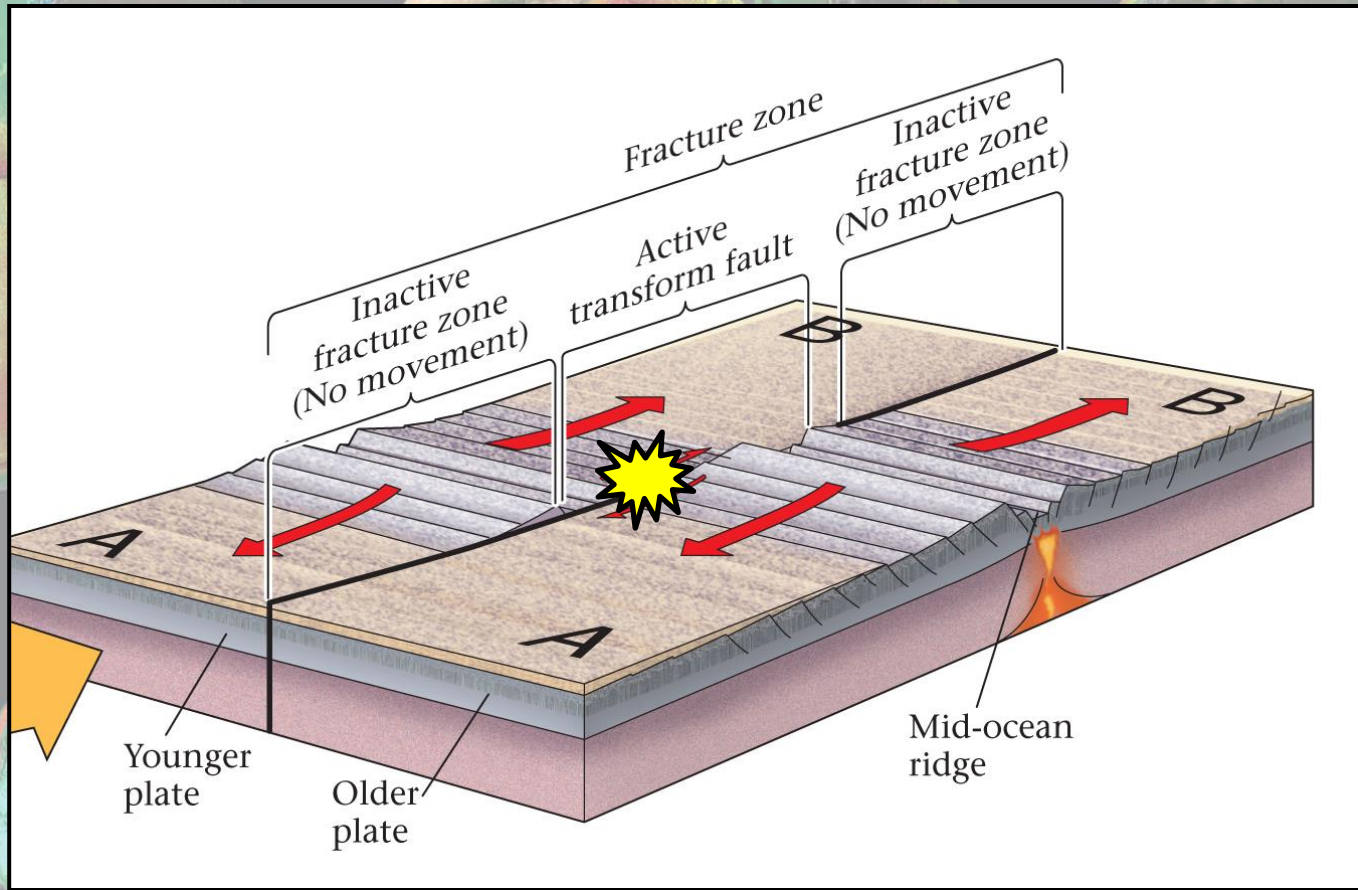
8. The Continental Drift

Transform plate boundaries



8. The Continental Drift

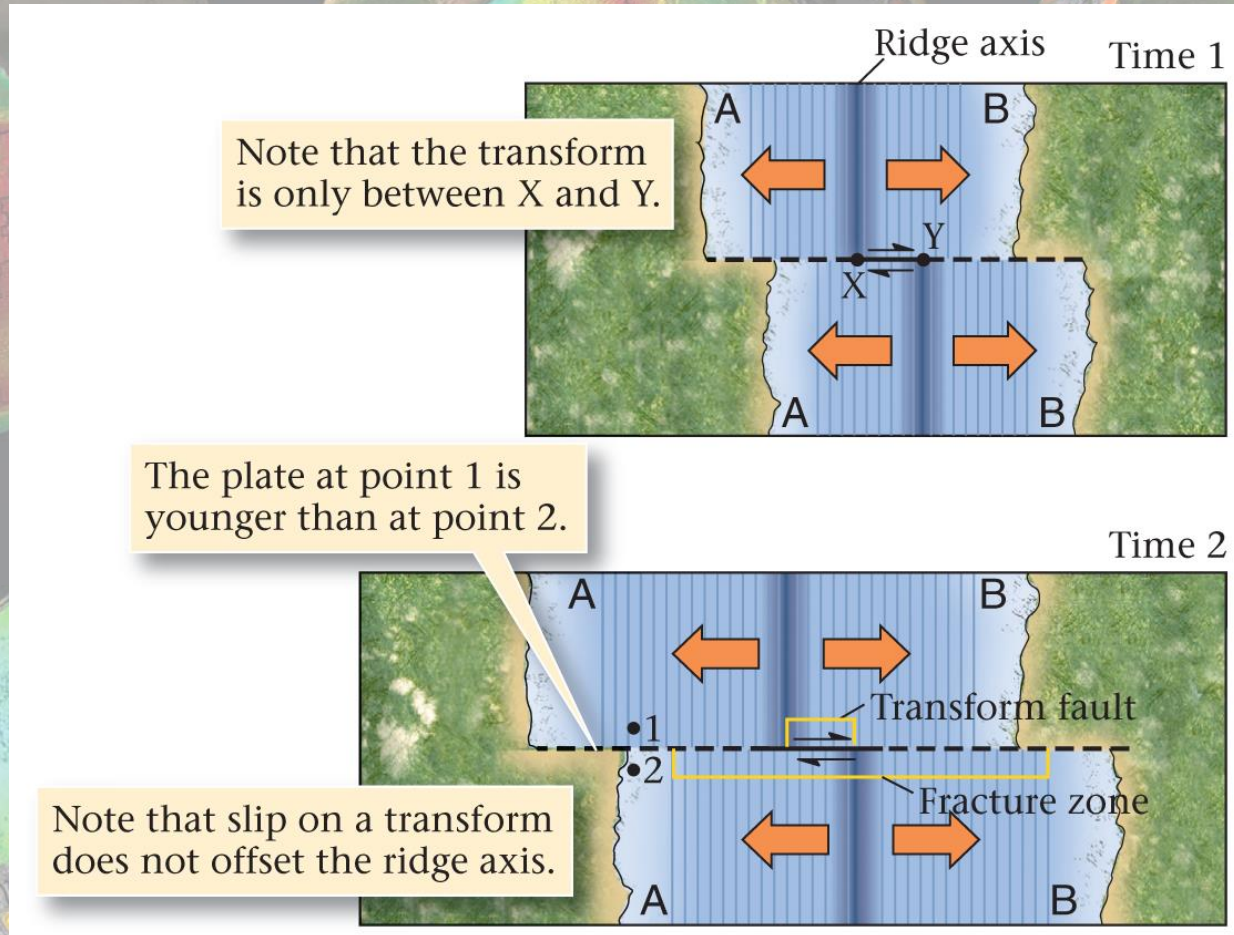
Transform plate boundaries



Active fault slip occurs only on the segment that lies between two ridge segments

8. The Continental Drift

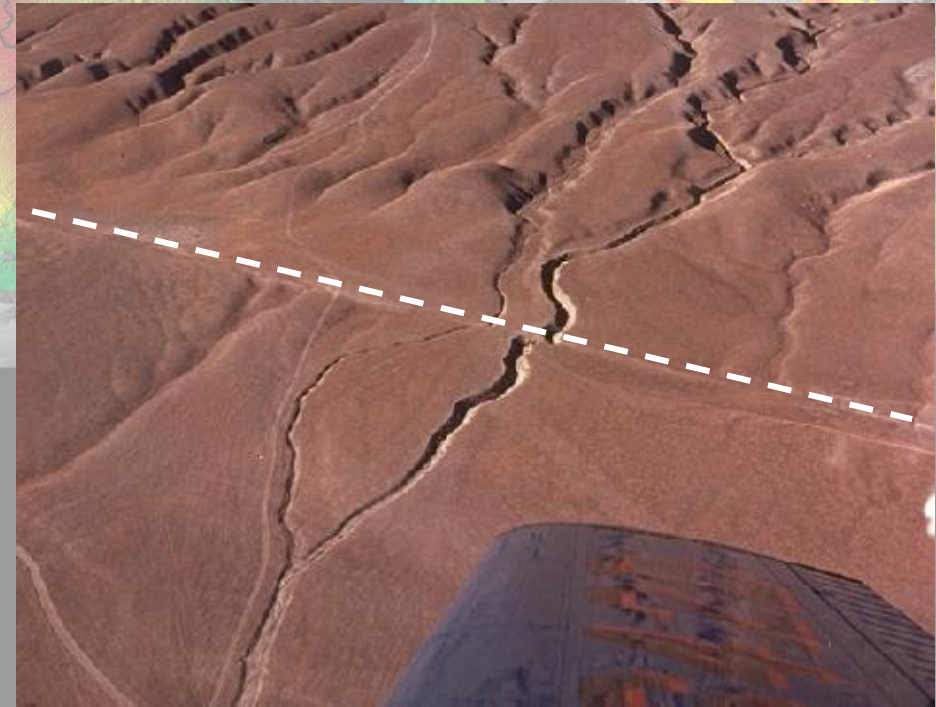
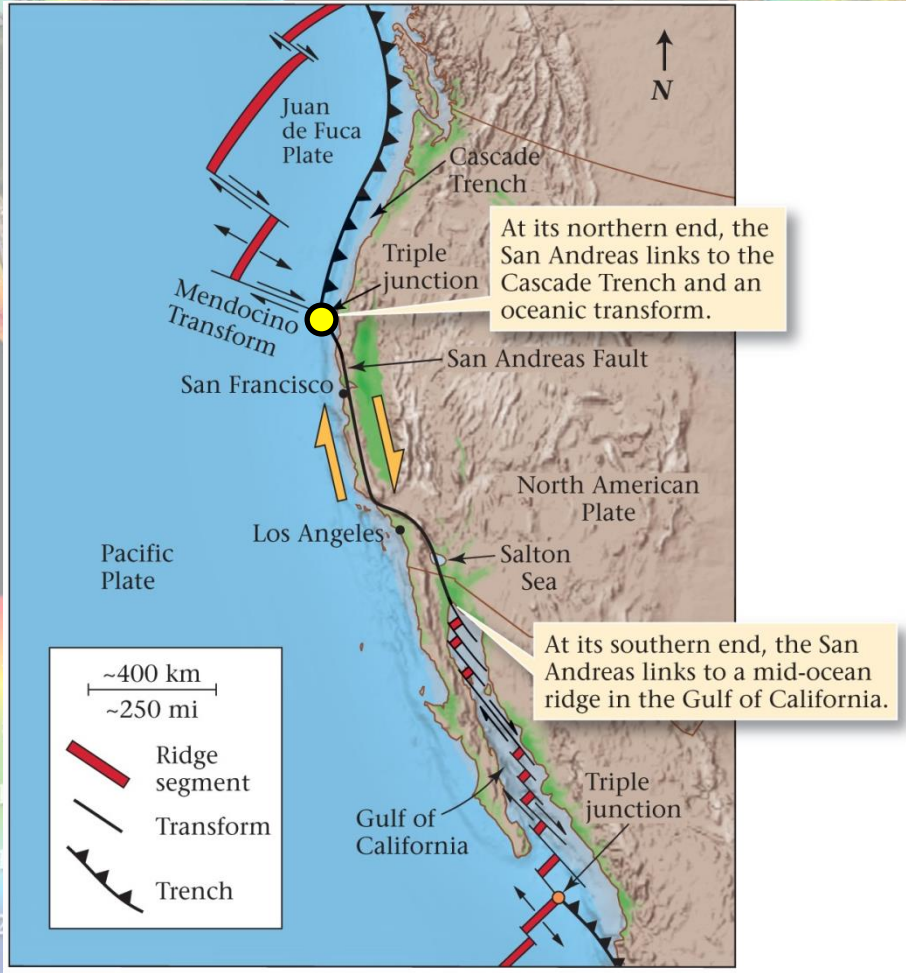
Transform plate boundaries



NO CRUST FORMATION, NO CRUST CONSUMPTION

8. The Continental Drift

Transform plate boundaries

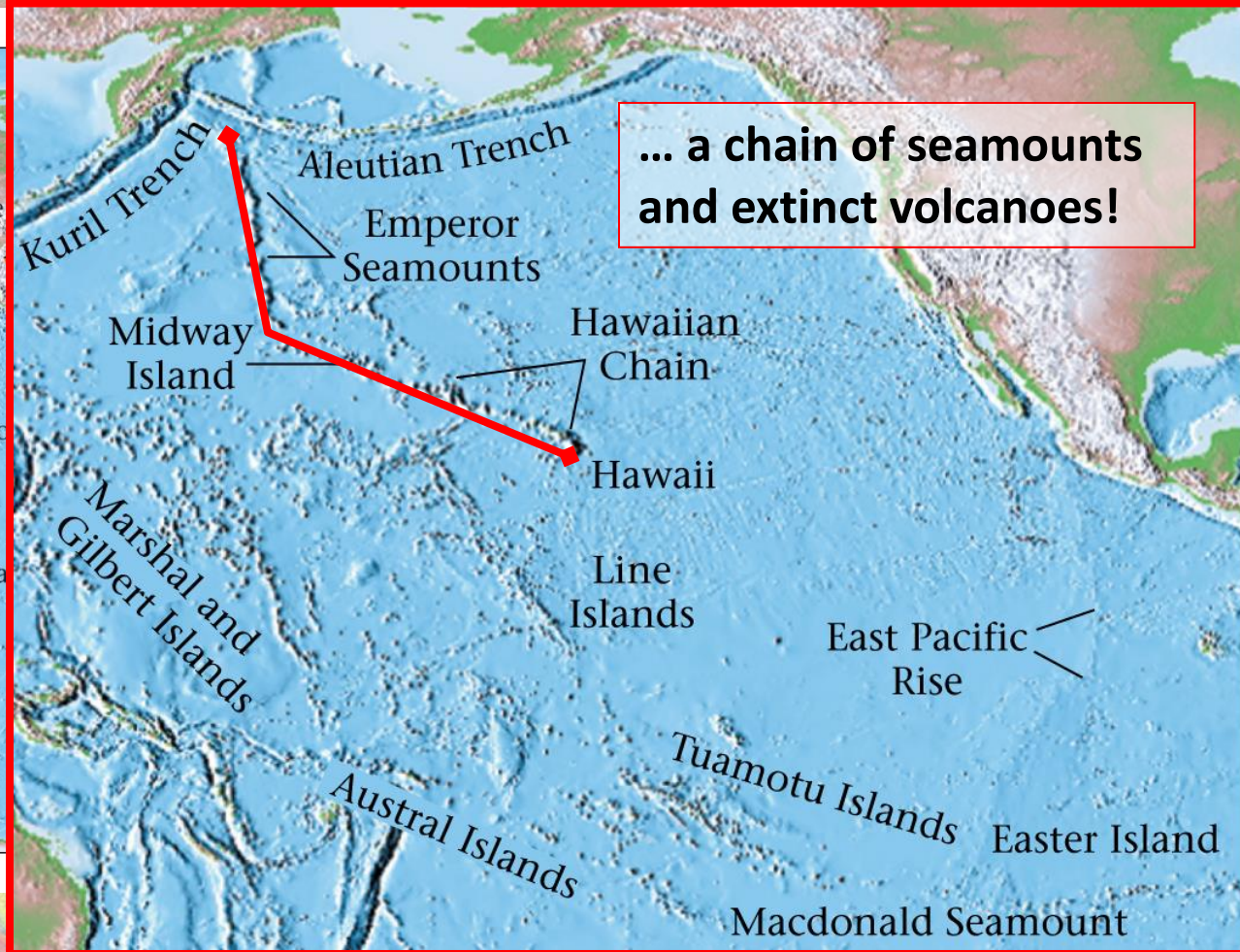


Triple junction = contact between three plate boundaries

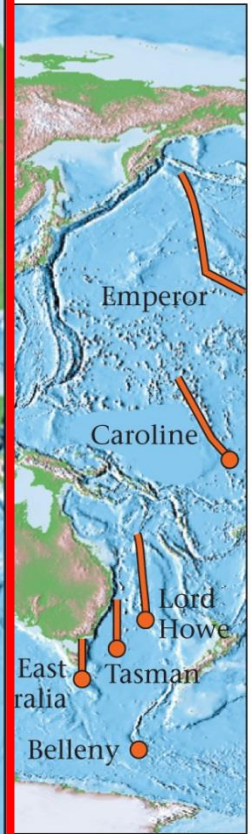
8. The Continental Drift

Special locations

CONCEPT: Hot spots



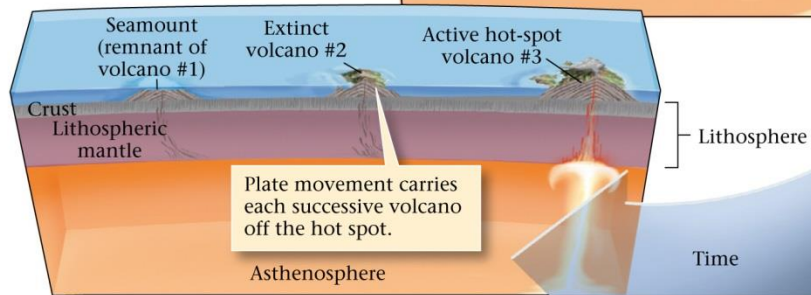
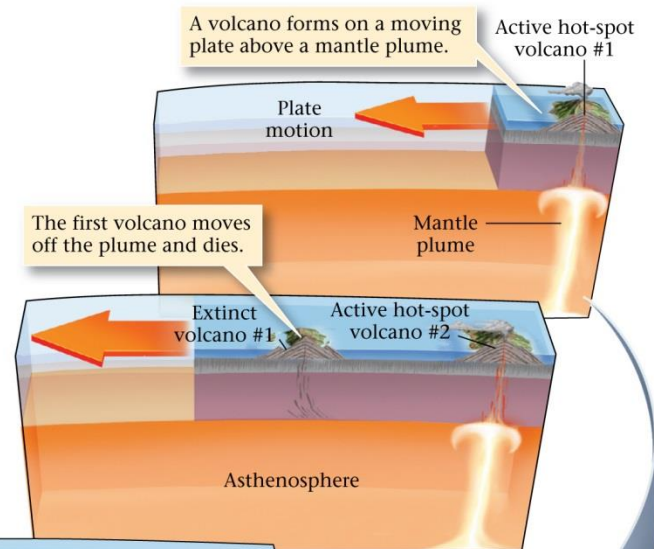
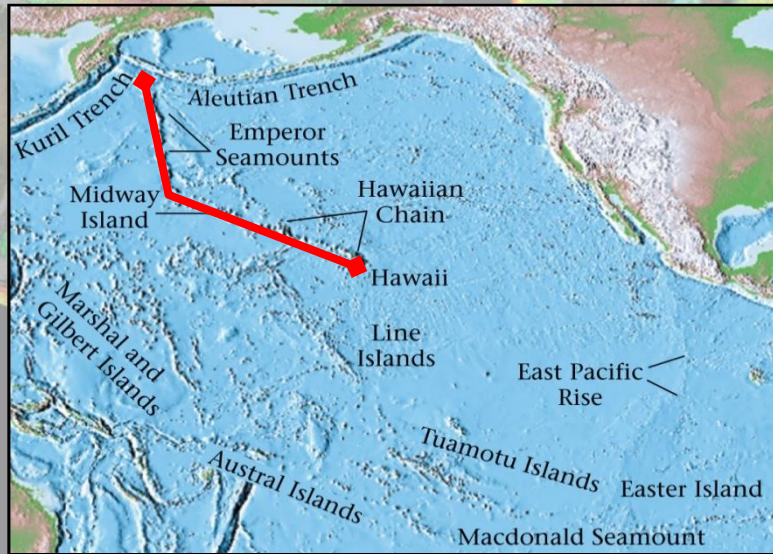
... a chain of seamounts and extinct volcanoes!



8. The Continental Drift

Special locations

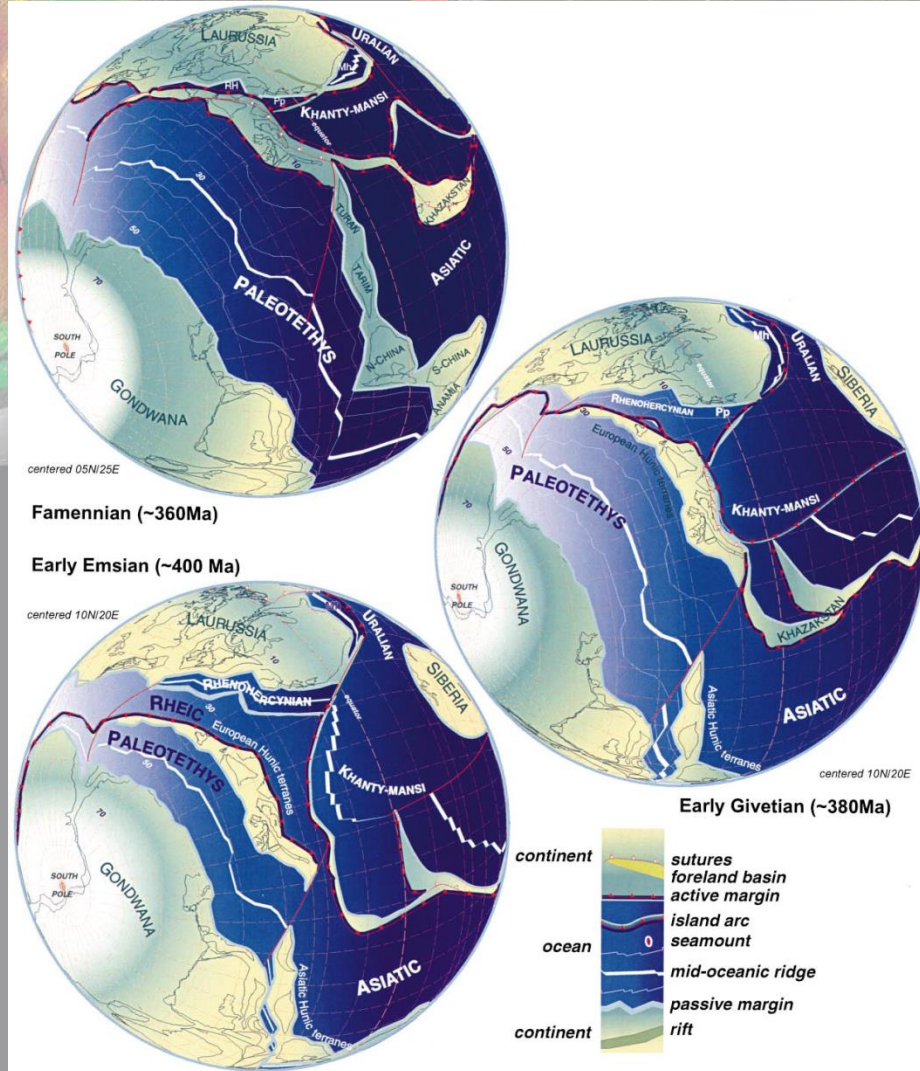
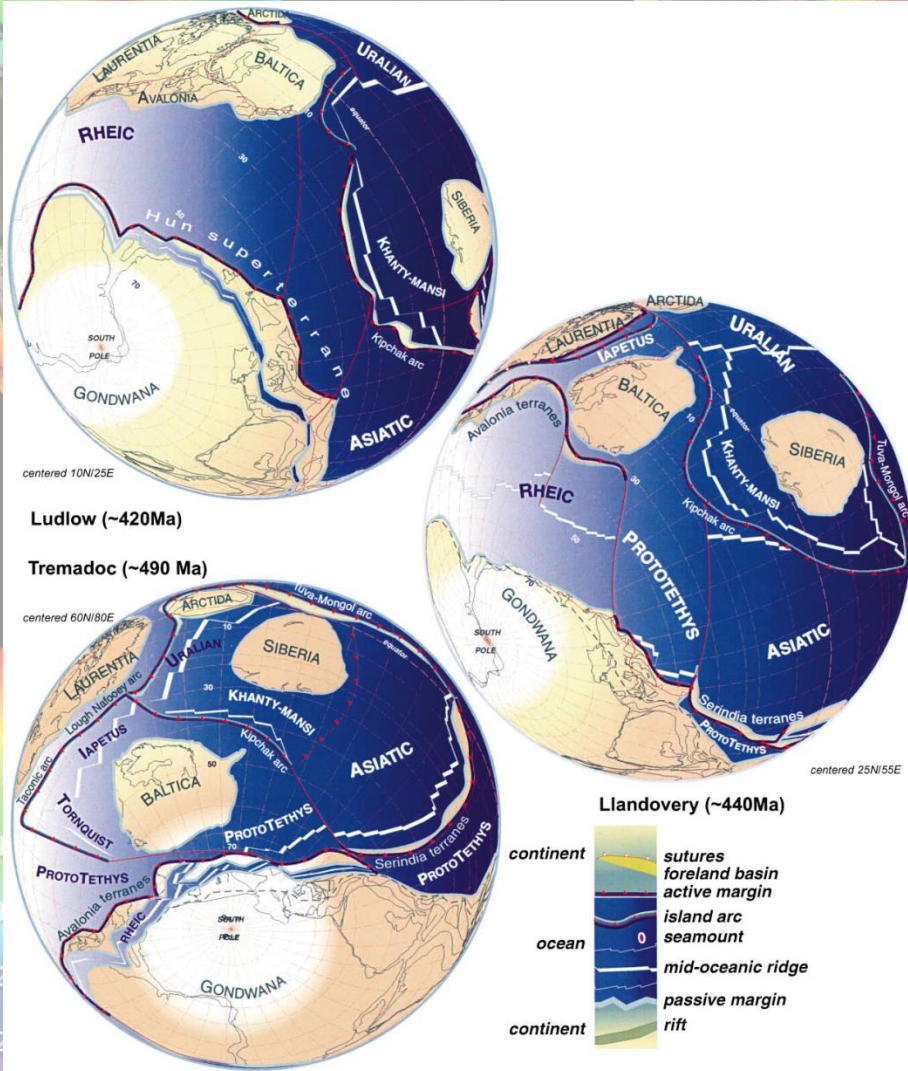
CONCEPT: Hot spots



(b)

8. The Continental Drift

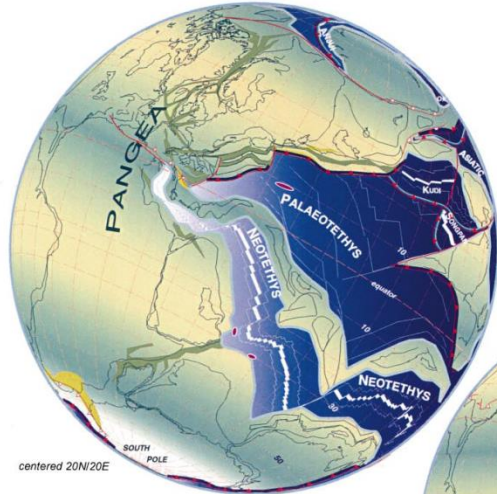
The puzzle of tectonic plates



Stampfli and Borel 2002

8. The Continental Drift

The puzzle of tectonic plates

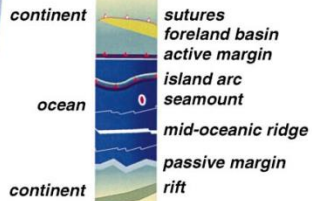
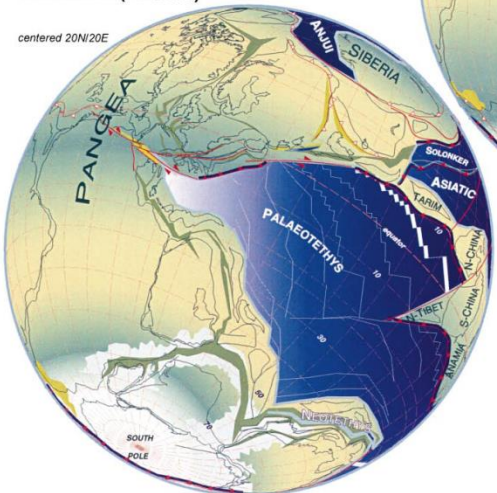


centered 20N/20E

Permian-Triassic boundary (250Ma)

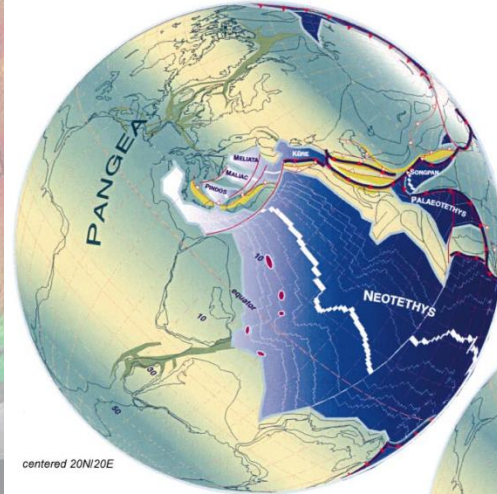
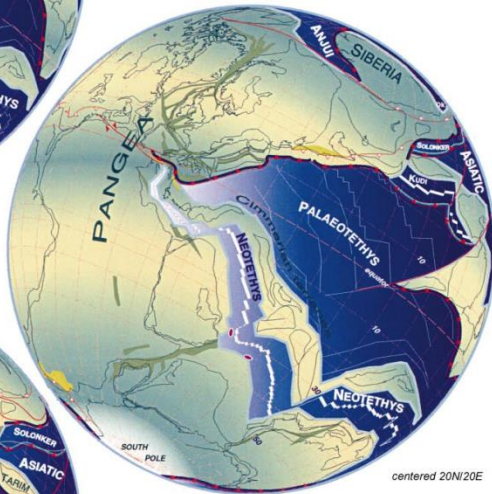
Sakmarian (~280Ma)

centered 20N/20E



Late Wordian (~260Ma)

centered 20N/20E

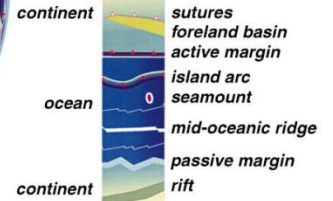
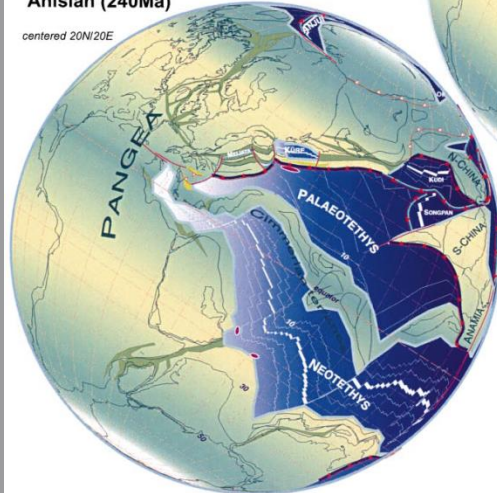


centered 20N/20E

Early Norian (220Ma)

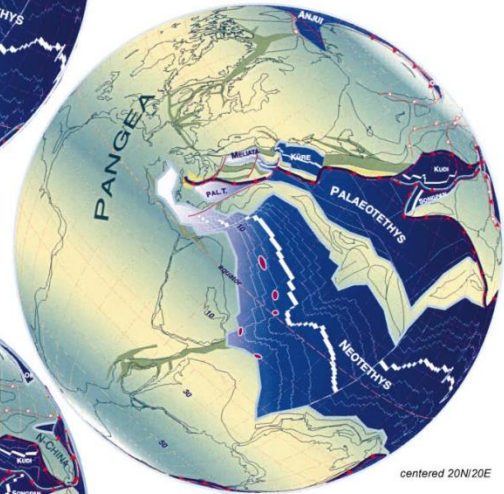
Anisian (240Ma)

centered 20N/20E



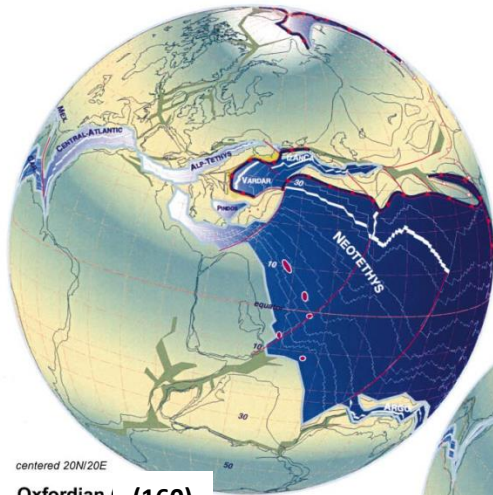
Ladinian (230Ma)

centered 20N/20E



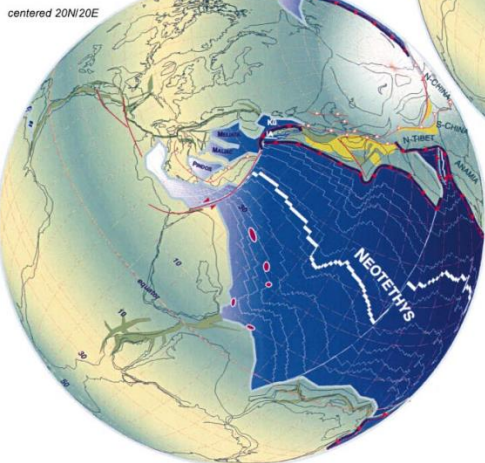
8. The Continental Drift

The puzzle of tectonic plates

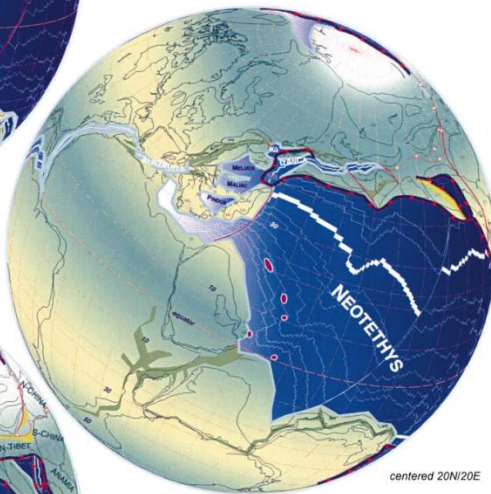


centered 20°N/20°E
Oxfordian (160)

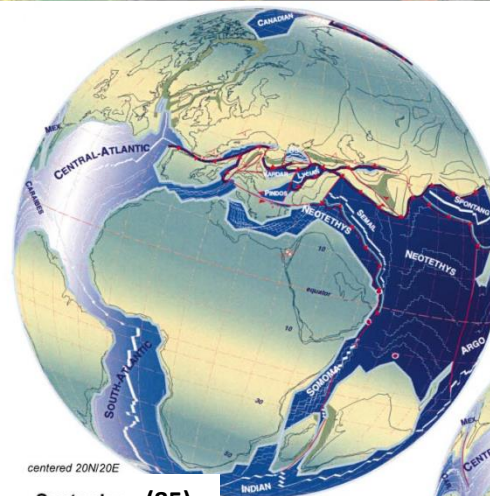
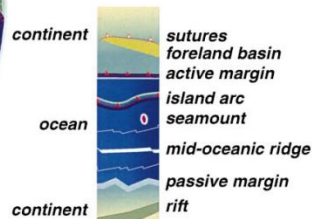
Sinemurian (~200Ma)



centered 20°N/20°E

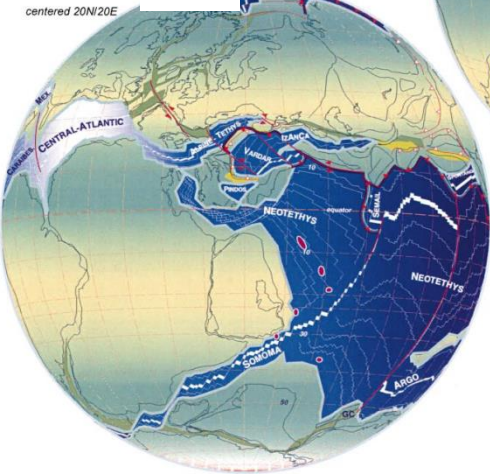


centered 20°N/20°E
Aalenian (~180Ma)

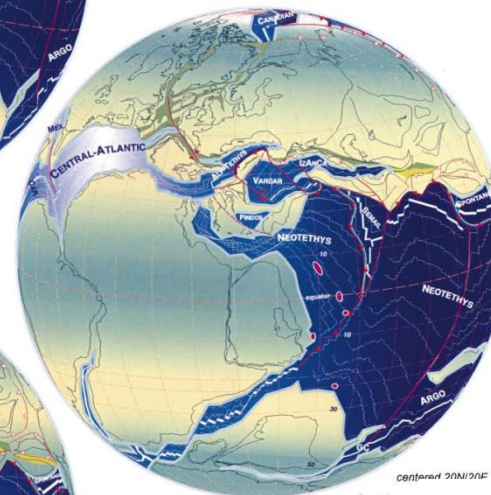


centered 20°N/20°E
Santonian (85)

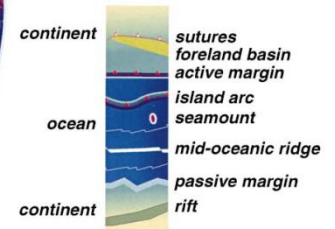
Valanginian (140)



centered 20°N/20°E



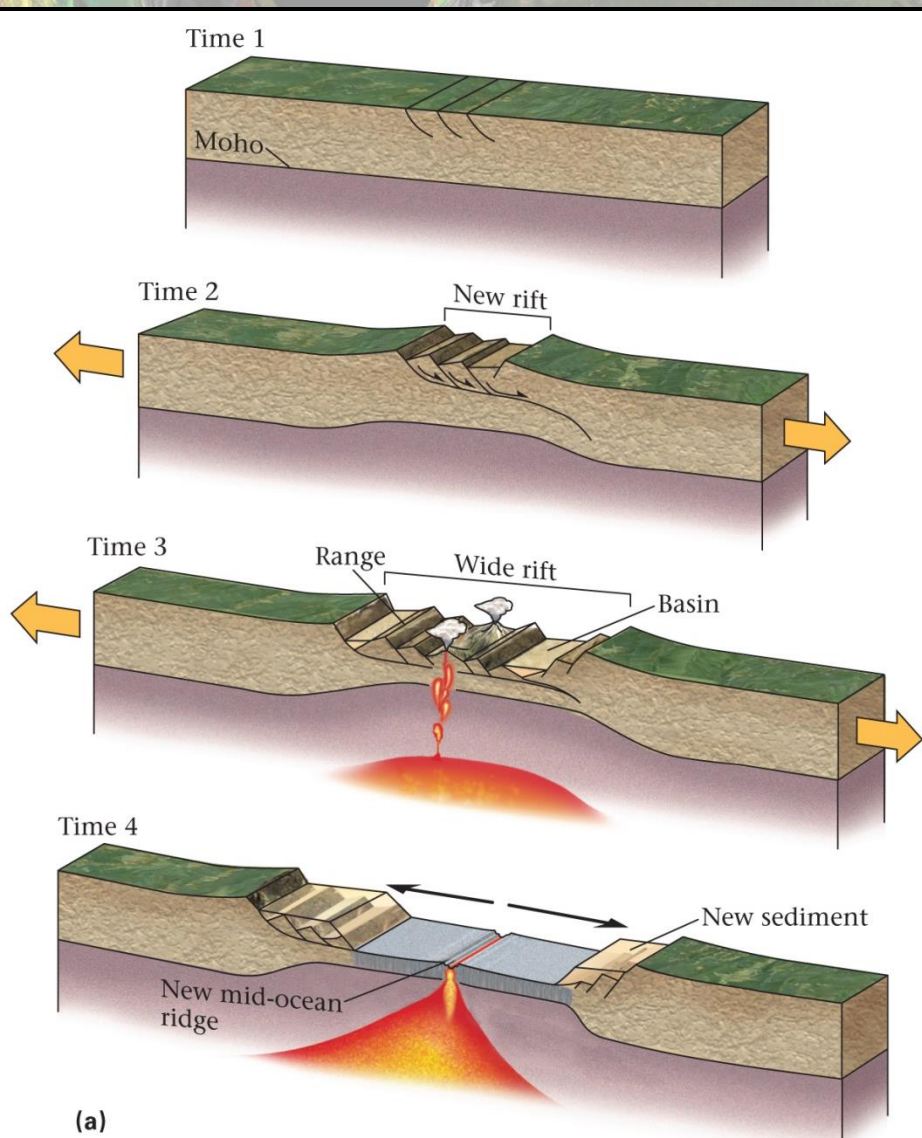
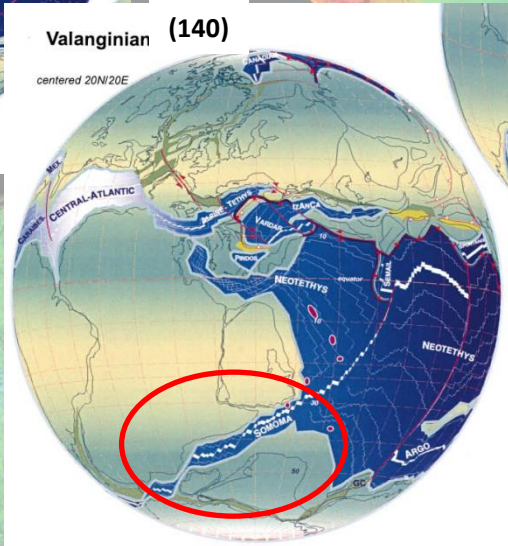
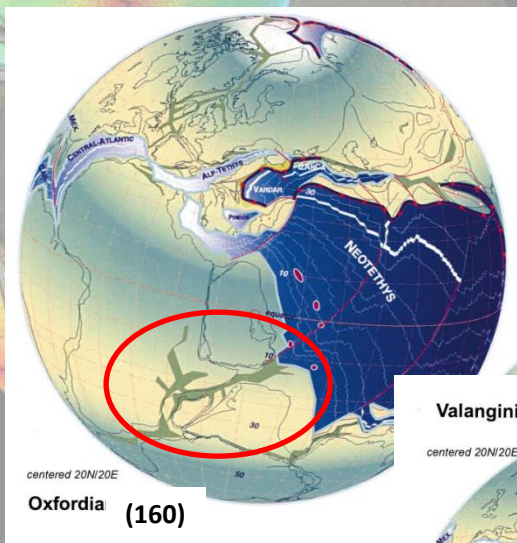
centered 20°N/20°E
Aptian (125)



Stampfli and Borel 2002

8. The Continental Drift

The puzzle of tectonic plates

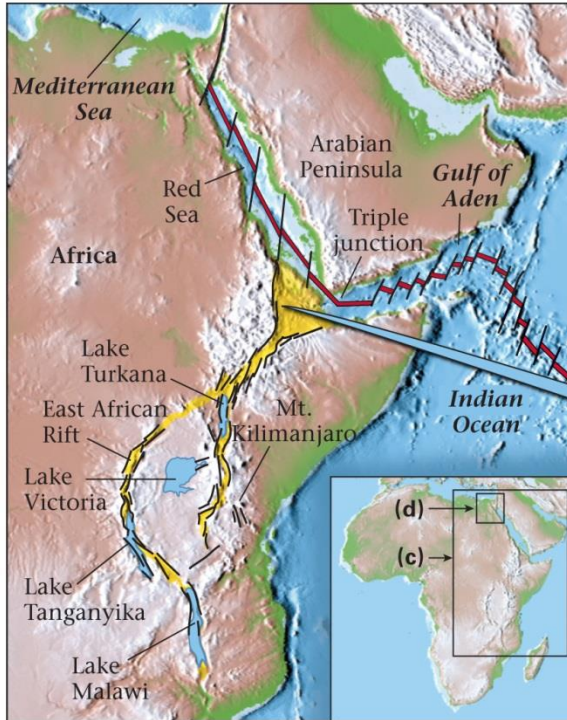


CONTINENTAL RIFTING

8. The Continental Drift

The puzzle of tectonic plates

CONCEPT: Continental rifting



The East African Rift is growing today

Photo taken at the north end of the East African Rift

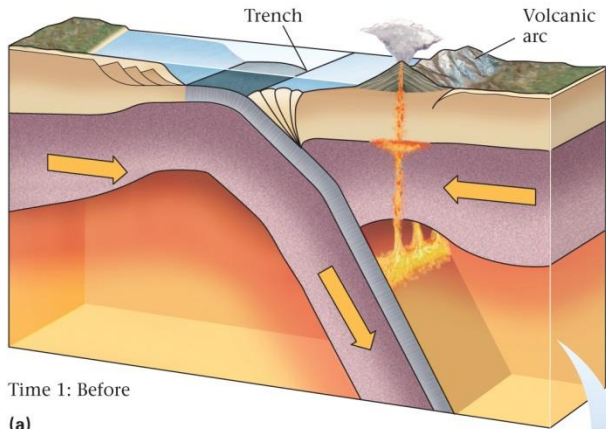


The Red Sea started as a rift!

8. The Continental Drift

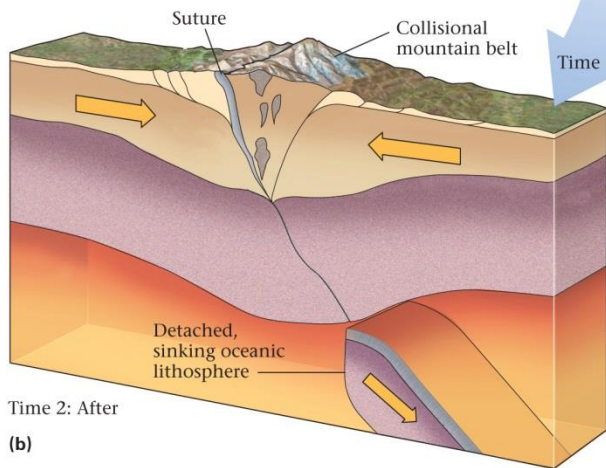
The puzzle of tectonic plates

CONCEPT: Continental collision



(a) Subduction consumes an oceanic plate until two continents collide.

(b) After the collision, the oceanic plate detaches and sinks into the mantle. Rock caught in the collision zone gets broken, bent, and squashed and forms a mountain range.



Continental collision is the final part of the subduction process.

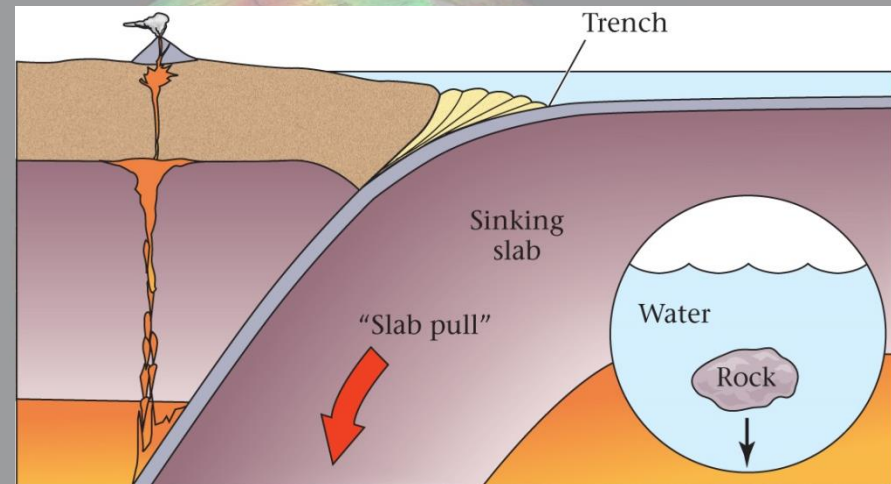
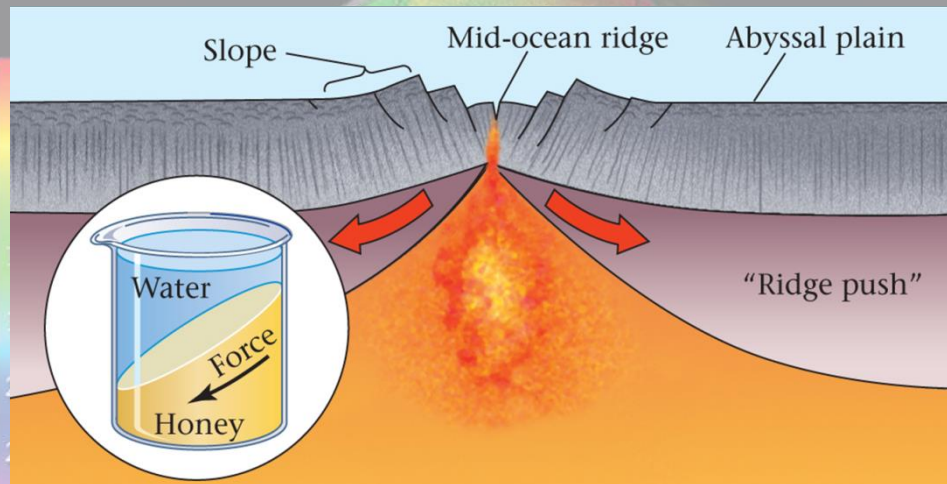
8. The Continental Drift

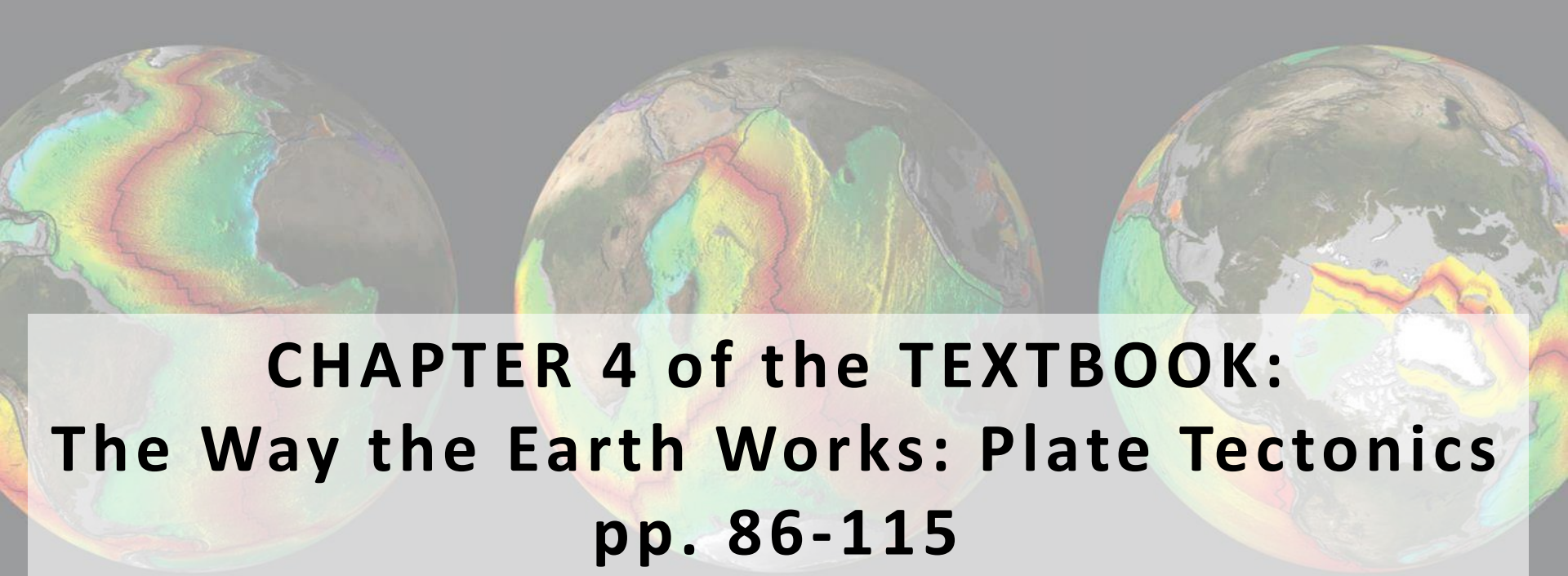
What drives plate motion?

Old hypothesis → Convective flows in the asthenosphere drag the plates

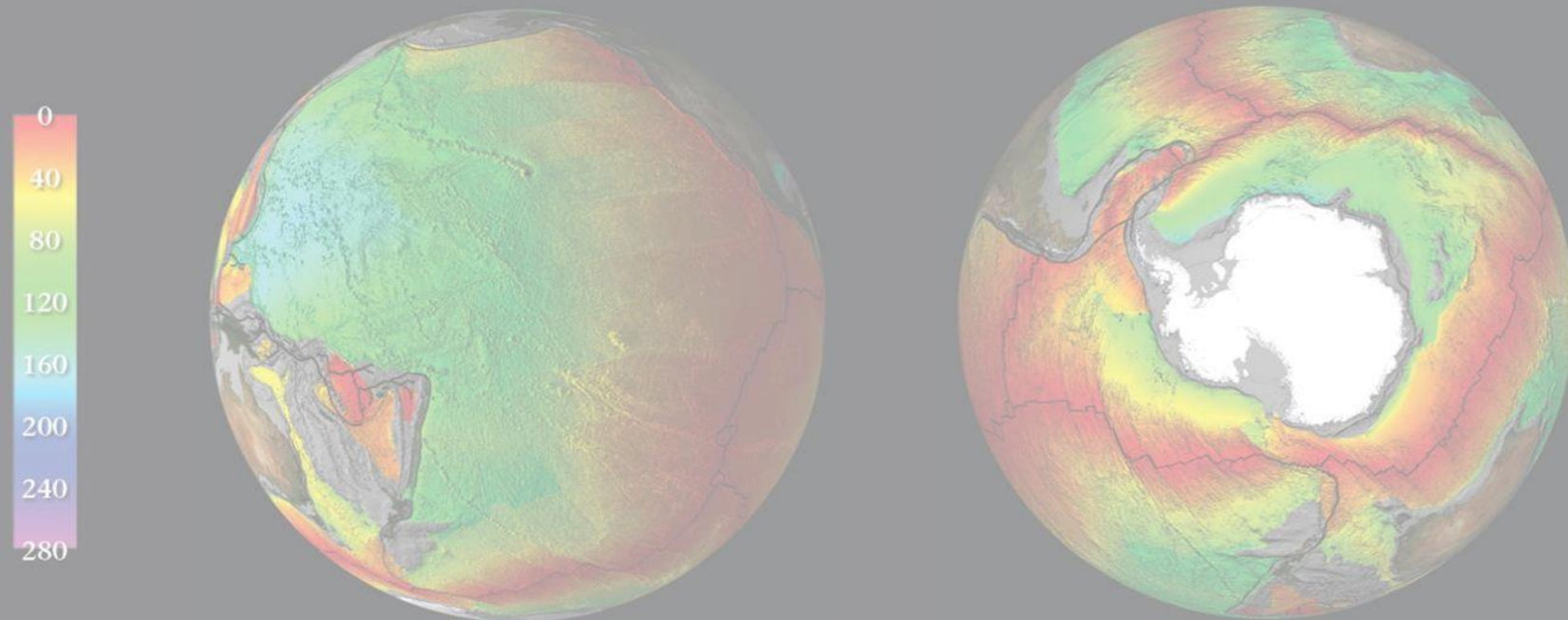
1 - Ridge-push force = gravity push apart the ancient lithosphere

2 - Slab-pull force = subducting plate (slab) pull down the above lithosphere





**CHAPTER 4 of the TEXTBOOK:
The Way the Earth Works: Plate Tectonics
pp. 86-115**



QUESTIONS?

