

OLLI SG 492

Plate Tectonics

Session 4 - October 10, 2022

Today's Meeting

- Finish the history of, and evidence for, the theory of plate tectonics.
- Plate movement.
- Types of plate boundaries, and their characteristics.
- The creation of the oceans.
- The rock cycle.

Why Is the Earth Still Hot?

4.5 Billion Years of Cooling

- Heat remains from the conditions that formed early Earth:
 - Kinetic energy of the collisions of meteorites, asteroids, etc. was transformed into thermal energy.
 - In addition, radiogenic heat resulted from the decay of short-lived radioactive isotopes, such as aluminum-26 and calcium-41.
- Heat continues to be produced from the decay of long-lived radioactive isotopes, such as uranium-235, uranium-238, thorium-232, and potassium-40.
- Heat from the latter slows the heat loss due to radiation into space.

Movement of Crustal Plates

How Can It Happen?

- The crust, the lithospheric mantle (together, they form the lithosphere), and the asthenosphere have different densities and composition, ranging in density from 2.7 gm/c^3 for continental crust to 3.3 gm/c^3 for the asthenosphere.
- Rocks in the asthenosphere are at temperatures and pressures near their melting point. They respond to forces by **flowing**.
- Rocks in the lithosphere are relatively cool and rigid. They respond to forces by **bending or breaking**, not flowing.
- The lithosphere is effectively detached from the asthenosphere, allowing it to move independently.

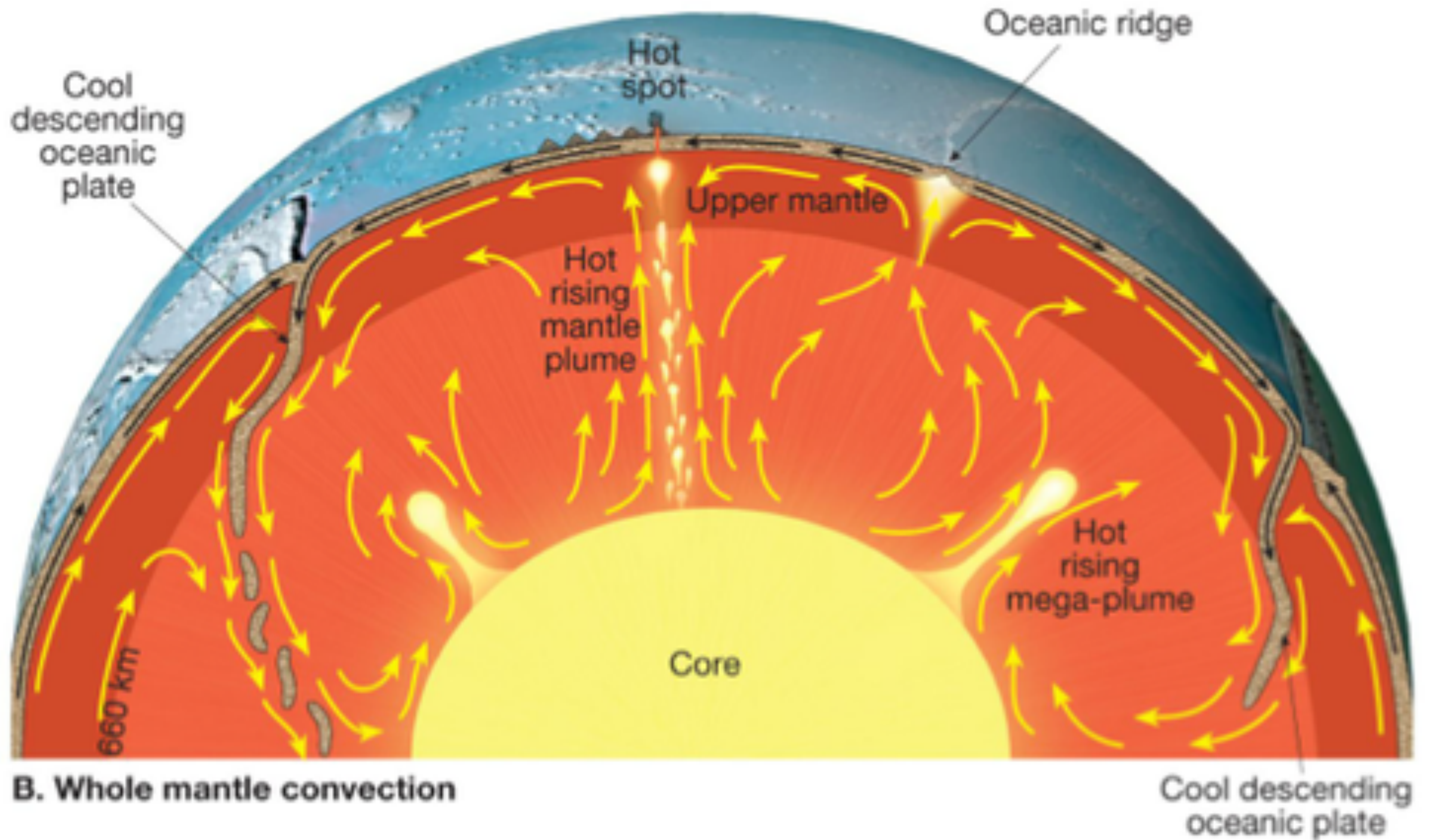
Movement of Crustal Plates

How Does It Happen?

- Convection in the upper mantle transports heat from the core to the crust through hot, rising mantle rocks in plume shaped structures.
- When the plumes reach the asthenosphere, they slide horizontally under the lithosphere. This results in the opening of a mid-ocean ridge or rift and “ridge push.”
- The magma entering the rift creates a ridge several thousand feet above the seafloor. As the ridge cools, it slumps away from the rift through gravity, adding to “ridge push.”
- A corresponding movement of cold oceanic crust being subducted back into the mantle results in “slab pull.”

Movement of Crustal Plates

Mantle Plumes



Movement of Crustal Plates

Ridge Push, Slab Pull

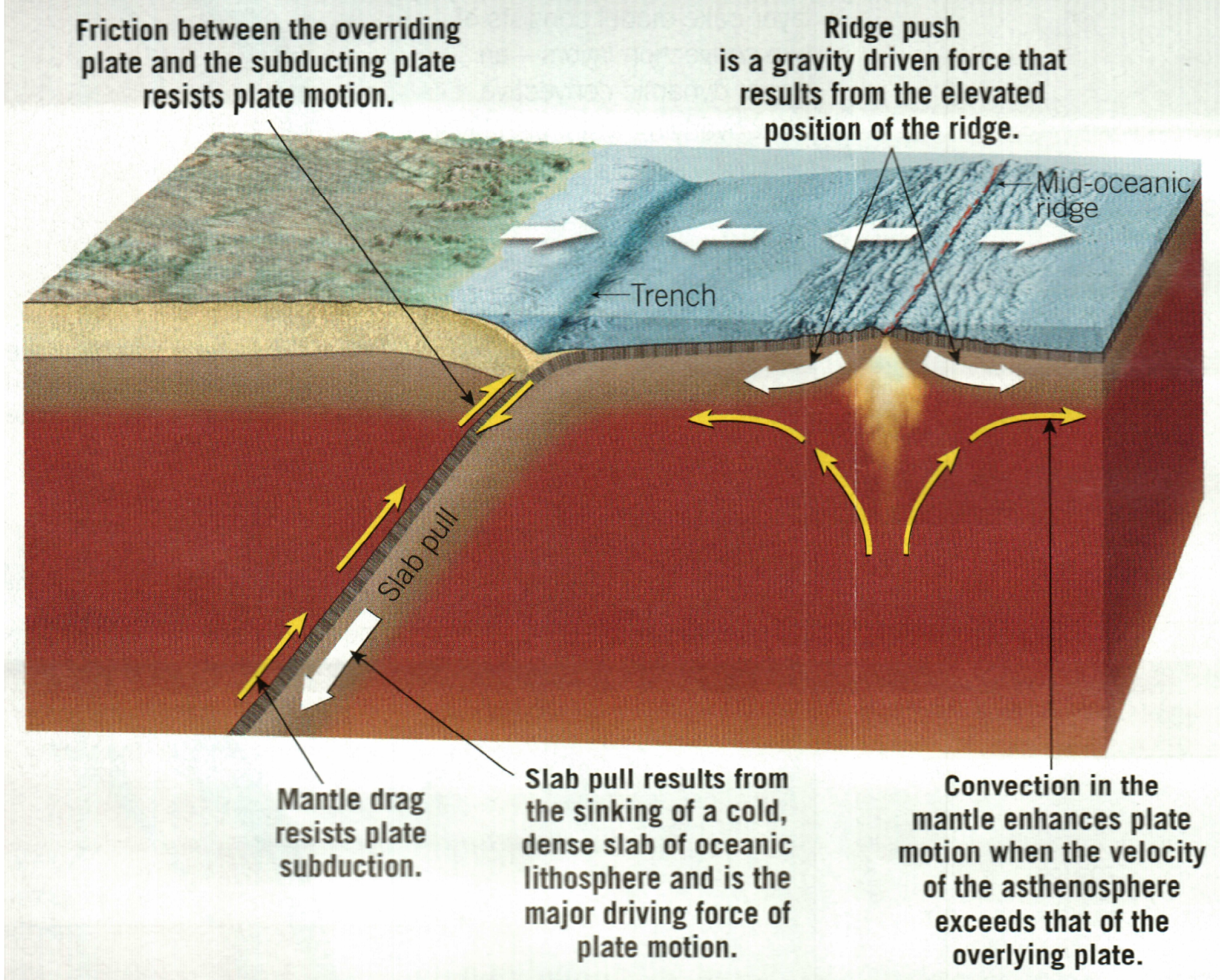


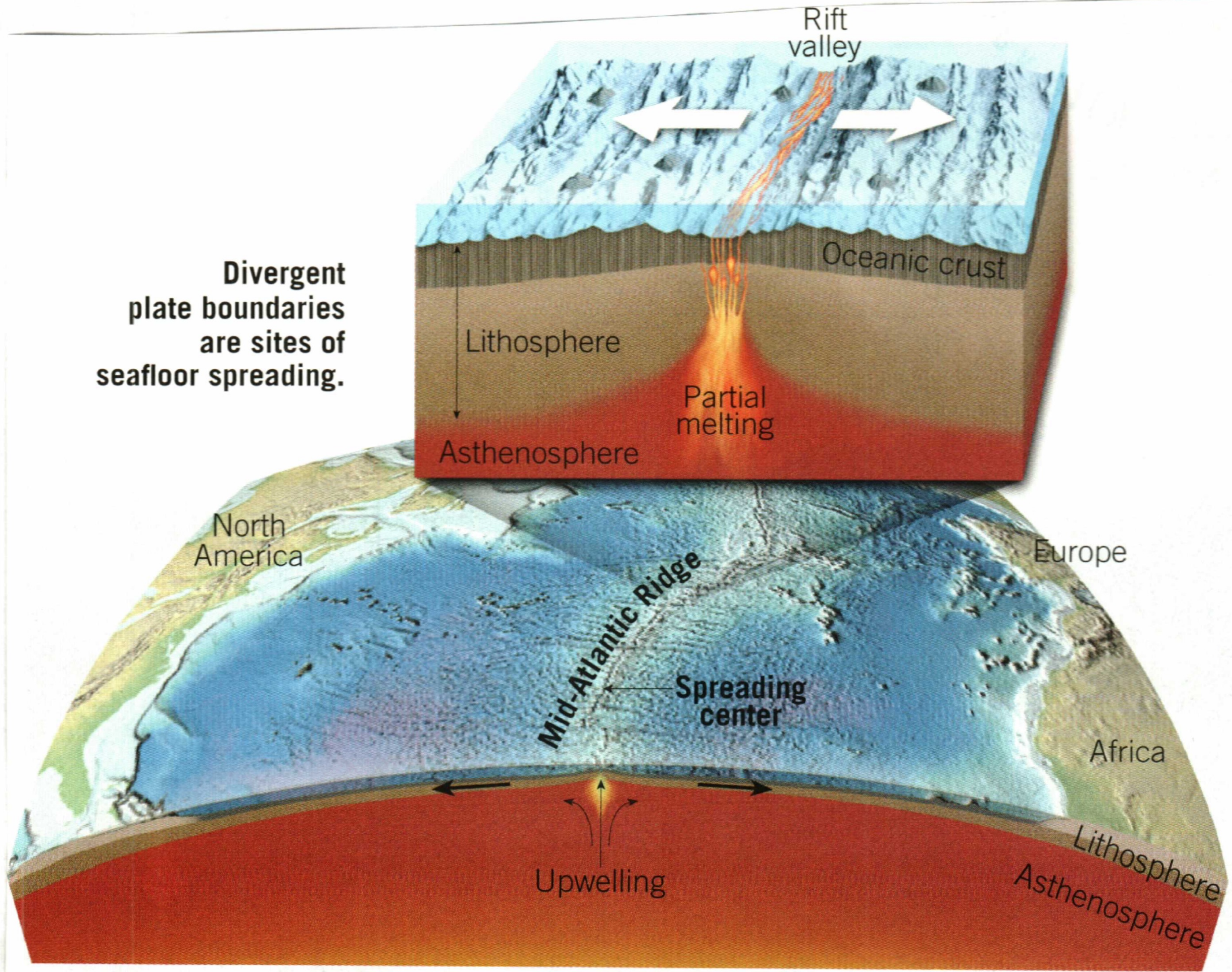
Plate Boundaries

- Geologically speaking, it's (mostly) happening at plate boundaries - both current and former boundaries!
 - Volcanos, earthquakes, mountain building, etc.
- Three types of boundaries:
 - Divergent boundaries - continental or oceanic crust is rifting, separating.
 - Convergent boundaries - plates are colliding:
 - Continental to continental collision.
 - Oceanic to oceanic collision.
 - Continental to oceanic collision.
 - Transform Boundaries - plates are sliding past each other.

Divergent Boundary

Seafloor Spreading

Divergent plate boundaries are sites of seafloor spreading.



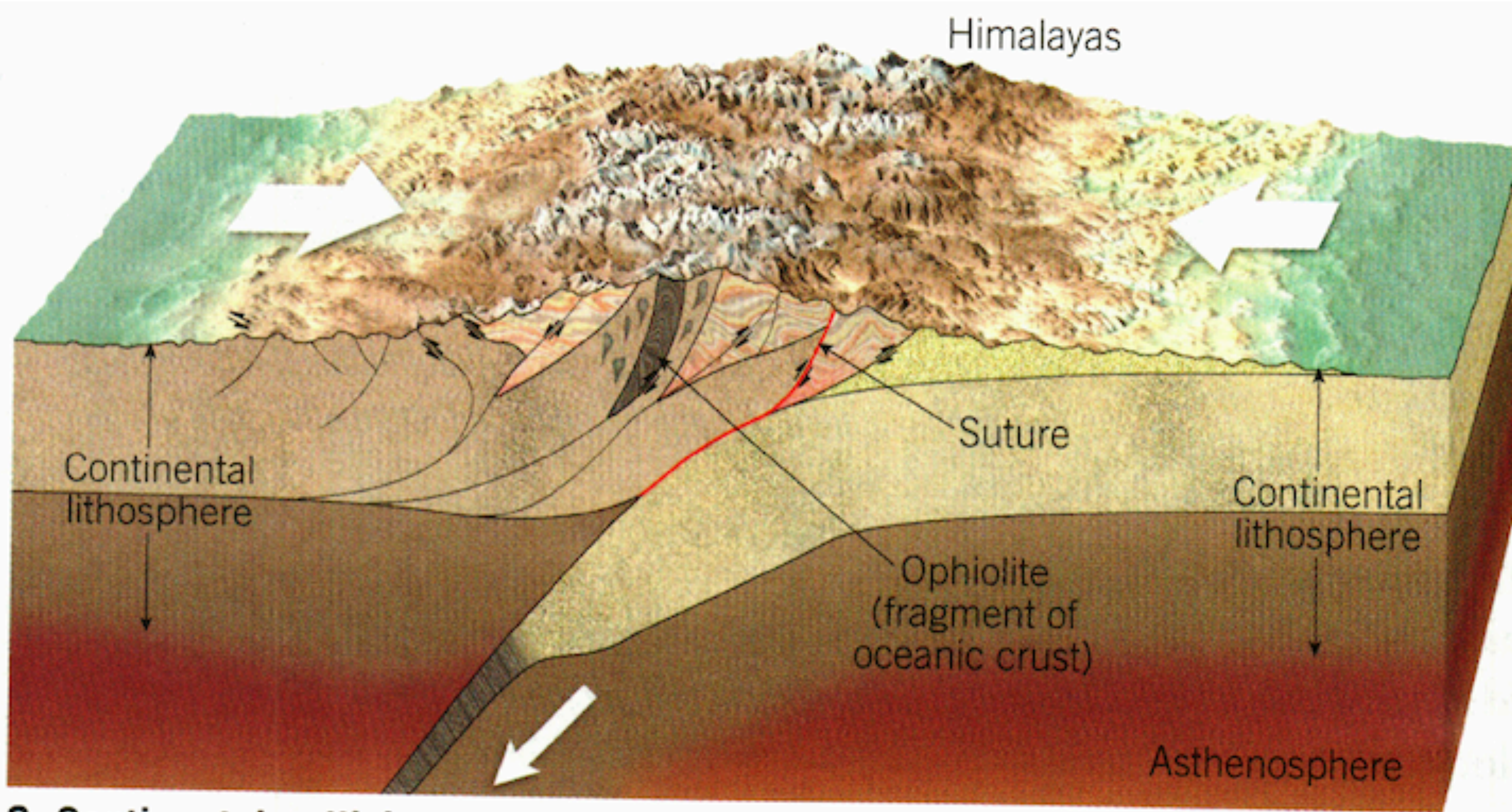
Divergent Boundary Continental Rifting



FIGURE 13.21 East African Rift Valley

Convergent Boundary

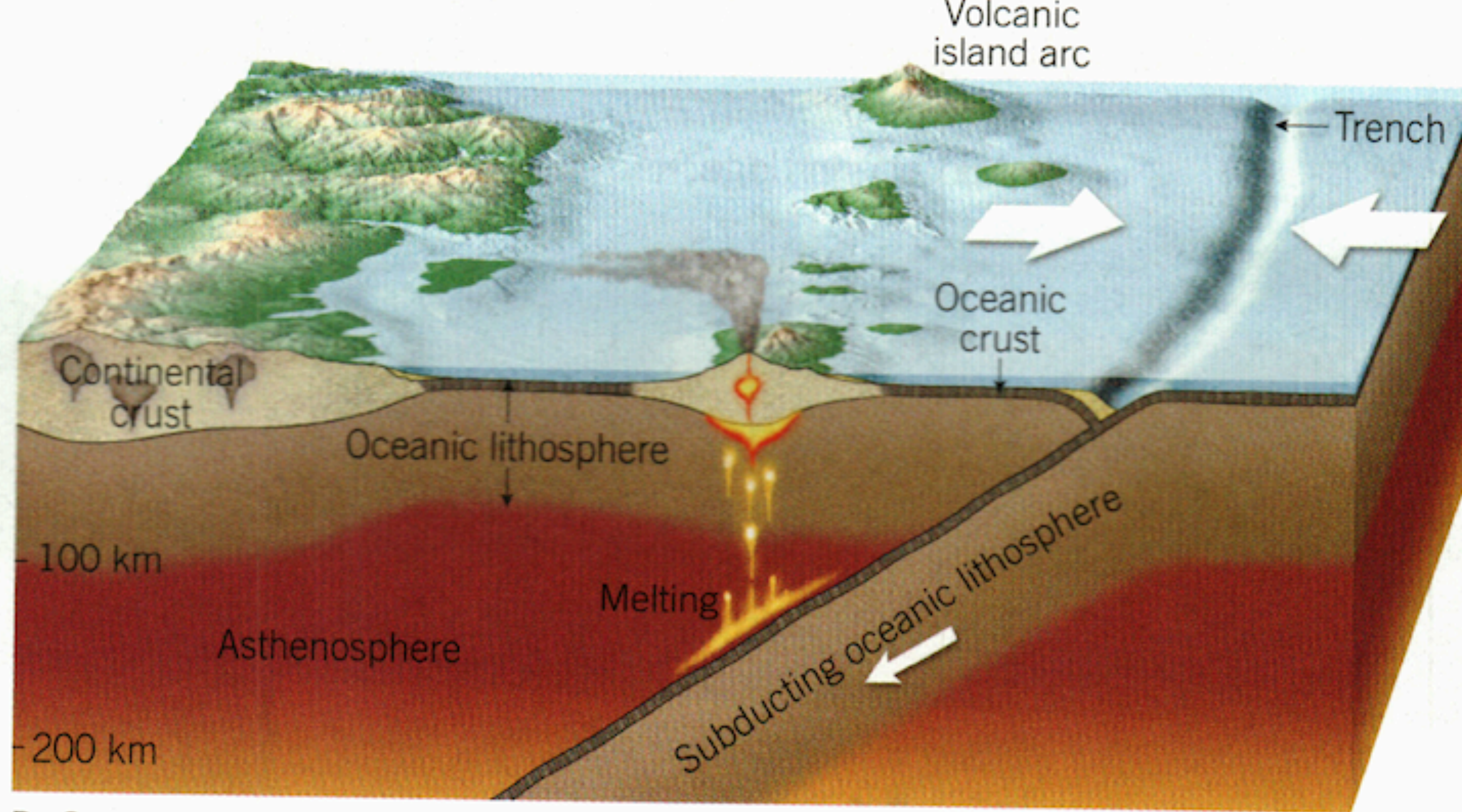
Continental to Continental Crust



C. Continental collisions occur along convergent plate boundaries when both plates are capped with continental crust.

Convergent Boundary

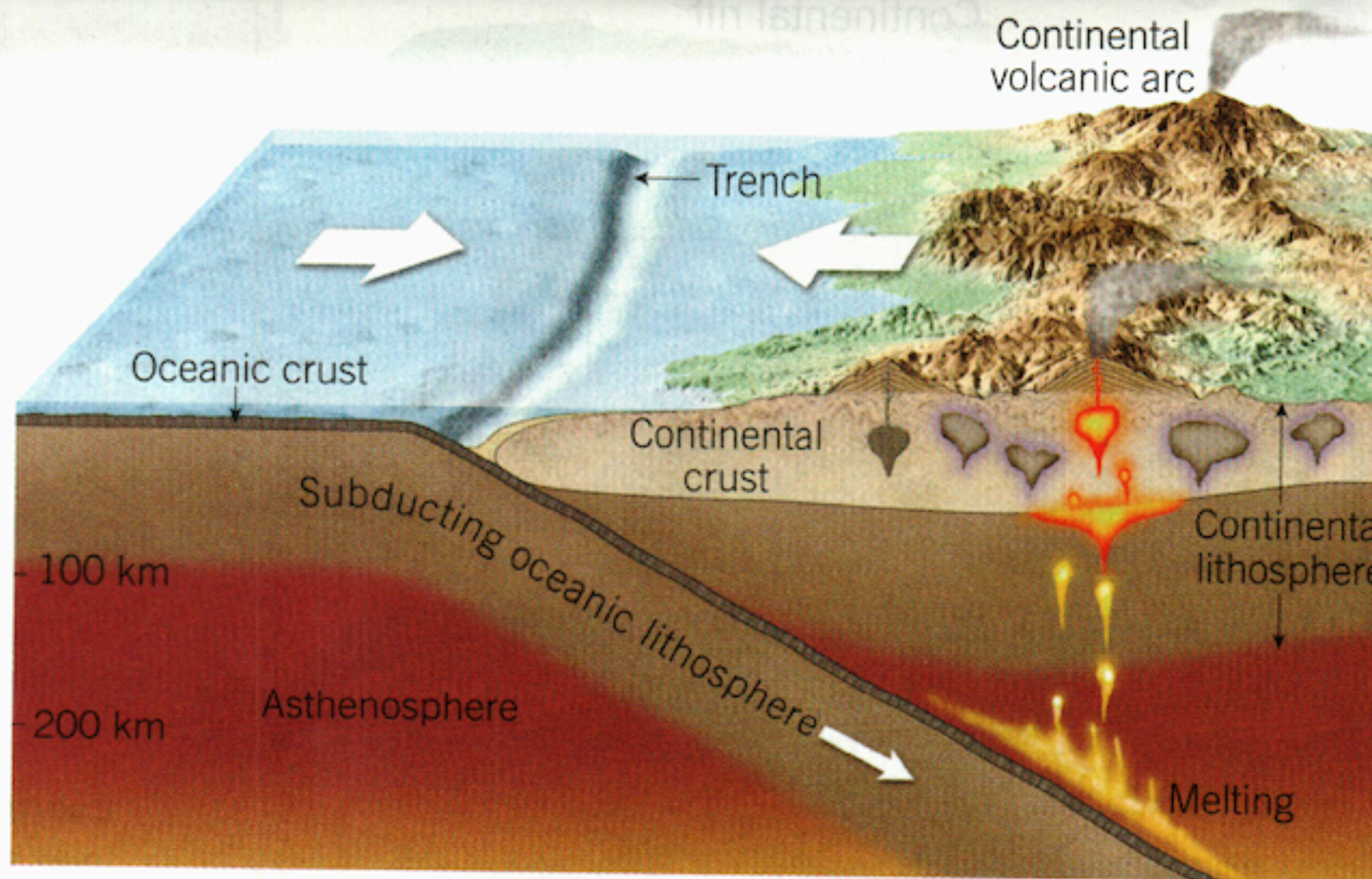
Oceanic to Oceanic Crust



B. Convergent plate boundary involving two slabs of oceanic lithosphere.

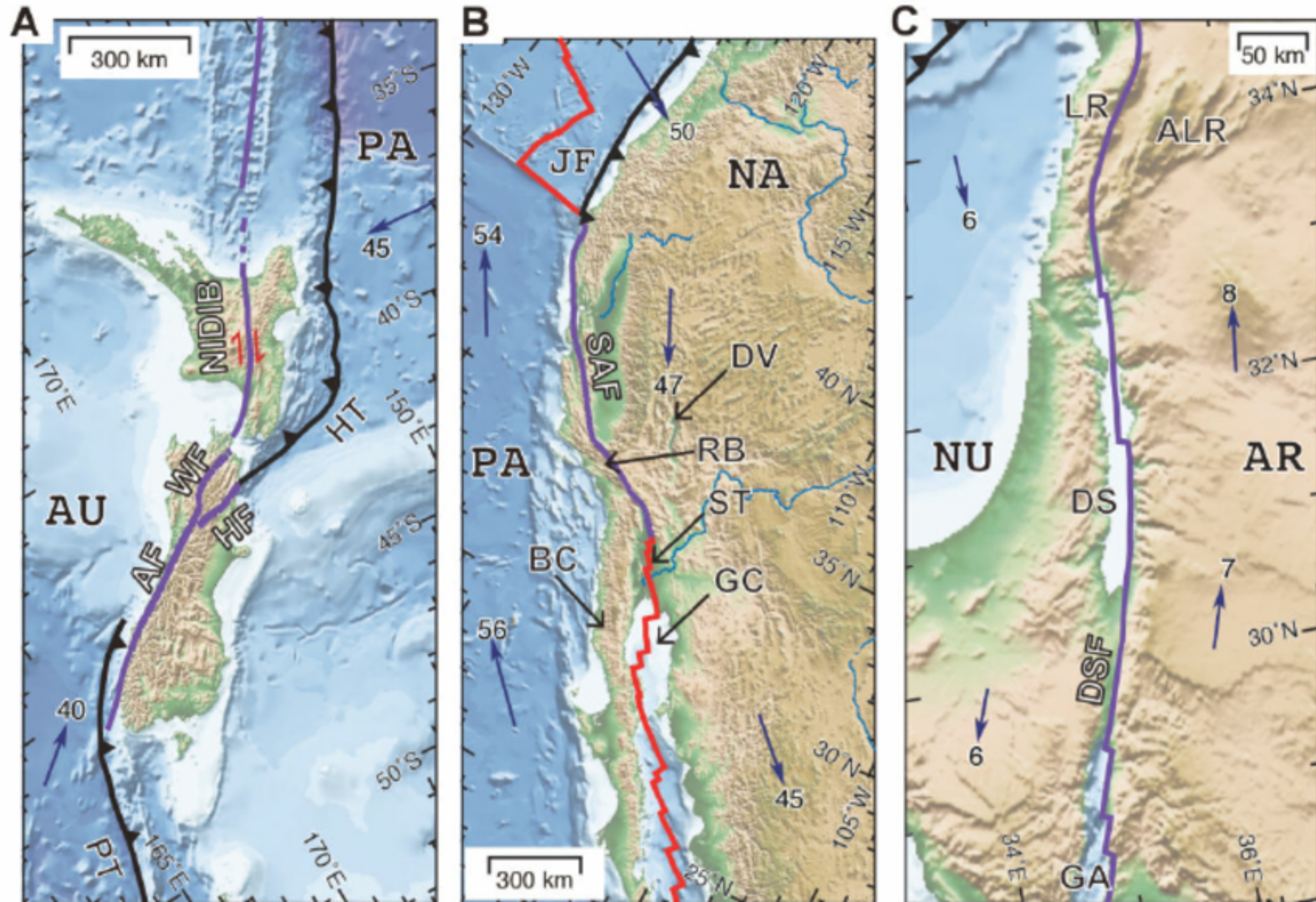
Convergent Boundary

Continental to Oceanic Crust



A. Convergent plate boundary where oceanic lithosphere is subducting beneath continental lithosphere.

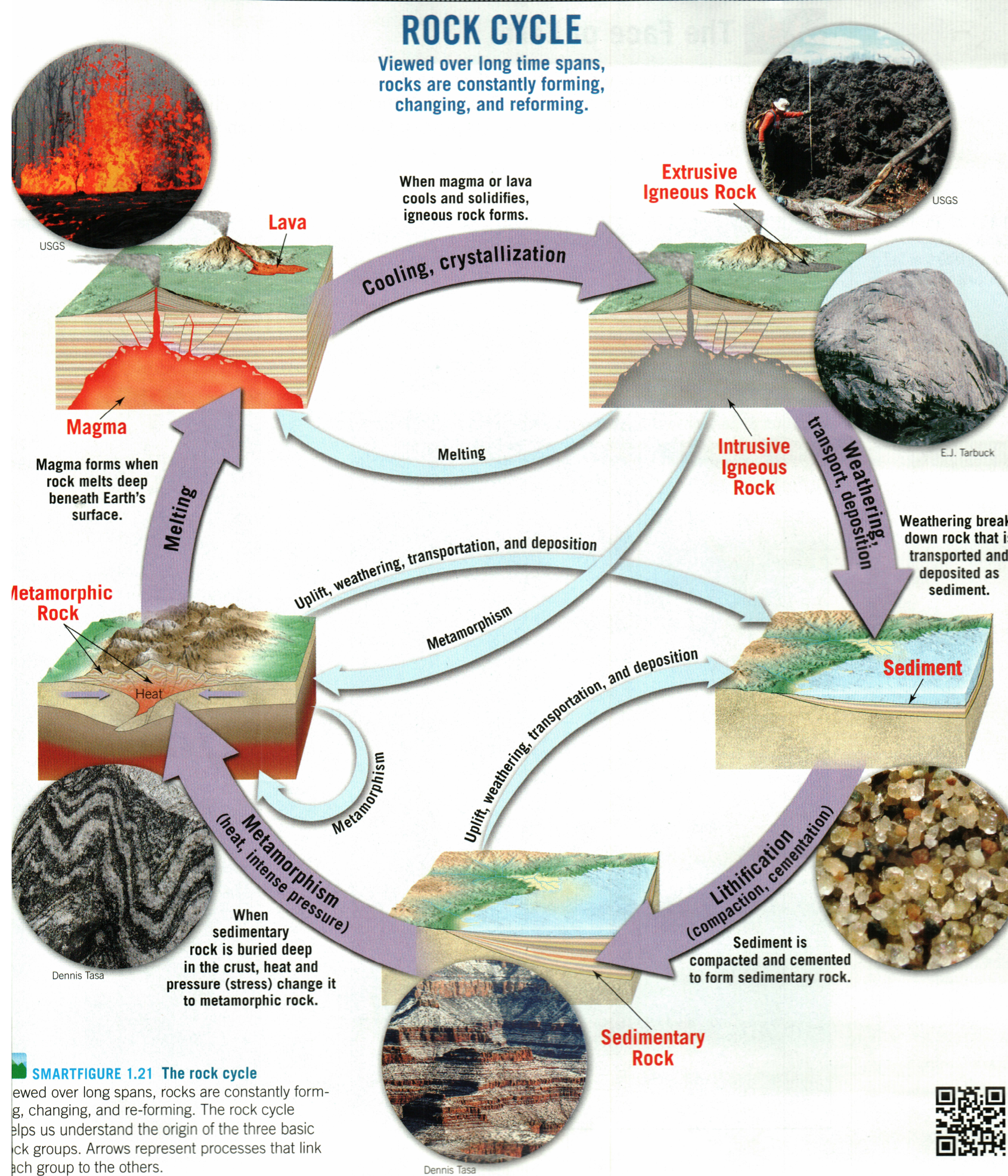
Transform Plate Boundaries



Creation of the Oceans

- Video clip 1 - from 2:38 to 3:00.
- Video clip 2 - from 7:18 to 9:22
- Video clip 3 - from 9:54 to 11:01
- Video clip 4 - from 12:47 to 13:02
- Video clip 5 - from 25:48 to 28:40

Rock Cycle



Up Next

- Formation of the continents.
- The supercontinent cycle.