University of Anbar

College of Science

Department of Applied Geology

Tectonics

Title of the lecture

The theory of plate tectonics

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The theory of plate tectonics

The outer portion oh the earth is a relatively rigid layer called the lithosphere. It consists of the crust (oceanic or continental) and the uppermost mantle. The mantle below the lithosphere is relatively plastic (it can flow) and is called the asthenosphere. The different in behavior (rigid vs plastic) between lithosphere mantle and asthenosphere mantle is a consequence of temperature, the former is cooler than the latter. Continental lithosphere is typically about 150 km thick, while oceanic lithosphere is about 100 km thick.

According to the theory of plate tectonics, the lithosphere is broken into about twenty plates that move to one another. Most of the motion is accommodated by sliding along plate boundaries (the edge of the plates); plate interior stay relatively undeformed. There are three types of plate boundaries.

1. Divergent boundaries: Here, two plates move apart by a process called sea-floor spreading. Divergent boundaries are marked by a mid-oceanic ridge. Asthenosphere mantle rise beneath a mid-oceanic ridge and partially melts, forming magma. The magma rises to form new oceanic crust. The lithosphere mantle thickens progressively away from the ridge axis as the plate cools Fig. 1.

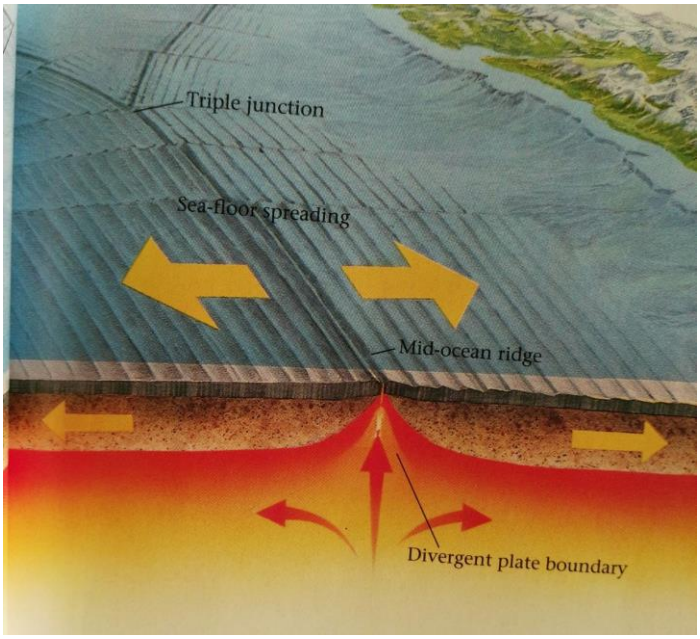

Fig. 1. Divergent plate boundary

2. Convergent boundaries: two plates move together, and one plate subducts beneath another (it sinks down into the mantle). Only oceanic lithosphere can subduct. At the earth´s surface, the boundary between two plates is marked by a deep-oceanic trench. During subduction, melting above the downgoing plate produces magma that rises to form a volcanic arc Fig. 2.

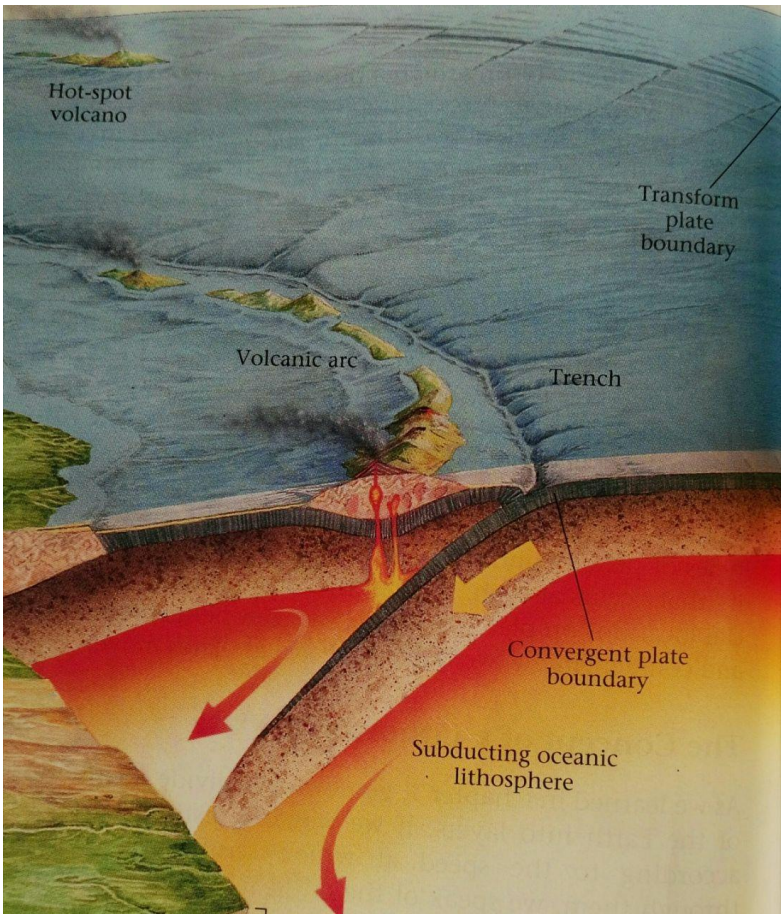

Fig. 2. Convergent plate boundary

3. Transform boundaries: one plate slides sideways past another, without the creation of a new plate or subduction of an old one. The boundary is marked by a fault. Transform boundaries link segments of mid-oceanic ridges. The may also cut through continental lithosphere Fig. 3.

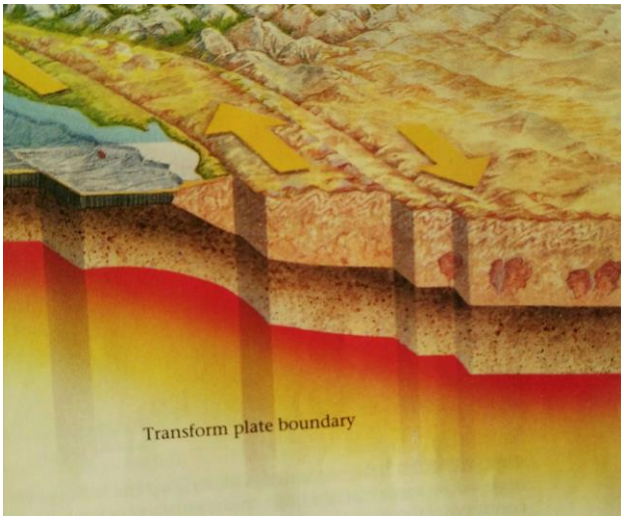

Fig. 3. Transform boundary

A point at which three plate boundaries meet is called a triple junction Fig. 1 (in the figure three mid-oceanic ridges meet). Where two continents converge, they collide and form a collisional mountain range. This happens because continental crust is too buoyant to be subducted Fig. 4.

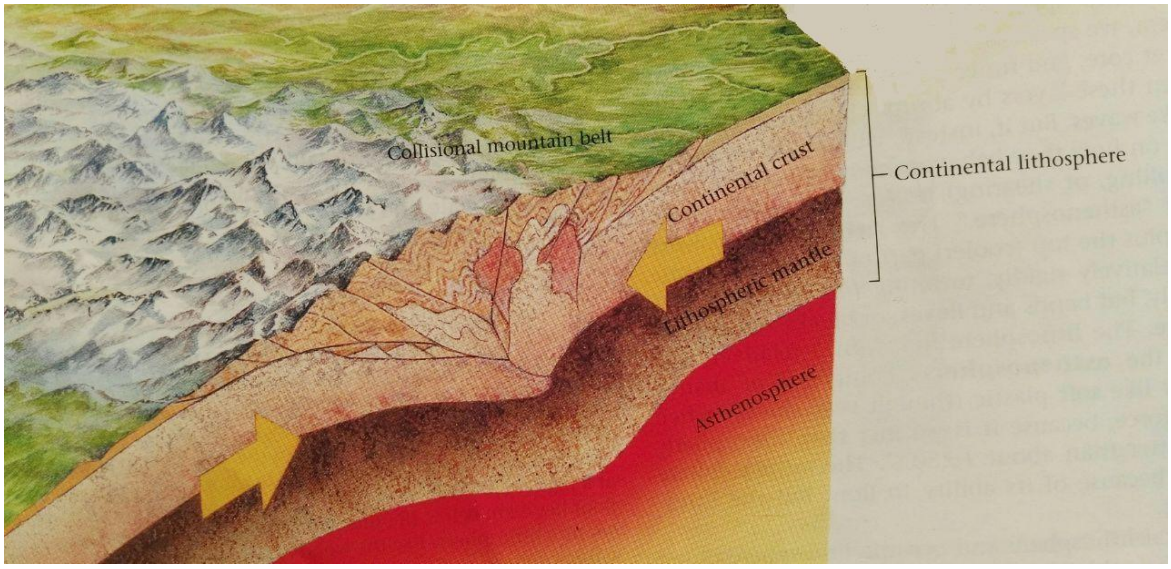

Fig. 4. Continental mountain belt occurs when two continental lithospheres collide

At continental rifts, a continent stretches and may break in two. Rifts are marked by the existence of many faults. If a continent rift apart, a new mid-oceanic rift develops Fig. 5.

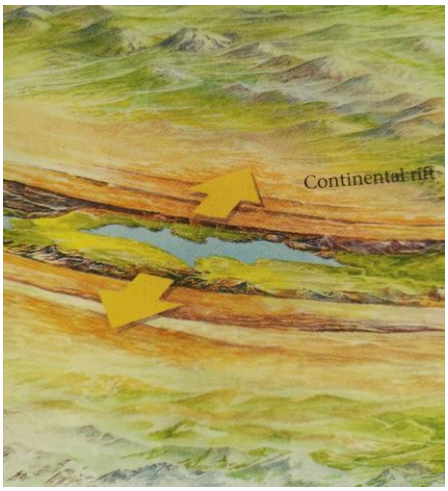

Fig. 5. Continental rift.

Hot-spot volcanoes form above plumes of hot mantle rock that rise from near the boundary between lower mantle and outer core. As a plate drifts over a hot spot, it leaves a chain of extinct volcanoes Fig. 6.

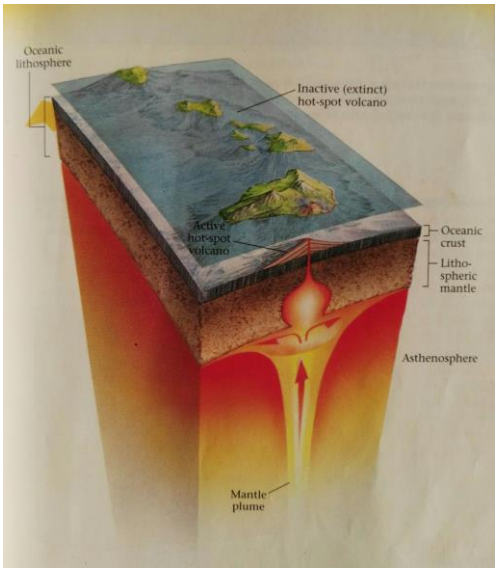

Fig. 6. Formation of hot-spot volcano above mantle plume

As we show above the lithosphere forms the earth´s relatively rigid shell. The lithosphere shell contains a number of major pieces. We call the pieces lithosphere plates or simple plates, and we call the breaks plate boundaries. Some plate boundaries follow continental margins, or

coasts, while others do not. For this reason, we distinguish between active continental margins, which are plate boundaries, and passive margin, which are not plate boundaries Fig. 7.

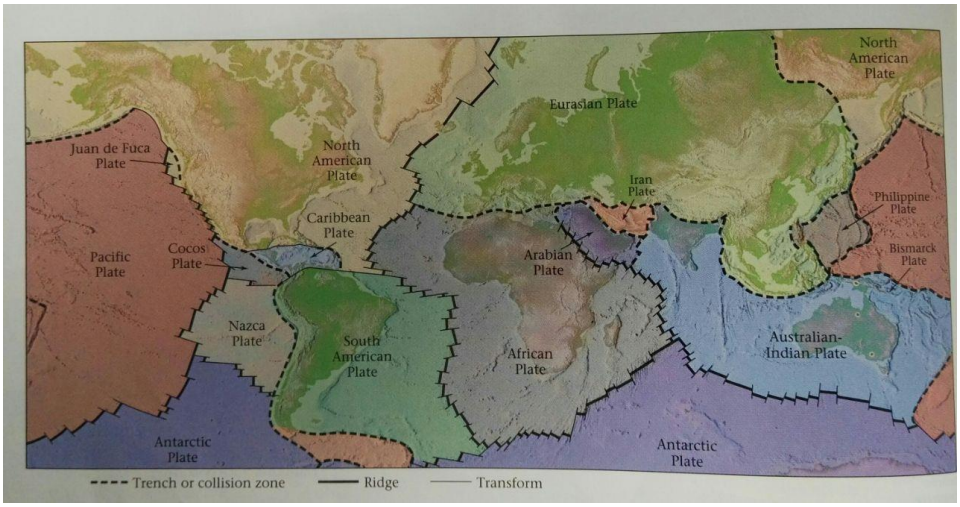

Fig. 7. The major plates making up the lithosphere. Note that some plates are all oceanic floor, while some contain both continents and oceans. Thus, some plate boundaries lie along continental margins (coast), while others do not. For example, the eastern border of South America is not a plate boundary, but the western edge is.

Along passive margin, continental crust is thinner than normal, and the upper (higher) part has broken into wedge-shaped slices Fig. 8. Thick 10-15 km accumulations of sediment cover this thinned crust. The surface of this sediment layer is a broad, shallow (less than 500 m deep) region of the continent called the continental shelf Fig. 8.

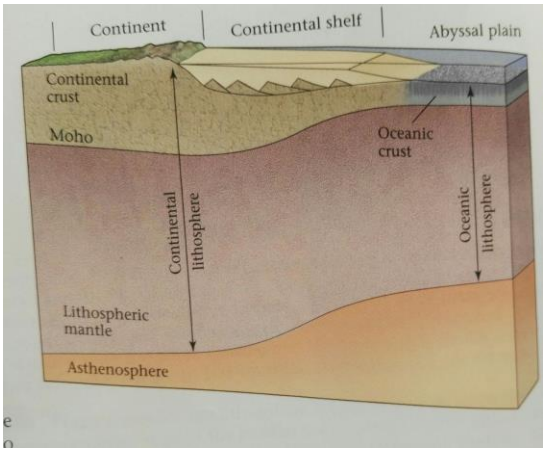

Fig. 8. Passive continental margin.

The reference

Stephen, M., (2004) Essentials of geology, first edition, printed in United State of America, P 536.