IQRA NATIONAL UNIVERSITY PESHAWER

ASSIGNMENT # 04

INTRODUCTION TO EARTHQUAKE ENGINEERING

B-tech(civil)

6th semester

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PLATE TECTONIC THEORY

Plate tectonics is the theory that the outer rigid layer of the earth (the ***lithosphere***) is divided into a couple of dozen "plates" that move around across the earth's surface relative to each other, like slabs of ice on a lake.

The drawing above is a cross section of the earth showing the components that lie within plate tectonic theory. The cross section should really be curved to correspond to the earth's curvature, but it has been straightened out here.

Note the ***continental craton*** (stable continent) in the middle of the drawing. Note the line under the craton; that is the lower boundary of the plate. Everything above that line is the plate. All similar lines in the cross section mark the bottom of the plates. Technically, everything above that line is lithosphere, the rigid, brittle shell of the earth. Everything below is ***asthenosphere***, the hot, plastic interior of the earth.

Within the asthenosphere are ***convection cells***, slowly turning over hot, plastic rock. The convection cells bring heat from the earth's interior out to the surface, but slowly. Movement is about 10 centimeters a year. When the convection cells reach the base of the lithosphere they release heat to the surface at the divergent plate boundary to escape to space. The cooled plastic rock then turns sideways and moves parallel to the earth's surface before descending back into the earth at subduction zones to become reheated. It is this turning over of the convection cells the drives the plate movements.

THE PLATES

Simplistically, the earth consists of the plates, and plate boundaries, those zones where the plates contact and interact. Observe that 7 different plates are labeled in the cross section. Plates are combinations of two units, continents and ocean basins. A plate may be an ocean basin alone, or a continent alone, or a combination of ocean basin+continent (common).

It is possible a plate could be a continent alone, but for this to occur all edges of the continent would have to be a plate boundary (very rare, perhaps not practically possible). Note that in the cross section several different ocean basin/continent combinations are present, but that it is difficult to get a continent with all plate boundaries.

PLATE BOUNDARIES

The three kinds of plate boundaries are also illustrated in the cross section, divergent, convergent, and transform. Plate interact at these boundaries.

Two ***divergent margins*** (plate boundaries) are present in the cross section, one labeled as such to the right of the continental craton, and the other on the left side. The left side divergent margin is labeled ***Back Arc (Marginal) Basin***. Back arc basins are formed by minor convection cells above subduction zones. Divergent plate boundaries always create new ocean floor (that is, new oceanic lithosphere, called the ophiolite suite).

Three ***convergent boundaries*** are present, all of them one way or another involving a ***subduction zone***. In the continent-continent collision the subduction zone is now extinct but can be seen below the surface. Subduction zones generate lots of igneous magma that rises to the surface to form volcanic mountains (volcanic arcs; also island arcs). The igneous batholiths that feed the volcanoes are the beginning of generation of new continental crust. Continents are created above subduction zones as small proto- and micro continents. They enlarge by colliding and fusing together, or suturing onto a larger continent, at a convergent plate boundary.

At convergent boundaries oceanic lithosphere is always destroyed by descending into a subduction zone. This is because oceanic rock is heavy, compared to the continents, and sinks easily. Because oceanic lithosphere is created and destroyed so easily ocean basins are young; the oldest we have is only about 200 million years old. Continents, on the other hand, composed of light weight rock never subducts. Thus, continental rock once formed is more or less permanent; the oldest continental fragment is 3.9 billion years old, virtually as old as the earth itself.

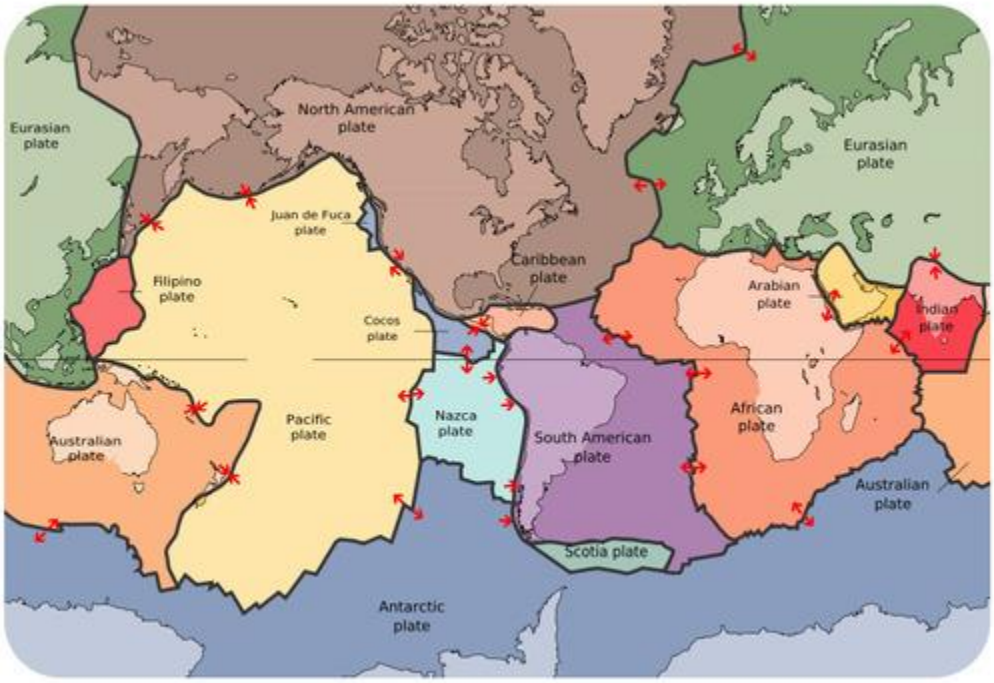
Only one transform boundary is present, on the left side of the drawing. At transform boundaries two plates just slide past one another horizontally, and quietly compared to convergent and divergent plate boundaries. Most of these are found in the ocean basins, but the San Andreas fault in California and Mexico is an example coming on land.

PLATE COLLISIONS

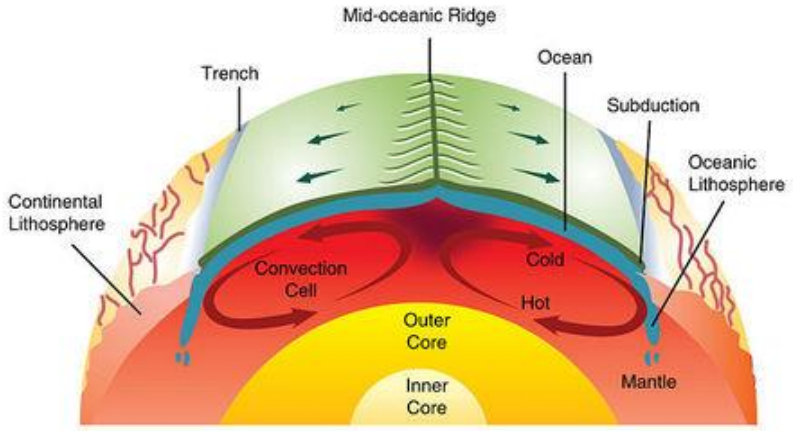
The essence of plate tectonic theory is that the plates (ocean basins plus or minus continents) slide around over the earth surface, interacting as they do at the plate boundaries. Thus, any time there is a divergent plate boundary where two plates are separating, there must be a convergent plate boundary (subduction zone) where the earth comes together again. And convergent boundaries always, eventually, lead to collisions between continents, or continents and terranes (island arcs plus or minus microcontinents). Observe the subduction zones in the cross section. Next to each one is a remnant ocean basin (ROB). An ROB is one that is disappearing down a subduction zone;

it is a remnant of its former self. But all subduction zones must eventually disappear completely and when they do the floating blocks on either side will collide, and create a mountain range. The continent-continent collision in the cross section is a case where the collision has already occurred.

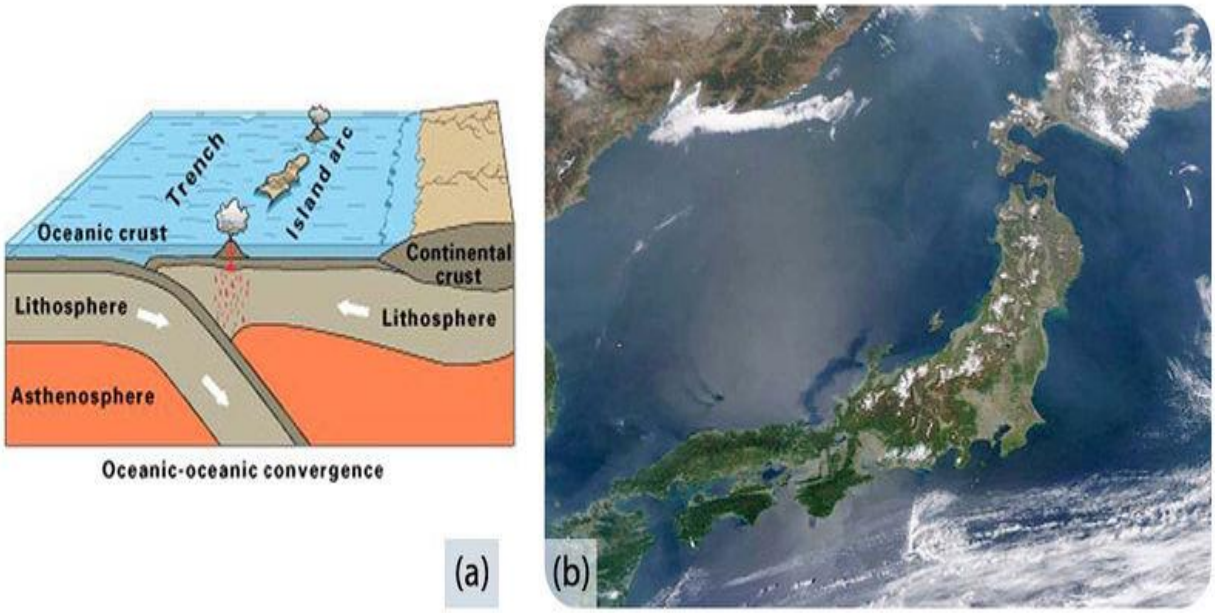
But in the larger picture, it is common for a divergent plate boundary to come into existence and create a new ocean basin, and then for that ocean basin to close again along a convergent plate boundary until two continents collide. This opening and closing of ocean basins is the ***Wilson Cycle***, and is the simplest model we have of how the earth operates historically.



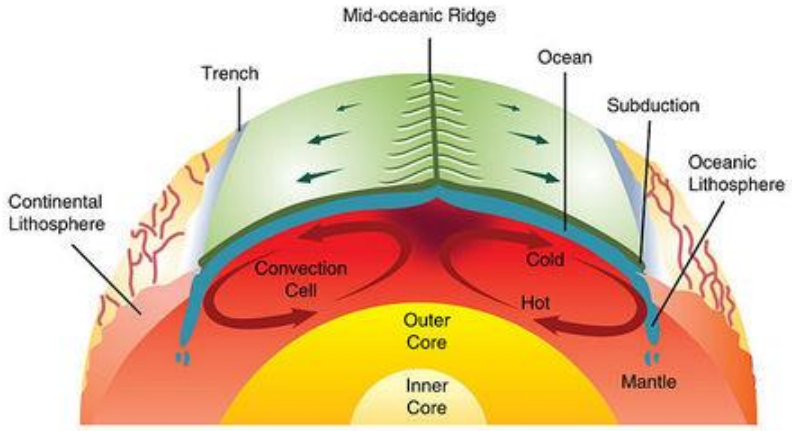
The lithospheric plates and their names. The arrows show whether the plates are moving apart, moving together, or sliding past each other.



Mantle convection drives plate tectonics. Hot material rises at mid-ocean ridges and sinks at deep sea trenches, which keeps the plates moving along the Earth's surface.



Subduction of an oceanic plate beneath a continental plate causes earthquakes and forms a line of volcanoes known as a continental arc.



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