# UNDERSTANDING PLATE TECTONIC THEORY

***Tectonic plates***:- large slabs of rock that divide Earth's crust, move constantly to reshape the Earth's landscape. The system of ideas behind plate tectonics theory suggests that Earth's outer shell (lithosphere) is divided into several plates that glide over the Earth's rocky inner layer above the soft core (mantle). The plates act like a hard and rigid shell compared to Earth's mantle. The mantle sits between Earth's dense, very hot core and its thin outer layer, the crust.

***The lithosphere***:- itself includes all the **crust** as well as the **upper part of the mantle** (i.e., the region directly beneath the **Moho)**, which is also rigid. However, as temperatures increase with depth, the heat causes mantle rocks to lose their rigidity. This change occurs within the mantle and defines the base of the lithosphere and the top of the **asthenosphere**.

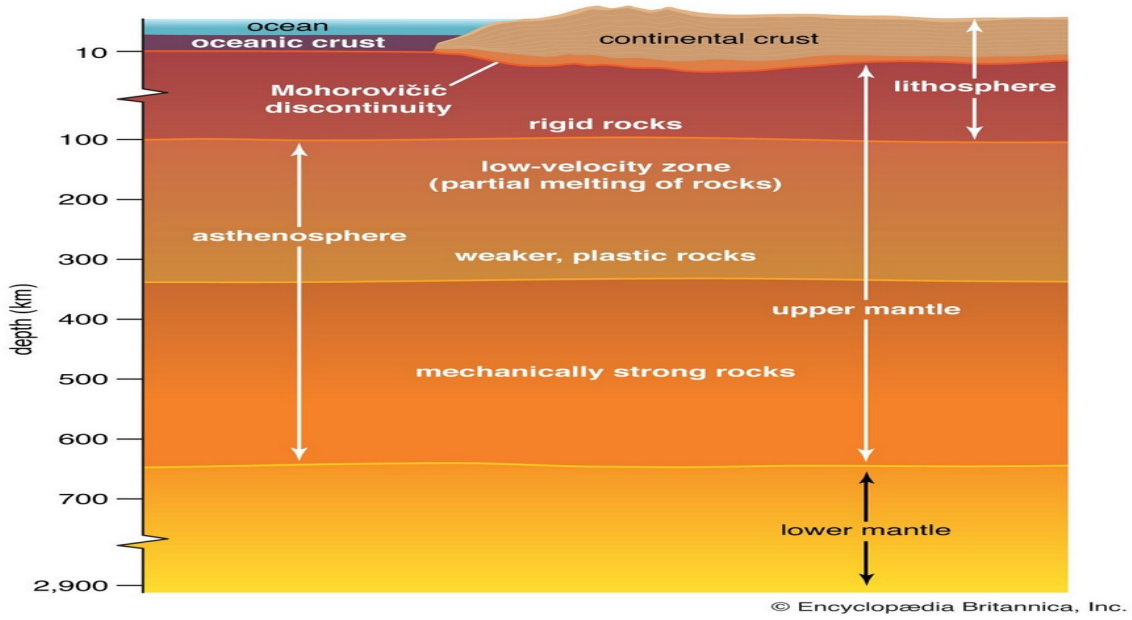



***Plate Tectonics Theory:-*** dealing with the dynamics of Earth's outer shell —the lithosphere—that revolutionized Earth sciences by providing a uniform context for understanding mountain-building processes, volcanoes, and earthquakes as well as the evolution of Earth's surface and reconstructing its past continents and oceans.

The concept of plate tectonics was formulated in the 1960s. According to the theory, Earth has a rigid outer layer, known as **the lithosphere**, which is typically thick and overlies a plastic (moldable, partially molten) layer called the **asthenosphere.**

Plate motions cause mountains to raise where plates push together, or converge, and continents to fracture and oceans to form where plates pull apart, or diverge. The continents are embedded in the plates and drift passively with them, which over millions of years results in significant changes in Earth's geography.

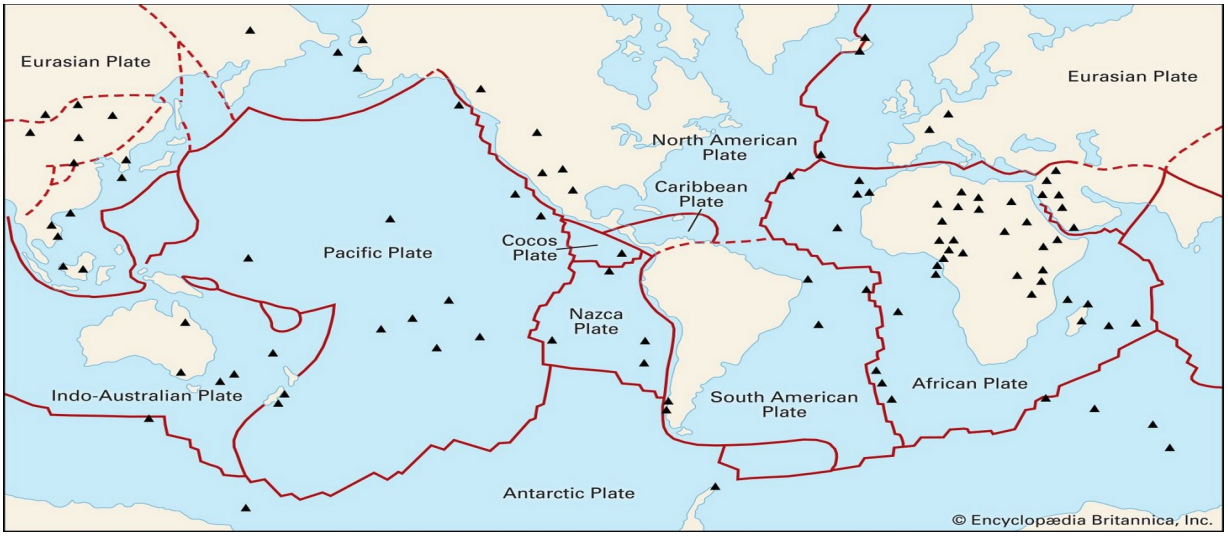
# TECTONIC PLATES

Major plates:- **African, Antarctic, Eurasian, Indo-Australian, North American, Pacific** and **South American.**

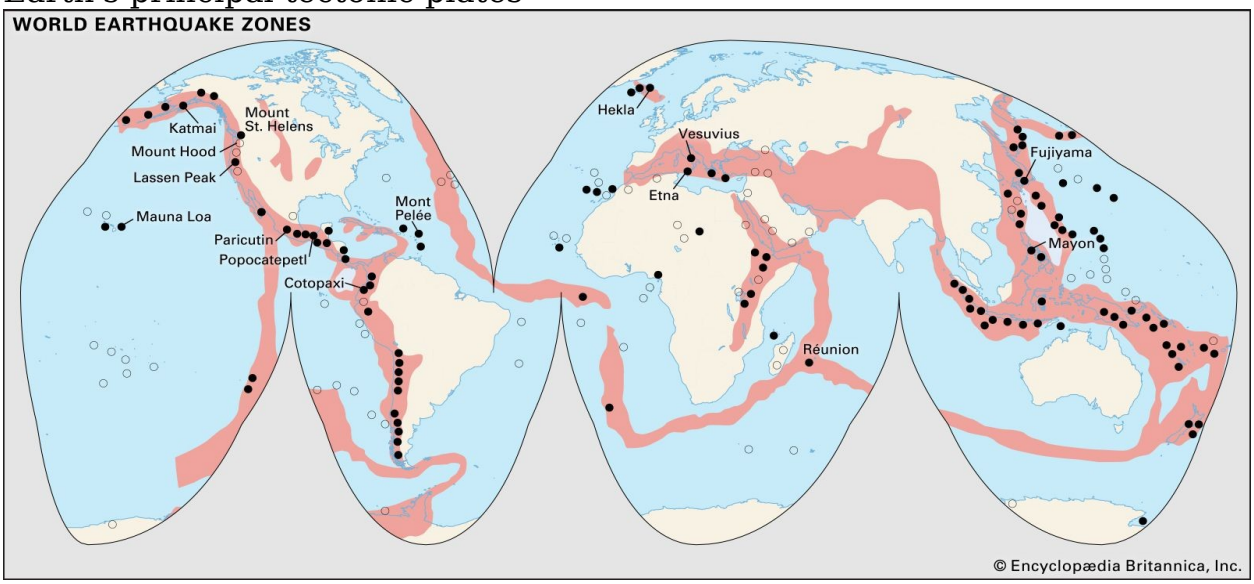
Minor plates**:- Nazca, Cocos, Caribbean, Arabian, Philippine, Indian**

# TECTONIC PLATE BOUNDARY

A tectonic plate boundary is the border between two plates. The tectonic plates slowly and constantly move but in many different directions. Some are moving toward each other, some are moving apart, and some are grinding past each other. Tectonic plate boundaries are grouped into three main types based on the different movements.




Earth's principal tectonic plates




Earthquake zones and volcanoes

Although most of Earth’s volcanic activity is concentrated along or adjacent to plate boundaries, there are some important exceptions in which this activity occurs within plates. Linear chains of islands, thousands of kilometers in length, that occur far from plate boundaries are the most notable examples.

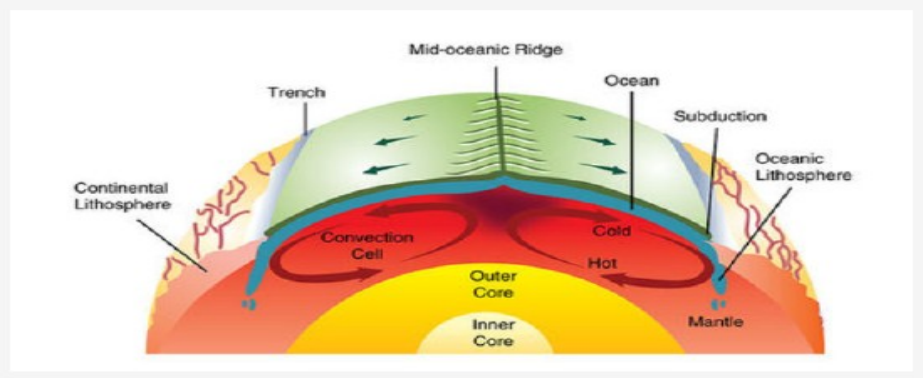
## The Ring of Fire (Hotspots)

The Ring of Fire is in the Pacific Ocean. It is made up of a string of volcanoes, deep ocean trenches, and high mountain ranges. It is the site of earthquakes around the edges of the Pacific Ocean.

The tectonic plates map of the Earth shows where mountain building, volcanoes, and earthquakes have occurred.

## HOW PLATES MOVE

If seafloor spreading drives the plates, what drives seafloor spreading? Picture two **convection cells** side-by-side in the mantle.




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.

1. Hot mantle from the two adjacent cells rises at the ridge axis, creating new ocean crust.
2. The top limb of the convection cell moves horizontally away from the ridge crest, as does the new seafloor.
3. The outer limbs of the convection cells plunge down into the deeper mantle, dragging oceanic crust as well. This takes place at the deep sea trenches.
4. The material sinks to the core and moves horizontally.
5. The material heats up and reaches the zone where it rises again.

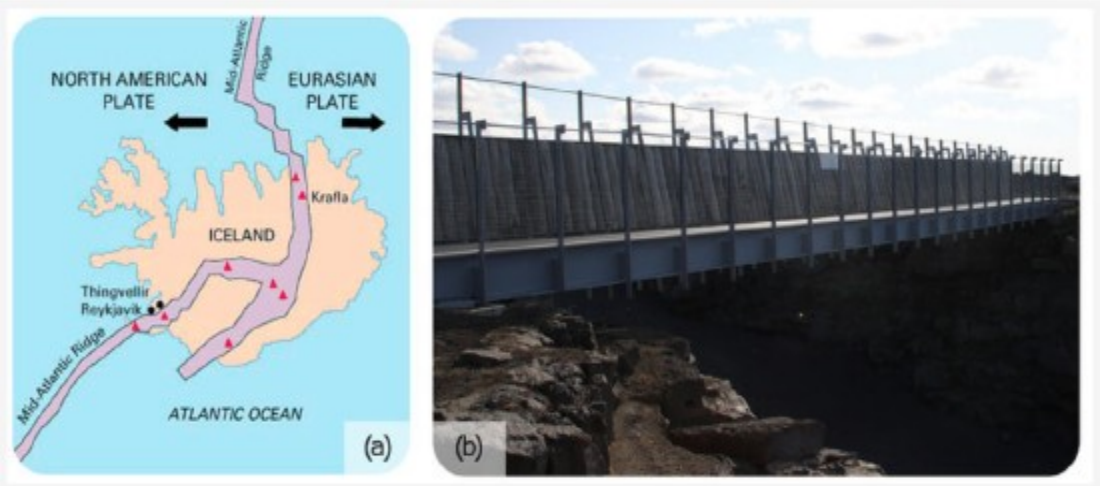
## TYPES OF PLATE BOUNDARIES

**Plate boundaries** are the edges where two plates meet. Most geologic activities, including volcanoes, earthquakes, and mountain building, take place at plate boundaries

The type of plate boundary and the type of crust found on each side of the boundary determines what sort of geologic activity will be found there.

### 1. Divergent Plate Boundaries

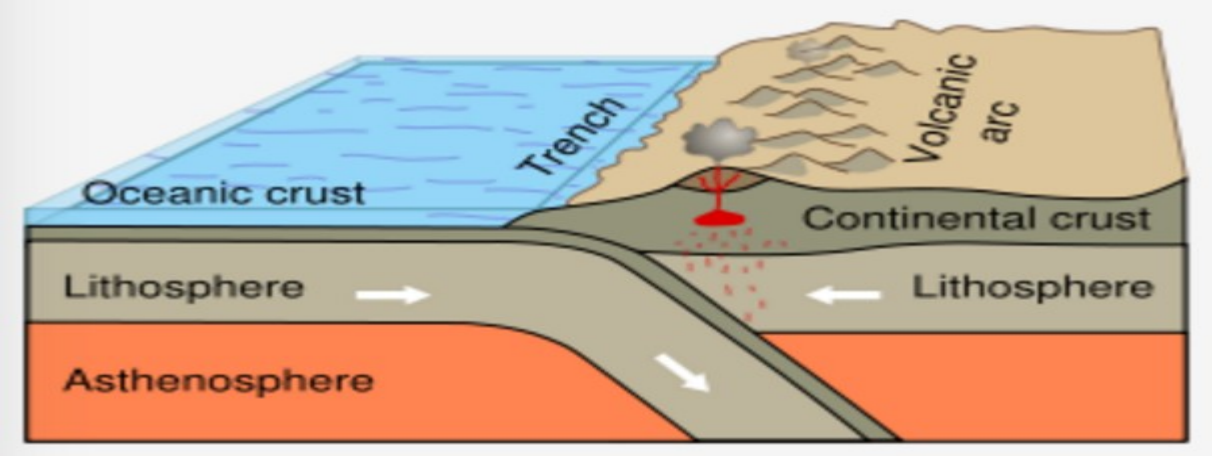
Plates move apart at mid-ocean ridges where new seafloor forms. Between the two plates is a rift valley. Lava flows at the surface cool rapidly to become basalt, but deeper in the crust, magma cools more slowly to form gabbro. So the entire ridge system is made up of igneous rock that is either extrusive or intrusive. Earthquakes are common at mid-ocean ridges since the movement of magma and oceanic crust results in crustal shaking. The vast majority of mid-ocean ridges are located deep below the sea.




(a) Iceland is the one location where the ridge is located on land: the Mid-Atlantic Ridge separates the North American and Eurasian plates; (b) The rift valley in the Mid-Atlantic

## 2. Convergent Plate Boundaries

When two plates converge, the result depends on the type of lithosphere the plates are made of. No matter what smashing two enormous slabs of lithosphere together results in magma generation and earthquakes.




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

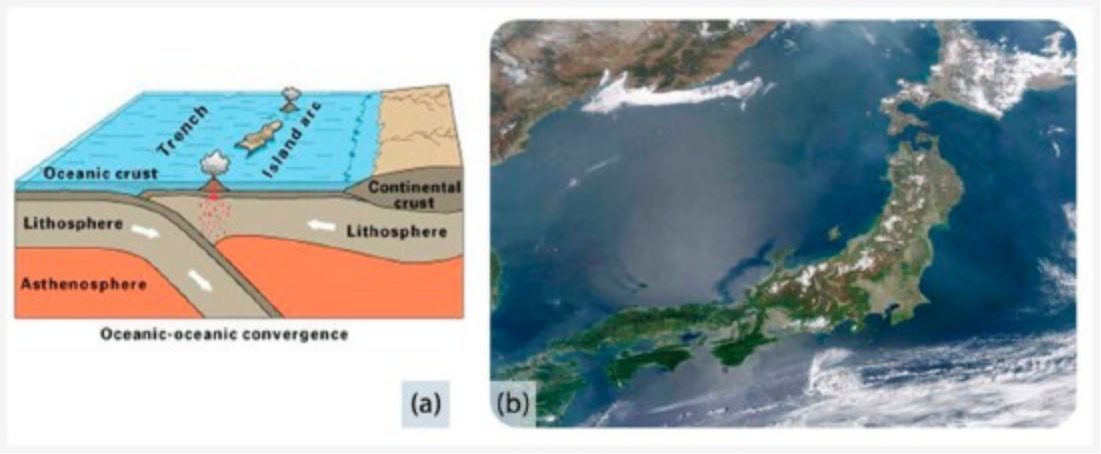
### a. Ocean-Continent

When oceanic crust converges with continental crust the denser oceanic plate plunges beneath the continental plate. This process, called **subduction**, occurs at the oceanic trenches. The entire region is known as a **subduction zone**. Subduction zones have a lot of intense earthquakes and volcanic eruptions. The subducting plate causes melting in the mantle. The magma rises and erupts, creating volcanoes. These coastal volcanic mountains are found in a line above the subducting plate. The volcanoes are known as a **continental arc**.

(a) At the trench lining the western margin of South America, the Nazca plate is subducting beneath the South American plate, resulting in the Andes Mountains (brown and red uplands); (b) Convergence has pushed up limestone in the Andes Mountains where volcanoes are common.

## b. Ocean-Ocean

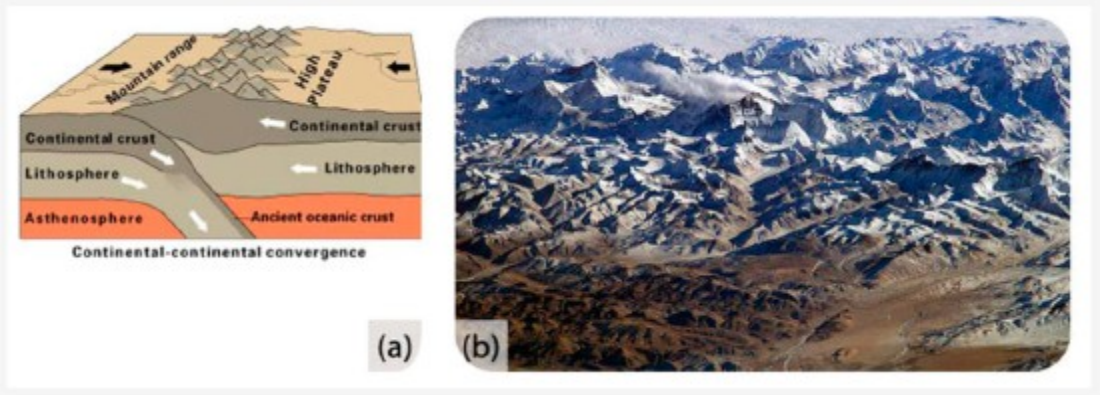
When two oceanic plates converge, the older, denser plate will subduct into the mantle. An ocean trench marks the location where the plate is pushed down into the mantle. The line of volcanoes that grows on the upper oceanic plate is an **island arc**.




(a) Subduction of an ocean plate beneath an ocean plate results in a volcanic island arc, an ocean trench and many earthquakes. (b) Japan is an arc-shaped island arc composed of volcanoes off the Asian mainland, as seen in this satellite image.

## c. Continent-Continent

Continental plates are too buoyant to subduct. What happens to continental material when it collides? Since it has nowhere to go but up, this creates some of the world's largest mountains ranges. Magma cannot penetrate this thick crust so there are no volcanoes, although the magma stays in the crust. Metamorphic rocks are common because of the stress the continental crust experiences. With enormous slabs of crust smashing together, continent-continent collisions bring on numerous and large earthquakes.



(a) In continent-continent convergence, the plates push upward to create a high mountain range. (b) The world's highest mountains, the Himalayas, are the result of the collision of the Indian Plate with the Eurasian Plate, seen in this photo from the International Space Station.

### 3. Transform Plate Boundaries

Transform plate boundaries are seen as **transform faults**, where two plates move past each other in opposite directions. Transform faults on continents bring massive earthquakes.

At the **San Andreas Fault in California**, the Pacific Plate is sliding northeast relative to the North American plate, which is moving southwest. At the northern end of the picture, the transform boundary turns into a subduction zone.

# LESSON SUMMARY

- Plates of lithosphere move because of convection currents in the mantle. One type of motion is produced by seafloor spreading.
- Plate boundaries can be located by outlining earthquake epicenters.
- Plates interact at three types of plate boundaries: divergent, convergent and transform.

- Most of the Earth’s geologic activity takes place at plate boundaries.
- At a divergent boundary, volcanic activity produces a mid ocean ridge and small earthquakes.
- At a convergent boundary with at least one oceanic plate, an ocean trench, a chain of volcanoes develops and many earthquakes occur.
- At a convergent boundary where both plates are continental, mountain ranges grow and earthquakes are common.
- At a transform boundary, there is a transform fault and massive earthquakes occur but there are no volcanoes.
- Processes acting over long periods of time create Earth’s geographic features.