THEORY OF PLATE TECTONICS

INTRODUCTION: The Earth's surface is not static but continuously changing due to various internal and external forces.

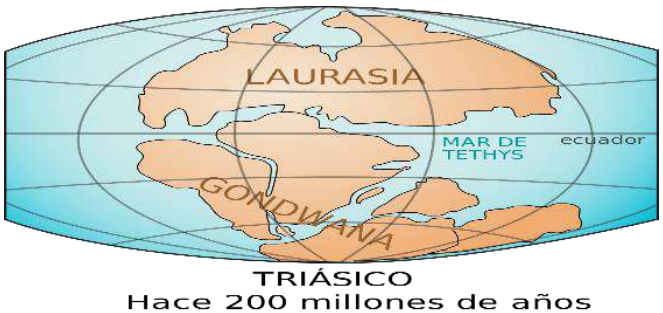
- **Endogenic Forces (Internal):** These forces act within the earth, causing sudden movements (earthquakes, volcanoes) or slow movements (mountain building).
    - **Volcanoes:** Vents in the crust that erupt molten material.
    - **Earthquakes:** Vibrations caused by the movement of tectonic plates.
- **Exogenic Forces (Surface):** These work on the surface, including weathering (breaking up of rocks) and erosion (wearing away by wind, water, and ice).
    - **Erosion:** Processes such as running water, glaciers, and wind change the landscape.
    - **Deposition:** The deposit of eroded materials by rivers, wind, and sea waves, which creates new landforms like beaches and flood plains.

Note: The Earth's surface has been changing throughout its history and continues to do so through these ongoing processes.

The present distribution of continents and oceans has evolved over millions of years. Early scientists observed similarities in the coastlines of continents, fossils, and rock structures across distant regions, suggesting that continents were once joined together.

A major breakthrough came with the **Continental Drift Theory** proposed by **Alfred Wegener in 1912**. He suggested that all continents were once part of a single supercontinent called Pangaea, which later split and drifted apart. Wegener supported his idea with geological (**Jigsaw Fit**) and **fossil evidence**, but his theory was not widely accepted at that time due to the lack of a clear mechanism for continental movement.

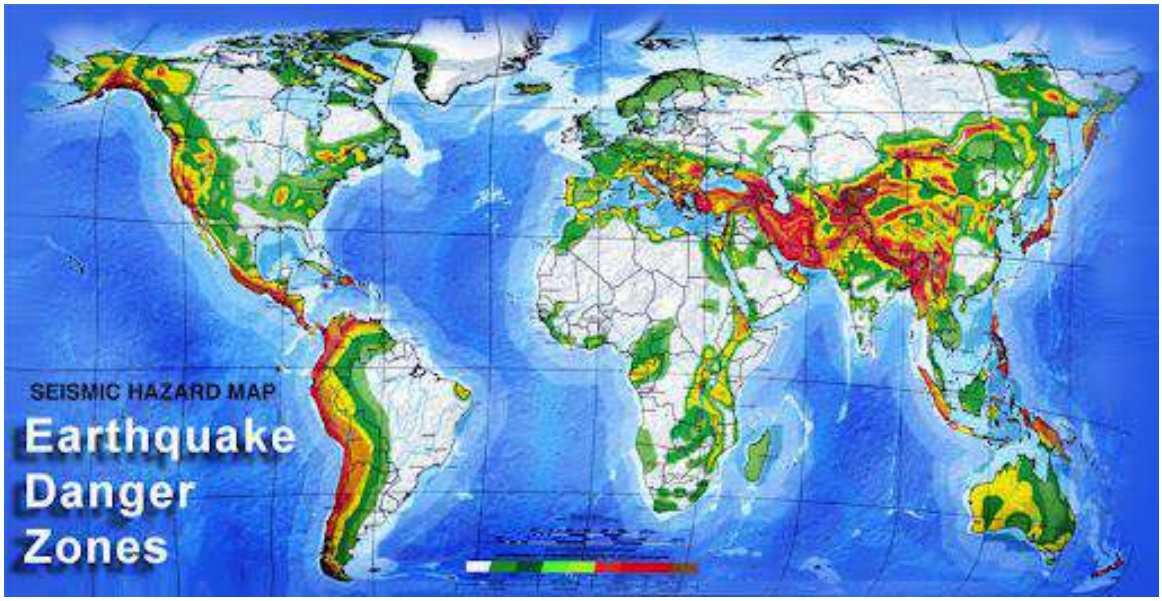
However, his work laid the foundation for the development of the Plate Tectonic Theory, which later provided a scientific explanation for the movement of continents.



TRIÁSICO
Hace 200 millones de años

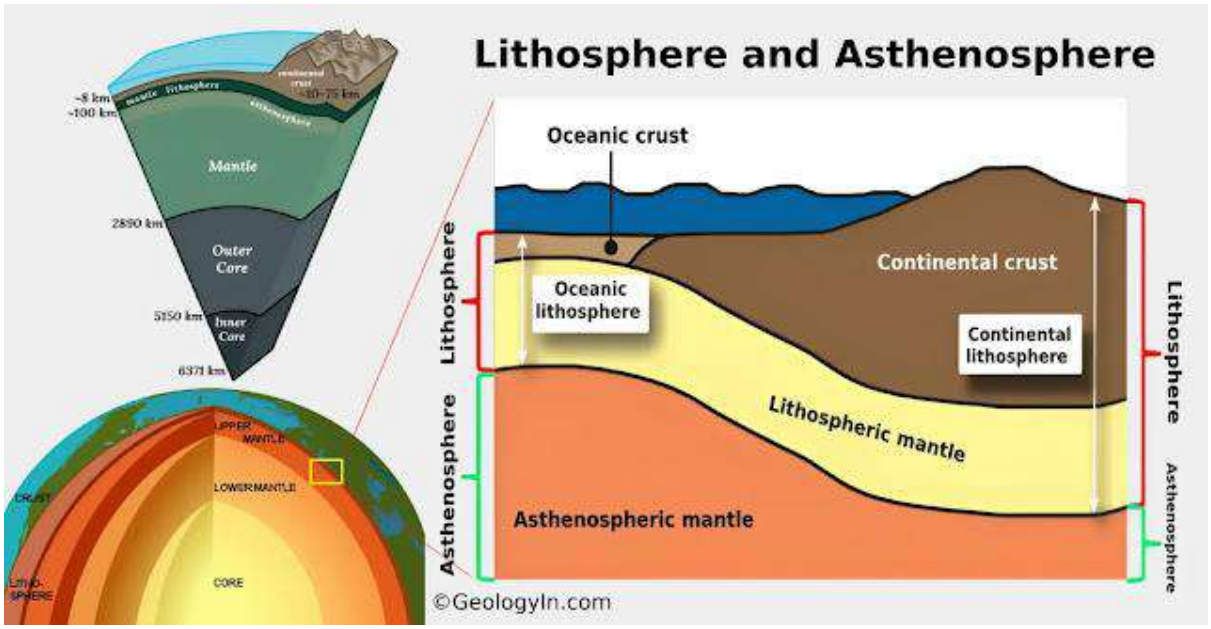
This theory also explains the distribution of earthquakes and volcanic eruption in specific areas of the earth, known as seismic zones.

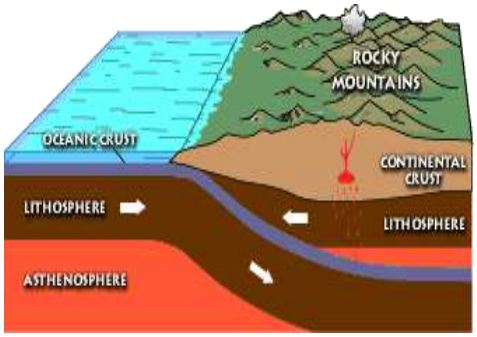
SEISMIC ZONES

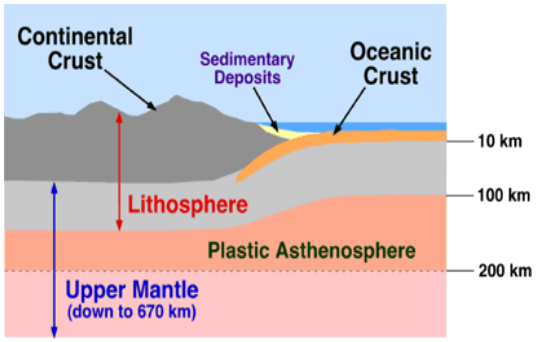


CONCEPT OF PLATE: The lithosphere is the upper most solid layer of the earth. This layer is not continuous, but is broken. Tectonic plate (also called lithospheric plate) is a massive, irregularly-shaped slab of solid lithosphere, generally composed of both continental and oceanic lithosphere. Plates move horizontally over the asthenosphere as rigid units.

ASTHENOSPHERE: The asthenosphere is a semi-molten layer of the upper mantle located 80–200 km below Earth's surface, situated directly beneath the rigid lithosphere. It is characterized by high temperatures (around 1300^0 C) allowing it to flow plastically, facilitating tectonic plate movement through convection currents.

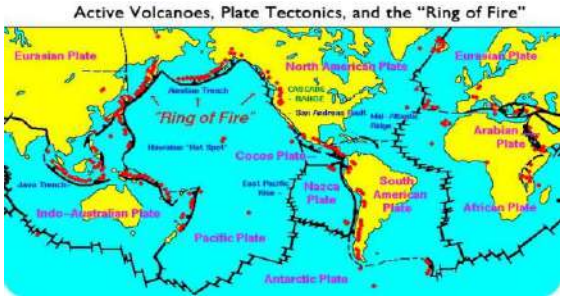






DEVELOPMENT OF PLATE TECTONICS:

- It was in 1967, McKenzie and Parker and also Morgan, independently collected the available ideas and came out with another concept termed *Plate Tectonics*.
- A tectonic plate (also called lithospheric plate) is a massive, irregularly-shaped slab of solid rock, generally composed of both continental and oceanic lithosphere.
- The lithosphere includes the crust and top mantle with its thickness range varying between 5 and100 km in oceanic parts and about 200 km in the continental areas.
- Plates move horizontally over the asthenosphere as rigid units.
- A plate may be referred to as the continental plate or oceanic plate depending on which of the two occupy a larger portion of the plate.



Plates: Plate tectonics theory states that there are a total of

1. 7 major or large plates

2. More than 20 minor plates in the crust. Among these, the notable plates are:

Major Plates: 1. Pacific Plate 2. Eurasian Plate 3. Indo-Australian Plate 4. Africa Plate 5. North America Plate 6. South America Plate 7. Antarctica Plate

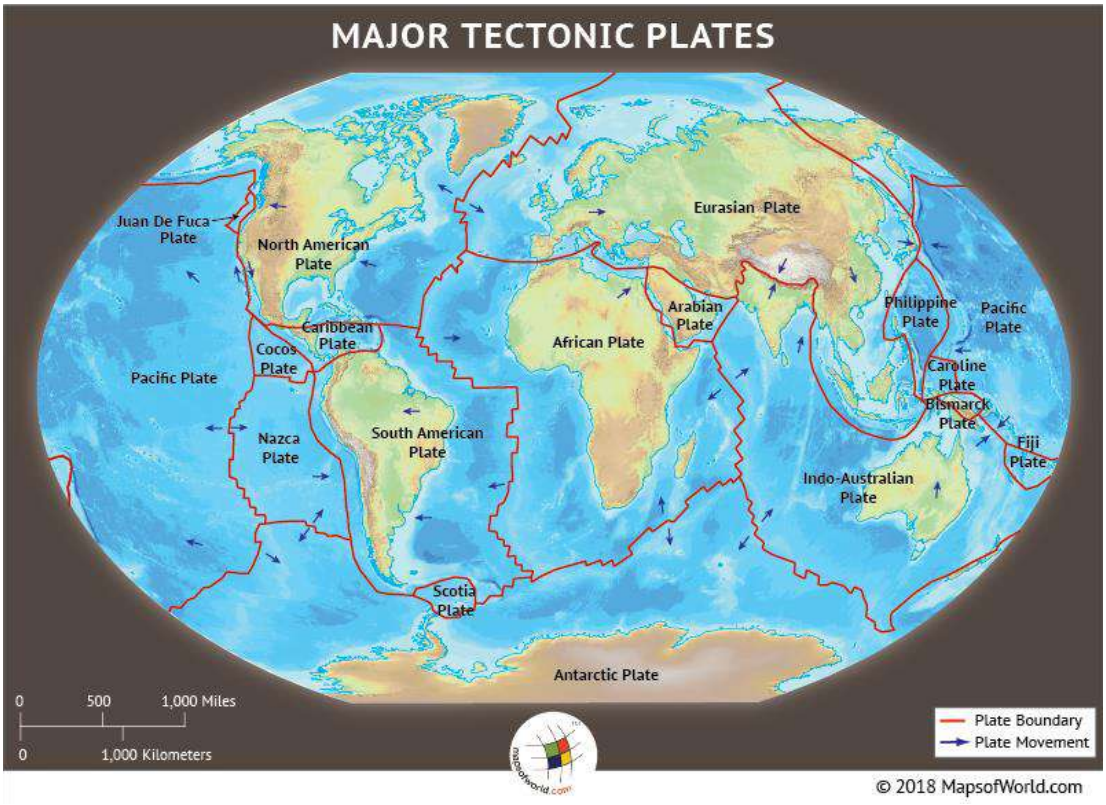
Minor Plates: Some important minor plates are listed below:

(i) **Cocos plate:** Between Central America and Pacific plate

(ii) **Nazca plate:** Between South America and Pacific plate

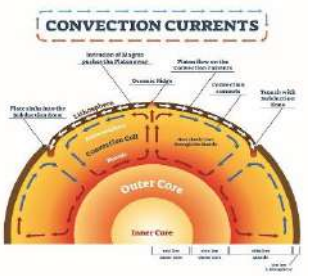
(iii) **Arabian plate:** Mostly the Saudi Arabian landmass

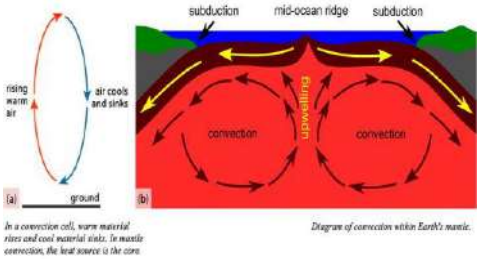
(iv) **Philippine plate:** Between the Asiatic and Pacific plate



CAUSES OF PLATE MOVEMENT: Geologists have found these following forces as causes of plate movements:

Convection Currents: According to the Convectional Current Theory of British geologist Arthur Holmes, where the current spreads upwards in two directions, the plates also move in both directions, and where the two downward currents coming from two directions meet, the plates also come closer to each other. The idea that underground convection currents are the cause of plate movement was later supported by experts such as Rayleigh, Turcotte, Tozer, etc.





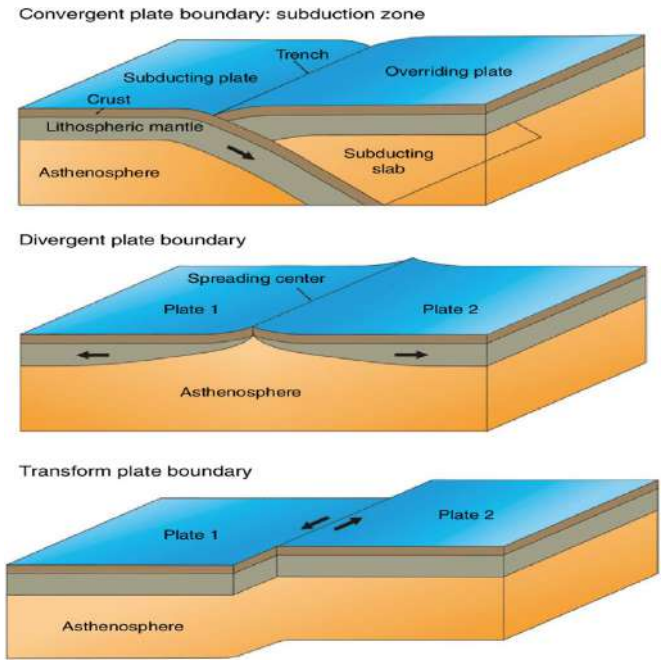
2. Gravitational force: The upward convection current reaches the boundary of two opposing plates (divergent boundary), where magma accumulates and forms oceanic ridges, and the plates move along the side slope under the influence of gravity.

TYPES OF PLATE BOUNDARIES: The edge or border around any plate is called the plate margin and the place where two plates meet is called the plate boundary. Geologists have observed that the movement of the plates has resulted in the formation of three main types of plate boundaries. These are:

(1) Divergent or Constructive plate boundaries

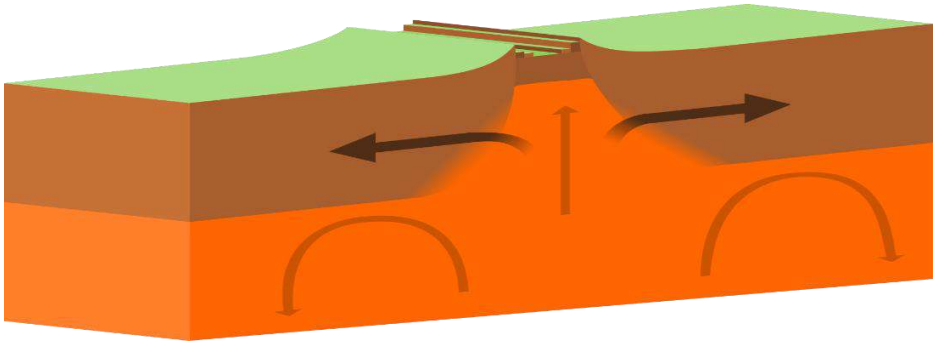
(2) Convergent or Destructive plate boundaries

(3) Transform or Parallel / Neutral/Conservative plate boundaries

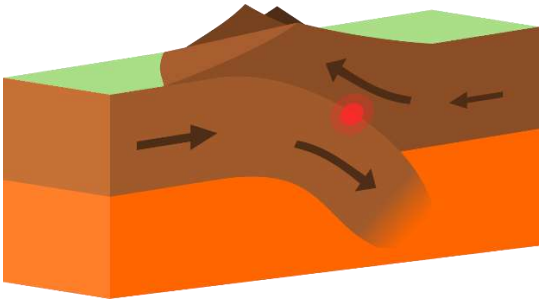


1. Divergent plate boundary: Where two plates move away from each other (divergent), that boundary is called **divergent plate boundary**. It is also called a spreading plate boundary. Divergent plate boundaries are usually observed along mid-ocean ridges. Here, as the two plates move in opposite directions, hot magma from the earth's crust rises along the fault line between them and gradually cools and hardens, creating new crust along the mid-ocean ridge. Since new crust is formed at divergent plate boundaries, it is also called a constructive plate boundary.

For example, a long divergent plate boundary is formed at the junction of the North and **South American plates and the Eurasian and African plates**, and the Mid-Atlantic Ridge is formed at that boundary.



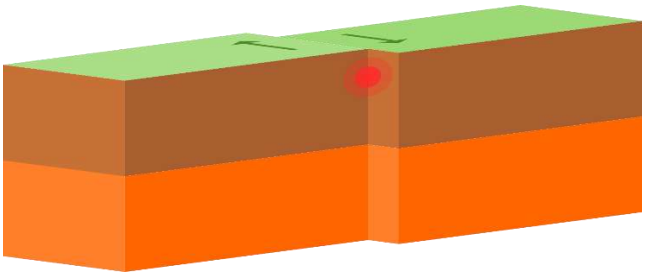
2. Convergent plate boundary: Where two plates move towards each other and collide, it is called a **convergent plate boundary**. This plate boundary can be observed mainly along young fold mountains and ocean trenches. Since at this plate boundary, through the collision of two plates, one plate (the heavier plate) moves downward and enters the interior of the earth and melts at a great height, it is also called a destructive plate boundary.



Where continental and oceanic plates come face to face, the oceanic plate gradually penetrates under the light continental plate. When the oceanic plate enters under the continental plate, the event is called subduction and the place where it enters is called the **subduction zone**.

For example, the Eurasian plate and the Pacific plate move towards each other, creating a convergent plate boundary.

3. Transform or Parallel plate boundary: When two plates on either side of a fault line cross each other side by side, that boundary is called a transform fault boundary. Since two plates move side by side and against each other, no plate formation or destruction occurs at such a boundary except horizontal displacement. That is why it is also called a neutral or conservative plate boundary. **Example- The San Andreas fault** line in California (about 1000 km long) in the western part of the United States of America is an example of such a neutral plate boundary. At this plate boundary, the Pacific plate moves northward and the North American plate moves southward.



❖ MOVEMENT OF THE INDIAN PLATE AND FORMATION OF HIMALAYAS:

The Indian plate includes Peninsular India and the Australian continental portions. The subduction zone along the Himalayas forms the northern plate boundary in the form of continent— continent convergence.

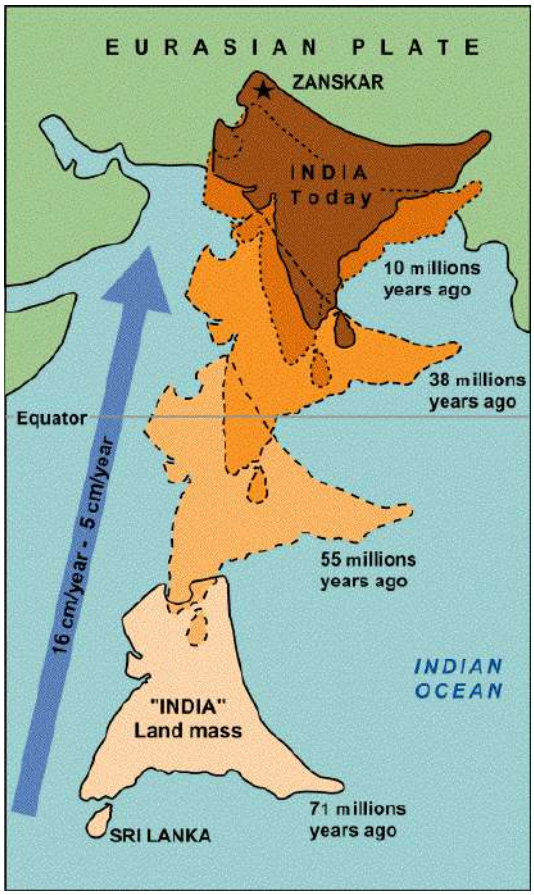
The boundary between India and the Antarctic plate is also marked by oceanic ridge (divergent boundary) running in roughly W-E direction and merging into the spreading site, a little south of New Zealand.

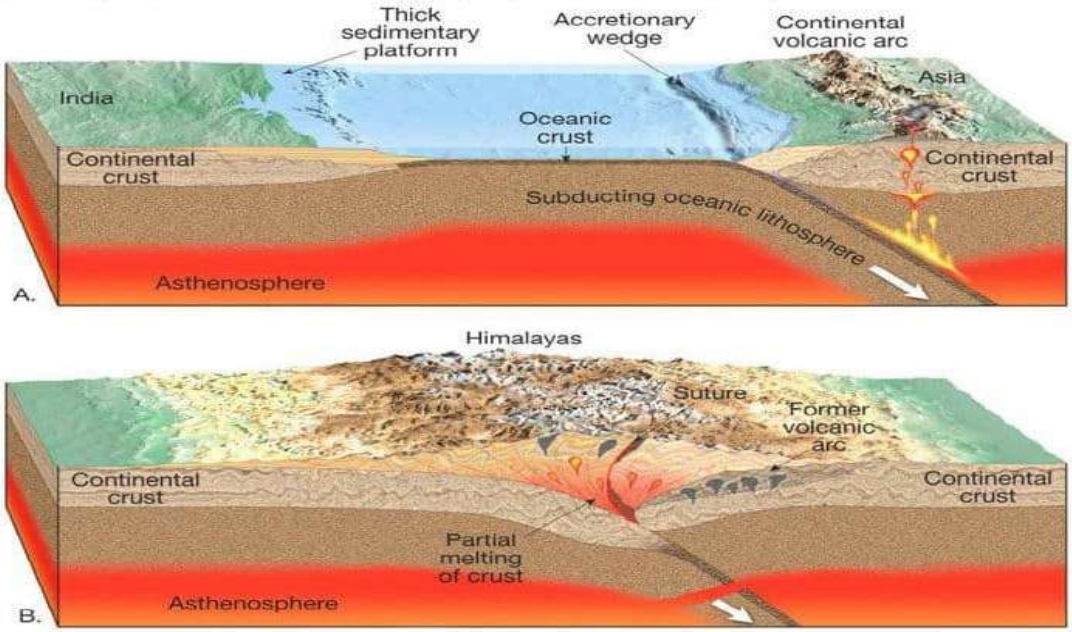
India was a large island situated off the Australian coast, in a vast ocean. The Tethys Sea separated it from the Asian continent till about 225 million years ago.

India is supposed to have started her northward journey about 200 million years ago at the time when Pangaea broke. India collided with Asia about 40-50 million years ago causing rapid uplift of the Himalayas.

The positions of India since about 71 million years till the present are shown in the Figure 4.6. It also shows the position of the Indian subcontinent and the Eurasian plate. About 140 million years before the present, the subcontinent was located as south as 50˚S latitude

During the movement of the Indian plate towards the Eurasian plate, a major event that occurred was the outpouring of lava and formation of the Deccan Traps. This started somewhere around 60 million years ago and continued for a long period of time. Note that the subcontinent was still close to the equator. From 40 million years ago and thereafter, the event of formation of the Himalayas took place. Scientists believe that the process is still continuing and the height of the Himalayas is rising even to this date.




Thick sedimentary platform
Accretionary wedge
Continental volcanic arc
India
Asia
Oceanic crust
Continental crust
Continental crust
Subducting oceanic lithosphere
Asthenosphere
A.
Himalayas
Suture
Former volcanic arc
Continental crust
Continental crust
Partial melting of crust
Asthenosphere
B.