

## 1. Details of Module and its structure

Module Detail	
Subject Name	Geography
Course Name	Geography 02 (Class XI, Semester - 2)
Module Name/Title	India: Structure and Geological Divisions
Module Id	kegy_20201
Pre-requisites	Basic concepts about Structure and Geological Divisions of India
Objectives	<p>After going through this lesson, the learners will be able to understand the following:</p> <ul style="list-style-type: none"><li>• Structure and Geological Divisions of India with reference to Continuity and Change and Appearance and Reality</li><li>• Plate Tectonics and Structure of India</li><li>• Movements of Indian Plate</li><li>• Stages of the rise of the Himalaya</li><li>• Origin and formation of the Peninsular Block Mountains</li><li>• Origin and formation of the Indo-Ganga – Brahmaputra Plain</li></ul>
Keywords	Plate Tectonic, Endogenic and Exogenic Forces, Plate Boundaries, Subduction Zones, Peninsula ,Geo-Syncline

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## India: Structure and Geological Divisions

### Continuity and change:

Do you know that our earth also has a history? The earth and its landforms that we see today have evolved over a very long time. Current estimation shows that the earth is approximately 460 million years old. Over these long years, it has undergone many changes brought about primarily by the endogenic and exogenic forces. These forces have played a significant role in giving shape to various surface and subsurface features of the earth.

### Endogenic and Exogenic Forces

Endogenic forces are defined as the internal forces which originate in the interior and create horizontal and vertical movements of earth. These movements (sudden and gradual) lead to land upliftment and subsidence, folding and faulting, earthquakes, volcanism and tsunami etc.



Folding and Faulting of Rocks by Endogenic Forces

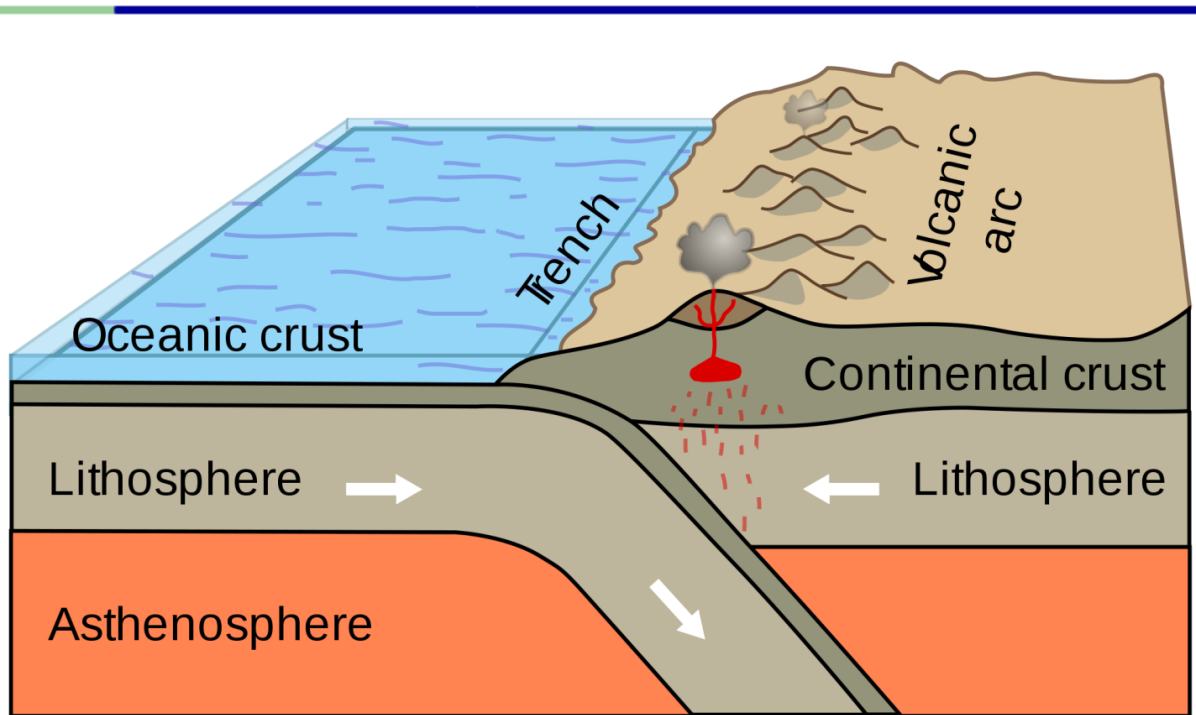
1. Sources: [https://s0.geograph.org.uk/geophotos/05/86/10/5861049\\_d7e3af17.jpg](https://s0.geograph.org.uk/geophotos/05/86/10/5861049_d7e3af17.jpg)  
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Endogenic movements are responsible for giving birth to major relief features such as mountains, plateaus, plains, valleys, etc. There are mainly two endogenic processes: volcanism and diastrophism. Diastrophism elevates or builds up portions of the earth's surface. Diastrophic processes are classified as Orogenic and Epeirogenic. Orogeny refers to horizontal earth movement, parallel to the surface of the earth. It is related to mountain building with deformation of the crust and the earth's surface. Folding, faulting and continental drifts are important features of horizontal movements. Epeirogeny refers to vertical movement characterised by regional uplift without marked deformation. Upwarping Downwarping and isostasy are result of vertical movement.





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Exogenic also known as exogenetic refers to external forces or slow processes and phenomena which occur on or above the earth's surface. The agents of weathering and erosion are exogenic forces.

It is primarily through the interplay of these endogenic and exogenic forces and lateral movements of the plates that the present geological structure and geomorphologic processes active in the Indian subcontinent came into existence the relief features of India.

Some of the principal forces and their manifestation are - weathering caused due to physical, chemical and biological processes, denudation caused due to erosion, transportation and deposition, etc.



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## Reality and Appearance (structure and Relief):

India is a land of diversity in all manners. From culture, economy and even the landscape of India has a diverse element, all on one landmass. The wide range of physical features of India makes the country a complete geographical study. In fact, India has every possible landscape that the earth has. From cold mountains to arid deserts, vast plains, hot and humid plateau and wide sea shores and tropical islands, the physical features of India cover every terrain.



<https://image.shutterstock.com/image-vector/vector-illustration-india-map-physical-600w-1477357358.jpg>

Recreate this map



<https://upload.wikimedia.org/wikipedia/commons/thumb/c/c8/Western-Ghats-Matheran.jpg/800px-Western-Ghats-Matheran.jpg>

The geography of India has been a theatre for the interplay of these forces. Some of the principal forces and their manifestation are:

### **Plate Tectonics**

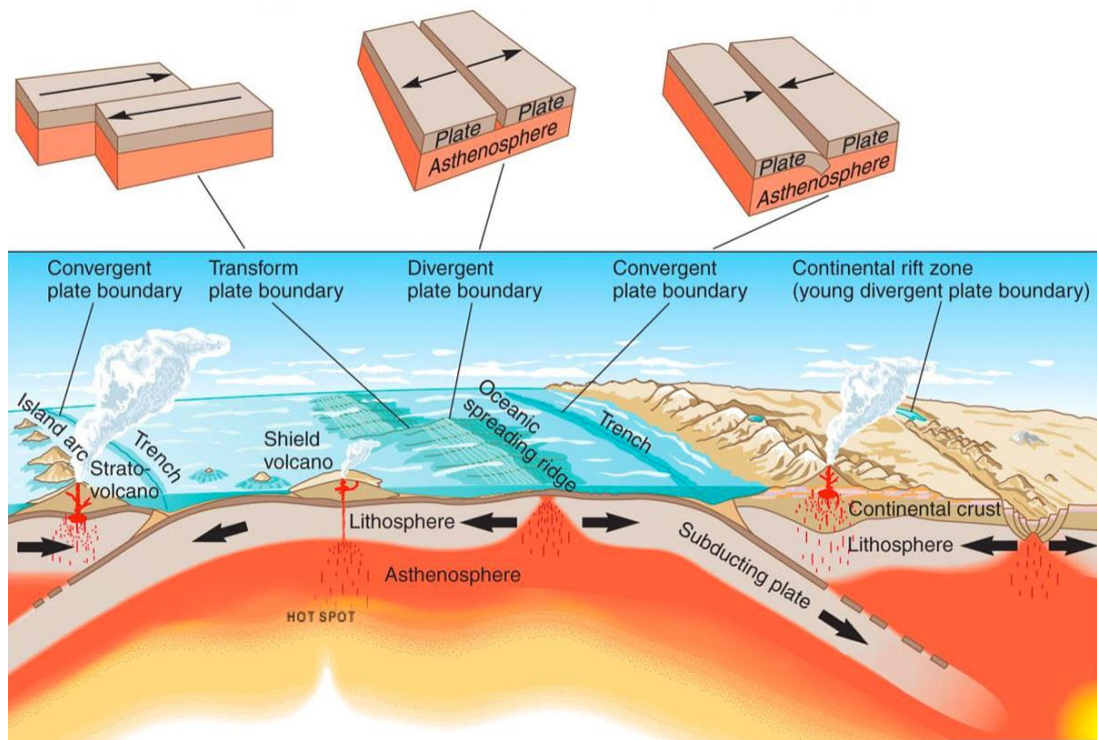
The geology of India is a testimony of the fact that it came into existence because of the Indian plate also known as Gondawana land moving away from the equator towards the North and collided with Eurasian Plate (Angara land) and both putting pressure on the Tethys Sea and its sediments. This collision resulted into upheaval in the Tethys Sea give rise to Himalayan Mountain ranges and modified the direction of mountain ranges, breaking of the Indian Plate and formation of new drainage system and river valley plain.

### **Plate Boundaries**

Meeting zones of two plates is called as a plate boundary. Such types of plate boundaries are commonly associated with geological events like-earthquakes or the creation of topographic features like- Mountains, volcanoes mid-oceanic ridges and oceanic trenches. Most of the active volcanoes of world are occurred along with the plate boundaries. Nowadays, it is widely known as the Pacific Plate's Ring of Fire or most active volcano. Formation and evolution of Himalayas and unstable land form vulnerable to frequent occurrence of earthquakes in the Himalayas is a special characteristic feature of Plate Boundary.

The collision between the Indian Plate and Eurasian Plate is a typical example of Convergent Plate Boundary or Active Margin or Destructive Margin.





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➤ **a. Transform Plate Boundaries or Conservative**

Transformation of plate boundary occurs where two lithospheric plates slide or grind past each other along the transform faults. These plates are neither created nor destroyed.

➤ **b. Divergent Plate or Constructive or Extensional Boundaries**

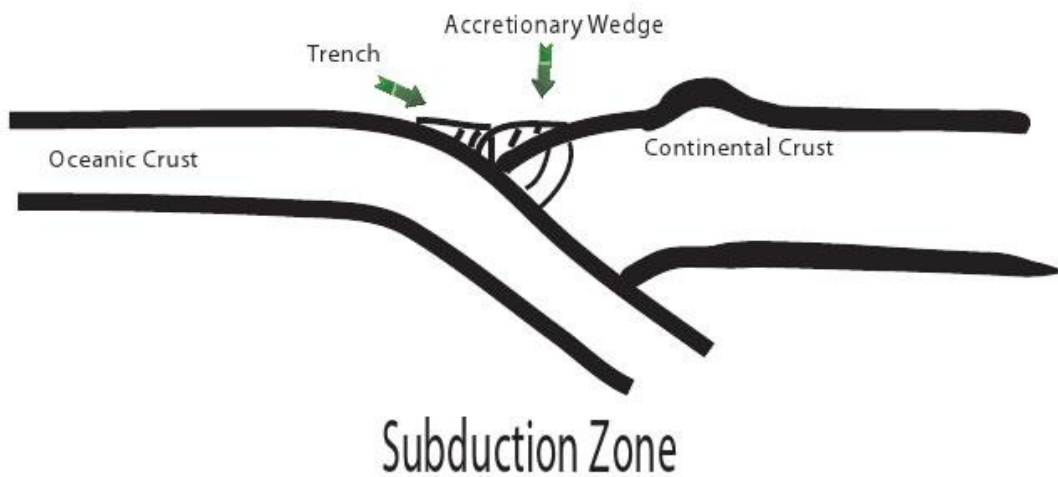
Divergent plate boundary occurs where two plates separate from each other. It is considered as a linear feature, used to exist between two tectonic plates which are moving away from one another.

➤ **Convergent Plate Boundaries or Active Margins or Destructive**

Convergent plate boundaries occur in those areas where lithospheric plates move towards one another and create collisions. When two plates come together, they both collide and crumble or one may slide under the other depending upon the density. At times, they may also move horizontally past over one another.

**Subduction Zones**

Subduction zones are considered as plate tectonic boundaries where two plates come to close with each other and then move further. As result of such continuous movement, one plate subsides under the other plate. This whole procedure results in geo hazards like-earthquakes and volcanoes.

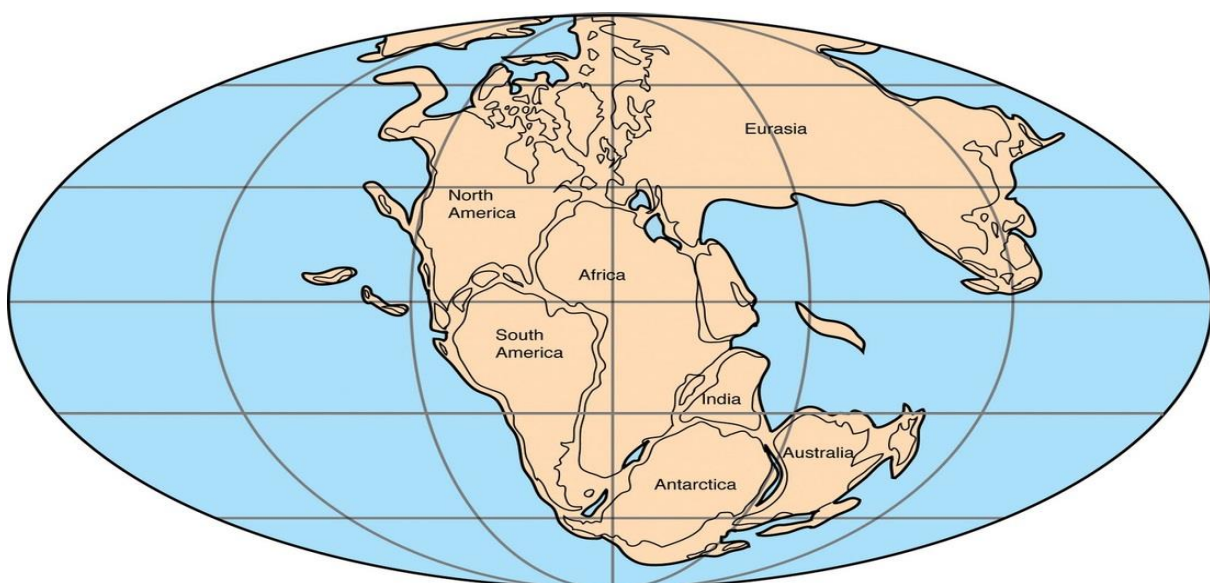


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Do you know that the Indian plate was to the south of the equator millions of years ago? Do you also know that it was much larger in size and the Australian plate was a part of it? Over millions of years, this plate broke into many parts and the Australian plate moved towards the southeastern direction and the Indian plate to the north. Can you map different phases in the movement of the Indian plate? This northward movement of the Indian plate is still continuing and it has significant consequences on the physical environment of the Indian subcontinent. Can you name some important consequences of the northward movement of the Indian plate?

### **Movements of Indian Plate**

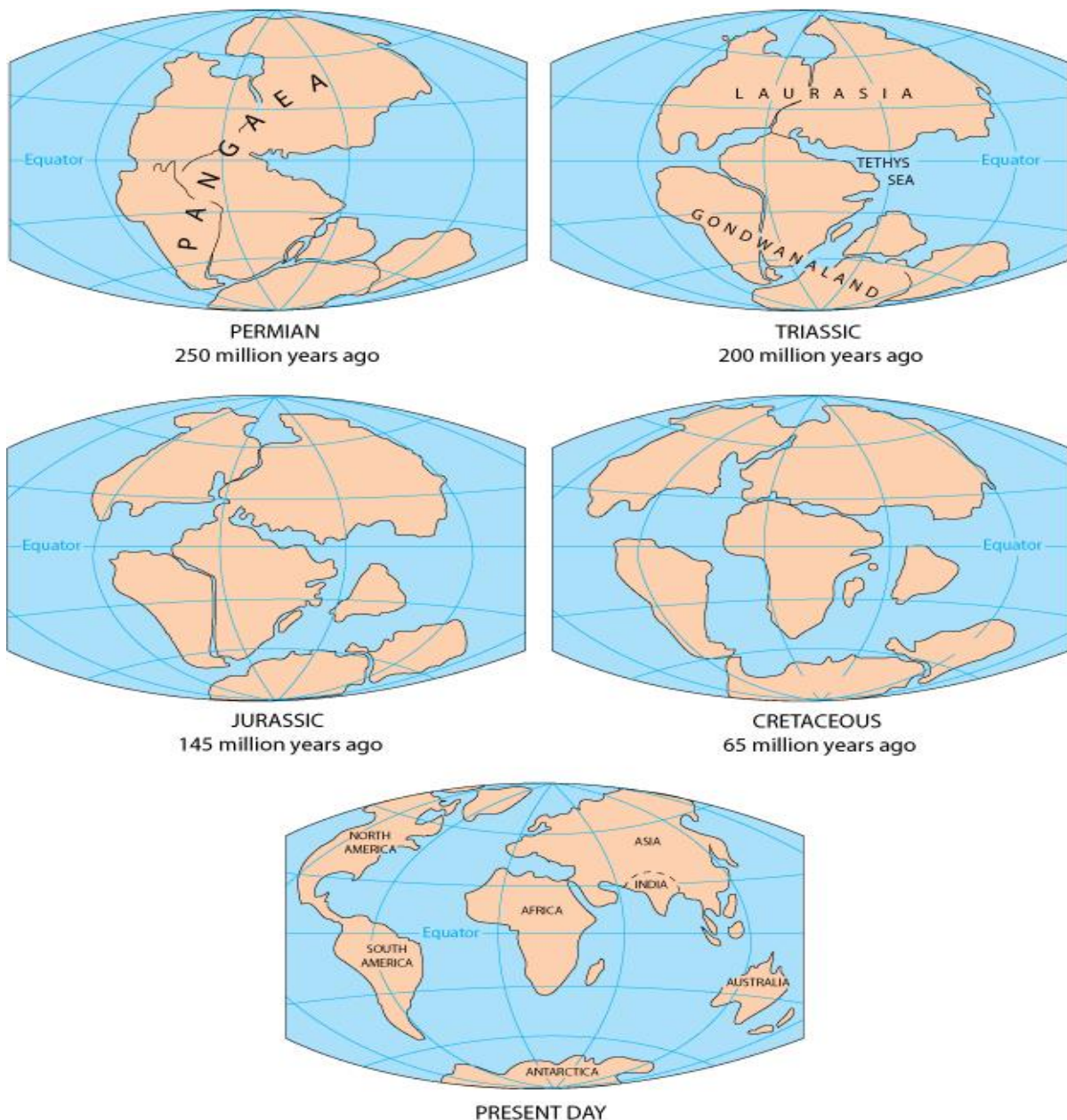
The Indian tectonic plate is located in the north east hemisphere. It is bounded by 4 major tectonic plates. North of the Indian plate is the Eurasian plate, to the south east, the Australian plate, to the south west, the African plate and to the west the Arabian plate.



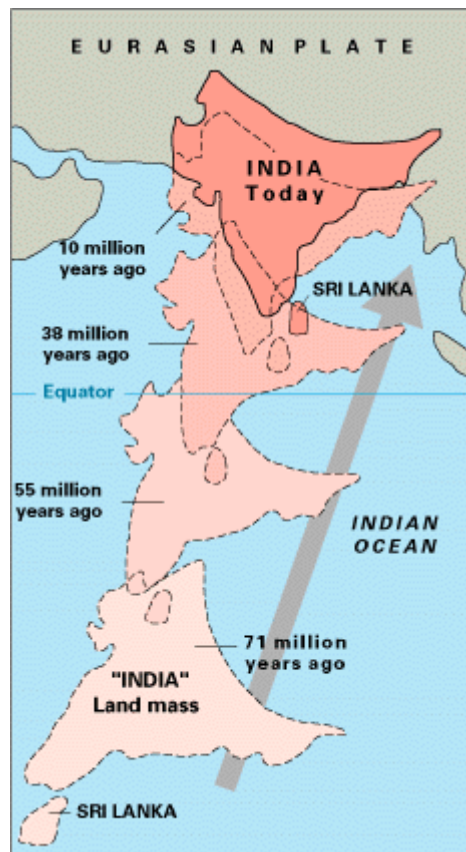
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About 140 million years ago the main landmass on Earth was concentrated together in a super continent called Gondwana which started to break up in four tectonic plates; African, Antarctic, Australian and Indian plates. The rifting is thought to be caused by the rising of a mantle plume which caused the Indian plate to drift northwards and resulted in the opening of the Indian Ocean. The velocity of the drifting of the Indian plate northwards was surprisingly high, 18 to 20 cm per year prior to the collision with the Eurasian plate. During the same period of time the adjacent African and Australian plates moved much slower, 2 to 4 cm per year. It is speculated that the Indian plate had such a high drifting velocity because of its low lithospheric thickness which extends to about 100 km where the other plates that formed Gondwanaland have lithospheric thicknesses of above 180 km which increased the drag and decreased the drift velocity.

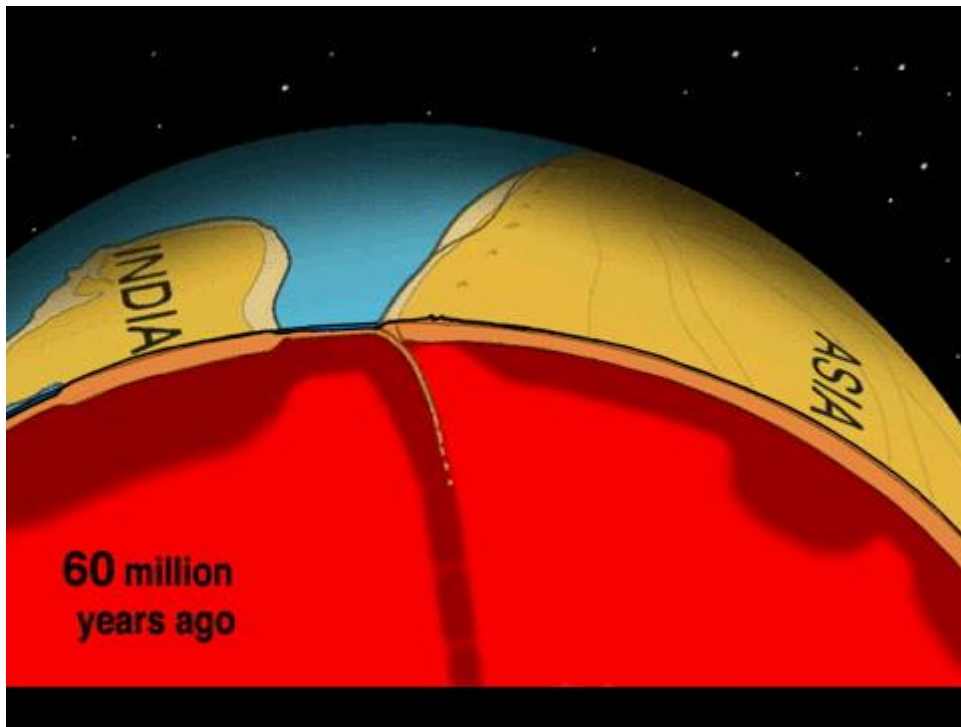


As the Indian plate is moving northward relative to the Eurasian plate and collides with it, a convergent boundary is created. On the opposite side, the Indo-African boundary is divergent. The western Indo-Arabian boundary is lateral relative to each other giving rise to a transform boundary. It was previously thought that the Indian and the Australian plates formed one single plate as there is no clear type of boundary but recent seismologic evidence suggests that the two plates will have a transform boundary as the drift velocities of these two plates are different even if the general direction of motion of the two plates is similar.



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The collision of the Indian plate into the Eurasian plate about 50 million years ago resulted in the erection of the Himalayan mountain chain which contains the highest peaks on the Earth today. Another result of the collision of the two plates is the creation of a multitude of small plates in the eastern boundary of the Indian plate. In addition, because the plate is located in an area with average temperature and humidity the Himalayan mountain chain create a barrier for the clouds which must precipitate in order to overcome the high peaks. This phenomenon generates large amounts of rain therefore some parts of India are subject to some of the largest amounts of yearly precipitation.



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As the Indian plate is still active today and drifts at a velocity of about 5 cm per year, earthquakes occur in the northern part of the plate. Low to 5 magnitude earthquakes were registered in the urban areas of India, the largest recorded earthquake occurred near New Delhi in 1950 and had a magnitude of 8.5.

Because of the low grade metamorphism that resulted in the collision of the Indian plate with the Eurasian plate, many micaceous minerals are mined in the north part of the country; in fact India is the greatest producer of mica blocks and splitting.

India is a vast country with having 3.28 million sq.km land area. Its varied landforms are- the plains, hills, valleys, rugged terrain, desert, island, etc. In fact, our country consists of all major physical features of the earth like- Mountains such as the Himalayas and the Aravallis, Plains such as Great Northern Plains, Coastal Plains, Deserts such as Thar, Plateaus such as Peninsular Plateau, Island Groups such as Andaman& Nicobar and Lakshadweep. Therefore, all forms of land are distributed into 29 percent mountains, 28 percent plateaus and 43 percent plains.

Based on the variations in its geological structure and formations, India can be divided into three geological divisions. These geological regions broadly follow the physical features:



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- (i) Phases of the Rise of Himalayas
  - (ii) Peninsular Block Mountains
  - (iii) Indo-Ganga-Brahmaputra Plain

### **Phases of the Rise of Himalayas**

The Himalayas are young, weak and flexible in their geological structure unlike the rigid and stable Peninsular Block. Consequently, they are still subjected to the interplay of exogenic and endogenic forces, resulting in the development of faults, folds and thrust plains. These mountains are tectonic in origin, dissected by fast-flowing rivers which are in their youthful stage. Various landforms like gorges, V-shaped valleys, rapids, waterfalls, etc. are indicative of this stage.

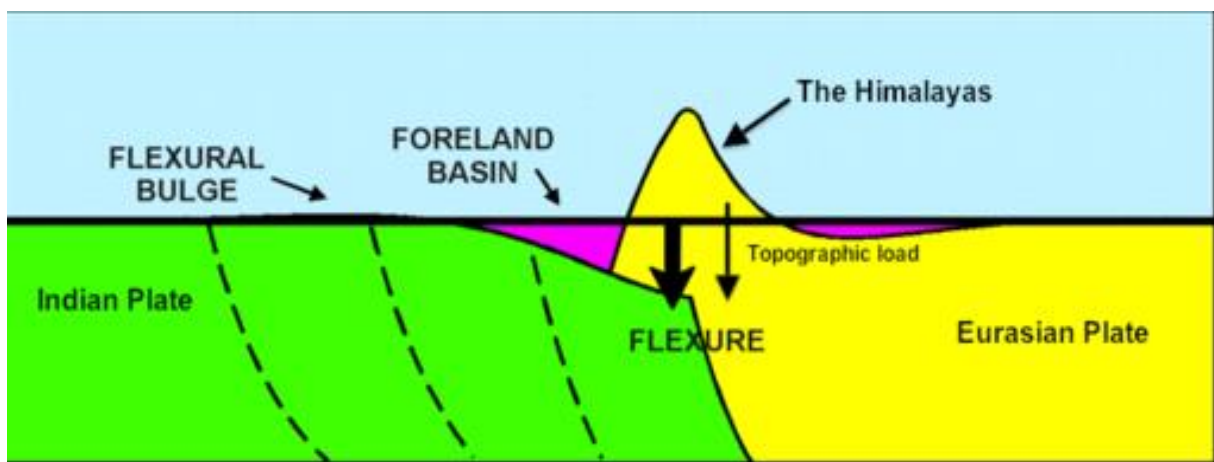
The Himalayas are considered as highest mountain range in the world and it extends almost 2,900 kilometres in many areas of India, Pakistan, China and Nepal. The Himalayan range is having several mountain peaks which are having elevation over 8,000 meters. Mount Everest is measured as the world's highest mountain peak comprising 8,848 meters. However, the Himalayan Mountains were not formed within a specific period of time. Different geological causes were involved in the formation of mountains.



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### ➤ Collision between the Indian Plate and Eurasian Plate

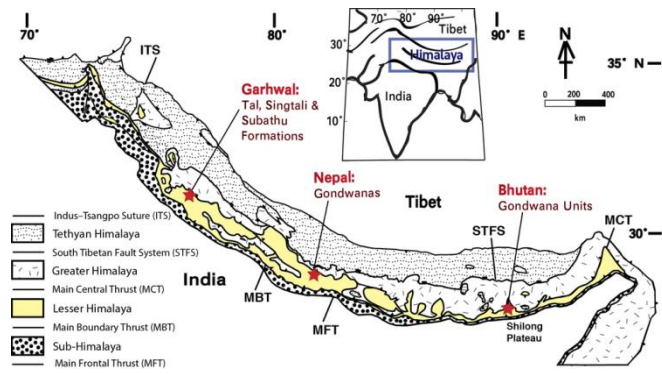
The Indian tectonic plate, located in the north-east hemisphere is surrounded by four major tectonic plates i.e. The Eurasian plate in the north, the Australian plate in the south-east, The African plate in the south-west and The Arabian plate in the west. Almost 50 million years ago, collision started between the Indian plate and Eurasian plate which led to the formation of the Himalayan mountain range and Tibetan plateau. The Collision between two plates as well as enlargement of height of the Himalayan Mountain is still in continuous process. The enlarged height of Himalayan mountain chain is found to act as barrier for the clouds which generate great quantity of rain throughout many parts of India.



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### ➤ Gradual Rising of the Himalayas

The gradual rising of Himalaya mountain ranges started millions of years ago. After separation from Gondwanaland, Indian landmass further separated from the Australian plate and started to drift towards north. The Indian plate was separated from Eurasian plate by the Tethys Sea. As a result of the collision, the Tethys Sea got filled up by the sediments which were accumulated in the geosynclines known as the Tethys were folded and formed the mountain system of Western Asia and Himalayas. After drifting almost 6,000 km, this landmass collided with Eurasian landmass 40 to 50 million years ago. As an effect of collision between Indian and Eurasian landmass, a part of the Indian landmass started to subside under the Eurasian landmass which resulted in the formation of the Himalayas. Continuously, the Indian landmass moves northwards and the Himalayas are still rising almost 2 centimeters per year.



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## Peninsular Block and Mountains

The southern part of India consists of an old plateau which is known as the Southern Plateau or the peninsular plateau. It is called so because it is surrounded by sea on the three sides. Geologists believe that it is the oldest landform of the Indian sub-continent formed on the Indian Plate.

Peninsula is well-known an area of land which is almost surrounded from three sides by water. In other words, peninsula may be stated as a piece of land which is not totally disconnected from a larger land but mostly surrounded by water.



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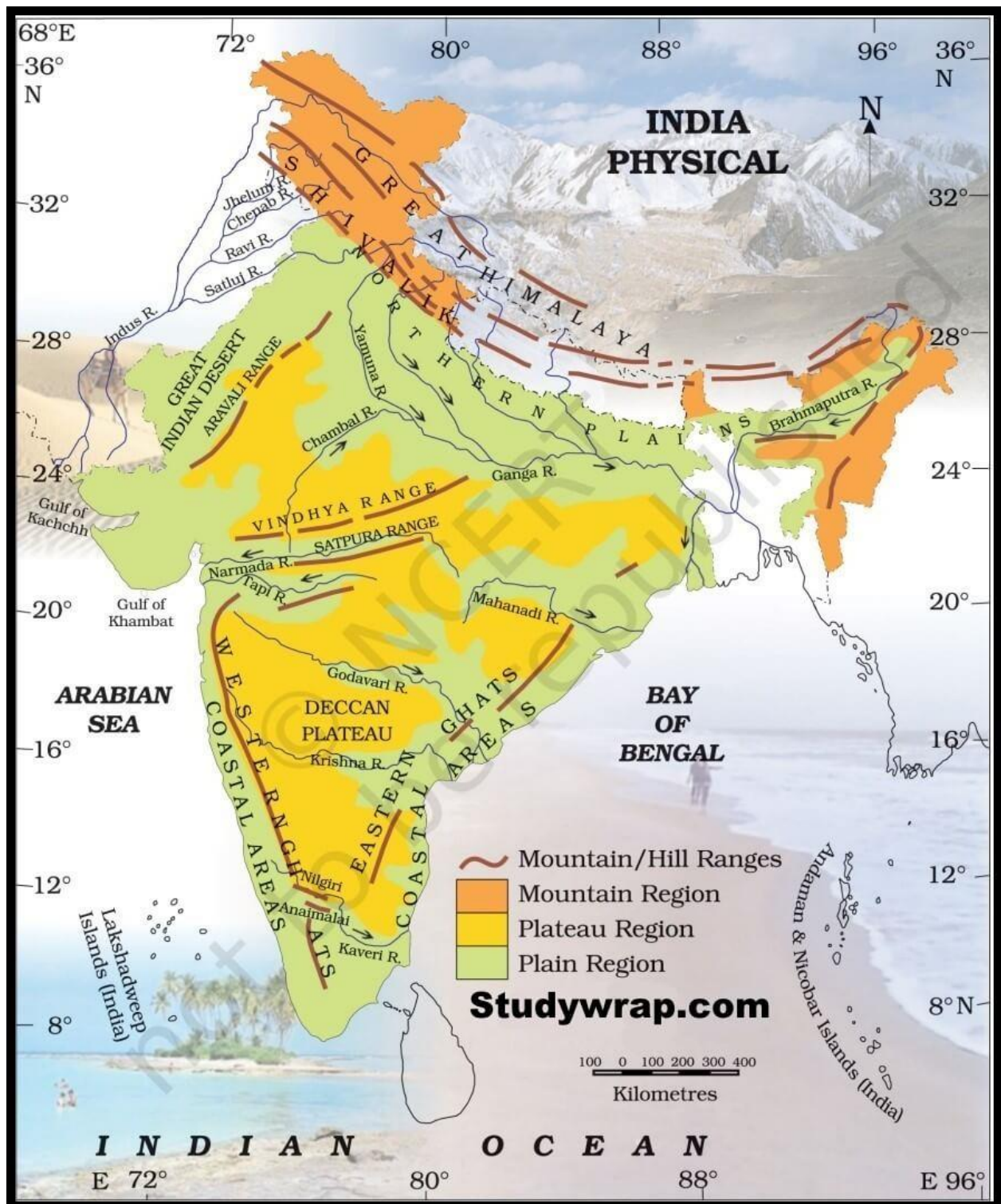
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Peninsular Plateau is an uplifted portion of landmass which is formed out of the old crystalline, igneous and metamorphic rocks. It is shown as the tableland. It consists of broad shallow valleys and rounded hills. This plateau is considered as the oldest land mass as it was formed due to the breaking and drifting of the ancient Gondwanaland landmass.



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The northern boundary of the Peninsular Block may be taken as an irregular line running from Kachchh along the western flank of the Aravali Range near Delhi and then roughly parallel to the Yamuna and the Ganga as far as the Rajmahal Hills and the Ganga delta. Apart from these, the Karbi Anglong and the Meghalaya Plateau in the northeast and Rajasthan in the west are also extensions of this block. The northeastern parts are separated by the Malda fault in West Bengal from the Chotanagpur plateau. In Rajasthan, the desert and other desert-like features overlay this block.



<https://studywrap.com/wp-content/uploads/2019/09/ip-with-physical-feature-map-of-india-1.jpg>

The Peninsula is formed essentially by a great complex of very ancient gneisses and granites, which constitutes a major part of it. Since the Cambrian period, the Peninsula has been standing like a rigid block with the exception of some of its western coast which is submerged beneath the sea and some other parts changed due to tectonic activity without affecting the original basement. As a part of the Indo-Australian Plate, it has been subjected to various vertical



movements and block faulting. The rift valleys of the Narmada, the Tapi and the Mahanadi and the Satpura block mountains are some examples of it. The Peninsula mostly consists of relict and residual mountains like the Aravali hills, the Nallamala hills, the Javadi hills, the Veliconda hills, the Palkonda range and the Mahendragiri hills, etc. The river valleys here are shallow with low gradients.



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<https://www.nps.gov/subjects/geology/images/Big-Bend.jpg?maxwidth=1200&autorotate=false>





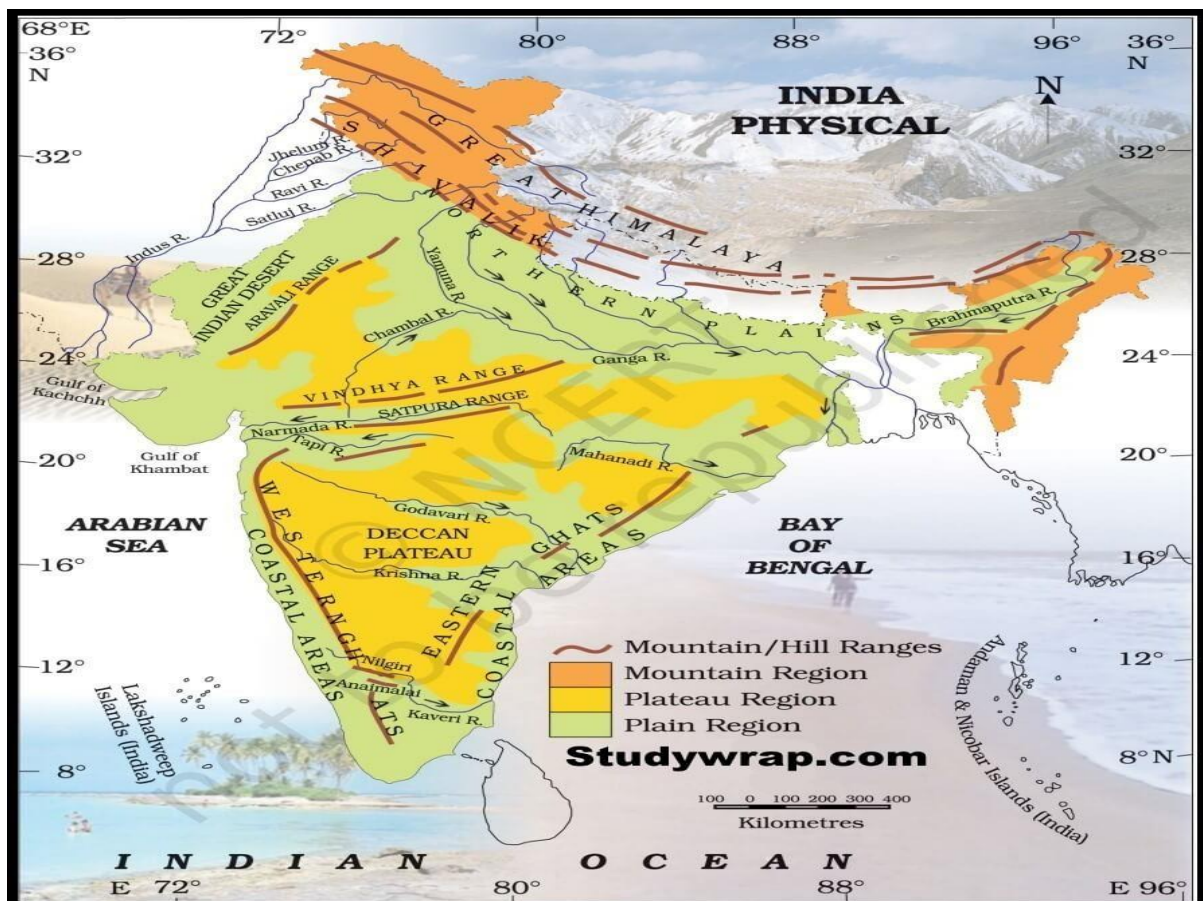
[https://upload.wikimedia.org/wikipedia/commons/thumb/0/0e/The Aravali Ranges of Mountains.jpg/1280px-The Aravali Ranges of Mountains.jpg](https://upload.wikimedia.org/wikipedia/commons/thumb/0/0e/The_Aravali_Ranges_of_Mountains.jpg/1280px-The_Aravali_Ranges_of_Mountains.jpg)

At the time of the uplift of the Himalayas, two important events took place. As a result of the first event, a volcanic eruption occurred in the north western part of the plateau leading to the formation of the horizontally arranged beds of the Deccan Lava. In the second event, the western flank of the Deccan Plateau subsided and the Indian Ocean advanced landwards leading to the formation of the Arabian Sea. The floundering of this flank has given rise to the Western Ghats in a sharp contrast in relief and a prominence of a mountain. The eastern coast and the adjoining continental shelf furnish contrary evidence. The Eastern Ghats are older than the Western Ghats, and have a complex geologic history related to the assembly and breakup of the ancient supercontinent and the assembly of the Gondwana landmass. The structure of the Eastern Ghats includes thrusts and strike slip faults all along its range. There is not much change in the coastline since the upper Paleozoic age.



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The peninsular mountains include the Satpura, Mahadeo and Kaimur ranges in the north, the Western Ghats in the west and the Eastern Ghats in the east. Further, the Western Ghats and the Eastern Ghats get together to develop Nilgiri Mountains which are located along the border of Karnataka and Tamil Nadu.



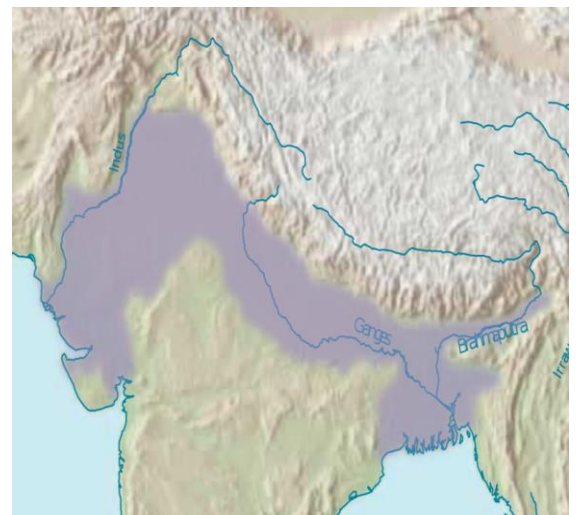
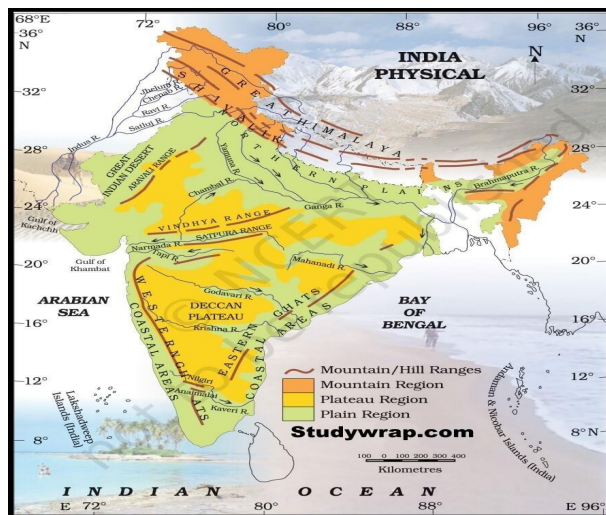
Most of the east flowing rivers form deltas before entering into the Bay of Bengal. The deltas formed by the Mahanadi, the Krishna, the Kaveri and the Godavari are important examples.



### **Indo-Ganga-Brahmaputra Plain**

The third geological division of India comprises the plains formed by the river Indus, the Ganga and the Brahmaputra. Northern Plains are extended covering a very vast area. It is located between the Himalayas on the north and the Deccan plateau on the south.





<https://upload.wikimedia.org/wikipedia/commons/thumb/2/2f/Indo-Gangetic Plain.png/800px-Indo-Gangetic Plain.png>

Originally, it was a geo-synclinal depression which attained its maximum development during the third phase of the Himalayan mountain formation approximately about 64 million years ago. Since then, it has been gradually filled by the sediments brought by the Himalayan and Peninsular rivers. Average depth of alluvial deposits in these plains ranges from 1,000-2,000m.

The upliftment of Himalayas out of the Tethys Sea and subsidence of the northern flank of the peninsular plateau were caused for the formation of a large basin. After the upliftment of the Himalayas, alluvium soils or sediments and debris were deposited at the foot-hills by the three major river systems -the Indus, the Ganga and the Brahmaputra and their tributaries during millions of year. Such deposits were extended throughout a vast area of northern region and this area is identified as the Northern Plains of India. Discussions of Geologists reflect that there was a shallow trough or geo-syncline between the Himalayas and the Deccan plateau which was formed at the latter geological period of Himalaya formation.

It is evident from the above discussion that there are significant variations among the different regions of India in terms of their geological structure, which has far-reaching impact upon other related aspects. Variations in the physiography and relief are important among these. The relief and physiography of India has been greatly influenced by the geological and geomorphological processes active in the Indian subcontinent. The land of India is characterized by great diversity in its physical features. The north has a vast expanse of rugged topography consisting of a series of mountain ranges with varied peaks, beautiful valleys and deep gorges. The south consists of stable table land with highly dissected plateaus, denuded rocks and developed series of scarps. In between these two lies the vast north Indian plain.