thorium and mica and building materials like granites, marbles, quartsite and slates.

Geological Structure of India

Geologically, India represents a monumental assemblage of rocks of different character belonging to different ages, ranging from Pre-cambrian to the recent times. The Geological Survey of India (Sir T Holland) *divides geological formations of India into four groups*

- The Archaean Rock System [first half of the Pre-cambrian era (about 4000 million years ago)].
- The Purana Rock System [second half of the Pre-cambrian era (1400-600 million years)].
- The Dravidian Rock System [Cambrian to middle Carboniferous (600-300 million years old)].
- The Aryan Rock System [Upper Carboniferous to the Pleistocene (300 million years old to the present].

ngetic Plains

ıut of the Tethys Sea and subsidence of the Northern Plateau resulted in the formation of a large basin. It evelopment during the third phase of the Himalayan proximately about 64 million years ago. Since then, it l with deposition of sediments by the rivers flowing ıuntains in the North and the Peninsular plateau in extensive alluvial deposits led to the formation of the Gangetic plains lying in India and Pakistan.

hus, resting on the continental shelf of a sea. The sea since the tertiary times leaving behind layers of ıarine, lacustrine and estuarine deposits. They now :k mantle of alluvium. Average depth of alluvial ıges from 1000 to 2000 m. The river Brahmaputra North-Eastern part of India and Bangladesh. The d the land has been slowly, but surely advancing,

ırphologic features noticed all over the plain. The :d to be a 'foredeep' formed in the wake of the a part of it was created as a result of the subsidence he plateau in its marginal process of mountain

e Dharwar System

from the rocks first studied in the Dharwar district of formed sedimentary rocks, found today in metamorphic ted in three major cycles; the earliest one is over 3100 test one about 2300 million years old. They were illion years ago.

and are found in Karnataka, Madhya Pradesh, Jharkhand, a and Rajasthan. They occur also in the central and quartsite and conglomerates are some of the rocks. This manganese ore, iron ore, chromium, copper, uranium, aterials like granites, marbles, quartsite and slates.

:ture of India

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The Archaean Rock System

The word Archaean was first used by JD Dana for rock structure prior to the Cambrian system.

It includes the following rock groups

Gneisses and Schist This system contains the first formed rocks of the Earth. These rocks in the peninsula are found primarily in Tamil Nadu, Andhra Pradesh, Karnataka, Odisha, Meghalaya, Madhya Pradesh and Chhattisgarh and Chhotanagpur plateau of Jharkhand. They also cover the whole of Bundelkhand in the North and to the North-West, they are formed in the number of isolated outcrops, extending from North of Vadodara to a long distance along the Aravallis.

The Purana Rock System

In India, the word Purana has been used in place of Proterozoic and *includes two divisions*

The Cuddapah System A long interval of time elapsed before the rock system next to the Dharwars and peninsular gneisses began to be deposited. A great thickness of unfossiliferous clay, slates, quartsite, sandstones and limestone was deposited presumably in great synclinal basins. This formation is known as the Cuddapah System, from the occurrence of the most typical and first studied outcrops of these rocks in Cuddapah districts of Andhra Pradesh.

The Vindhyan System This system of ancient sedimentary rocks stands over the Cuddapah rocks. Except a few traces of animal and vegetable life, this group is devoid of any recognisable fossils. It covers a large area in Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Bihar, Rajasthan, Karnataka and Andhra Pradesh. This system contains rocks like limestones, sandstones, shales and slates, which are useful as building materials often over 4000 m thick.

The Dravidian Rock System

These rocks do not occur in the Peninsular Plateau as it was above the sea level at that time, but are found in continuous sequence in the Himalayas. Most rocks of this system are found in the extra peninsular region and in one or two patches of lower Permian age, near Umaria. The rocks belonging to the Dravidian System contain abundant fossils which help in finding the inclusions of rocks of different periods like the rocks of Cambrian, Ordovician, Silurian, Devonian and Carboniferous periods.

The Cambrian Rocks These are best developed in the North-West Himalayan region. It includes slates, clays, quartsites and limestones.

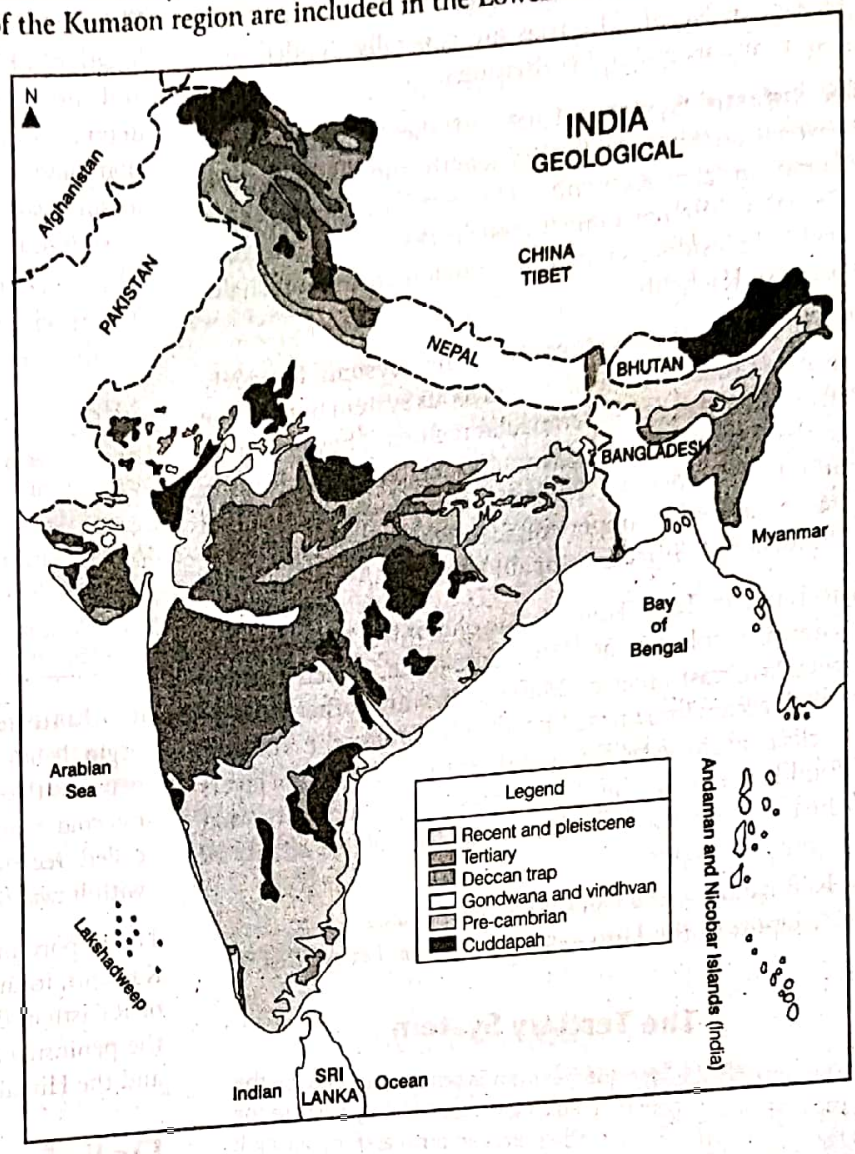
The Ordovician Rocks These rocks overlie the Haimanta System and also present in the Lidar valley of Kashmir and in the Kumaon region. It includes quartsites, grits, sandstones and limestones.

The Silurian Rocks In the Spiti valley, the Silurian rocks are in continuation with the Ordovician. Round the core of the Lidar anticline, there runs a thin but continuous band of Silurian strata. The Lahul and Kulu valleys of Himachal Pradesh also have some Silurian deposits. The lime and shale of the Kumaon region belongs to the Silurian period.

The Devonian Rock These rocks have been identified in the Muth quartsite of Spiti and Kumaon, on the flanks of Lidar anticline and in the Haridwar district of Uttarakhand.

The Carboniferous Rocks These rocks are generally divided into upper carboniferous, middle carboniferous and lower carboniferous types. The upper carboniferous rocks are made of limestone and dolomite. Mount Everest is composed of upper carboniferous limestone. The middle carboniferous has been the age of great upheavals.

These are mainly found in the Spiti valley, Kashmir, Shimla and in the Eastern Himalayas. Slates of different types, Pir Panjal trap and some rocks of the Kumaon region are included in the Lower Carboniferous group.



The Aryan Rock System

The marine sedimentary rocks belonging to late plaeozoic to tertiary periods are exposed today in the Northern part of the Central Himalayan axis extending from Kashmir to Sikkim. These rocks in the peninsula occur in several places in Gujarat, Rajasthan, Tamil Nadu and North-Eastern India.

The Gondwana System The peninsula during the upper carboniferous period experienced crustal movements, which led to the formation of basin shaped depressions. These depressions had countless terrestrial plants and animals, which were buried to form coal deposits in India known as the *Gondwana rocks*. These rocks have also marks of climatic changes from Arctic cold to tropical and desert conditions. These rocks are found mainly in the Damodar, the Mahanadi and the Godavari valleys of the peninsula.

The Triassic System This system is almost unknown in the peninsula, but is found over extensive areas from Hazara to Nepal. The trias are generally divided into lower, middle and upper divisions.

The Jurassic System Rocks of the Jurassic System covered an area of 190 km length and 64 km width found in the Kachchh. The area of Jaisalmer of Rajasthan also has some Jurassic rocks. Coral limestone, oolitic limestone, sandstone, conglomerates and shales occur in Kachchh.

The Cretaceous System No other system is widely distributed in India as the cretaceous system both in the peninsular and extra-peninsular regions. They are found in the Spiti area, in the Kumaon region, in the Rupshu and Burzil areas of Kashmir and in the plateau of Meghalayas. The upper cretaceous system occurs in the Puducherry-Tiruchchirappalli belt.

The Deccan Trap Towards the end of the Mesozoic era, intensive volcanic activity took place, which flooded with lava vast areas of Maharashtra and other parts of the Deccan known as the *Deccan Traps*. the volcanic rocks contain some thin fossiliferous sedimentary layers found between the lava flows. This indicates that the lava flows was not continuous. *The volcanic activity led to two great events*

1. Breakup of the Gondwanaland masses
2. Uplift of the Himalayas out of the Tethys Sea.

The Tertiary System

The Tertiary rocks were formed from Eocene to Pliocene. It is the most significant period in India's geological history because the Himalayas were born and India's present form came into being. It is the age of the mammals.

It is generally divided into three systems

- The Eocene System It is mainly found in Jammu and Kashmir, Himachal Pradesh, Rajasthan, Gujarat and in the North-Eastern part of India. Some Eocene deposits have recently been noticed in Puducherry.
- The Oligocene System It is very poorly developed in India. Rocks of the Oligocene period are found in the greater part of the Barail series of Asom, where they were overlain with a marked unconformity by Lower Miocene rocks.
- The Miocene System It is fully developed in India and is found in all the tertiary areas of the extra-peninsula. It is also found in outcrop of Muree series in Jammu hills, in the Dagshai-Kaushali band of Shimla, in the coal measures of Asom and in the Garo hills. Besides some rocks of Kuchchh in Gujarat, Mayurbhanj in Odisha, Durgapur in Paschim Banga and Kollam in Kerala also belong to this group.

The Shiwalik System (Middle Miocene to Lower Pleistocene) The Shiwalik strata are found all along the length of Shiwalik hills. Sandstone, grit, conglomerate, clays and slits comprise the rocks of this system. They have been deposited in lagoons and fresh water lakes by the rivers of that time. The great bulk of the Shiwalik formation is-non fossiliferous, but in certain areas, some formations are highly fossiliferous. The fauna records the sedimentation from Middle Miocene to Lower Pleistocene and has yielded a variety of fossils showing wide range of environment from humid forests to aridity.

Division of Shiwalik Strata

Upper Shiwaliks 1800-2750 m	Boulder conglomerate beds, sandstone thick Earthy clays. Richly fossiliferous in Shiwalik hills	Lower Pleistocene to Upper and Lower Pliocene
Middle Shiwaliks 1800-2500 m	Gravels, sandstones, shales and clays	Upper to Middle Miocene
Lower Shiwaliks 1200-1500 m	Bright red shales and sandstones	Middle Miocene

The Quaternary System A brief period is said to have just begin. It has two divisions without any clear cut boundary in between them. The older is the Pleistocene, which is marked by cold climate and glaciations. The younger division is called recent, started about 12000 years ago since, the withdrawal of the last glaciations.

The important quaternary formations are ice age deposits in Kashmir, formation of Alluvial plains in North India, creation of Rajasthan deserts, Rann of Kuchchh, laterite formation in the peninsula and the formation of the regular soils. Kashmir and the Himalayas experienced deposits of the ice age.

Relief or Physical Features

The land of India, in the North, there is a vast expanse of rugged terrain made of sedimentary and metamorphic rocks. Series of mountain chains with lofty peaks, enclosed plateaus and narrow and deep valleys are the characteristic feature of this part. In contrast, the North Indian plain drained by the Indus, the Ganga and the Brahmaputra is made up of the alluvium.

It is an area of low relief and level or featureless surface. Here, the diversity of relief features are seen in the levees and bluffs formed by the rivers along their banks. The older alluvial deposits appear like terraces overlooking the flood plains of the rivers. In many areas, in the relatively drier parts of the plain erosion has led to the formation of the ravines, in the valleys of the Yamuna and the Chambal. These ravines are often referred to as badlands.