INTRODUCTION

Physiography deals with the study of the surface features and landforms of the Earth. On the basis of tectonic history, stratigraphy, and physiography, India may be divided into the following four physiographic divisions **(Fig. 2.1)**:

1. The elevated Peninsular region;
2. The mighty Himalayas and their associated young folded mountains;
3. The Indo-Gangetic-Brahmaputra Plains; and
4. The Coastal Plains and Islands.

ORIGIN AND PHYSIOGRAPHY OF THE PENINSULAR INDIA

The origin of rocks of Peninsular India is more than 3600 million years old. Before the Carboniferous period, it was a part of the Gondwanaland. In the opinion of geologists, during the Archaean Period, the Indian Peninsula never subsided under the sea permanently. It was more rigid, stable, and had remained almost unaffected by the mountain building forces. However, it experienced block faulting and displacement during the subsequent periods as evidenced by the Dharwar and Gondwana formations and the fault valleys of the Narmada, Tapi and Son rivers.

It was during the Carboniferous Period that coal was formed in the Damodar, Son, Mahanadi, and Godavari basins. During the Cretaceous Period, large scale vulcanicity produced the Deccan Trap (the Lava Plateau of India), comprising lava sheets of several thousand metres in depth. The Deccan Trap originated about 146 million years back when the magma flowed from the depth of about 40 km below the crust.

Major Geological Formations of the Peninsular India (about 3600 million years ago)

The plateau of Peninsular India exhibits a complex system of geological structures. It has some of the oldest rocks of the world from the Precambrian period (Archaean) and the youngest rocks of the Holocene epoch (Quaternary/recent period). The major rock systems found in the Peninsular India have been described briefly in the following section:

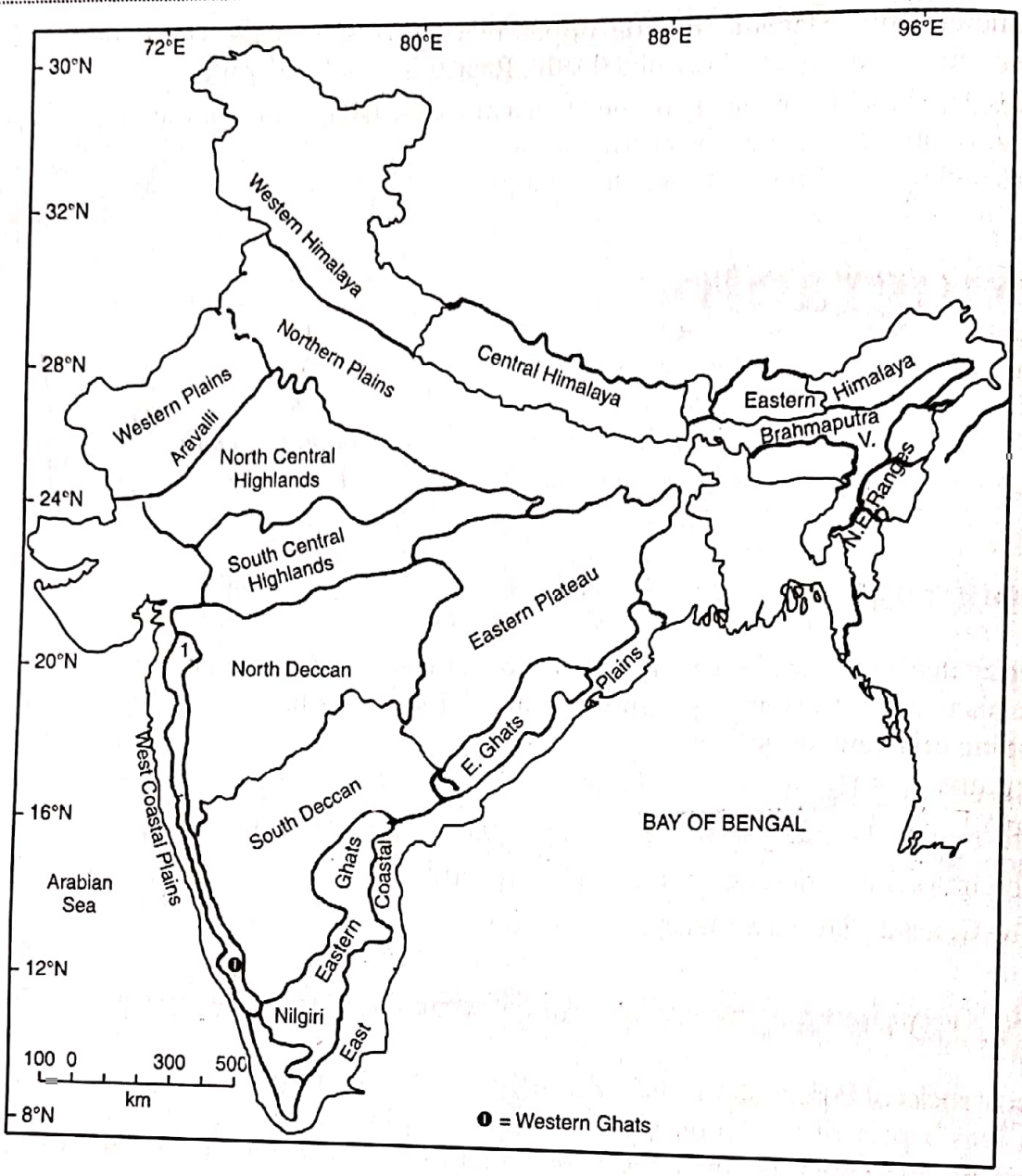

Fig. 2.1 Physiographic Divisions

1. The Archaean Group

Ancient crystalline and highly metamorphosed gneisses of the Archaean System are found in the plateaus of Tamil Nadu, Nilgiris, Karnataka, Andhra Pradesh, Maharashtra, Chhotanagpur, West Bengal, Odisha, Jharkhand, Chhattisgarh, Madhya Pradesh, Meghalaya, Mikir, Bundelkhand (UP), and the Aravallis (Rajasthan). The Bengal gneiss known as Khondolite is found in the Eastern Ghats. These rocks are rich in metallic and non-metallic minerals, precious stones, and building materials.

2. The Dharwar System

These are the oldest metamorphosed-sedimentary rocks found in narrow geosynclines flanking the Archaean gneiss. They occur mainly in (i) Dharwar, Bellary and Hospet districts of Karnataka,

(ii) the Chhotanagpur Plateau, (iii) the upper reaches of Godavari (Durg, Bastar, Dantewala, Chandrapur, etc.), and (iv) the Aravallis (Delhi, Rajasthan, and Gujarat).

It is presumed that the majority of the Dharwar rocks had escaped folding completely and had deposited into the hollows and the corrugations of landmasses or were only mildly folded. These rocks are rich in iron ore, manganese, mica, copper, zinc, lead, silver, gold, slate, asbestos, marble, and limestone.

3. The Cuddapah System

The Cuddapah formations (Andhra Pradesh) occupy the deep basins of: (i) the lower valleys of Penganga and Godavari, (ii) the Talcher Series between Mahanadi and Brahmani (Odisha), the upper courses of the Narmada and Son rivers, and (iii) the west of Aravallis near Jodhpur. These rocks are rich in building material, shales, limestone, and sandstone. Some inferior quality of iron ore, manganese, copper, and asbestos are also found in these formations.

4. The Vindhyan System

The Central Indian Highlands known as the Vindhyan Mountains occupy a large basin extending from Chittorgarh (Rajasthan) in the west to Sasaram and Dehri-on-Son (Bihar) in the east. One branch of it extends from Sasaram to Hoshingabad (Madhya Pradesh). It occupies a large contiguous area stretching over one lakh sq km from the Chambal to Son rivers. Several isolated exposures of sedimentary rocks occur in the Bastar area of Chhattisgarh. In some of the exposures of the Vindhyan System are found the diamond bearing conglomerates. The Panna District of Madhya Pradesh and the Kurnool District of Andhra Pradesh are well known for diamond production. Elsewhere in the south, the upper Vindhyans are covered by the Deccan Traps. The Vindhyans are known for the good quality of building materials. They are rich in ornamental stones, precious stones, diamonds and materials used in ceremics. The historical monuments of the Medieval Period and majestic religious places like Stupa of Sanchi, Agra Fort, Fatehpur Sikri, Red Fort, Jama-Masjid, Birla Mandir, etc., have been constructed with the red-sandstones obtained from the Vindhyan Ranges.

5. Gondwana System

The coal belts of Peninsular India were developed during the Gondwana (Carboniferous) period. The Talcher Series, the Damuda Series and the Panchet Series are the products of this period. The rocks of the Upper Carboniferous Period, Permian, Triassic, Jurassic, Cretaceous, Tertiary, etc., are preserved in different parts of the Damodar, Mahanadi, Godavari, and Krishna river basins.

6. The Deccan Trap

The Cretaceous system is a very widely distributed system in the country. The Gondwanaland developed fissures and its broken parts started drifting from each other. There was large scale upheaval of lava (basalt) from the interior of the Earth to form the Deccan Trap. The eruption of lava was of the Hawaiian or fissure type.This period is marked by the transgression of the sea (Narmada valley and Coromandal coast), and outpouring of huge quantity of basalt so as to form the Deccan Trap. There had been intrusions of the plutonic rocks such as gabbro and granite. The basalt of the Deccan Trap is used for the construction of roads and buildings. Moreover, there are quartzites, agates, and carnelians in the lava formations of the Deccan Plateau.

7. The Tertiary System

The final fragmentation of the Gondwana took place during the Tertiary Period. There occurred faulting of the Peninsula alongwith the subsidence of the broken blocks beneath the Arabian Sea and the Bay of Bengal. The Tertiary rocks are found in Kathiawar, Kachchh (Gujarat), Laki Series (Rajasthan), and along the Coromandal and Malabar coasts. In north-east, they are found in the Meghalaya Plateau; the Jaintia Series.

8. The Pleistocene Period

The Pleistocene deposits are found in the lower reaches and deltas of Mahanadi, Godavari, Krishna, and Kaveri and the western coastal plains of Gujarat, Konkan, and Malabar. These deposits are, however, more pronounced along the eastern coast of India.

Physiography and Relief Features of Peninsular India

Covering an area of about 16 lakh sq km, the peninsular upland forms the largest physiographic division of India. With a general elevation between 600–900 m, the region constitutes an irregular triangle with its base lying between the Delhi Ridge and the Rajmahal Hills and the apex formed by Kanyakumari. It is bounded by the Aravallis in the north-west, Maikal Range in the north, Hazaribagh and Rajmahal Hills in the north-east, the Western Ghats (Sahayadri Mountains.) in the west and the Eastern Ghats in the east **(Fig. 2.1)**. The highest peak of Peninsular India-Anai-Mudi (Nilgiris), is 2695 metres above sea level. According to Prof. S. P Chatterji (1964), the Peninsular Uplands can be divided into the following eight macro-physiographic units **(Table 2.1)**.

Table 2.1 The Physiographic Regions of Peninsular India

	Meso-Regions
1.	The North Central Highlands
2.	The South Central Highlands
3.	The Eastern Plateau
4.	The Meghalaya-Mikir Uplands
5.	The North Deccan
6.	The South Deccan
7.	The Western Ghats or Sahayadri
8.	The Eastern Ghats

Source: ***S.P. Chatterji, 1964, National Atlas Organisation, Kolkata.***

1. The North Central Highlands

The central highlands of peninsular India include the Aravallis, the Malwa Plateau, and the Vindhyan Range **(Fig. 2.2)**.

(i) **The Aravallis:** It is a range that runs from north-east to south-west for about 800 km between Delhi to Palanpur (Gujarat). It is one of the oldest folded mountains of the world. Being highly denuded, its highest peak—Guru-Sikhar—is only 1722 m in height. The Aravillis are mainly composed of quartzites, gneisses and schists of the Precambrian period. North-west of Udaipur, the Aravallis are called Jarga Hills (1431 m). The Goranghat

Pass separates Gurushikar from Mount Abu. The Great Boundary Fault (GBF) separates the Aravallis from the Vindhyan Mountains.

(ii) **The Malwa Plateau:** It is bordered by the Aravallis in the north, the Vindhyan Range in the south and the Bundelkhand Plateau in the east. The Malwa Plateau has two drainage systems, one towards the Arabian Sea (Narmada and Mahi), and another towards the Bay of Bengal (Chambal, Sind, Betwa, and Ken) joining the Yamuna river.

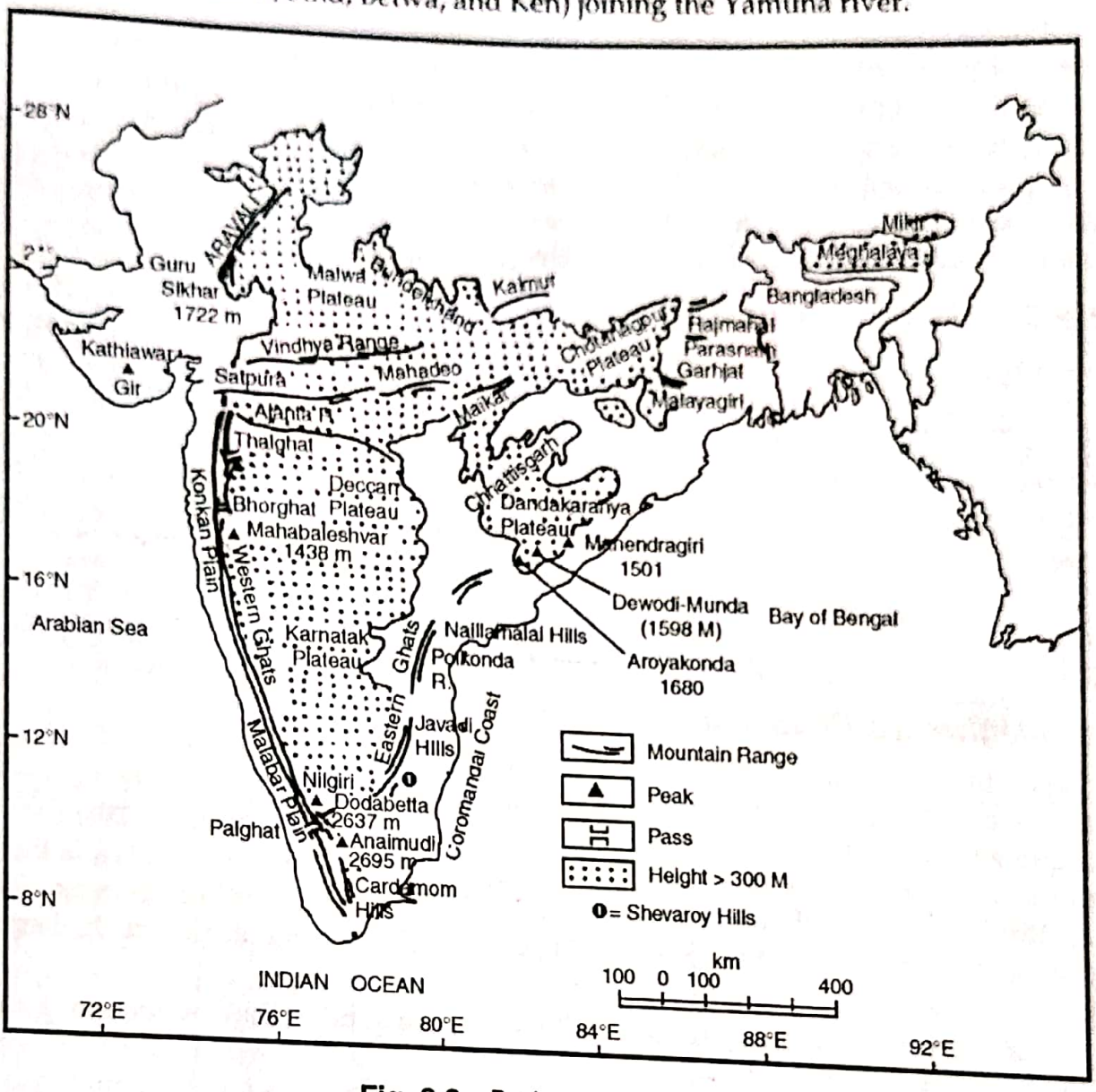

Fig. 2.2 Peninsular India: Relief

2. *The South Central Highlands*

The Vindhyan Range extends from Jobat (Gujarat) and Chittorgarh (Rajasthan) to Sasaram in Bihar. It extends for about 1050 km with general elevation between 450 to 600 m. Apart from the Kaimur Hills in the east, the Maikal Range forms a connecting link between the Vindhyans and the Satpura mountains.

(i) **The Bundelkhand (Vindhyachal Plateau):** It is bounded by the Yamuna river in the north, the Vindhyans in the south, the Chambal in the north-west, and Panna-Ajaigarh Range in the south-east. The Bundelkhand upland stretches over the districts of Banda, Hamirpur, Jalaun, Jhansi, and Lalitpur (UP), and Datia, Tikamgarh, Chhatarpur and Panna (MP). The

region is characterised by senile topography. The rivers like Betwa, Dhasan, and Ken have carved out steep gorges, rapids, cataracts, and waterfalls.

(ii) **The Vindhyachal-Baghelkhand or Vindhyachal Plateau:** It includes the plateaux of Satna, Rewa (MP) and Mirzapur (UP). Its elevation varies between 150 to 1200 m with uneven relief. To the south of this lies the Narmada-Son trough (rift valley) characterised by the Archaeans and Bijwar series. South of this trough is the eastward extension of the Satpura which is an area of radial drainage. Among the basins, Singrauli and Dudhi (150–300 m) are Upper Gondwana basins, which are rich in coal deposits. Besides the Narmada and Son, this region is drained by the Karmanasa, Tons, Ken, and Belandare rivers.

Parallel to the Vindhyas between the Narmada and the Tapi rivers is the Satpura Range. Satpura consists of Rajpipla Hills, Mahadev Hills and the Maikal Range. Dhupgarh (1350 m, near Pachmarhi) is the highest peak of Satpura. Amarkantak (1064 m) is another important peak of the Satpura mountains.

3. The Chotanagpur Plateau

The Chotanagpur Plateau sprawls over parts of West Bengal, Jharkhand, Chhattisgarh, Odisha, and north-eastern part of Andhra Pradesh. This plateau has a series of the meso and micro plateaux (Ranchi, Hazaribagh, Singhbhum, Dhanbad, Palamu, Santhal, Parganas, and Purulia districts of West Bengal). It is composed of Archaean granite and gneiss rocks with patches of Dharwar (mica-schists), the Damuda series of the Gondwana Period, and the lava flow of the Cretaceous Period.

Moreover, the Chhotanagpur Plateau consists of plateaux at different levels of elevation, the highest general elevation of about 1100 m in the mid-western part is known as pat lands. The rivers which drain the Chhotanagpur Plateau are Barakar, Damodar, Subarnarekha, and Koels. These rivers have carved out deep gorges, rapids, cataracts, and waterfalls in the plateau region.

4. The Meghalaya Plateau and Mikir Hills

Consisting of the Garo, Khasi, Jaintia hills and the outlying Mikir and Rengma hills, it is a plateau which has been detached from the Indian Peninsula by the Malda Gap. The Meghalaya Plateau has a chequered evolutionary history of emergence, submergence, planation surface with several phsases of erosion, sedimentation, diastrophism and intrusions. The Shillong Peak is the highest elevation (1823 m) in the Meghalaya Plateau, while Norkek (1515 m) is the highest peak of the Garo Hills. Mawsynram (25°15′N, 91°44′E) about 16 km west of Cherrapunji records the highest rainfall in the world.

The Mikir Hills are detached from the Meghalaya Plateau and are surrounded by plains from three sides. The southern range of the Mikir Hills is known as the Rengma Hills (900 m). The Mikir Hills are characterised by radial drainage with Dhansiri and Jamuna being the main rivers.

5. The North Deccan (Maharashtra Plateau)

The plateau of Maharashtra includes the entire state of Maharashtra, except the Konkan coast and the Sahyadris. It is mainly covered by the basalt of the Cretaceous Period. The basaltic sheet has a thickness of about 3 km in the western parts which diminishes towards the east and south-east. The most striking feature of the Maharashtra Plateau is the fault (1000 m), giving rise to the present shoreline of the Arabian Sea.

Through the northern part of the Maharashtra Plateau flows the Tapi River from east to west. It has a gentle slope in the south and steep gradient in the north (towards the Satpura Hills).

(i) **The Mahanadi Basin:** Sprawling over the districts of Raipur, Bilaspur, Durg, and Rajgarh, the Mahanadi basin is also known as the Chhattisgarh Plain. The region is largely dominated by the Archaean and Cuddapah formations. The Mahanadi river and its tributaries like Seonath, Hasdeo, Mand, Ib, Idra and Tel drain this plain.

(ii) **The Chhattisgarh Plain:** It is bordered by a series of hills and plateaux. The northern boundary is formed by the Lomari Plateau, Pendra Plateau, the Chhuri, and the Raigarh Hills. The Korba coalfields of Chhattisgarh lie in this basin. The Gondwana formations are rich in bituminous coal which is supplied to the Bhilai Steel Plant. The western rimland includes the Maikal Range with crest line of 700–900 m. The southern rimland includes the Dhalli-Rajhara Hills in southern Durg district and the Raipur uplands in the south-eastern Raipur district. The Rajhara Hill contains Dharwarian rocks in which iron ore of haematite type is found. The iron ore from the Dhalli–Rajahara mines is supplied to the Bhilai Steel Plant.

(iii) **Garhjat Hills:** The Garhjat Hills are also known as the Odisha Highlands. It is bordered by the Chotanagpur Plateau in the north, Mahanadi basin in the west, Eastern Ghats in the south, and Utkal plains in the east. The region is mainly composed of Archaean rocks like granite, gneisses, and magmatic rocks. The Gondwana, Talcher, Barakar and Kamathi series are also located in this region.

(iv) **Dandakaranya:** Sprawling over the Koraput and Kalahandi districts of Odisha, Bastar District of Chhattisgarh and East Godavari, Vishakhapatnam and Srikakulam districts of Andhra Pradesh, Dandakaranya is an undulating plateau. Its Abujhmar Hills provide one of the richest iron-ore deposits at Bailadila Range. It is drained by the Tel and Udanti; tributaries of Mahanadi, and the Sabari and Sileru; tributaries of Godavari rivers.

6. The South Deccan

The South Deccan consists of several plateaux:

(i) **Karnataka Plateau:** This plateau spans in the S.W. parts state of Karnataka and the Kannur and Kozhikode districts of Kerala. It shows dominance of Archaean and Dharwar formations. This plateau has an average elevation of 600–900 m. Mulangiri (1913 m) is the highest peak in Baba-Budan Hills, followed by the Kudermukh (1892 m) peak.

The northern upland of the Karnataka plateau is known as Malnad, while the southern part is called a Maidan. It is drained by the Kaveri and the Tungbhadra rivers. The Nandi valley is a summer resort in this region.

(ii) **The Telengana Plateau:** The plateau of Telengana consists of Dharwar and Cuddapah formations. Hyderabad, the capital and cultural city of the state lies in Telengana.

(iii) **The Tamil Nadu Uplands:** This upland lies between the South Sahyadri and Tamil Nadu coastal plains. It is largely covered by the Archaean rocks. The charnockites are found in Javadi and Shevaroy hills. Moreover, there are Cuddapah and alluvial formations. Between Coimbatore and Anaimalais, there is a broad gap, known as Palakkad Gap (Palghat), about 25 km wide, through which flows the Gayitri river from east to west joining Tamil Nadu with the coast of Kerala.

7. The Western Ghats

The Western Ghats in Sanskrit Sahyadris run parallel to the western coast for about 1600 km in the north south direction from the mouth of the Tapi river to Kanyakumari (Cape Camorin). The

western slope of Sahyadri is steep while the eastern slope is gentle. These are block mountains formed due to the downwarping of a part of land into the Arabian Sea. The Sahyadris form a watershed of the peninsula. All the important rivers of Peninsular India, like the Godavari, Krishna, and Kaveri rise from the Western Ghats. The western rivers merging into the Arabian Sea are swift. The Gersoppa (Jog Falls) on Sharvati is the highest waterfall in India. The average elevation of the Western Ghats varies between 1000 to 1300 m **(Fig. 2.3)**.

The important peaks of the Western Ghats are Kudermukh (1892 m), Pushpagiri (1714 m), Kalsubai (1646 m) and Salher (1567 m), Mahabaleshwar (1438 m) and Harishchandra (1424 m). In the Nilgiris the Eastern Ghat joins the Western Ghat to form a mountain knot (Nilgiri) whose highest point is Anaimudi (2695 m). South of Nilgiri lies the Palghat (Palakkad Gap). South of Palghat, the Western Ghat is known as Anaimalai Hills. Anaimudi is the highest peak of Sahayadris Mt. is 2695 m above the sea level. The other important passes of the western Ghat are Thal Ghat and Bhor Ghat.

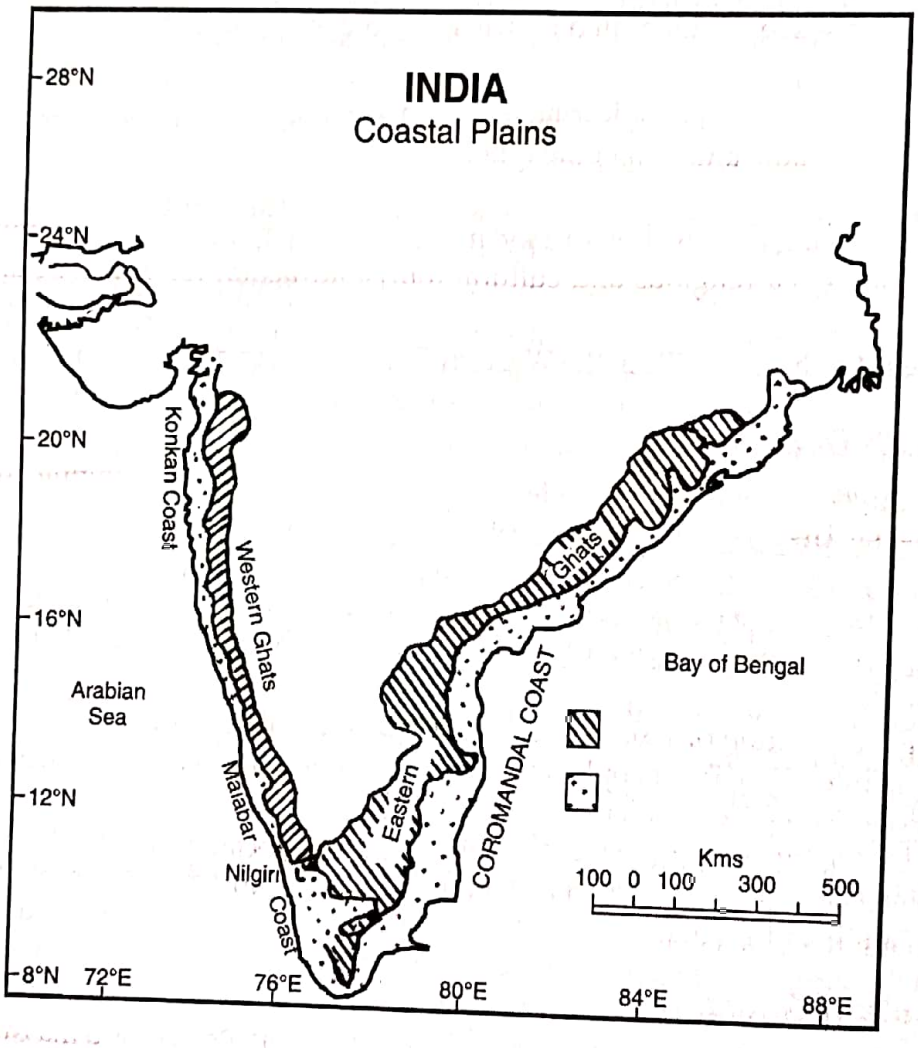

Fig. 2.3 The Eastern and Western Ghats and the Coastal Plains

Bhor Ghat: (Joins Mumbai with Pune): Having an elevation of about 1,000 m above sea level, the Bhorghat joins Mumbai with Pune. It is one of the most busy passes in the Western Ghats. The frequency of trains and commercial vehicles is enormous.

Goran Ghat: Lying to the south of Mount Abu, it connects the city of Udaipur with Sirohi and Jalore in Rajasthan. It is about 1200 m above sea level. The surrounding rocks are desolate, characterised by thorny bushes and cacti.

Haldighat: It is a mountain pass in the Aravalli range of Rajasthan. Situated about 40 km from Udaipur, it connects Rajsamand and Pali district. The name is believed to have come from the turmeric-coloured yellow soil. The mountain pass is historically important as the location of the historic battle of Haldighat which took place in 1576 between Rana Pratap Singh of Mewar and Raja Mansingh of Amber, General of the Mughal Emperor—Akbar the Great.

Harishchandra: The Harishchandra mountain ranges in the southern parts of Maharashtra from north-west to south-east. It stretches in the districts of Pune and Osmanabad. It is covered by degraded forests.

Jog Falls: The short westward flowing Sharavati river pours down the Western Ghats, forming one of the highest waterfalls in the world at 250 m.

Kalsubai: Situated in the state of Maharashtra, it is one of the highest peaks of Western Ghats. It is 1646 metres above sea level. Inhabited by tribal people, its forest wealth has diminished due to deforestation.

Kudarmukh: Situated in the state of Karnataka, the Kudarmukh range (1892 m) is rich in iron ore. The iron-ore is of haematite and magnetite type. Iron ore from here is exported to Iran through the port at Mangalore.

Mahabaleshwar: Having an elevation of 1438 m, Mahabaleshwar is one of the important peaks of the Western Ghats. It is a religious and cultural tourist attraction for domestic and international tourists.

The Nilgiri Hills: The Nilgiri Hills in the Western Ghats cover an area of about 2500 sq km and rise over 2500 m. Udhagamandalam, one of southern India's most famous hill resorts, is located here.

Palghat (Western Ghats; joins Coimbatore with Kochi and Kozhikode): Also known as the Palakkad Gap, it lies to the south of Nilgiri Hills. It has an elevation ranging from 75 to 300 m above the sea level. The width of this gap is about 25 km. It joins the state of Tamil Nadu with the seaports of Kerala. The river Gayitri flows through it from east to west.

Pushpagiri: This is one of the highest peaks of the Western Ghats. Its elevation is 1714 m above the sea level. It is the abode of Dravidian tribes. The forests are, however, degraded and soil erosion is the main problem.

Salher: Having an elevation of 1567 m above sea level, the Salher peak lies between Malegaon and Nashik. It is inhabited by tribal people. Heavy deforestation has reduced its aesthetic beauty and created numerous ecological problems.

Thal Ghat (Western Ghats; joins Nashik with Mumbai): Located in the Sahyadri Ranges, Thal Ghat is over 1,000 m above sea level. The National Highway No. 3 and the Bhopal-Indore Railway Line pass through the Thal Ghat.

8. The Eastern Ghats

The Eastetrn Ghats form the eastern boundary of the Deccan Plateau. It is a massive outlying block of hills. The average height of the Eastern Ghats is about 600 m. The Eastern Ghat is a series of detached hills of heterogeneous composition which are called by various local names. Between Mahanadi and Godavari, the average elevation of the Eastern Ghats is about 1100 m **(Fig. 2.3)**. The peak of Aroya-Konda (Andhra Pradesh) with an elevation of 1680 m is the highest peak of the Eastern Ghats. Among other peaks Dewodi-Munda (1598 m), Singa-Raju (1516 m) and Nimalgiri (1515 m)

in the Koraput District and Mahendragiri (1501 m) in Ganjam District are the other important peaks. The predominant rocks of the Eastern Ghats are khondalites, metamorphosed-sedimentary, and charnokites (intrusive rocks being granite). Between the Krishna river and Chinnai are the Kondavidu, Nallamalai, Velikonds, Palkonda, and Erramala Ranges. Their continuation can be seen in the Seshachalam (Cuddapah and Anantapur districts), Javadi, Shevaroy, Panchaimalai, Sirumalai, and Varushnad Hills south west of Madurai (Tamil Nadu).

Significance of the Peninsular Plateau

Richly endowed with natural resources, Peninsular India has an important role in the economic development of the country. The importance of Peninsular India is mainly because of the following benefits from its location and rock formations:

(i) The Peninsular region of India is rich in both the metallic and non-metallic minerals. Mineral ores like iron, manganese, copper, bauxite, chromium, mica, gold, silver, zinc, lead, mercury, coal, diamond, precious stones, marble, building materials and decorative stones are found in abundance in this physiographic region. About 98 % of the Gondwana coal deposits of India are also found in the Peninsular region.

(ii) A substantial part of the Peninsular India is covered by black earth (Regur soil). The regur soil is conducive for the successful cultivation of cotton, millets, maize, pulses, oranges and citrus fruits. Some areas of south Peninsular India are suitable for the cultivation of tea, coffee, rubber, cashew, spices, tobacco, groundnut and oilseeds.

(iii) On the southern and eastern parts of Peninsular India are large stretches of Archaean, Dharwar, Cuddapah, and Vindhyan formations in which red, brown, and laterite soils have developed over time. These soils are the bases of rural economy.

(iv) The Western Ghats, Nilgiris and the Eastern Ghats are covered by thick tropical moist deciduous and semi-evergreen forests. These forests provide teak, sal, sandalwood, ebony, mahogany, bamboo, cane, rosewood, iron-wood, and logwood as well as a large variety of forest products.

(v) The rivers flowing eastward into the Bay of Bengal make several gorges, waterfalls, rapids and cataracts, which have been harnessed for the generation of hydro-electricity. The rivers originating from the Western Ghats offer great opportunity for the generation of hydel power and irrigation of agricultural crops and orchards.

(vi) There are numerous hill stations and hill resorts, of which Ooty, Udhagamandalam, Kodaikonal, Mahabaleshwar, Khandala, Metheron, Pachmarhi, and Mount Abu are the most important.

(vii) Apart from teak and fuelwood, the forests of Western and Eastern Ghats are rich in medicinal plants.

(viii) The hilly and mountainous areas of the Peninsula are the abodes of many scheduled tribes. South of the Vindhyans is a predominance of Dravidian culture.

THE HIMALAYAS

The Himalayas consist of four lithotectonic mountain ranges, namely (i) the Trans-Himalaya or the Tethys Himalaya, (ii) the Greater Himalaya, (iii) the Lesser Himalaya, and (iv) the Shiwalik or the Outer Himalaya. The Indian Himalayas extend from the eastern boundary of Pakistan to