CHAPTER-I

GENERAL GEOGRAPHICAL SETTING AND PHYSIOGRAPHY

Indian Ocean, the third largest body of water on the globe, covering about 73,425,000 square Km. It is bordered on four sides by the continents of Africa, Asia, Australia and Antarctica. No natural line of demarcation separates the Indian Ocean from the Atlantic Ocean, but the 20°E meridian of Greenwich, connecting Cape Agulhas at the southern end of Africa, is generally taken to be the boundary. To the east, the Malay Peninsula (Cape Talbot), the Sunda islands (Sumatra, Java and Timor), and the west coast of Australia from Cape Londonderry to the south East Cape of Tasmania (43° S- 147°E). To the south, this ocean is in free communication with the southern ocean and their separation is represented by the hydrological limit of the subtropical convergence (the tropical waters of the Indian Ocean meet the cold water of the Antarctic Ocean) at about 50°S latitude. \(^1\) The Red Sea and the Persian Gulf, these two seas push the geographic domain of the Indian Ocean to nearly 30° N.

On 30°S, the distance from Africa (Durban) to Australia (Freemantle) is 4200 nautical miles: from the top of the Bay of Bengal (Calcutta) to 40°S, it is 3700 nautical miles. The great area of this ocean lies between the Equator

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and the sub-tropical convergence. Four-fifths of its area is in the Southern Hemisphere and only one-fifth in the Northern Hemisphere.²

Between the subtropical convergence and 10°S, the shape of this ocean, on a Mercator projection, is nearly that of a rectangle, whose long axis is west to east. But north of 10°S the closing in, of the continental landmasses, more and more reduces its extent. Near the Tropic of cancer, it appears as completely, closed towards the north. The Indian peninsula divides its northern part into two great gulfs; the Bay of Bengal and the Arabian Sea, which is itself extended to the north by the Gulf of Oman and the Persian Gulf and to the west by the Gulf of Aden and the Red Sea.

Ocean water touches the shores of thirty-five states, situated on the littoral, which contain nearly a fourth of world's total population and a fifth of world's total arable land. Geographically, the Indian Ocean basin is an aggregate of several sub-regions. It includes South Asia, Southeast Asia, Southwest Asia, part of the Middle East, Western Coastal area of the Red Sea, the Horn of Africa, East Africa and Southern Africa, Australia and the islands. Littoral countries of Africa, from the Nile delta to Cape of Good Hope; Egypt, Sudan, Djibouti, Eritrea, Somalia, Kenya, Tanzania, Mozambique and South Africa, Arabian Peninsula; Israel, Jordan, Saudi Arabia, Yemen, Oman, U.A.E., Qatar, Bahrain, and Kuwait; West-Asia: Iraq and Iran; South and Southeast Asia; Pakistan, India, Bangladesh, Myanmar, Thailand, Malaysia,

² Ibid., p. 137.
and Island States: Madagascar, Maldives, Seychelles, Mauritius, Sri Lanka, Indonesia, Singapore and the Australia continent.

The longitudinal extension of the littoral States is from 16°E (mouth of the Orange river to the Atlantic coast of South Africa and Southern boundary of Namibia) and 153°E Cape Byron of Australia. Though the northern limitations are 39°30'N (Iran) to 43°S (Southeast cape of Tasmania). Thus, though the littoral countries have direct navigation connections—South Atlantic in the west, South Pacific in the east, the Mediterranean in the northwest and the Caspian Sea in the north, however, the IOR countries have direct links with the big regional trading blocs of the world.

Evolution of the Indian Ocean and Rim Countries

The Indian Ocean was formed, when Gondwanaland broke-up and the continents moved apart by two independent processes: one actual crustal sliding, and two, expanding oceans. It is believed that convection currents operating beneath the crust provided motive force, since perhaps the Precambrian. A re-orientation of convection currents caused continents to rupture, but such rupture did not reach below the Mohorovicic Discontinuity and the result was crustal sliding. On the other hand, expansion of the earth caused deep ruptures. Convection currents were localised by these fractures and pumped lava (basalts) through these eruptions, which spread on the continents and plateau-basalts were formed. But later on, as the distance

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between landmasses on the two sides increased, the eruptions were sub-oceanic and this built up the Mid-Oceanic Ridges.

It appears that the break up of Gondwanaland started in the Africa-Tasmania-Victorialand region, so that; there was Triassic igneous activity in this region.\textsuperscript{4} India – Australia- Antarctica started sundering apart from Africa in the Cretaceous, and the Carlsberg Ridge was formed (fig.1.a).

Widespread faulting occurred in Peninsular India and it extended to Western Australia. Thereafter, Australia, and Antarctica, drifted away from India by crustal sliding. Antarctica broke away from Australia in the Oligocene and moved into frigid zone.\textsuperscript{5} On the basis of the evolution, the physiography of the Indian Ocean region can be seen under two parts.

\textsuperscript{4} Ibid., p. 374.
\textsuperscript{5} Ibid.
Submarine Topography

The principal ridges, which diversify the bottom of the Indian Ocean, pertain to the great oceanic ridge system, which encircles the globe in a submarine girdle, continuous for 40,000 nautical miles⁶. In the Indian Ocean the arrangement of ridge system is more complex than the Atlantic and does not occupy the characteristics of an axial orientation (fig. 1.b).

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Fig. 1.b. Indian Ocean Bathymetry

⁶ Dehernia, *Descriptive Regional Oceanography*, *op. cit.*, p. 173.
The Mid-Oceanic Ridge in the South Atlantic bends towards the east at Bouvet Island (54°25'S-03°17'E). It runs northeast into the Indian Ocean, joining a mountainous central massif about 20°S-67°E. From this massif, the Mid-Indian Ridge continues towards the south-southeast as far as the Islands of St. Paul and Amsterdam. Then it turns to the southeast towards the Pacific, across the Antarctic Ocean, "Between Tasmania and Antarctica" is the Macquarrie Ridge, which marks a natural boundary, between the Indian and Pacific Oceans. The Macquarrie Ridge restricts the flow of deep water between the Pacific and Indian Oceans. The ridge systems, divide the Indian Ocean into different basins. But most of the ridges are longitudinal, relatively broad and continuous at depths greater than 2000 fathoms.

The Carlsberg Ridge, is in the northwestern part of the Mid-Ocean Ridge and situated at 5°N and 62°E. It cuts transversally by fracture lines. The Owen Fracture Zone runs between Karachi and the Somali Basin. The Carlsberg Ridge inflected towards the island of Socotra and Cape Guardafui, where it joins with the very rugged relief of the Gulf of Aden and formed triple junction with the East-African and Red sea rift systems. This triple junction is the boundary of three plates viz., the African, Arabian and Indian Ocean. It continues northward through the Red Sea, the Gulf of Aqaba, the remarkable U-shaped trench of Wadi-el-Arab, and on the Dead Sea, the Jordan Valley,
and Lake Tiberias. When this branch of the ridge emerges on the land at Gulf of Aqaba, it is known as Levant-strike fault and the above mentioned lakes and valleys are located on it. From the Mediterranean Sea, the Aegean subduction zone re-emerged on the mainland (Anatolian Plateau) and the Levant strike-slip-fault joined with it. Finally it extends towards northeast and merges with the North Anatolia- Zagros main strike-slip-fault\(^{10}\)(fig.1.c).

![Fault System of the Afro-Asian Region](image)

**Fig.1.c. Fault System of the Afro-Asian Region**

The Red Sea, which runs almost 2000 kms from the Mediterranean to the Indian Ocean, forms an important unit in the pattern of earth morphotectonics. The structural relationship between the Carlsberg Ridge of the Indian Ocean, the Gulf of Aden, the East African Rift Valley, the Red Sea, and the Dead Sea- Aqaba Rift is of considerable importance to earth scientists, because this area represents one of the two places in the world (the

\(^{10}\) Ibid., p. 134.)
Gulf of California is the other) in which a mid-oceanic ridge-rift system runs into a continent.\textsuperscript{11}

The Red Sea extends from Suez (30\textdegree N) to Bab-el-Mandeb (12\textdegree 30'N) and lies in a fault depression between Arabian-Nubian shield. The width of the northern portion is approximately 180 Km and the sea floor consists of a single main trough with a maximum depth approximately 1300 meters. However, the Carlsberg Ridge and the associated features with this, are constituent seismic zones.

East of the Carlsberg Ridge, a north-south ridge connected at about 15\textdegree W (from Carlsberg Ridge) to the continental shelf of the west coast of India, is marked by the coral reefs chain of the Laccadive-Maldives-Chagos Ridge.

The Seychelles Archipelago consists of a large number of islands. Most of which, are coral atolls, relatively of recent origin. The Mahe'-Praslin groups of islands, the principal islands of the archipelago, are situated approximately, 1000 miles east of Mombasa. Fortune and Saya de Malha, together with the Seychelles, form the northern extremity of the Mascarene Ridge, are composed of sedimentary and plutonic rocks. Reunion and Mauritius are in the Southern part of the Mascarene Ridge. These two islands formed by the recent volcanic lava. The Amirante Ridge, to the west of the Mahe'-Praslin group, is covered by coral formations.

Central Indian Ridge (CIR) is an important morphotectonic feature of the Indian Ocean. It is located between 2\textdegree S, 68\textdegree E and 25\textdegree 30'S, 70\textdegree E. in other

words, from the southern end of the Carlsberg Ridge triple Junction (RRR) 25°30's, 70°E. The Central Indian Ridge broadly follows the N-S line of earthquake epicenter. It is an intermediate to slow spreading ridge. The ridge is highly segmented by NE-SW trending fracture zones. The most striking fracture zone is the Vema Trench (9° S, 67° 5'E) with 6402 meters deep (the greatest known depth in the Western Indian Ocean) with a width of 15-35 km. At 10°S, is the boundary of five plates (Antarctic, Australian, African (Somalian), Arabian and Indian of the Indian Ocean. This Wide Boundary Zone (WBZ) also called "Diffuse plate Boundary".

From Rodrigues triple junction, the Central Indian Ridge bifurcates into southwest and southeast ridges and looks inverted Y-shape at 20° S. At 35° S, 45°E, Madagascar Plateau converge with the Southwest Indian Ridge. Between 40°-48°S the ridge is further diffused towards SW and known as Crozet Ridge. In this diffused part, Prince Edward and Crozet Islands are situated. Further in the Southwest, the ridge is known as "Atlantic-Indian Ridge. Finally joined to the Atlantic Ridge of Bouvet Island (45°S, 5°30'E). The trends of fracture zones are WNW-ESE. The Bouvet Island is the physical demarcation between the Indian and Atlantic Oceans.

The Southeast Indian Ridge extends up to the Macquarie Ridge (55°30's, 170E). The area between 35°S to 50°S and 70°E to 95°E is a

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13 Ibid., p. 413.
14 Ibid.
diffused boundary of the Indian, Australian and Antarctic plates. The ridges like Ninety east, Broken and Kerguelen radiate into different directions from this complex area. The Amsterdam and St. Paul islands are situated in this area. The trends of fracture zones are N-S.

The Ninety East ridge is a single asymmetric ridge in the Indian ocean. The southern end is about 200km wide. It runs 4,800kms from the Ganga cone in the north to the vicinity of Broken plateau in the South. This is an aseismic ridge.

In the eastern half of the Indian Ocean, there are three possibly continental type aseismic plateaus. Both Broken and Naturaliste lie to the north of the Diamantia Fracture Zone (DFZ). Naturaliste plateau adjoins the continental shelf of southwest Australia and shows morphological similarities to Broken plateau. These two plateaus were once part of the western Australian shield, and that the crust has either "been thinned tectonically or the mantle has risen at the expense of the crust by some process at the Mohorovicic Discontinuity" 15

On the basis of convergence of plates, the formation of trenches is rare in the Indian ocean region. The Sunda is a single subduction zone of this area. The eastern end of the Himalayan collision zone connects via a large strike slip boundary with the Indonesian Subduction Zone (ISZ). Here the oceanic part of the Indian plate is being destroyed in an arcute zone from the Andaman

Islands along the Sunda arc as far as Timor. The eastern continuation of this belt, from Timor to New Guinea, is affected by the collision of the Australian continental crust. However, Southeast Asia represents the complex interaction of three main plates: the Indian plate to the south with Australian continental crust in its eastern half; the Southeast Asian Part of the Eurasian plate to the northwest, and the pacific plate to the northeast. Subduction of oceanic Indian plate is taking place at the Java trench below the Sunda arc. This subduction zone extends south of Sumatra and Java, eastwards to the edge of the Timor Sea, where Oceanic Crust of the Indian plate gives way to continental Australian Crust. The Australian continental crust extends northwards to include New Guinea (Irian). However, the Mid-Oceanic ridges and continental fragments divide the Indian Ocean into a number of Ocean basins.

**Important Basins of the Indian Ocean**

Oman Basin, the Southeastern physical division of this basin is the Murray Ridge. This basin faces the Gulf of Oman and is spread over the extensive continental shelf with average depth of 3,658m. The sedimentation of this area constitutes petroleum and natural gas bearing rocks.

Arabian basin, is a circular depression it extends upto 5°S in the form of southward narrow extension of the basin, between Carlsbedrg and Chagos ridges. The Arabian basin is surrounded by the Chagos- Laccadive plateau in

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the eastern side; Carlsberg and Socotra ridges in the west and northwest respectively, which separate from Somali basin. On the other hand, the Murray Ridge, separates the Arabian basin from the Oman basin.

Natal- Agulhas basin, the eastern border is the Madagascar ridge, in the west, African continental margin and the cape Ridge. In the South and Southeast, this basin is separated from the Atlantic-Indian basin by the Atlantic-Indian Ridge and Southwest Indian ridge respectively. This basin is situated at the Saucer-shape ridge of the Atlantic-Indian ridge. The average depth is 3,600m. Other important basins are Atlantic-Indian-Antarctic, Somalia and Mascarene, Madagascar basins in the Western Part of the Indian Ocean.

The West Australian basin, is the most extensive basin and the shape is rectangular. It is surrounded by Ninety East Ridge in the west, Broken plateau in the south, continental shelves of Java- Sumatra in the northeast and the continental shelf of west Australia. The average depth varies from 3,600m to 6,100m, but the central part of the basin is 6,459m deep. This area of Australia has the largest reserve of natural gas.

Continental Shelves
Between the Republic of South Africa and Mozambique the continental shelf is abnormally narrow (<10kms) except for Agulhas Bank, which is immediately south of the Cape, where the shelf extends 200kms from the coast. Even continental shelf off Kenya is very narrow.

In the North Somali basin the normal shelf, slope and rise sequence is found. Although the shelf is unusually narrow (10-20 km). Sediment
accumulation is less than 2kms, and is confined by the Chain Ridge, which is the southern half of the Owen Fracture Zone (OFZ). The bottom gradients indicate that they come from north, and suggest that they may have originated from the Arabian region before the formation of the Gulf of Aden.\textsuperscript{17} The morphology and geophysical characteristics of the Arabian continental margins are similar to the North Somali Basin. The Owen fractures Zone (OFZ) lies 200km off the coast. The whole belt including Persian Gulf covered with thick sediments. The petrographic structure consist petroleum and natural gas bearing rocks. Such structure extend up to Somali basin.

The continental shelf, from Karachi to Mumbai extends 200kms seaward, the basement, under the ocean is covered by 5.8kms thick sediments. A sedimentary cone, which from 2.5 to 5kms has been found over the Arabian Basin, north and east of the Carlsberg Ridge. These sediments, from the Himalayan erosion, carried by the turbidity transport via the Indus canyons. In contrast to the western side, the continental shelf east of India is very narrow and is cut by numerous canyons. The principal canyons are: Ganga, Mahanadi, Godavari, Krishna, Pondichery, Trincomalee etc.

The Arakan Coast, with its numerous estuaries and inlets extending from a broad submarine shelf, is an excellent instance of an area that has undergone sub-recent depression. Similarly, it appears that the whole of the Malaya region, which was once a continuous stretch of land from Assam to

Indonesia, has been converted into a chain of islands and peninsula or a rise in sea level during the Miocene period, Himalayan formation.\textsuperscript{18}

All the eastern ends of the Indonesian islands are, the Timor trough separates the arc complex from the continental shelf north of Australia. The Sahul shelf is abnormally wide (400km) and consists of a central basin that is surrounded by broad shallow rise. In the West Australian sector, the broad continental shelf extends southward to 21°S. Between Northwest Cape and Perth, the shelf is narrow. The Naturalistic plateau, which lies off Southwest Australia, is a continuous extension of the continent. Here probably the situation was same as the Coromandel Coast and island of Sri Lanka. The South Coast of Australia lies close to and parallel to the Diamantina Fracture Zone. The eastern end of the fracture zone is not well defined. South of Perth and southwest of Adilaide has a normal transition from continental to oceanic structure which shows broader continental shelf.\textsuperscript{19}

\textbf{Abyssal Plain.}

The surface is of very low relief that characterises some of deep ocean basin floors. The deep sea plain covers the major portion of sea relief between the depth of 2,000-600m.\textsuperscript{20} But the most important characteristics of the deep sea plain are covered with various oozes and pelagic deposits. It is particularly free from the deposition made by the agents of erosion. The deep sea floor covers

\textsuperscript{20} Cotter, \textit{The Physical Geography of the Oceans, op. cit.}, pp.30-36.
49.3 percent area of the Indian Ocean. But there are only two well defined deep sea plains, (a) the Ceylon abyssal plain in the northeastern part and (b) Somali abyssal Plain, just north of the Somali Basin, in the northwestern region of the Indian ocean.

**Sediments of the Indian Ocean.**

Ocean deposits are the source of vast organic and inorganic minerals in one hand, and help to know the history of climate and glaciation for 200 million years of the earth on the other. However, by reason of its positions in latitude, the depositions of the Indian Ocean are mainly those of the warm seas. About 80 percent area of the Indian Ocean covers with the pelagic deposit of which Red clay covers 25 percent of the total area. It is found in the deep parts of the eastern region between $10^\circ$N and $40^\circ$S off shore from the continents and archipelagos.

The calcareous and globigerina ooze covers 54 percent of the bottom. In some places there are found, mixed with these two principal types, siliceous radiolaria and calcareous, but these are in the north of $40^\circ$S. The western half of the Indian ocean and the Bay of Bengal area covered with the calcareous and globigerina ooze. In the South of $40^\circ$S major part covers with diatom ooze.

In the bottom of the Bay of Bengal and the Arabian Sea, related to the great rivers of India, vast terrigenous deposits burying the structure relief. The terrigenous sediments, have derived from erosion of the Himalayan mountain chain extend to the Arabian basin and Central Indian basin. These two areas
contain about 40 percent of the sediment of the Indian Ocean and the thickness is 72km.

Geological and physiographical environments assume a prominent role in the economic development of any geographical unit. A brief overview of some of the other natural factors affecting the present and potential economies of the Indian Ocean Rim region is essential. These include climate, natural vegetation, soil and energy and mineral resources. The littoral and islands countries of the region are the sub units of the ancient Gondwanaland. Generalizing about the areas of three continents, islands and ocean are a hazardous undertaking. Hence the bulk of this study is devoted to analyses of Indian Ocean Rim region and sub-regions.

The Physical Environment of Littoral and Islands of Africa: Structure and Configuration

The structure and relief of Africa, are the simplest form. The greater part consists of a plateau of marked geological stability, whose foundation of ancient Archaean rocks has resisted compressional and tensional movements of the earth crust. Within the limits of the plateau there is an absence of recent folded mountain system by the compressional force. The Archaean base is exposed at the surface in the whole region from South Africa to southern Egypt. No fossils have been discovered in these ancient systems. They have great mineral bearing importance, especially, coppers, uranium, gold and diamond. From the Devonian age onwards the sea has advanced over the
continental margins. On the floor of the submerged margins limestones were deposited and now, unsubmerged and exposed. They bear witness to the marine invasion. Continuing the geological sequence, the carboniferous system contains very extensive land deposits, especially the lower Karroo beds in the Union of South Africa. Outside the Union, similar coal bearing beds occurs in Tanzania and Mozambique. At the close of Triassic times the sea reached the East African littoral, as indicated by the occurrence of Jurassic marine beds on the coasts of Tanzania, Kenya and Somalia and western part of Madagascar (Fig. 1.d).

Fig. 1.d. Rocks of African sub-region

The Littoral countries of Africa and Islands countries have distinctive geographical features. Political frontiers usually bear little relationship to
geographical realities and for this reason political units generally provide very unsatisfactory bases for geographical division. Hence the whole area has been divided into small regions.

The sub-continental peninsula of South Africa, where the area of Mozambique, south of Zambezei river included due to structural and geographical similarities. However, structurally this region can be divided into two parts.

(a) The northern plateau, without folded mountain ranges, where the Archaean platform of the continent is widely exposed. The rocks of this area consist of quartzite, schists, sandstones and shales. It comprises the northern and central districts of the Transvaal, Bechuanaland and neighboring parts of the Cape Province.

(b) The Southern plateau of greater elevation, together with a marginal belt of folded mountain ranges, occupying the southern district of Transvaal, Natal, Basutoland, Orange Free State and the greater part of the Cape province. In this area Archaean rocks over by the Paleozoic sediments. It includes Karroo beds of sandstones, shales and coal measures. (Fig.1.e).

![Fig.1.e. Geological Structure of South Africa](image-url)
The Karroo beds are the thickest in the south and east; farther north along the border of Zimbabwe, they are thinner or have been entirely worn off the underlying and now exposed Archaean core. Towards the close of the deposition of the Karroo series, in the early Triassic time, crustal folding directed mainly from the south, produced the Cape Ranges, of which Zwartebergen and Langebergen are the most prominent remnants. After this folding, igneous activity was widespread over the plateau and lava floods poured out over large areas in the eastern and east-central districts and northern parts of south West Africa.

The most spectacular structural features of South Africa are the Great-Escarpment which encloses the interior plateau at distances between 50 and 250 miles from the coast. The Escarpment is the highest in the Darkensberg of Natal, south of Zambezi. From the south western end of the Darkensberg, the escarpment has a westerly trend for about 400 miles and known under a succession of local names, Stormberg, Sneeuwbery, Nieuwveld Range, and Komsbery. From the latter it swings sharply to the northwest nearly parallel to the western coast of the Cape Province, and one of its local names here is the Roggeveld Range. Generally the altitude of the Escarpment on the east exceeds that on the western side of the sub-continent by 3,000 feet.

21 Ibid., p. 147
22 R.J. Harrison Church et al., Africa and the Islands (London: Longman), pp. 400-405.
24 Ibid., p. 7.
East Africa: Structure and Physiography

The Great Lakes plateau, average elevation over 3000 feet, is a region of distinctive physiography of Africa. The political units of the region are Tanzania, Kenya and Mozambique. As a detached fragment of the East African plateau, Madagascar is suitably included, but in respect to cultural life there is little connection between the great island and the continent despite its proximity at one point, of not more than 200 miles. The civilization of Madagascar owes more to Malayan and other easterly contacts than to the Negro world.

On its northern side, the boundary zone of the region is clearly indicated by the existence of two depressions of average altitude not more than 1500-2000 feet. Of these depressions, one is a part of the broad basin of the Bahr-el-Jebel in the Sudan; the other culminating in Lake Rudolf, occupies the northern third of Kenya and by reason of its low elevation, aridity and sparse population is more closely associated with Eastern Somali than with the East African plateau.25

Westwards, there is a comparatively abrupt contrast between the highlands of the western Rift Valley and the Congo Basin. The delimitation of the region on this side has both geographical and ethnological justifications.26

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25 Ibid., p.214.
Southwards, the boundary limits the border with South Africa and Mozambique. The littoral belt with which we are concerned is mainly that of Mozambique, Kenya, Tanzania, together with the neighboring islands, especially Zanzibar. This coastal zone provides the commercial and cultural contracts between the interior plateau and the outer world.

From the Ethiopian highland to the Republic of South Africa, is known as high Africa, the bulk of which is a great uplifted landmass. Steep scarps along the coasts and at regular interval inland, are typical throughout the area. The landform pattern shows signs of extreme geological youth: freshness of scarps, steepness of canyons, disturbed drainage patterns including areas of inland drainage, and lack of extensive alluvial depositional landforms. However, the landform of the interior plateau is associated with the Great Rift Valley system. It has a strong influence on land-use pattern.

The physiography of East Africa is very complicated, therefore, divided into sub-regions.

**The Coastal Low Land**

The true coastal belt is relatively a narrow plain except where it broadens in the Tana lowlands of eastern Kenya and the Rufiji lowland in central Tanzania. Many of the coastal lands are formed of coral rocks, and light sandy soils. Coconut woodlands and bush are common vegetations; mangroves swamps line the coastal creeks and river valleys; only occasionally are dense forests found.
The Eastern Lower Plateau

The low plateau varying in elevation from 300 to 2,000 feet and rising from the coastal belt, by a series of scraps belt marked at the Kenya-Uganda border. On the west, it is bounded by the plateaus and mountains associated with the Eastern Rift system, to which the outlying volcanic peaks of Mt. Kilimanjaro, Mt. Meru and the Usambara mountains belongs.

Northern half of Kenya is occupied by the low plateau, though most of the part is made of volcanic rocks. This area is a desert and supports only small nomadic population. The important tribe of this area is *Pagan Borans* and the *Somalis*.

Southern part of Kenya is dry and sparsely populated. But this area of Kenya is famous for tourist industry. The famous large game reserves, Tsavo and Amboseli of Kenya are located in this area. On the other hand, the Kenya-Tanzania border area is dominated by the Masai tribe. Though the south eastern Tanzania is a broad and flat plateau and covered with shrubs, yet this area of Tanzania is highly prone to tsetse and sparsely populated.

The Eastern Highlands and Rift Valley System

The Eastern Rift Valley may be considered as the axis of the system. About 30 to 40 but sometimes 60kms wide it is well marked in Kenya and northern Tanzania. The Valley, which is often at a very considerable elevation, is typically bordered on both sides by mountains and plateaus.
Mozambique: Structure and Physiography

Topographically, it is broadly divided into three zones

(1) the coastal belt, which is one of the largest in Africa. It covered about 42 percent area of the country, narrow in the north, it widens constantly to the south, extends for inland in the Zambezi valley, and includes most of the country south of Beira. The line of the great rift valley ends at the coast and is marked in Mozambique in the Shire Valley;
(2) a transitional zone of hills and low plateaus ranging from about 500 to 2,000 feet in elevation and covering about 29 percent area of the country; and
(3) plateau and highland regions with average elevations of 3,000 feet, composed mainly of granitic and gneissic rocks. Most of the north between the lower Zambezi, Lake Nayasa, and the coast is part of this zone.

Structurally Madagascar is the part of East Africa but ethnologically, it is a part of the Malayo- polynesian. Therefore, this island is considered separately.

This island is separated from the African coast by the 250 to 500 miles wide Mozambique Channel. The total area is 2,277,736 square miles and it is the fourth largest island of the world. The geology of Madagascar determined the largest topographic regions. It divides the island into two main zones, highland region composed largely of Archaean granites, and the western plain of almost undisturbed sedimentary rocks, dipping gentle towards the Mozambique channel and covering around 25 percent area. From the topographic standpoint, the dominant feature is the great central highland.

Horn of Africa: Structure and Physiography

Under physiographic study of this section only Somalia, Djibouti and Eritrea are included. Separate attention to the high plateaux and their maritime borderlands of North East Africa (Horn of Africa) is justified mainly by the
characteristics of a civilization that is almost completely separated from the Bantu World of East and Central Africa. Ethnologically, this is the first African zone of the Indian Ocean that experienced the influence of the Semetic world. The virtual isolation from Egypt, is promoted by the forbidding ramparts of the Ethiopian massif. In the south west, the complexity of the Rift valley and specially lake Rudolf, isolated it from East African plateau. The southern zone separated from the Bantu culture and East Africa by the basin of the River Sobat and the Jubaland coast and at the same time the torrid aridity is hostile to life. The Bantu have not been entirely excluded by it, but their penetration northwards has been small. There can be no doubt that this arid depression, between the East African plateau and the Abyssinian Massifs, provides one of the most complete ethnological ‘divides’ of the entire continent.

Most of the Somalia is a low plateau, which rises gradually from the Indian Ocean. In the north, an extension of the Harar plateau runs in two ranges parallel with the Gulf of Aden coast to Cape Gardafui. Except in the north, land forms are seldom a limiting factor to their economic use. The coastal plain in the north is very narrow.

**North-East Africa: Structure and Physiography**

If a longitudinal section of the main Nile valley be taken from the foot of the Equatorial plateau (Ethiopian Massif) to the Mediterranean coast, three

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28 Ibid., p.455.
reaches, distinct in their respective gradients are apparent. The first, about 900 miles in length, extends from Bor, below Mongalla, to beyond Khartoum. This is rapid free with 1: 19000 gradients. The second reach is, from the Shabluka gorge, about 50 miles below Khartoum as far as the first cataract (immediately above Aswan). The length of this area is nearly 1,200 miles, where the bed of the river follows alternately, sandstone and crystalline rocks that provide the famous five 'cataracts' or series of rapids. The third reach is, like the first of low uninterrupted gradient, approximately 1: 14000 over a distance of about 700 miles.

The Nile enters Egypt, a little to the north of the Second Cataract, which is above Wadi Halfa. From Nag Hammadi to Cairo, the width of the cultivated land is about 10 miles, outside which there is a border of unfarmed land, sandy or stony in character. For the last 200 miles of its course, before Cairo, the Nile shows a strong tendency to hug the eastern edge of the valley floor, so that the greater part of the cultivated land is to the West.

The delta is a monotonous plain with its greatest width-155 miles between Alexandria and Port Said; and extends 100 miles form North to south. Its alluvium, includes the debris of Ethiopian basalt, with varying depth from 50 to 75 feet. Towards the seaward border, there is a considerable amount of salt marsh and a number of extensive lagoons, the Lake Menzala is a famous

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29 Ibid., p. 419.
lagoon, bounded in the east side by the Suez Canal and have an area of nearly 800 square miles.

The Middle East: Structure and Physiography

The littoral states of the Middle East make a vast geographical region, but the physiographic entities are not homogenous. They consist, in fact, a vast tract of mountain, plateau, and desert, broken intermittently by Valleys and oasis. It is against this generally harsh environment that the people of this area have had to battle throughout their long history. The struggle still goes on, with more and more land reclaimed from the hostile desert and harnessed the resources such that their achievements have become increasingly notable and numerous in recent times. (Fig.1.f)

Fig. 1.f. Geological Structure of the Middle East

The total area of Jordan is 9,7740kms² The territory west of the Jordan River (West Bank) some 5,600km² has been occupied by Israel since 1967.
but since May 1994 the Palestine National Authority (PNA) has assumed jurisdiction for civil affairs in some areas. The greater part of Jordan consists of a plateau lying some 700m to 1000m above sea level, which forms the north-western corner of the great plateau of Saudi Arabia. There are no natural topographical frontiers between Jordan and its neighbors – Syria, Iraq and Saudi Arabia. The plateau continues unbroken into all the three countries, with the artificial frontier boundaries drawn as straight lines between the defined points.\(^3^0\)

The Jordan plateau consists of a core of ancient rocks covered by layers of newer rock, chiefly limestones, lying almost horizontally. In a few places these old rocks are exposed at the surface. On its western side the plateau has been fractured and dislocated by the development of strongly marked tear faults that run from the Red Sea via the Gulf of Aqaba northwards to Lebanon and Syria. The narrow zone between the faults has sunk, to give the well known Jordan rift valley, which is bordered both on the east and west by the Dead Sea. The valley has a maximum width of 22 Kms. At its northern end it is just above sea-level, the surface of Lake Tiberias (the sea of Galilee) is 209m below sea level. The Dead Sea is 65kms long and 16km wide, the deepest part (400m below sea level) on the earth.

The physiography of Israel is complex though numbers of regions are easily distinguished.

The Coastal Plain: This plain extends from Haifa southwards to the border at Gaza, where it joins the greater plain leading to the Sinai Desert. It varies in width from a few hundred meters near Haifa to more than 25 kms at its southern extremity. It is divided by the spur of Mount Carmel near the sea into the Acre Plain, to the north and the more extensive Plain of Sharon, to the south. The coastal plain is mostly fertile. The Bay of Acre, was formerly marshland, which had to be artificially drained and reclaimed, now this area is very productive. The plain between Haifa and Jaffa, is suitable for the cultivation of citrus fruit.

The Plain of Gaza.

The Gaza plain or 'Strip', as it is better known, 45 kms long and varying in width between 5 to 8kms, is a coastal strip on the south-eastern corner of the Mediterranean, extending from Rafah in the south to Beit Hanum in the north. Its total area is 289 Km

The Negev

The Negev Desert constitutes almost half of the total area of Israel and is a Steppe and Semi-desert. It is separated from the Judaean plateau by the Wadi Beersheba. It forms an extensive triangle with its apex on the Gulf of Aqaba. The soil is formed of a mixture of sand and clay, which makes great parts of this area suitable for agriculture where irrigation is being carried out.

31 Ibid., p. 229.
The Judaean Plateau

To the South of Samaria lies Jerusalem and Hebron on the Judaean mountains. The western side of this plateau declines gently towards the coastal plain, whereas the eastern side falls abruptly into the Dead Sea. The plateau is deeply dissected by numerous small streams after heavy rainfall in winter. The limestone terrain and surface faults allow the water to seep through and reappear in the form of springs, which are the dominant factor in deciding the demographic, settlement of the population.\textsuperscript{32} The total area of Samaria and Judaean together is about 7000 kms\textsuperscript{2} of which 46 percent is suitable for agricultural production\textsuperscript{33} The Northern extension of Judaean is known as the Samaria plateau.

\textbf{Al- Jalil:}

This plateau comprises the whole of northern Israel except the narrow plain of Acre. It rises towards the extreme north where it joins the Lebanese Mountains. This area enjoys the highest annual rainfall, which ranges between 50 to 70cms and is suitable for good harvesting. The cultivable area is estimated at 51 percent and for this reason the Jewish immigrants tried during the British mandate, to concentrate their settlement in this area.\textsuperscript{34}

\textsuperscript{33} Ibid.
\textsuperscript{34} Hatem, \textit{Land of the Arabs}, \textit{op. cit.}, p.227
The Vale of Jezril and Merjlbn-Amer

Also known as vale of Esdraelon, is an irregular trough formed by subsidence along faults, with a flat floor. It runs inland from the Mediterranean to southeastwards to reach the Jordan Valley. At its western end (Mediterranean) the vale opens into the wide Bay of Acre, 25kms to 30kms in breadth. For centuries it has been a corridor of major importance linking the Mediterranean coast and Egypt with the interior of south-west, and has thus been a passage-way for ethnic, cultural and military invasions.

Arabian Peninsula: Structure and Physiography

The Arabian Peninsula includes the territories bordered by the Indian Ocean on the south, on the east by the Persian Gulf and the Gulf of Oman, while on the west by the Red Sea. The northern boundaries are made up of the deserts of both Jordan and Iraq. This Peninsula is 2000 kms long; its average width is 1125kms. Its area is larger than that of India or nearly two and a half million square kms.\textsuperscript{35}

Geologically, the peninsula can be divided into two regions, namely the Western Province (Hijaz and Asir) and the western part of the central province (Nejd), which consist of crystalline rocks; and the eastern region, which is mainly made up of sedimentary hydrocarbon strata. The sedimentary constitutes limestone and sandstone rocks. However, most of the part of this peninsula are covered with deserts. Among these are the Ad-Dahna, the

\textsuperscript{35} Ibid., p.270
Nafud and the Rub-Al-Khali. The Peninsula is tilted to the east, and the height of the mountain chains is in the west. Rainfall in the Red Sea area seems through seepage to percolate in the easterly direction, to reappear in the form of springs along the coast of the Persian Gulf.36

The Arabian plateau is corrugated with deep wadis, caused by the erosive process of rivers in the geological period. Many of these wadis are covered with layers of clay deposits left behind by the fluvial action in the past. Structurally, the Arabian peninsula is a vast platform of ancient rocks. The peninsula is divided into four main geographical divisions, which do not in every case correspond to political divisions.37

The Western Coastal Lowland:- This area is also known as Tihamah or Tihama and is about 40 miles wide. At many places it is fringed by coral reefs. A rugged mountain area rises for about 80 miles to the east of the seashore-then slopes gradually to meet the deserts of Nejd and Rub-Al-Khali. The coastal lowland is fertile, and the mountains of the western slope are terraced for retention of fertile land for agriculture. There is more rainfall than any other part of the Saudi Arabia and there is luxuriant vegetation. This coastline is about 700 miles long along the Red Sea, from Gulf of Aqaba to Asir.38 In Yemen, the Tihama coastal plain is 25 to 40 km wide.

36 Ibid.
38 Ibid.
Al-Hijaz:- The total area of this geographical region is about 1,50,000 square miles. This area extends inland from 100 to 200 miles to un-dermarcated boundary with Nejd. Dislocation of the rock strata in the west of Arabia has led to the upwelling of much lava, which has solidified into vast barren expanses known as Harras. Volcanic cones and flows are also prominent along the whole length of the western coast as far as Aden, where peaks rise more than 3000m above sea level. In this areas are Wadi's (Valleys normally dry but carrying run-off water in the rainy season) and basin where both water and fertile soil make sedentary habitation possible. The city Medina is located at an altitude of 2500 feet in the centre of an upland plain. Mecca is on the western side of the steep escarpment separating the plain of Al-Hijaz from the mountain areas and Nejd beyond.

The southern part of the Western highland is known as Asir, it comprises the highland of Yemen. This area is about 180 miles wide. In Yemen, this is the most fertile and climatically suitable for both food and commercial crops.

The Nejd Region

This is a plateau area and known as the core area of the Arabian peninsula. It has a common frontier on the north with Iraq and Jordan; on the east with Al Hasa; on the south, across the Rab-Al-Khali a boundary dispute with Yemen and Oman, on the west with Al Hijaz and Asir. The whole area is a plateau gently sloping eastwards. Within the province are stony and sandy deserts, smaller plateaus and depressions. Running northeast to southwest is a major
depression, bounded by steep escarpments, which has provided a natural dividing line for the migratory. The Nejd region is considered to be the homeland of the Wahhabi sect.

**The Eastern Region:**
The Eastern region runs parallel to the Persian Gulf. The coastal area is flat, low lying and fringed with extensive reefs, which makes it difficult to approach the shore in many places. This region, formerly called al-Hasa, after the oasis of that name, with its enormous springs of water extends south ward for about 200 miles from the Neutral Zone and are jointly administered by Kuwait and Saudi Arabia. The average width is not more than 100 miles. Exceptionally, there is a hill in the southern most part (Oman), namely Jebei-Al-Akhdar (Green Mountain), formed of sedimentary rocks, gravel and sand, which are the common oil producing formations of the Middle East. The coast is low and flat with sand dunes, separating it from the desert. Another feature is the large river valleys or wadis. The largest is the Wadi Hadramawt, which runs parallel to the southern coast for several hundred kms.

**Iraq: Structure and Physiography**
The old name of Iraq is Mesopotamia. It means, the land between the rivers. At the lower course the Tigris and Euphrates merge, and known as Shatt-Al Arab. Most of the part of Iraq, especially, the Euphrates and Tigris river valleys are situated between two highland areas in the north and north-eastern part

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39 Ibid.
are the Turkish high land and Iranian highland respectively, and in the western side is the Arabian highland. The main physiographic divisions are:

**The Eastern Mountain Belt**

On the eastern side of the double valley, the Zagros mountains appear as an abrupt wall, hanging the riverine lowlands, particularly in the south below Baghdad. North of Baghdad the height of the mountain is more gradual. The area, lying north and east of Baghdad, is the ancient land of Assyria. Nowadays the higher hill ranges lying in the extreme east are known as Iraqi Kurdistan.

This crescent mountain belt is drained by the Diyala, the greater and the lesser Zab rivers and the tributaries of the Tigris. Since the building of the Darbandi Khan dam on the Diyala river, this has emerged as the largest fruit growing area in Iraq.

**The Western Plateau Region**

On the western side of the river valley, the land rises gradually to form the plateau, which continues into Syria, Jordan and Saudi Arabia, and its maximum height in Iraq is about 1000m. This plateau is also known as Romadi region. South of Romadi, 5 kms from the Euphrates, there is a Habbaniya Depression, about 24 kms long and 12 kms wide. This depression is used as a water reservoir for irrigation.

**The Shatt-al-Arab**

It is made of delta in the Persian Gulf created by the Tigris and Euphrates rivers and is situated 47 miles north of Basra. The confluence of both rivers is
at Qurna and the mouth is at Faw, in the Persian Gulf. The Shatt-al-Arab at Qurna is 185kms (136miles) from the sea. Its width varies from ¼th to 1/3rd miles. It constitutes the only maritime outlet of Iraq. It is the waterway connecting Iraq to the Gulf and beyond it, the Indian Ocean. Consequently, this region is vital for Iraq, as it links the South of the country to the north. This region is of primary importance to the country’s economy notably with regard to its privileged position in international commercial relations.\textsuperscript{40} The width at the mouth is 48kms. Over centuries it survives as the disputed waterway.\textsuperscript{41} This is the highly irrigated and fertile plain and famous for date palm orchards. Geostrategically, the Shatt-Al-Arab is like a gateway for Iraq.

**Iran: Structure and Physiography**

Iran is 16,45,000 square Km in area and extends from 25°N to 39°N and 44°E to 64°E. It is bordered by Armenia, Azerbaijan and Turkmenistan (2300km) Caspian Sea (644km) on the north, Afghanistan (850km) and Pakistan (850km) on the east, Gulf of Oman and the Persian gulf (combined frontage: 1880km) on the south and southwest and by Iraq (1280km) and Turkey (470km) on the west.\textsuperscript{42}

Iran is like a high irregular quadrangular bowl in structure, with broad high mountains, the Zagros, along its western and south western rim. The Elburz, high and narrow mountains, extend across its north central side, and

\textsuperscript{41} R. C. Sharma (ed.), *Perspective on Iran-Iraq Conflicts* (New Delhi: Rajesh Publications, 1984), pp.5-9.
lower, broken uplands form its eastern periphery. However, the physiography of Iran is in the following divisions.

**The Mountainous Region**

The western and south western parts of Iran and also northern part are guarded by the high young fold mountains.

In Azerbaijan, the Zagros mountain is a rolling plateau, form largely of bare stones. Numerous streams have eroded the plateau and formed gorges. The main drainage basin is that of Aras, which formed the boundary between Azerbaijan and Iran and drain into the Caspian Sea. The Rizaiyya basin is bounded by mountains and plateau in the south. Azerbaijan is an important farming area, although much of the area is rugged land, but many valleys have fertile soil. The rainfall of this area is adequate. The Zagros mountain properly begins in the vicinity of Hamadan and Kirmanshah.\(^4^3\)

**The Elburz Mountain Region**

In the northern boundary, there is an arch shaped Elburz mountain. The western part of the Elburz is known as Talish mountain. The Talish hills run 175km southeast along the southwestern Caspian coast. Much of this range rises to over 2100 meters. Numerous streams fed by abundant rainfall have cut riverines through hills on their way to the Caspian sea. In the northeastern side of the Talish is a Kangan rud, a fertile valley. The northwestern slope of this mountain is covered with thick woodland.

\(^{43}\) Ibid.
The Caspian Lowland

North of Elburz is the Caspian lowland, also known as the Mazandran plain. It is 650km long and 25 to 35km wide, although foothills come close to the sea at places. From the shore to the mountains are sand dunes, some lagoons and marshes. The Caspian plain is hot, humid, and quite rainy. It has extensive vegetation and is heavily cultivated. This plain is drained by the Gurgan river. The Atrak river forms the boundary between Iran and Turkmenistan. This area has the largest petroleum and natural gas reserve of Iran.

Elburz Piedmont

South of the Elburz is a piedmont zone where Tehran is located. The slope of the piedmont is towards the inner plateau region. This is the dry region. The largest basin, the Dasnt-I-kavir (a Kavir is a tract of viscous, salty slaine or mud) lies southeast of the Elburz. In this area there are deep channels of salty flowing mud that are treacherous because they are covered by a hard crust of salt. In the north west salt domes are very common44 Dasht-I- Lut is located southeast of the Dasht-I-Kavir.

Most of the part of Iran is very rugged but in the southeastern part, on border of Afghanistan is a Sistan basin, although only one ninth of this basin lies within Iran. This lowland receives the drainage of the silt laden water that flows from the mountain of Afghanistan, after the thaw of snow in the spring.

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44 Ibid., p. 550.
The main feeding river is the Helmand, which drain to the Helmand lake. The Sistan basin is an important area for farming, especially fruits and pasturage. This area is known as the paradise of Iran. In the historical period the ruling families of Iran usually came to Sistan in spring season for entertainment. It is the most attractive tourist place of Iran.

**Pakistan: Structure and Physiography**

Pakistan is situated to the north-west of India. It is bordered on the west by Iran, on the northwest by Afghanistan, on the east by India, and on the south by the Arabian Sea. It lies approximately between latitudes 24° and 36°N and 61° and 75°E. It has an area of about 803928 sq. km.

Pakistan is mountainous in the north, where the Hindu Kush rises to 7639 meters in Tirich Mir. In the west, there are Sulaiman, Kirthar and other ranges. The heart of the country is the fertile plain and drained by the Indus, and its large tributaries- the Jhelum, Chenab, Ravi, Beas and Sutlej. To the east is the Thar Desert. Some portion in the South-west of the Indus basin is a semi desert merging in the Baluchi hills, which attain a height of nearly 3350 meters. Near Quetta on the south towards the Arabian Sea lies the Makran Coast. However the major physical divisions are (Fig.1.g)

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The Northern and Western Hills Region

This is the rugged fringe of Afghanistan. In the north is the great wall of the Hindu Kush. The routes through the Khyber area, which converge on the vale of Peshawar, were the principal means of entry for the successive invasions from central Asia. The northwestern hills are the country of the Pathan tribes. However, this region can be divide into two parts (a) the region to the east of the Indus. It consists of a dry sandy plateau bounded by the Lesser Himalayas on the north and terminated abruptly by the Salt Range, which overlooks the fertile Punjab plain on the south. Almost in the centre lies the little oilfield of Khaur with that of Dhulian nearby, (b) The Trans-Indus tract between the Indus and the hills of the frontier, consists of a series of three plains- Peshwar, Bannu and Dera Ismail Khan. These plains are separated from one another by the low hills and offshoots of the frontier ranges. The vale of Peshawar is extensively irrigated and well wooded. This vale is drained by the Swat, a tributary by Kabul river. The northern part of Peshawar is irrigated from the
water of Swat, brought from the upper reaches of the Swat through a tunnel under the Malakhand pass.

**Plateau of Baluchistan**

Physiographically, Baluchistan comprises an arid plateau surrounded by a ring of mountains and forming a region of inland drainage. The plateau of Baluchistan varies from 1000 to 3000 feet above sea level; most of the surrounding mountains reach over 6000 feet. Most of the area is a barren mountain, deserts and stony plains. The Sui gas field is in Baluchistan. In terms of minerals this is the richest geographic region of Pakistan (chapter II).

South of the Makran Range, is the Makran Coastal area. This area provides a way into the Indus lowland from the west. The longitudinal valleys that run parallel with it and unto about 100 miles inland, are suitable for farming and grazing. This is the route for Alexander the Great as his army withdrew from India along this Makran routes, in the August of 325 B.C. In the eighth century A.D. the first muslim invaders of India used the same route. Recently, Pakistan has developed the Gwadar Naval port in the Makran coast (Chapter VI).

**The Lower Indus Valley**

The lower Indus valley is a plain about 100km wide and 400km long, bordered on the east by the Thar Desert and on the west by the Kirthar and other ranges. Most of the ground to the east of the present course of the Indus is

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Khadar. To the west, most of the land is bhangar. Running through the centre of the plain, is its life and soul, the Indus river. Just as Egypt is the 'Gift of the Nile' so may Sindh be described as the 'Gift of the Indus'.  

Some distance below the point where the Indus leaves the Punjab. It flows through a rocky gorge, which separates the Punjab plains from the plains of Sindh. The west Nara, a distributary that takes off from the Indus below Sukkur, might once have been the main river channel. In early times the east Nara was probably the lower course of the Saraswati. The areas along the Indus are irrigated land. Away from the irrigated land, Sindh is a lonely barren desert.

The Punjab Plain proper

The Punjab plains are really the valley plains of the five rivers- Jhelum, Chenab, Ravi, Beas and Sutlej. Between the rivers, there is usually a flat, alluvial plain. On the northwest of the Punjab plain the height abruptly increases because of the Salt range. In the north and northeast the plain is bordered by the Himalayas.

India: Structure and Physiography

India is one of the oldest civilizations, with a Kaleidoscopic variety and rich cultural heritage. It covers an area of 32,87,263 km$^2$. Lying entirely in the northern hemisphere, the mainland extends between 8°4′ N to 37°6 N and 68°N E to 97°25′E and measures about 3214 km from north to south between

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47 Ibid., p.289.
the extreme latitudes and about 2933km from east to west between the extreme longitudes. It has a land frontier of about 15200km. The total length of the coastline of the mainland including Lakshadweep and Andaman and Nicobér islands is 7,516.6km\textsuperscript{49}

As the seventh largest country in the world and with the boundary fixed with mountain and sea, it gets a distinctive geographical entity. It is bounded by the great Himalayas in the north and it tapers off into the Indian Ocean between the Bay of Bengal and the Arabian Sea in the east and west respectively.

Countries having common border with India are Afghanistan and Pakistan to the northwest, China, Bhutan and Nepal to the north, Myanmar to the east and Bangladesh to the east of West Bengal. Sri Lanka is separated from India by a narrow channel of sea formed by the Palk Strait and the Gulf of Mannar.

All kinds of geological formations from pre-Cambrian to recent alluviums are found. There are well defined geological provinces, especially in the Peninsular India. Most of the rocks of this part belong to the Archaean, Dharwarian, Cuddapha, Vindhyan and Gondwana systems. These are the major sources of metallic, non-metallic and fossil fuels (coal). Though from the Jurassic period, several parts of the peninsula viz the coasts, and the low lying flat regions of the interior, like Saurashtra, large part of Rajasthan extending

northwards to the Salt range and Assam are covered with marine transgressional deposits. On the other hand the Himalayas and the Indo-Gangatic plains formed in the recent geological period.

The Himalayas are the backbone not only for the Indian economy, but also for the whole South Asian region. It extends from the Indus in the west to the Brahmaputra in the east. They form an arc between these two extremes, covering distance of 2500km. The width of the Himalayas varies from 400 km in the west to 150km in the east. The height of the eastern half is greater than the western half.

The Himalaya was formed from the folding of the tethys sediments, by the compressional forces, due to the convergence of the Gondwanaland and Eurasian palates under the Indus Tsangpo Suture Zone (ITSZ). The suture zone is important in recording older plate movements in the geological record of the continents. At its western end, the suture is terminated be a large strike slip fault, the Quetta- chaman fault, which continues into the Indian Ocean as the Owen transform fault. West of this fault lies the Arabian plate. At the southern end of the suture zone at Namcha Barwa, the plate boundary runs southwards along a large strike slip fault, which continues through Burma to connect with the Indonesian subduction zone. This fault also continues into the Indian Ocean as the large inactive Ninety-East ridge transform. The Indian

Ibid.
plate, therefore, may be regarded as a two pronged wedge that has driven northwards into the Eurasian plate between two large transform faults.

This mighty range of mountains exercises a dominating influence over the meteorological conditions of India. Its high snowy ranges have a moderating influence on the temperature and humidity of north India. Glaciers of enormous magnitude are nourished on the higher ranges by this precipitation, which together with the abundant rainfall of the lower ranges, feed a number of rivers, which courses down to the plains in hundred of fertilizing streams. Geostrategically the Himalaya has been playing a vital role (Fig. 1.h).

![Fig. 1.h Physical Features of India](image-url)
The great plain of India occupies the space between the peninsula and the northern mountains. This initial depression is believed to be a 'foredeep' formed in the wake of the Himalayan uplift. It was perhaps created as a result of the subsidence of the northern flank of the plateau in its marginal process of mountain building. The plain extends for 3200km between the mouth of the Indus and the Ganga, with a width from 150 to 300km. Being the largest alluvial plain of the world, about 60 percent population of India have been residing in this region. Geographically it covers about 40 percent area of the country. It is the richest agricultural belt of the world with very large crop diversification. The agricultural economy of this plain is the backbone for the economic development of the country.

The Geological structure of the Deccan peninsula forms a single block. This Deccan shield is a rigid block and is not immune from fractures or faults. Several prominent lines of faulting traverse it, due to tensional stresses, as against compressional forces. This has caused uplift or subsidence of the blocks. The western flank of the plateau subsided, resulting into a landward advance of the Indian Ocean. This subsided portion of the plateau is occupied by an expansion of the Arabian Sea. The foundering of this flank has given rise to the Western Ghat. At a time when the Himalayan ranges were being uplifted in the cretaceous period, in the northwestern part of the plateau there was an extensive volcanic eruption through fissure and Deccan lava trap was

formed, which produced black soil, suitable for cotton and sugar cane production. The southern plateau mainly consists of Archaean and Dharwarian rocks and most of the metallic minerals are associated with them. Where as the Vindhyan-Kaimur Range, between the Valleys of the Narmada and Son, is the major source of diamond, Limestone, Sandstone and ornamental stones.

However, in the eastern part of the Peninsula, is the Chottanagpur plateau. The Damodar river valley and the adjoining areas consist of Gondwana system rocks, famous for coal. Singhbhum district and the surrounding area of Orissa and West Bengal produce iron-ore, manganese, copper, uranium and other metallic minerals. The Chottanagpur region is known as store house of minerals in the world. Most of the Iron and steel industries and other allied industries are in this area. This region has emerged as the largest industrial region of India. The prosperity of India depends on this geographical region. Either directly or indirectly, FDI in India has been regulated from the resources of this region. The resources and the manufactured goods of the Chotanagpur have a significant role in the magnitude and direction of Indian trade.

The coastline of India is comparatively uniform and regular, and is broken by few indentations. For the greater part of its length a sandy and gently shelving coast strip is washed by a shallow sea. The western sea board has, however, a number of shallow lagoons and backwaters, which constitute an important topographic feature of these coasts. The eastern coastal line has
many deltas and wider fertile plain. There are chains of cities and ports in this coastal area. They geographically linked India with the world, especially Indian Ocean Rim countries.

**Myanmar**

The country as a whole is cut off by mountain barriers and difficult hills from its neighbors and so is remarkably isolated. It is geographically part of Indo-China rather than India and for French Known an 'Indo-China anglais' 54. It stretches from 9° 55' to about 28° 30'N and from 92° 10' to 101° 9' E. It thus has extreme length form north to south of about 1200 miles and an extreme width of 575 miles. The total area is 677980 km². However, Myanmar falls naturally into three great geomorphological units:

**The Arakan Yoma,** is a great series of fold ranges of Alpine age, which forms the barrier between Burma and India. The foot hills of the Arakan Yoma stretch as far as the shores of the Bay of Bengal. The Arakan coast is of the Pacific type. It has considerable coastal plain, some part cover with mangroves swamps. There are number of large islands such as Ramree Island. In this area Akyab and Kyaukpyu are famous ports. These ports are the terminal points between the Indian Ocean and the South China Sea.

**The central basin,** lies between the Arakan Yoma and the Shan plateau. Formally a gulf of the early Tertiary sea, it open to the south. It is now occupied by a great spread of tertiary rocks. The Pegu Yoma is the most

54 Stamp, *Asia: A Regional and Economic Geography, op. cit.,* p.387
important hill of this area – running from north to south. This hill separates the Irrawaddy Valley from the Sittang valley. This hilly area is the major petroleum producing belt of Myanmar. The most important oil fields of this area are Indaw, Singu, Yenangyaung and Minu. L.D. Stamp, in his book ‘Asia: A Regional and Economic geography’ has shown the structural unity of eastern India (Assam valley), the oilfields with the oil fields of Myanmar in a geosynclinal form (Fig. 1.i).

Fig. 1.i. The Structure of Eastern India & Myanmar, showing the relation of the Oil belts of Myanmar

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55 The structural units in eastern India and Myanmar showing the relation of the oil bets of Myanmar and Assam to the geosynclinal areas of early Tertiary times, quoted in Stamp, Asia: A Regional and Economic Geography, op.cit., p. 388.
The Shan plateau massif, occupies the whole of the east of the country and extends southwards into Tenasserim. The average height of the plateau is 3000 feet, but its surface has been much dissected and running through the centre from north to south is the deep trough occupied by the Salween River. The predominant rocks in the Shan plateau are gneiss— which yields the rubbies and other gemstones for which Myanmar has so long been famous. At Bawdin, associated with a group of ancient volcanic rocks, are very extensive deposits of silver-lead ore.

Tenasserim forms a continuation of the tin-bearing belt of Malaysia and large quantities of tin and tungsten are obtained. Geologically this portion of mountainous belt consists of large granitic intrusions, elongated in the north-south direction.

Thailand

Thailand is the only country in Southeast Asia, which was not occupied by any western colonial power. As a matter of fact, its location between the British colony of Myanmar to the west and Malaysia to the south and the French colony of Indochina to the east, gave it a buffer status whereby both the European superpowers made a tacit agreement not to occupy Thailand. Thailand, thus, remained a buffer state with sovereign status throughout the colonial era. Thailand has an area of some 514000 km$^2$ made up of river plains, plateaus and forested mountains. Thailand is located between $5^\circ30'$ to

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20°N 97°30' to 105°30' E. \(^5^7\) It is about 1600 km long. The country can be said to be at the centre of mainland south-east Asia. Its coastline extends for some 1200 miles around the Gulf of Thailand and 120 miles stretch of coast along the Indian Ocean.

**Malaysia**

Malaysia covers on area of about 130,000 square miles. It occupies two main regions. The first is the Malaya peninsula, extending south east from the narrow isthmus of Kara to the strait of Johore, and including islands of Penang and Langkawi on the west and a number of small islands to the east. The second is the East Malaysia. The northwestern coastal area of island of Borneo with some associated off shore islands, known as East Malaysia. These two regions are separated by, about 400 miles of the South China Sea. The position of this peninsula is important in the world. It lies at meeting place of the continent and insular parts of the region on the one hand and the Indian Ocean and the South China Sea on the other. These facts contributed to its commercial importance. Malacca, in particular, gained a great deal from this advantageous position. The latitudinal extension is from the island of Singapore (1°20'N) to a point to the north in 6°40'N.

**Australia: Structure and Physiography**

In Australia we find a remarkable unity in most of the geographical features. The dominant structure is the *Ancient Shield* of western and central Australia.

It has the similar geological features as Africa and peninsular India. There are in Australia no young fold mountains, active volcanoes, great ice fields, fault-scraps, etc., However, sharp folding and faulting, which produce the most marked topographic features. In the western half there is an arid peneplain of more than 1 million square miles. While the eastern peneplain was elevated differently as a series of warps and horsts along the coast (Taylor)\textsuperscript{58}

The distribution of the major economic resources of Australia is closely linked to the Palaeogeography. The geological rigidity of the Australian landmass did not lead to the alternation of rock structures (Fig.1.j).

\textsuperscript{58} G. Taylor, \textit{Australia: A Study of Warm Environment and Their Effect on British Settlement} (London: Methuen & Co. Ltd., 1940), p. 45.
extent to that of shield. However, in recent times large gas fields are discovered in Australia (see Chapter II); all are associated with the marine deposits of the continental shelves and slopes.

The physiography of the IOR region is much diversified. All kinds of resources that are associated occur with the physiographic structures. Without geographical knowledge, it is very difficult to know the spatial distribution of resources. Resources are very localized and associated with some specific physical structure. Similarly economic development and trade are directly derived by the resource factor. Geopolitically, the Indian Ocean region is very sensitive. The reasons behind the sensitiveness are the geographic location and richness of resources.