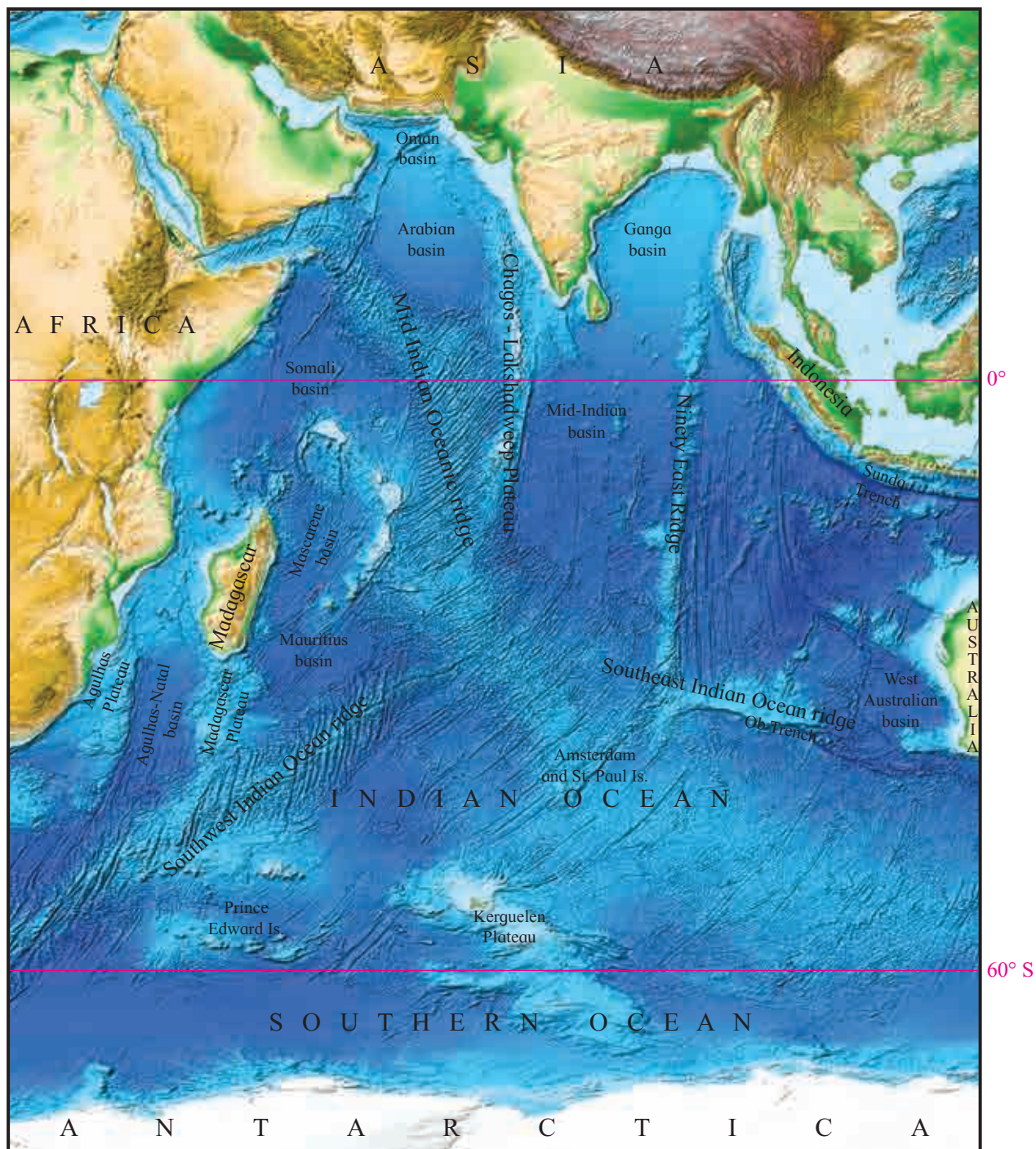


## 7. Indian Ocean - Relief and Strategic Importance



Make friends with maps!

Look at figure 7.1 and answer the following questions :



**Fig. 7.1 : Image showing relief of Indian Ocean floor**

- 1) What does this map show?
- 2) Which continents and sub-continents are visible in this map?
- 3) What lies between the continents?

- 4) Chagos Plateau, Sunda Trench, Central Mountain range are a part of what?
- 5) What are the conclusions you can draw after looking at the map?

### Geographical explanation

The Indian Ocean is the 3rd largest ocean in the world after Pacific and the Atlantic Ocean. It is the only ocean in the world named after a particular country i.e. India. About 20 percent of the total oceanic area is occupied by the Indian Ocean. A part of the Indian Ocean is located in the southern hemisphere. Indian Ocean spreads between Africa in the west, Asia in the north and east, Australia in the east, and Southern Ocean in the south. Look at figure 7.2 the areal extend of the oceans is given in the table. Note that unlike Pacific and Atlantic Ocean, the Indian Ocean does not extend northwards to the Arctic Ocean. This situation has resulted in complete blockage of the Indian Ocean towards its north. This peculiar arrangement of the ocean and the continental portion contributes a lot to the development of monsoon climate of the Indian subcontinent.

Ocean	Area in sq. km.
Pacific	166,240,977
Atlantic	86,557,402
Indian	73,426,163
Southern	20,327,000
Arctic	13,224,479

### Bottom relief of Indian Ocean :

The floor of Indian Ocean exhibits complex and varied features like continental shelf, mid-oceanic ridges, ocean basins, oceanic deeps, islands etc. These features are formed by tectonic, volcanic and denudation processes. These processes operate in the same manner as like that on the continents. The average depth of the Indian Ocean is 4000 m. It also has a few marginal seas.

### Continental Shelf :

It is a portion of continents, submerged under oceanic water. It is normally occupied by different gulfs, seas, bays and straits. There is a wide range of variation in the continental shelves of Indian Ocean. Quite extensive shelves are found along the Indian coasts. The Eastern coast of Africa and Madagascar record relatively narrow width of continental shelves and along the Indonesian coast, it is very narrow (160 km). The continental shelves are very wide in the west side of India whereas these are narrow along the eastern coast. Continental shelves are veneered with deposits brought down by terrestrial agents of erosion. Some of the sedimentary deposits, received over thousand years. As they remain deposited for a long time, sedimentary rocks are formed. Some of them are a potential source of fossil fuel.



### Let's recall.

Name the fossil fuels.

### Mid-oceanic ridges :

Mid oceanic ridges are submerged mountain ranges that separate deep portions of the sea (ocean) floor. In Indian Ocean also has a Mid Oceanic ridge called as a Mid Indian Oceanic ridge. It originates from Gulf of Eden near the Peninsula of Somalia. Further it extending toward the south and at east side of Madagascar it divided into two branches Among these, one branch diverts towards southwest and extends up to Prince Edward Island. It is known as Southwest Indian Ocean ridge. Second branch extends southeast up to Amsterdam and St. Paul Island. Mid Indian Oceanic ridge has many parallel ridges. This ridge is not continuous due to many fracture zones in it. Such as Owen fracture zone, Amsterdam fracture zone, etc.

A part from it in south Indian Ocean there is Kerguelen Plateau, in south side of Madagascar



is Madagascar Plateau and in south side of Africa is Agulhas Plateau.

In the west of India in Indian Ocean lie a Chagos Plateau, which extends up to Mid Indian Ocean ridge. There are many archipelagos and islands in this part of Indian Ocean such as Lakshadweep, Maldives, Diego Garcia etc.

In the eastern Indian Ocean (Bay of Bengal) there is a long north-south extending range, called as Ninety East Ridge. It originates from the west of Andaman and Nicobar Island and extends south ward up to eastern part of Amsterdam and St. Paul Island.



### Find out !

Why Ninety East ridge name has been given to this ridge?

### Islands of Indian Ocean :

In this section we shall consider mostly the deep sea islands and not the coastal islands. Besides the large islands like Australia, Madagascar and Sri Lanka there are a large number of islands are located in the Indian Ocean. These can be grouped as islands of

- 1) Arabian Sea
- 2) Along Bay of Bengal
- 3) Australian Coast
- 4) Islands near Antarctica

**1) Islands in the Arabian Sea :** In Arabian sea one can identify two subgroups such as those closer to African Coast and the ones along central ridge i.e. Lakshadweep - Chagos Ridge. Amongst those closer to African Coast, Madagascar is the largest island. It has an area of 5.9 lakh sq. km. It believed by most of the geologists that Madagascar was a part of African Continent in geological past. It has under gone two separations such as first separation from Africa and later from the Indo-Australian plate. It is one of the seismologically active

provinces. There are number of islands between Madagascar and the eastern coast of Africa. Noteworthy amongst them are Comoros, Bassas de India, Europa Island. To the east of Madagascar lie islands like Reunion, Mauritius and Seychelles. In the north, close to African Horn lies island of Socotra. All these islands are to the West of Mid Indian Ocean Ridge. Those forming a group of islands along Lakshadweep - Chagos Ridge are Lakshadweep, Maldives, Chagos. Most of these are in the form of archipelagos formed by coral atolls.

Besides these island there are a few islands like Bundle Island near the coast of Pakistan and a few island such as the Kish, Hendorabi, Lavan, Siri, etc. are found along the Persian Gulf part of Iran.

**2) Islands of Bay of Bengal :** The largest amongst this group is the Sri Lanka island. The islands to the east of 90°E Ridge are the group of islands like Andaman and Nicobar, a chain of islands along the western coast of Sumatra Island of Indonesia. Barring a few coral islands in Nicobar Group most of these islands are volcanic islands. All these islands are associated with the converging plate boundary. These island are the peaks of submerged mountains.

**3) Islands along Australian Coast :** There are very few islands along the western coast of Australia. Noteworthy among these are Ashmore, Christmas and Cocos (or Keeling) islands.



### Try this.

Locate these islands on the map given in figure 7.1.

### Ocean Basins :

The term ocean basins indicate deep flat areas on the ocean bottom. On a global scale,

all the major oceans are called ocean basins. Each of the oceans houses number of small ocean basins with in it. These ocean basins are terminal destinations for the sediments brought from the continents as well as those generated within the oceanic part. The Indian Ocean has ten major ocean basins.



### Try this.

Given below are names of some ocean basins in the Indian Ocean. Identify these in figure 7.1. Write a note on their locations, their separators and the rivers entering into them. Rank these according to their size on the basis of your perception.

- (1) Oman basin (2) Arabian basin
- (3) Somali basin (4) Mauritius basin
- (5) Mascarene basin (6) Agulhas-Natal basin
- (7) West Australian basin (8) Mid-Indian basin
- (9) Ganga basin

### Deeps and Trenches :

Trenches are the deepest portions in the oceans. There are very few deeps and trenches in the Indian Ocean as compared to other oceans. Most of the trenches of Indian Ocean are located towards its eastern boundary. These are located along the converging boundaries between the Indo-Australian Plate and the Pacific Plate. Most noteworthy among this are Java or Sunda Trench (7,450m deep) and Ob Trench (6,875m deep). This area is seismically active because of plate movements.

### Distribution of temperature and salinity in Indian Oceans :

The study of temperature of ocean is essential. It influences the biotic component in the oceans. It is also largely responsible for the movement in the oceanic water. Other factor besides the temperature it is salinity. The density of ocean water depended upon temperature and salinity of ocean water. The density and temperature differences cause the movements in

sea water. Let us take up the study of temperature distribution in Indian Ocean.



### Can you do it?

Study maps given in the figure 7.2 carefully. These maps are showing the portion of Indian Ocean lying north of equator. Maps in the figure depict the temperature conditions in three seasons : (a) pre SW monsoon, (b) NE monsoon (c) during SW monsoon.



Fig. 7.2

### Answer the following questions.

- 1) Why are iso therms not drawn on the continental part?
- 2) Why is the temperature in Arabian Sea lower than in Bay of Bengal?

- 3) Why is the temperature higher in southern portion of Indian Ocean during pre SW monsoon?

#### Geographical explanation

During the pre monsoon season when the summer solstice is approaching the temperatures generally increase high and much higher in the southern portion closer to the equator. Once the SW monsoon sets in the temperature pattern gets altered with lowering of temperature in the Arabian Sea area which comes under the influence of monsoonal winds. By the season of NE monsoon, when the winter solstice approaches, the temperatures get reduced. The northern parts of Bay of Bengal record temperature of the order of 24° C.

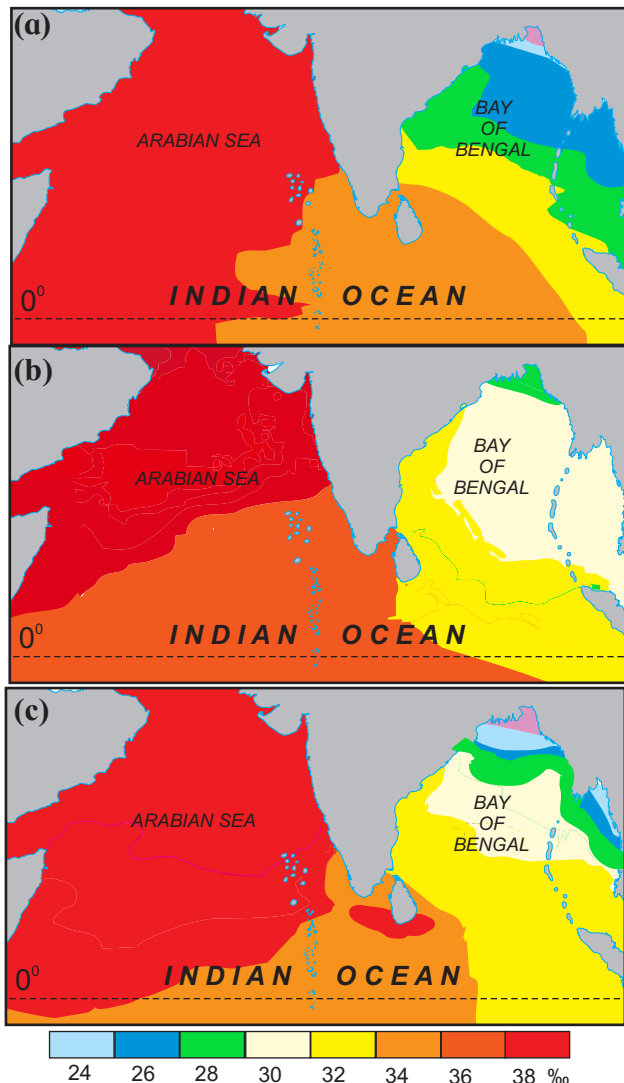


Fig. 7.3

#### Indian Ocean salinity :

The other characteristic of ocean water is salinity. Salinity is a measure of amount of salts in the sea water. It is expressed as parts per thousand (‰). Average salinity of sea water is 35‰.



#### Can you do it?

Given below are the maps depicting the salinity distribution of northern Indian Ocean. Study the maps (a) NE monsoon, (b) pre SW monsoon (c) SW monsoon given in the figure 7.3 carefully and answer the following questions.

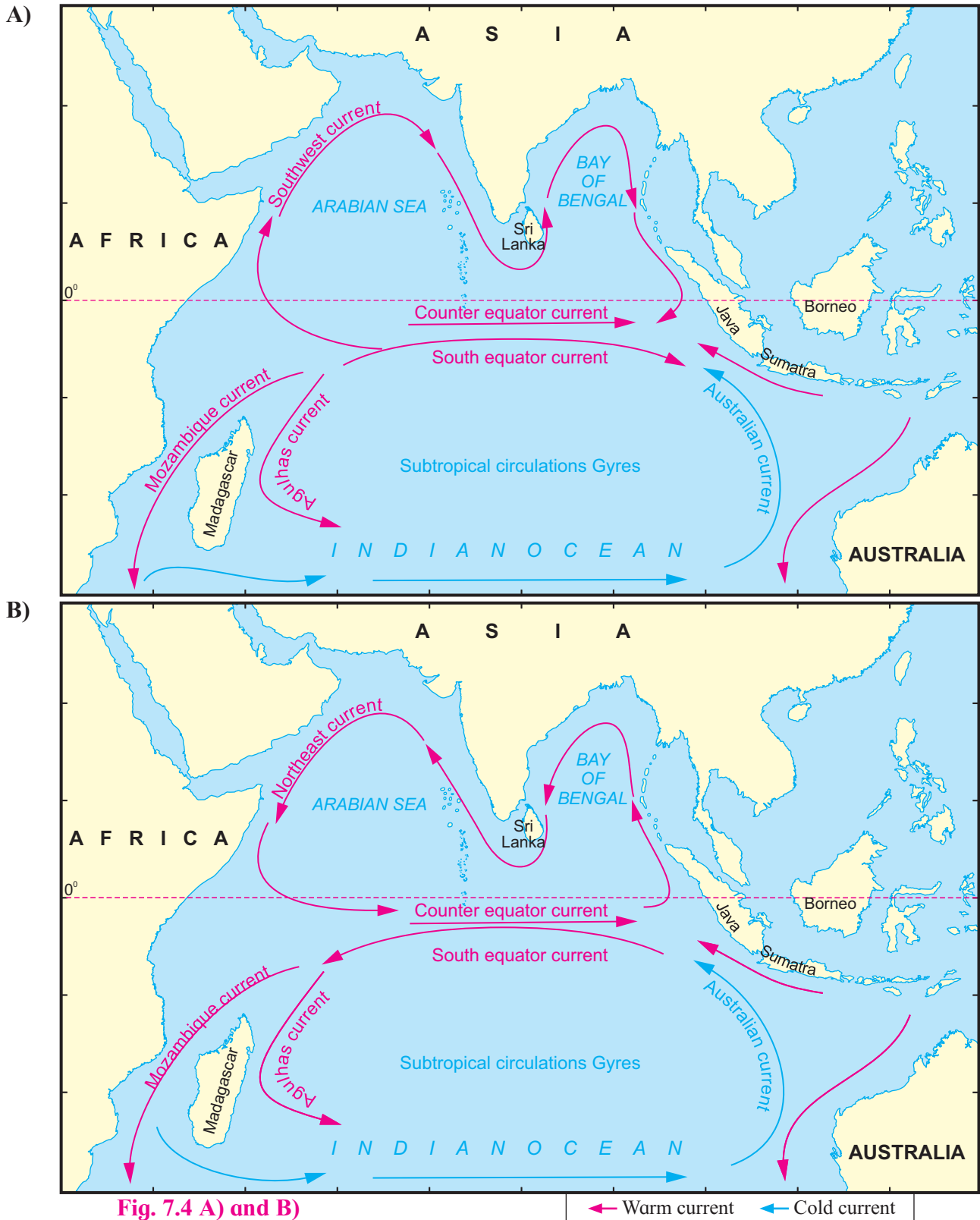
- 1) Why does the Arabian Sea records higher salinity than Bay of Bengal?
- 2) What is the minimum salinity in Bay of Bengal? In which seasons do we find it?
- 3) Account for the high salinity in Arabian Sea throughout the year?

#### Geographical explanation

You will notice that the maps showing the distribution of salinity have a peculiar pattern. The salinity is generally high around the Somali Peninsula and closer to the Saudi Arabian Coast. These are the regions having high temperature and low rainfall. Not many rivers enter in to the sea in this area. In case of Bay of Bengal huge discharges from Ganga System and also from the Peninsular rivers lead to the lowering of salinity in this area. Comparing the three maps you will notice that the salinity is less during the period of SW monsoon.

#### Ocean Currents in Indian Ocean :

The pattern of currents in Indian Ocean differs considerably from those in Pacific or Atlantic oceans. The effect of monsoon wind system is clearly seen on the currents in northern Indian Ocean.



### Do you know?

See the maps in figure 7.4 A and B. They show the pattern of ocean currents in Indian Ocean during different seasons.

Study the maps carefully and answer the following questions.

- 1) Identify the season each map is representing and name them accordingly.
- 2) What difference do you notice in the

direction of currents between winter and summer in Northern part of Indian Ocean.

- 3) How many cold currents are there in the Indian Ocean? Name them.
- 4) Why do you think the cold currents are fewer in Indian Ocean.
- 5) Which currents maintain the direction in both the season?
- 6) Can you see any circulation in the currents of Indian Ocean? What are such circulations called? If yes name the currents sequentially.

### Geographical explanation

Ocean currents are bodies of oceanic waters maintaining their separate entity. They flow across oceans under the influence of specific wind system. They perform the function of mixing of waters and transfer of heat from one part of ocean to the other. Ocean currents are classified as warm or cold currents depending on the temperature conditions of the flowing water in them.

System of ocean currents in the Indian oceans is highly influenced by shape of its coast line, its extent, and the peculiar arrangement of the wind system that prevails in the region. It has equatorial currents but the north equatorial current is weaker than the south equatorial current. North of equator the currents are influenced by the seasonally reversing monsoon wind system.

The current system in the southern part of the Indian Ocean leads to development of a large gyre. The two major arms of this gyre are – a) South equatorial current flowing east to west direction under the influence of easterlies. b) The ‘West Wind Drift’ flowing from west to east under the influence of westerlies. The circulation is completed in the west by Mozambique – Agulhas currents and in the east by West Australian current. It is considered to be one of the major gyres on global scale.

In the northern portion of the Indian Ocean seasonal monsoonal winds drive the currents. Mostly these currents follow along the coast lines. During summer they follow clockwise direction and during the winter their direction shows a complete reversal and they flow in anticlockwise direction.

### Importance of the Indian Ocean:

Indian Ocean Region connects three continents namely Asia, Africa and Australia. It supports some of Asia's biggest economies. This alone shows the economic and political significance that it has. It contains three busiest straits namely Hormuz, Malacca, and Bab-el-Mandeb. Majority of crude oil exported by Gulf Countries passes through this route via Strait of Hormuz. Hence, the Indian Ocean serves an important route for crude oil supplies worldwide. Several island countries such as the Maldives, Seychelles are located in the Indian Ocean. The economy of these countries entirely depends upon the marine ecosystem and marine tourism in the Indian Ocean.



### Can you tell?

- Name the Gulf countries
- In which direction do they lie in the Asian content.



### Do you know?

Strait of Hormuz is a strategically important strip of water which links the Persian Gulf with the Arabian Sea. This strait is 33 to 95 km wide. It acts as the main artery for the transport of oil from the Middle East. About 30% of global oil is exported from this strait, Iran and Oman share territorial rights over the waters. Due to its importance, Iran has threatened to close it in recent times.



Due to its economic importance, the Indian Ocean region has become important for the world powers. Military and naval bases in the region have given rise to tensions in the region.



### Always remember

Abyssal plains of the ocean have deposits of poly-metallic nodules. These nodules will also be the source of nickel, copper, manganese and cobalt. India has allotted an area of 2 million square kilometres for research and excavation of poly-metallic nodules by International Seabed Authority in the Indian Ocean.

### The Importance of Indian Ocean for India!

India occupies a central and strategic location in the Indian Ocean area. Its national and economic interests are inseparably linked up with Indian Ocean. Hence to keep the Indian Ocean as a zone of Peace free from superpower rivalry and increasing cooperation among littoral countries in the region has always been India's foreign Policy's goal. For example Indian Ocean Rim Association for Regional Cooperation, BIMSTECK and Ganga-Mekong Cooperation etc.

No industrial development, commercial growth, stable political structure is possible unless countries shores are protected. Most of the conflicts since the end of the Cold War have also taken place in or around the Indian Ocean region. As a result almost all the world's major powers have deployed substantial military forces in the Indian Ocean region.

A major concern of India in the Indian Ocean is energy. India is fourth-largest economy in the world. It is almost 70 per cent dependent on oil import, major part of which comes from gulf region.



### Can you do it?

Show the route of oil import from the Gulf countries to India on a map with relevant stops.

The Indian Ocean provides major sea routes connecting the Middle East, Africa and East Asia with Europe and the Americas. It carries a particularly heavy traffic of petroleum and petroleum products from the oilfield of the Persian Gulf and Indonesia.

Large reserves of hydrocarbons are being tapped in the offshore areas of Saudi Arabia, Iran, India and Western Australia. An estimated 40% of the world's offshore oil production comes from the Indian Ocean. Beach sands, rich in heavy minerals, and offshore deposits are actively exploited by bordering countries, particularly India, South Africa, Indonesia and Sri Lanka.

With increasing trade relations with the countries of the East, India has higher stakes in the region, in the years to come. Trade volumes with the ASEAN countries have more than doubled in a decade from a mere \$1484 million in 1993. The Indian market has emerged as one of the largest importers of South East Asian goods with imports touching \$10,942 million in 2004-. The recently concluded Free Trade Agreements with countries like Thailand and Singapore are set to contribute to this trend. Expanding markets and larger import flows imply not only economic prosperity but also vulnerability at sea. The incidence of piracy, armed robbery and maritime terrorism are on the rise and has placed a premium on the complexity of sea-lane defense.

The northern area of the Indian Ocean is the area of great significance in economic and strategic terms. India's foreign policy orientation towards its eastern neighbours has spurred interest and attention there. India's burgeoning economy, now forecasted to become one of the



three fastest growing economies in the world entails expansion of existing export and import markets. Being a sea faring nation with island neighbours has added to the need for safe sea-lanes in the inter-lying waters. The world's busiest choke point in the straits of Malacca located here adds complexity to a strategic factor.



### Do you know ?

Diego Garcia is an atoll just south of the equator in the Central Indian Ocean. There are 60 small Islands. It was first discovered by European and named by the Portuguese. It is an important place for

navel and military activity. It has gained strategic importance in Indian Ocean due to its specific geographic location.



### Find out !

- You must have heard about the forts on the western coast like the forts of Janjira, Alibaug, etc. Find out the historical connection between India and the countries located on the western coast of Arabian Sea through these forts.
- What is the meaning of the word 'Ratnagiri' and what is its connection with the historical trade.



### Exercise

#### Q. 1) Complete the chain :

A	B	C
1) Pacific Ocean	1) Christmas	1) Bab-al-Mandeb
2) Chagos	2) Atlantic Ocean	2) Lakshadweep
3) Ashmore	3) Maldives	3) Indian Ocean
4) Hormuz	4) Malacca	4) Cocos

#### Q. 2) Give geographical reasons :

- 1) Salinity is less in the Bay of Bengal in Indian Ocean.
- 2) The eastern coastal part of Indian Ocean is seismically active.
- 3) Gyre develops in Southern Indian Ocean.
- 4) Temperatures are high in pre-monsoon season in equatorial region in northern Indian ocean.

#### Q. 3) Write short notes on :

- 1) The width of continental shelf in Bay of Bengal and Arabian Sea
- 2) Mineral resources in Indian ocean
- 3) Ocean currents in Indian ocean
- 4) Oil and natural gas in Indian ocean

#### Q. 4) Answer in detail :

- 1) Outline the importance of Indian ocean with respect to trade and transport routes

- 2) Evaluate the strategic location of India with respect to its location in Indian Ocean.
- 3) Explain the Indian ocean with respect to following aspects :
  - a) Ocean Trenches
  - b) Abyssal Plains
  - c) ridges,
  - d) Ocean Currents

#### Q. 5) On an outline map of the world, locate the following and make an index :

- 1) Sunda Trench
- 2) Diego Garcia
- 3) SW Monsoon
- 4) Agulhas Current
- 5) West Australian Current
- 6) Ninety East ridge
- 7) Strait of Holmuz
- 8) Chabahar port

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