Notes

8

OCEANS: SUBMARINE RELIEF AND WATER CIRCULATION

Water is important for life on the earth. It is required for all life processes, such as, cell growth, protein formation, photosynthesis and, absorption of material by plants and animals. There are some living organisms, which can survive without air but none can survive without water. All the water present on the earth makes up the hydrosphere. The water in its liquid state as in rivers, lakes, wells, springs, seas and oceans; in its solid state, in the form of ice and snow, though in its gaseous state the water vapour is a constituent of atmosphere yet it also forms a part of the hydrosphere. Oceans are the largest water bodies in the hydrosphere. In this lesson we will study about ocean basins, their relief, causes and effects of circulation of ocean waters and importance of oceans for man.

OBJECTIVES

After studying this lesson, you will be able to :

- identify various oceans and continents on the world map;
- differentiate the various submarine relief features;
- analyze the important factors determining the distribution of temperature both horizontally and vertically in oceans;
- locate the areas of high and low salinity on the world map and give reasons for the variation in the distribution of salinity in ocean waters;
- state the three types of ocean movements - waves, tides and currents;
- explain the formation of waves;

- give various factors responsible for the occurrence of tides;
- establish relationship between the planetary winds and circulation of ocean currents;
- explain with suitable examples the importance of oceans to mankind with special reference to the significance of continental shelves for human beings .

8.1 OCEAN BASINS

Our earth is the only planet in the solar system which has water in abundance, hence, it is often called a 'watery Planet'. About 71 % of the earth's surface is covered by water.

Oceans form a single, large, continuous body of water encircling all the landmass of the earth. They account for four- fifth of the Southern Hemisphere and three fifth of the Northern Hemisphere. They contain 97.2 percent of the world's total water.

There are four principal oceans in the world which are separated largely on the basis of their geographical locations. These are the Pacific Ocean, the Indian ocean, the Atlantic Ocean and the Arctic Ocean. All the other seas, inland seas or the arms of the oceans, are counted within these four main oceans.

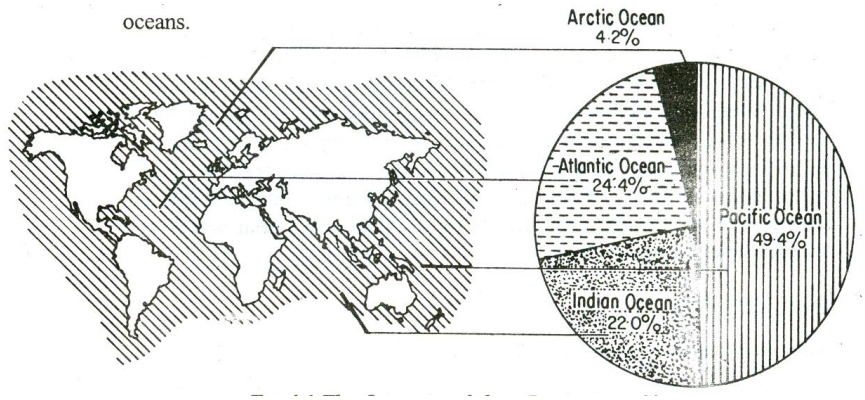

Fig 8.1 The Oceans and their Percentage Share of the Planet's total Ocean Area.

8.2 THE RELIEF OF THE OCEAN BASINS

The ocean water conceals a considerable variety of landscape very similar to its counterpart on the continents. There are mountains, basins, plateaus, ridges, canyons and trenches beneath the ocean water too. These relief features found on the ocean floor are called submarine relief. The Ocean basins are broadly divided into four major sub-divisions. They are:

(a) Continental shelf;

(b) Continental slope;

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(c) Abyssal plains and

(d) The ocean deeps.

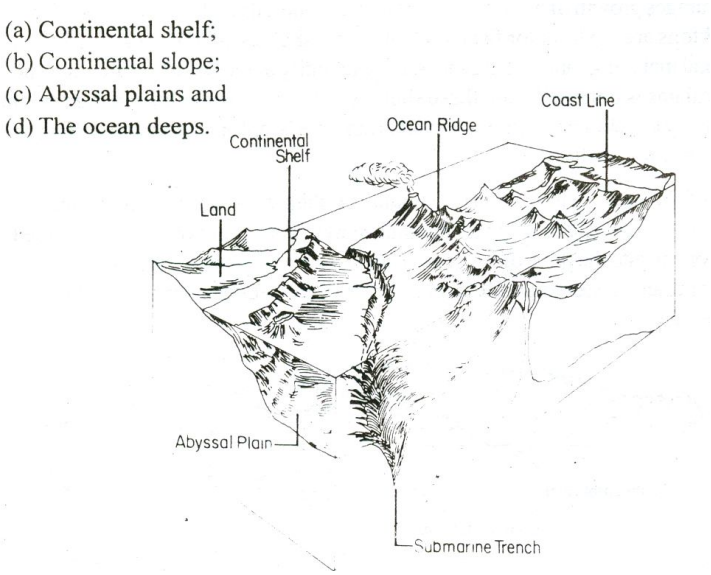


Fig 8.2 The Relief of the Ocean Basins

(a) Continental Shelf

There is no clear or well-defined line separating oceans from continents. Infact, continents do not end abruptly at shoreline. They slope seaward from the coast to a point where the slope becomes very steep. The shallow submerged extension of continent is called the continental shelf. The depth of this shallow sea water over the continental shelf ranges between 120 to 370 metres. The width of the continental shelf varies greatly ranging between a few kilometres to more than 100 kilometres. This variation can be seen even in the context of Indian peninsula. The continental shelf off the eastern coast of India is much wider than that of the western coast. Similar variations are seen all over the world. Off the coast of West Europe, it extends to 320 kilometres from the Cape of Land's End. Off the coast of Florida the shelf is 240 kilometres wide. They are much narrower or absent in some continents, particularly where fold mountains run parallel or close to the coast as along the eastern Pacific Ocean.

Most of the continental shelves represent land which has been inundated by a rise in sea level. Many regard their formation due to the erosional work of waves or due to the extension of land by the deposition of river borne material on the off-shore terraces. Off the coast regions which were once covered by ice sheets, they may have developed due to glacial deposits.

The continental shelves are of great importance to man. The shallow water over the shelf enables sunlight to penetrate through the water to the bottom and encourages growth of microscopic plants and animals called planktons. These planktons are the food for fishes. Continental shelves are the source of fishes, mineral including sand and gravel. A large quantity of the world's petroleum and natural gas is obtained from these shelves. The Bombay High and the recent discovery of petroleum in the Godavari basin are examples of on shore drilling on the continental shelf. Coral reefs and lipoclastic materials are also common on continental shelves.

One of the striking features of the continental shelf is the presence of submarine canyons which extend to the continental slope. These canyons are 'steepsided valleys' cut into the floor of the seas. They are very similar to the gorges found on the continents. Godavari Canyon in front of the Godavari river mouth is 502 metres deep.

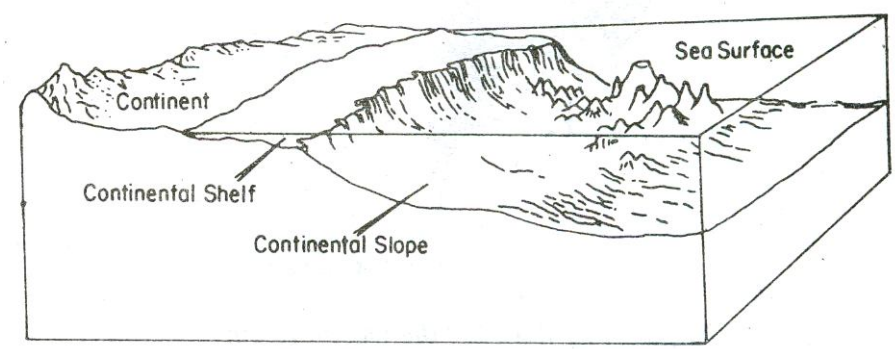


Fig 8.3 Submarine Canyon

One of the reasons for the formation of submarine canyon is underwater landslide. The sediments collected on the continental shelves get dislodged by a storm or a earthquake. The force of these moving sediments erode the slopes as they come down and as a result submarine canyons are carved out. The continental shelf is generally considered to be territorial water extent of the nations to which it adjoins.

- Continental shelf is the submerged portion of the continent which gradually slope seawards from the shore line.
- Submarine canyon is a deep valley cut into a continental shelf and extends to continental slope.

(b) Continental Slope

The continuously sloping portion of the continental margin, seaward of

the continental shelf and extending down to the deep sea floor of the abyssal plain, is known as continental slope. It is charactersied by gradients of 2.5 degrees. It extends between the depth of 180 to 3600 metres. In some places, for example, off the shore of Philippines, the continental slope extends to a great depth.

Continental slopes, mainly due to their steepness and increasing distance from the land have very little deposits of sediments on them. Sea life is also far less here than on the shelf.

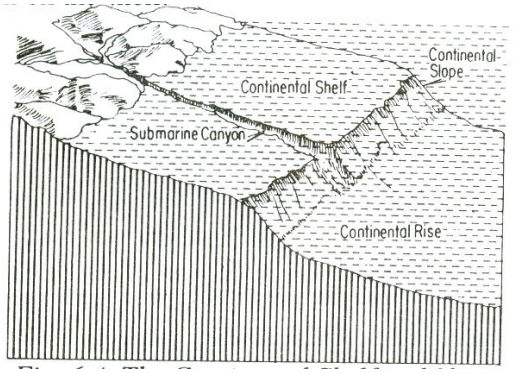


Fig 8.4 The Continental Shelf and Slope

Along the base of the continental slope is a deposit of sediments. This belt of sedimentary deposits form the continental rise. In some regions the rise is very narrow but in others it may extend up to 600 km in width.

- Continental slope is the steeply sloping part of the sea floor which marks the boundary between the sea floor and the continental shelf.
- The belt of sediments deposited along the base of the continental slope is called continental rise.

(c) Abyssal Plain

Abyssal plains are extremely flat and featureless plains of the deep-ocean floor. In fact, the abyssal plains are likely the most level areas on the earth. Abyssal plains covering a major portion of ocean floor between the depth of 3000m to 6000m. They were once regarded as featureless plains but modem devices have shown that they are as irregular as the continental plain or surface. They have extensive submarine plateaus, hills, guyots and seamounts.

The floor of the abyssal plain is covered by sediments. The plains close to the continents are covered mostly by sediments brought down from the land. But those seas which favour, an abundant growth of organisms have a thick layer of sediments, formed from the remains of living things.

These sediments are called oozes. Some of the open seas do not support enough life to produce ooze on the floor. They are covered with a type of sediment called red clay which is of volcanic origin or made up of tiny particles brought by wind and rivers.

(i) Submarine Ridges

The lofty mountain systems which exist on the continents is also represented beneath the ocean waters. These oceanic mountains are known as submarine ridges. They are linear belts occurring near the middle of the oceans and are also called mid-oceanic ridges. All the mid oceanic ridges constitute a world-wide system which is interconnected from ocean to ocean. These ridges are intersected by faults. The oceanic ridge is the site of frequent earthquakes. Volcanism is common in ocean ridges and it produces many relief features.

The Mid-Atlantic Ridge is the largest continuous submerged mountain ridge which runs from north to south in the Atlantic-Ocean. It is in the shape of S. At some places, the peaks, rise above the surface of water in the form of islands. Many of the islands are volcanic in origin. The East Pacific Ridge and Carlsberg Ridge are some of the important submarine ridges. (see fig 8.5)

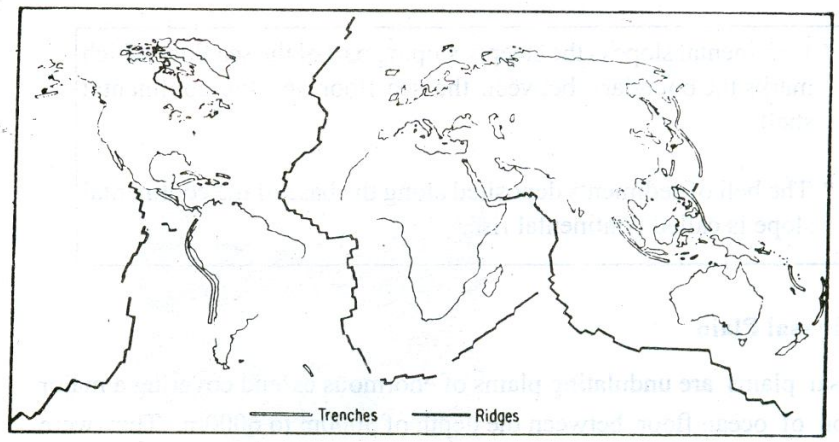


Fig 8.5 The World wide System of Submarine Ridges and Trenches

(ii) Seamounts and Guyots

Scattered over the entire sea floor are thousands of submerged volcanoes with sharp tops called seamounts. Sometimes they rise above the sea as isolated Islands. Hawaii and Tahiti Islands are the exposed tops of volcanoes. Volcano rising above the ocean floor whose top has been flattened by erosion and is covered by water is called guyot. .

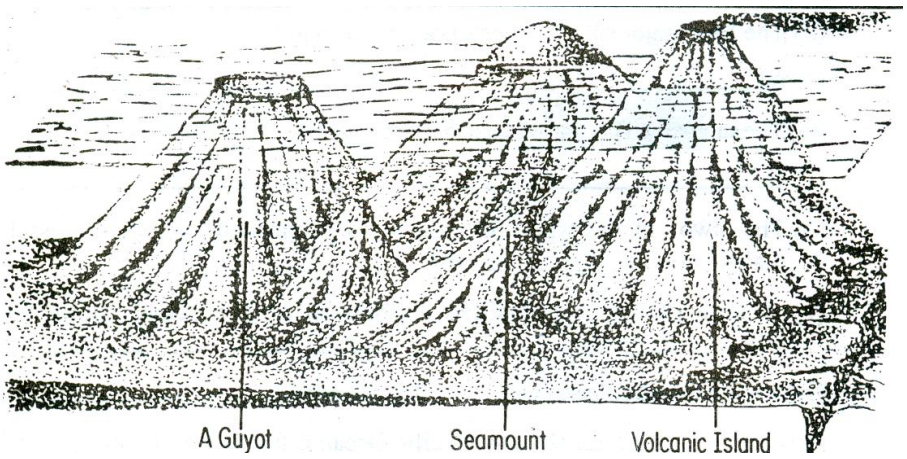


Fig 8.6 Seamounts and Guyots

(d) The Ocean Deeps

The ocean deeps are the deepest part of the ocean. They are long, narrow, steep sided and flat-floored depressions on the ocean floor. They are generally called submarine trenches. These trenches are not always located in the middle of the ocean basins, as may be generally expected but are situated very close or parallel to the continents bordered by fold mountains. They are usually found adjacent to the areas of volcanic and earthquake activity. Great earthquakes and tsunamis are born in them. They occur in all the major oceans. The Pacific Ocean has the largest number of trenches. The Mariana Trench in 'the Pacific Ocean is the deepest known part of the oceans. This trench is so deep that if we place the highest mountain of the world - the Mt. Everest in it, even this shall have a few kilometers of water above its summit.

- Abyssal plains are undulating plains of enormous extent which have many irregularities such as submarine plateaus, hills. guyots and seamounts.
- Long, narrow steep sided and flat floored depressions in the oceans are known as ocean deeps.

INTEXT QUESTIONS 8.1

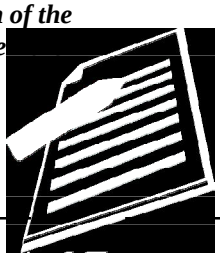
1. Fill in the blanks:

   (i) The four oceans are

   (a)_____(b)_____(c)_____(d)_____

   (ii) The four major subdivisions of ocean basin are

   (a)_____(b)_____(c)_____(d)_____



(iii) The submerged portion of the continent is called

_____

(iv) The two main types of sediments deposited in the abyssal plains are (a) _____ (b) _____

(v) A long narrow, steep-sided depression on the ocean floor is called _____

(vi) A submerged volcano with sharp top is called_____.

(vii) _____ trench in the Pacific Ocean is the deepest known part of the ocean.

2. Tick (√) the correct ending.

(i) The boundary between the continental shelf and ocean floor is always marked by

(a) continental slope (b) abyssal plain (c) trench (d) seamount.

(ii) The best fishing ground in the world are located in

(a) continental shelves (b) abyssal plain (c) submarine trenches (d) ocean deeps.

3. Write True against the correct statements and False against the Wrong.

(i) A submerged volcano with a flat top is called seamount

(ii) Oozes are formed by non-living things.

(iii) Submarine ridge is continuous -chain of mountains.

8.3 PROPERTIES OF OCEAN WATERS

The temperature and salinity are two important aspects of the ocean waters which affect their movements. Therefore, the temperature, salinity and density of the ocean water have special significance in the study of circulation of ocean waters.

(i) TEMPERATURE OF OCEAN WATERS

The temperature of the surface water of the oceans varies in much the same way as that of the land surface. This is because insolation is responsible for the varying quantities of heat which are received at different latitudes and in different seasons. Generally, the temperature is higher near the equator and gradually decreases towards the poles. . The mean annual temperatures of about 27°C or higher, are common in tropical seas but there is a general decrease towards the poles where the mean temperature of around 1.8°C are

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found. However, the decrease of temperature of surface water towards the poles or increase towards the equator is not uniform because drifting warm water from the tropical seas may move into higher latitudes or vice versa and gives a local increase or decrease of temperature. Upwellings of deep, cold water also reduce locally the surface temperature of tropical and subtropical sea waters.

The high temperatures of waters are found in enclosed seas in the tropics e.g. the Red Sea. The Arctic and Antartic waters are so cold that their surface remains permanently frozen down to a depth of several metres. In the summer months, parts of the ice break off as icebergs which dilute the water and lower the surface temperature of surrounding ice free seas.

There is also variation in the vertical distribution of temperature. Temperature decreases with increase in depth. This is because the surface of the sea water receives the largest amount of insolation. As the rays penetrate the water, their intensity is reduced by scattering, reflection and diffusion. However, the rate of decrease in the temperature is not equal at all depth. Upto a depth of about 100 metres, the temperature of water is about the same as that of the surface, while it falls from 15°C to about 2°C between the surface and a depth of 1,800 metres. The decrease between 1,800 and 4,000 metres is from 2°C to about 1.6°C.

The main process of heating the ocean waters are

(1) by absorption of heat from the sun

(2) by convection of heat through the ocean bottom from the interior of the earth.

The cooling processes are:

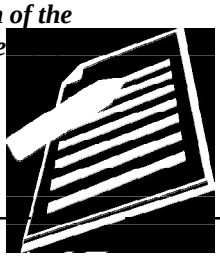
(1) by loss of heat to the atmosphere,

(2) by evaporation

(ii) SALINITY OF THE OCEAN WATERS

One of the most striking characteristics of the ocean water is its salinity or saltiness. When we speak of salinity we have in mind not only common salt or sodium chloride but a great variety of other salts as well. The dominant salts among these are sodium chloride & Magnesuim Chloride with 77.7% & 10.9% respectively. Due to the free movement of ocean water, the proportion of different salts remain remarkably constant in all oceans and even to great depth. But the degree of concentration of the salt solution in oceans does vary appreciably in different seas.

The salinity of the ocean water is produced by a large number of dissolved chemical compounds. Salinity is defined as the weight in grammes of solid material left after the evaporation of 1000 grammes of sea water. If the weight



of solid material is 35 grammes (and it is usually very near this figure), the salinity would be shown $35^0/_{00}$ (35 per thousands). Salinity is expressed in this way rather than as percentage.

In the Baltic Sea, fresh water enters it from the surrounding land and reduce the salinity to $7^0/_{00}$ and it may fall in this sea as low as $2^0/_{00}$. But great evaporation combined with a very dry climate in the Red Sea region gives the water of this sea a high salinity of $41^0/_{00}$ to $42^0/_{00}$. In enclose sea, which are areas of inland drainage such as the Caspian Sea, the salinity is very high, $18^0/_{00}$ in the Dead Sea of Jordan. The salinity may by as high as $25^0/_{00}$. The variation of salinity in different seas and oceans is affected by

(i) The rate of evaporation,

(ii) The amount of fresh water added by streams and icebergs,

(iii) Mixing of the ocean waters.

INTEXT QUESTIONS 8.2

(1) Define the term salinity

_____

(2) When 1000gm of water from the Great Salt Lake is evaporated, 250gm of salt remains. What is the salinity of the Great Salt Lake?

_____

(3) Fill in the blanks.

(a) Solar radiation is _____ in equatorial region on in the polar region.

(b) The average salinity of sea water is _____

(c) Enclosed seas are the areas of _____ salinity.

8.4 MOVEMENTS OF OCEAN WATERS

The waters of oceans are never still. The oceans actually exhibit three major types of movements - waves, tides and currents.

(I) WAVES

Waves are oscillatory movements that result in the rise and fall of water surface. Infact, the movement of each water particle in a wave is circular. The movement of the waves is just like the wind blowing across a wheat

field and causing wave like ripples to roll across its surface. The wheat stalk returns to its original position after the passage of each wave of wind. Similarly water also returns to its original position after transmitting a wave.

A wave has two major parts. The raised part is called the *crest*. Between the two crests are low areas called *troughs*. The vertical distance between trough and crest is called wave height. The horizontal distance between two crests or two troughs is called wave length. The time it takes for two crests to pass a given point is called wave period. Fast moving waves have short period while slow moving waves have long period (see fig 8.7)

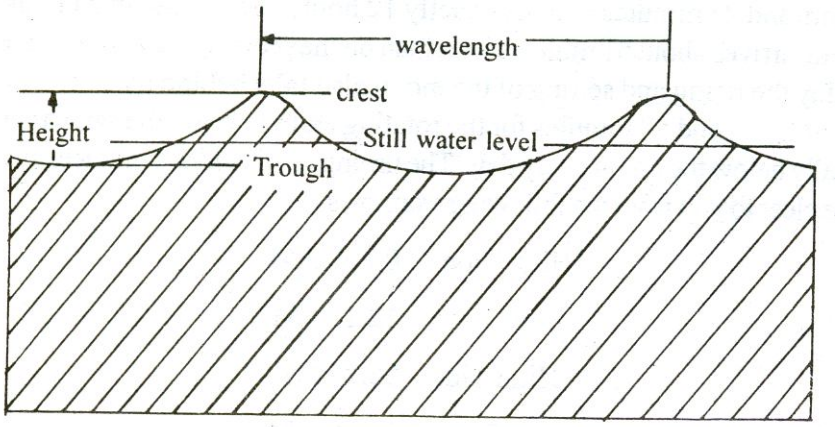


Fig. 8.7 Part of a Wave

The size and force of a sea wave depends on three factors

(i) Velocity of the wind,

(ii) The length of time the wind blows and

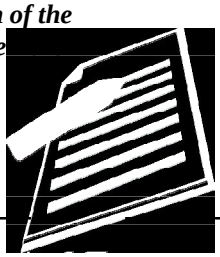
(iii) Distance that the wind has travelled across the open sea. This is called a fetch.

Waves are an important agent of erosion. When waves are associated with storms or volcanic eruption, they are very violent and cause damage on coastal areas. They are also a source of energy and efforts are being made to harness their energy.

- Waves are the to and for movements of ocean water in which water particles move roughly in a circular path. They rise up in a crest, advance, descend and retreat in the trough as the wave passes.

(II) TIDES

Along a coast all over the world, we observe the sea water moving both upwards and downwards at rates varying from place to place. Such a variation in sea level occurs from hour to hour and from day to day. At the time of a



rising sea level, the incoming tide towards the land is spoken of as a flow tide or a flood tide. At the time of a falling sea level after a few hours, we speak of the tide water going out or withdrawn, is an ebb tide (low tide). The flood tide is a high tide and the ebb tide is a low tide. Tides are really the largest waves keeping the ocean water restless. Twice a day regularly at constant intervals, a tide flows in and twice a day it ebbs away. Twice a month, flow tides are higher and the ebb tides are lower than the average. Also twice a month flow tides are lower and the ebb tides are higher than the average.

However the regular interval between two high tides or between two low tides is 12 hours and 25 minutes and not exactly 12 hours. Each day (in 24 hours) the high tide arrives about 51 minutes later than on the previous day. It is so because each day the rising and setting of the moon also falls behind by 51 minutes. It takes 24 hours and 50 minutes for the rotating earth to bring the same meridian vertically below the moon every day. The timings of the tides at a place on a coast will be clear to you from the following examples.

High Tide	06.00 AM
Low Tide	12.13 PM
High Tide	06.25 PM
Low Tide	12.38 AM
High Tide	06.51 AM next day

The factors responsible for bringing about such a variation in the regulation and the size of tides are:

1. The location of the sun, the moon and the earth in relation to each other which is rarely in a straight line.
2. The distances of the sun and the moon from the earth are not constant.
3. Our globe is not entirely covered with water.
4. The outline or shape of the coast may help or hinder the tides.

Still the tides follow each other with a great punctuality at any given coast. What are the forces that generate the tides? The earth attracts and is also attracted by the sun, the moon and by other planetary bodies. It is called the gravitational force and it operates between the sun, moon and the earth. It sets the ocean waters in motion producing a tidal current. Tides are the proof of such a gravitational pull.

The moon and the sun both exert their gravitational force on the earth. The Oceans, Submarine Relief And Circulation sun which is bigger in mass than the moon is also at a greater distance from the earth than the moon. Therefore,

the gravitational attraction of the moon is more effective on the earth than the gravitational attraction of the sun. Since the water is liquid and mobile, its bulging in the direction facing the moon is easily noticed, yet a lower tidal bulge also develops on the other side of the earth farther from the moon because of moon's least attraction. (see fig 8.8)

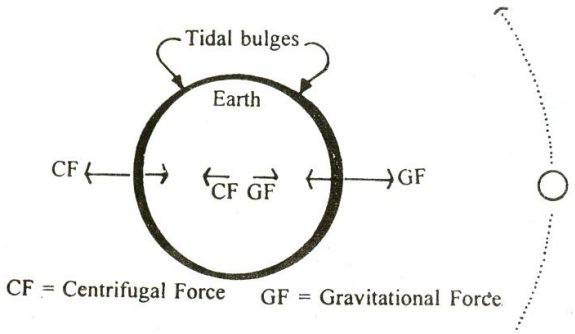


Fig 8.8 Formation of Tides

- The rise and fall of the ocean water at a particular place are called tides.
- Interval between two high tides or low tides is exactly 12 hours 25 minutes.
- Tides are produced as a result of gravitational pull of the moon and the Sun on the earth.

(a) SPRING AND NEAP TIDES

The moon, as it is closer to the earth, exerts twice the gravitational pull of the sun on the earth. When the sun and the moon are in a line as on a new moon *(Amavasya)* or a full moon day *(Purnima)* both of them pull together at the same time in the same direction. This combined pull produces an extra large tide. It is called a *spring tide* see fig 6.9(1). In its first quarter *(Asthmi Shukla Paksha)* and the third quarters *(Asthmi-Krishna Paksha)* the gravitational force of the two heavenly bodies is at right angle. At this time, the two pulls are opposing each other and are not acting in the same direction. In other words they cancel or neutralize each other's effect. It produces a weak tide which is called a *neap tide* see fig.8.9(2).

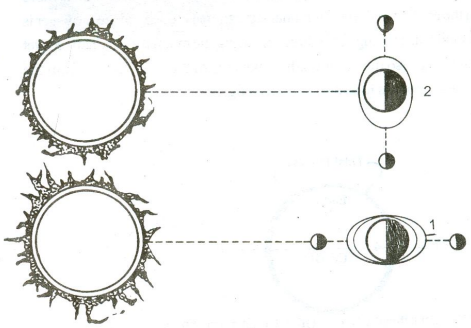
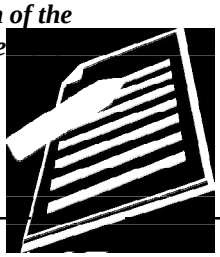


Fig 8.9 Spring(1) and Neap(2) Tides



(b) EFFECT OF TIDES

The phenomenon of tides, which is so universal has been of immense value to man for ages. Tides act as link between the port and the open sea. Some of the major ports of the world, such as London port on the river Thames and Kolkata port on river Hugli are located on the rivers away from the sea coast. The tidal current clear away the river sediments and slows down the growth of delta. It increases the depth of water which help ships to move safely to the ports. It also acts as a source for producing electricity.

- Tides make the rivers navigable for ocean going ships, clear sediments, retard formation of delta and are a source of producing electricity.

INTEXT QUESTIONS 8.3

1. Choose the correct alternative for the following statements:

   (i) The source of most waves on the sea surface is_____.

   (a) winds (b) tides (c) earthquakes (d) density difference

   (ii) The length of time for one crest of a wave to follow another crest past is called the wave _____

   (a) height (b) length (c) period (d) frequencey

   (iii) The time between a high tide and a low tide is about _____

   (a) 6 hours 13 minutes (b) 12 hours (c) 24 hours (d) 24 hours, 50 min

2. Define tide?

   _____

3. Define wave length?

   _____

4. If the first high tide occurred at 9.00 a.m on one day, when will the first high tide most likely to occur the next day?

   _____

(III) CURRENTS

The ocean current are horizontal flow of a mass of waters in a fairly defined direction over great distances. They are like stream of water flowing through the main body of the ocean in a regular pattern. The average speed of current

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is between 3.2 km to 10 kms per hour. Ocean currents with higher speed are called stream and currents with lower speed are called drift.

Ocean currents can be broadly divided into two :-

(1) Those currents which flow from equatorial regions towards poles have a higher surface temperature and are called warm current.

(2) Those currents which flow from polar regions towards equator have a lower surface temperature and are called cold currents.

The origin. and the nature of circulation of the ocean currents depend on the following factors:

(i) Differences in Density

The sea water's density varies from place to place according to its temperature and proportion of salinity. The higher the temperature of water, the lesser will be the density. Hence the less dense water of the equator moves towards the poles while the cold and dense waters of the poles move towards the equator. Thus cold currents always move from the poles to the equator while the warm currents move from equator towards the poles

Currents are also produced by changes in the salinity of ocean waters. If the salinity of the water is more, the density of the water increases, and the water sinks. Hence water with Lower salinity flows on the surface of the high salinity water while an under current of high salinity flows towards the less dense water. The currents caused by difference in salinity are found between the Atlantic ocean with lower salinity and the Mediterranean Sea with higher salinity.

- The higher the temperature of water, lower is its density.
- The higher the salinity of water, higher is its density.

(ii) The Earth's Rotation

We have studied in an earlier lesson that the earth's rotation deflects air to its right in the northern hemisphere and to its left in the southern hemisphere. Similarly, ocean water is also affected by Coriolis force and follows the Ferrel's Law. So all the ocean currents follow clockwise direction in the northern hemisphere and anticlockwise direction in the southern hemisphere.

(iii) The Planetary Winds

The planetary winds like the trade winds and westerlies, drive the ocean water in a steady flow in front of them. If we compare the world map of planetary wind system, with that of the ocean currents it will be clear that currents follow the main direction of the planetary wind system. In low latitudes or in the region of the trade winds the ocean currents change their direction according to the change in the direction of summer and winter monsoon winds.

8.5 CURRENTS OF THE ATLANTIC OCEAN

To the north and south of equator there are two westward moving currents i.e., the north and south equatorial currents. Between these two equatorial currents is the Counter Equatorial Current which flows from west to east. (Locate it in the fig 8.10). This counter current replaces the water removed from the eastern side of the oceans by North and South Equatorial Currents.

The South Equatorial Current bifurcates into two branches near the Cape De Sao Roque in Brazil. Its northern branch joins the North Equatorial Current. This combined current enters the Caribbean Sea and the Gulf of Mexico, while the remaining current passes along the eastern side of the West Indies as the Antilles Current. The part of the current which enters the Gulf of Mexico, comes out from the Florida strait and joins the Antilles Current. This combined current moves along the south eastern coast of U.S.A.. It is known as Florida Current upto cape of Hatteras. Beyond the Cape Hatteras, upto the Grand Banks, off New Foundland, it is called the Gulf Stream. From the Grand Banks, the Gulf Stream is deflected eastwards under the combined influence of the westerlies and the rotation of the earth. It crosses the Atlantic Ocean as North Atlantic Drift.

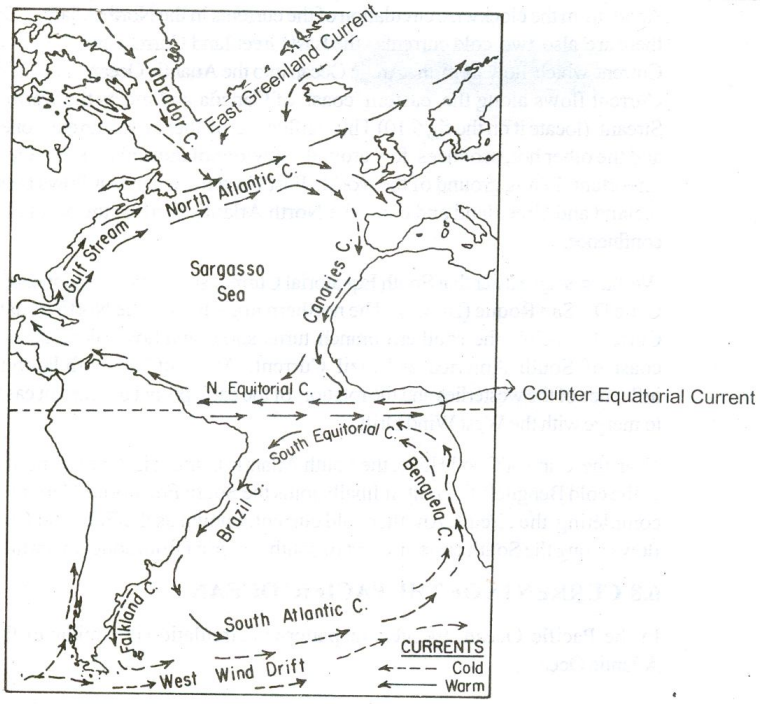


Fig 8.10 Currents of the Atlantic Ocean

The North Atlantic Drift bifurcates into two branches on reaching the eastern part of the ocean. The northern branch continues as North Atlantic Drift; reaches the British Isles from where it flows along the coast of Norway as the Norwegian Current and enters the Arctic Ocean. The southern branch flows between Spain and Azores Island as the cold Canaries Current. The Canaries Current finally joins the North Equatorial Current and completes

the circuit in the North Atlantic Ocean. Within this circuit lies the Sargasso Sea which is full of large quantities of seaweeds called sargassum, a brown algae.

Apart from the clockwise circulation of the currents in the North Atlantic Ocean, there are also two cold currents - the East Greenland Current and the Labrador Current which flow from the Arctic Ocean into the Atlantic Ocean. The Labrador Current flows along the eastern coast of Canada and meets the warm Gulf Stream. (locate it on the fig 8.10) The confluence of these two currents, one cold and the other hot, produces fog around Newfoundland and makes it the most important fishing ground of the world. East Greenland current flows between Iceland and Greenland and cools the North Atlantic Drift at the point of their confluence.

We have seen earlier that South Equatorial Current splits into two branches near Cape De Sao Roque (Brazil). The northern branch joins the North Equatorial Current, whereas the southern branch turns south and flows along the eastern coast of South America as Brazil Current. At about 35° south latitude the influence of the westerlies and the rotation of the earth propel the current eastward to merge with the West Wind Drift.

Near the Cape of Good Hope, the South Atlantic Current is diverted northward as the cold Benguela Current. It finally joins the South Equatorial Currents thus completing the circuit. Another cold current, known as the Falkland Current, flows along the South eastern coast of south America from south to north.

8.6 CURRENTS OF THE PACIFIC OCEAN

It may be observed that the same broad circulatory systems, clockwise in the Northern Hemisphere and anti-clockwise in the Southern Hemisphere, are present in the Pacific ocean also.

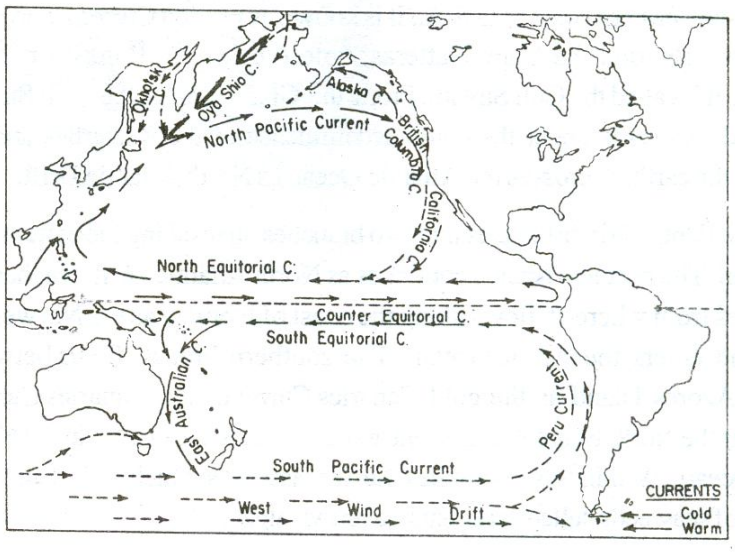
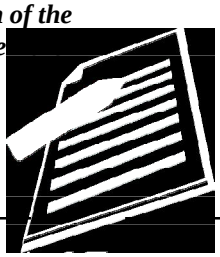


Fig 8.11 The Currents of the Pacific Ocean



In the Equatorial belt of the Pacific Ocean, two streams of equatorial currents flow across the ocean from the Central American Coast. Between these two - the North Equatorial Current and the South Equatorial Current flows a Counter Equational current moves west to east. The North Equatorial Current turns northwards and flows along the Philippines Islands, Taiwan and Japan to form the warm Kuro Shio or Kuro Siwo current. From the southeast coast of Japan, the current comes under the influence of westerlies and flows right across the ocean as North Pacific Current (see fig 8.ll). After reaching the west coast of North America, it bifurcates into two branches. The northern branch flows anti clockwise along the coast of British Columbia and Alaska and is known as the Alaska Current. The warm waters of this current help to keep the Alaska coast ice free in winter. The other branch of the North Pacific Current moves southward along the coast of California as the Cold Californian Current. It eventually joins the North Equatorial Current to complete its circuit. In the northern part of the Pacific Ocean two cold currents also flow. These are the Oya Siwo Current and Okhotsk Current. The cold Oya Siwo Current flows along the coast of the Kamchatka Peninsula. Another cold current, Okhotsk Current flows past Sakhalin to merge with the Oya Siwo Current near Hokkaido Island. It later merges with Kuro Siwo Current and sinks beneath the warm waters of the North Pacific Currents. (locate it in figure 8.11).

In the South Pacific Ocean, the South Equatorial Current flows towards west and turns southwards as the East Australian Current. It then meets near Tasmania the cold South Pacific Current which flows from west to east. On reaching the South Western Coasts of South America, it turns north wards as the cold Peru Current. It then meets the South Equatorial Current and completes the circuit. The cold waters of the Peru Current are partly responsible for making the coast of northern Chile and western Peru with very scanty rainfall.

8.7 CURRENTS OF THE INDIAN OCEAN

The pattern of circulation of currents in the Indian Ocean differs from the general pattern of circulation in the Atlantic Ocean and the Pacific Ocean. This is because Indian Ocean is blocked by the continental masses in the north. The general pattern of circulation in the southern section of the Indian Ocean is anti clockwise as that of other oceans. But in the northern section there is a clear reversal of currents in winter and summer. These are completely under the influence of the seasonal changes of the monsoon winds. So there is a clear reversal of currents in the winter and summer season i.e/south-westwards during the north-east Monsoon, north-eastwards during the south-west Monsoon and variable during transition season.

During winters Srilanka divides the currents of the Arahian sea from those of the Bay of Bengal. The North Equatorial Current flows westward just south of Srilanka with distinct counter equatorial current flows between it

Notes

and the South Equatorial Current. (See fig. 8.12) At this time in the northern section, the whole of Bay of Bengal and Arabian sea is under the influence of North East Monsoon. The North East Monsoon drives the water of Bay of Bengal and Arabian Sea west wards to circulate in an anti clockwise direction. This current is known as North East Monsoon Drift.

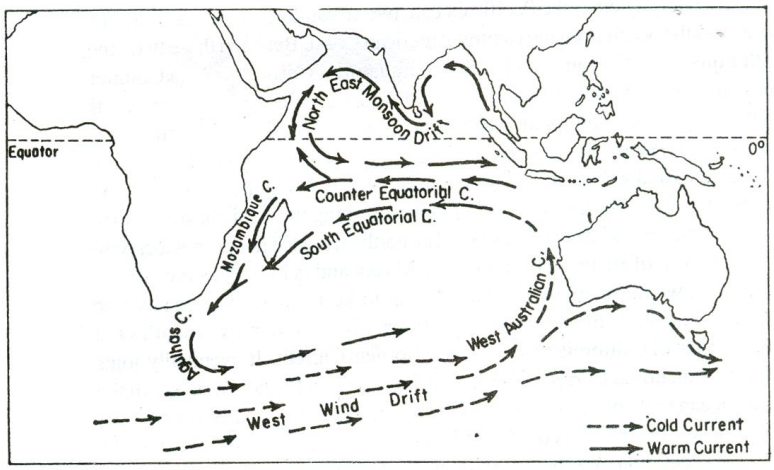


Fig 8.12 The Currents of the Indian Ocean (Winter)

In summers, the northern section comes under the influences of South West Monsoon. There is an easterly movement of water in the Bay of Bengal and Arabian Sea and produces a clockwise circulation. This current is known as South West Monsoon Drift (see fig.8.13). In general the summers currents are more regular than those of winter.

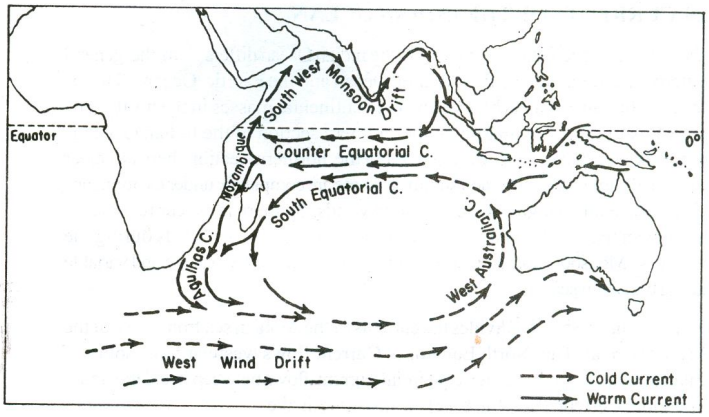
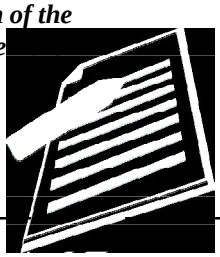


Fig 8.13 The Currents of the Indian Ocean (Summer)

In the southern Indian Ocean, the South Equatorial Current, strengthened by its corresponding current of the Pacific Ocean, flows from east to west. It turns south-wards along the Coast of Mozambique in Africa. A part of this current which flows between the mainland and the Madagascar Island is known as warm Mozambique Current. After the confluence of these two



currents, it is called Aghulas Current. It then turn eastwards and merges with the West Wind Drift.

The West Wind Drift flows across the ocean in west east direction in the higher latitudes to reach the southern tip of Australia. A branch of this stream turns north to flow along the western coast of Australia as cold West Australian Current. West Australian Current later joins the South Equatorial Current to complete the circuit.

8.8 EFFECTS OF OCEAN CURRENTS

(a) Influence on climate

Oceans currents closely influence the distribution of temperature, pressure, winds and precipitation, which directly or indirectly influence the economy and society of the people, especially those living in the coastal regions. Some of the important effects of oceans currents are as follows:

Currents move from warm temperature areas to colder temperature areas and vice versa. As they move from one place to another they partly attempt to modify the temperature. The temperature of a mass of water affects the temperature of the air above it. Therefore, the ocean current that moves from the equatorial region to the colder latitudes raises the temperature of the air in the areas into which it moves. For example, warm North Atlantic Drift which flows northwards to West European coast helps to keep the coast of Great Britain and Norway free of ice in winter too. The effect of the ocean current becomes more clear if you compare the winter conditions of the British Isles with that of the North East Coast of Canada situated on the same latitudes. Since the North East Coast of Canada comes under the influence of cold Labrador current, it remains ice bound during the winter time.

When cold and warm currents meet they produce mist and fog. For example, near New Foundland warm Gulf Stream meets Labrador Current and produces fog. They also create conditions for storms. Hurricanes in New Found land and Typhoons in Japan are perhaps the result of the meeting of warm and cold currents.

(b) Influence on marine Life

Temperature has a great influence on marine life. It determines the type of flora and fauna. The areas where warm and cold currents meet are among the most important fishing grounds of the world. The oceanic movement in the form of currents helps in the dispersal of marine life.

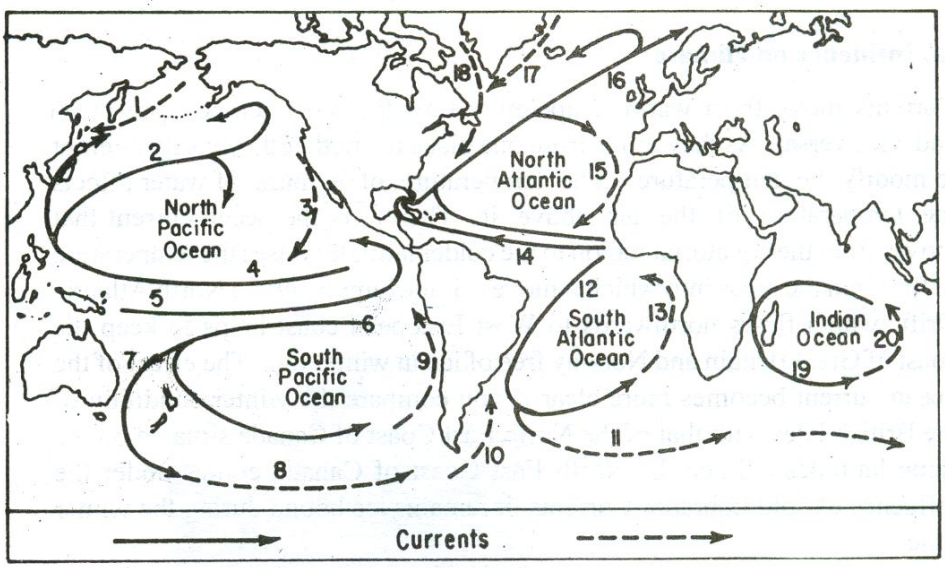
(c) Influence on Trade

Ocean currents influence the trade. The ports and harbours of higher latitudes which are affected by warm currents are ice free and open for trade all the

year round. For example, the ports of North Western Europe remain open throughout the year while port of Quebec in Canada gets frozen in winters.

INTEXT QUESTIONS 8.4

1. Study the map given below. Each current in the map is shown by a number. Write the name of the corresponding ocean current against the number given below. Also complete the key of the map by writing appropriate words.



1 _____ 11 _____

2 _____ 12 _____

3 _____ 13 _____

4 _____ 14 _____

5 _____ 15 _____

6 _____ 16 _____

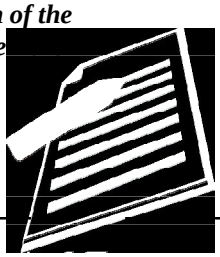
7 _____ 17 _____

8 _____ 18 _____

9 _____ 19 _____

10 _____ 20 _____

2. The warm current which flows off the east coast of South East Africa is called the



(i) Benguela Current

(ii) Mozambique Current

(iii) Canaries Current

(iv) West Wind Drift.

3. Which one of the following statement is not true?

(i) Ocean currents sometimes cause fog.

(ii) The distribution of fishes is often influenced by ocean currents.

(iii) Ocean current can influence coastal temperature.

(iv) Warm water wells up along a coast from which an ocean current moves.

8.9 IMPORTANCE OF OCEAN FOR HUMANS

We are well aware that oceans cover about 71 % the earth's surface. They form a major part of our environment and have an overwhelming influence on humans and his activities. In this section we will be studying the importance of oceans in different spheres of human life.

(a) Ocean as modifiers of climate

The most important part played by the oceans is as modifiers of climate.

(i) The ocean stores a large quantity of heat, hence it is often called "the saving bank for the solar energy, receiving deposits in season of excessive insolation and paying them back in seasons of want". The extensive deep waters of oceans gain as well as loose heat more slowly than the land when both are subjected to the same amount of insolation. The contrast in the temperature of the ocean and land explains the difference in the temperature of coastal and interior region.

(ii) The oceans supply water vapour to the atmosphere and thus are the basic source of all precipitation on earth. They are also the vital source of fresh water on earth.

(iii) Ocean currents are important regulators of temperature on the earth's surface. They help in exchange of heat between low and high latitudes and are essential in sustaining the global energy balance. On the local scale, the warm ocean currents bring a moderating influence to coasts in higher latitudes; cool currents reduce the heat of tropical deserts along narrow coastal belts.

(iv) The influence of oceans on climate becomes more clear if we consider the distribution of pressure and prevailing wind system over the sea

Notes

surface. The oceans surface has six or more permanent centres of high pressure. These high pressure areas give birth to the planetary wind system over the earth. These planetary winds determine the amount of rainfall and its distribution over the earth's surface. The westerlies give rainfall on the West European Coast after collecting moisture from the warm North Atlantic Drift.

(b) Oceans and Resources

The oceans have always been a great source of food and other products of value to man. The animals and plants of the sea constitute a vast resource from which man can derive food, fertilizers for agriculture and raw material for industry. Fish and other marine animals form a rich source of food and nutrition for man. With the progress of human society and the increasing population, man's dependence on sea for other products has increased. Fishes now make up more than 10 per cent of the total animal protein that human consume.

(c) Oceans and Mineral Resources

Oceans are the store house of a large number of useful metallic and non-metallic minerals. Foremost among the minerals are the petroleum deposits of the continental shelves. In the energy hungry world, they are the most sought after resources. Vast deposits of petroleum have been found in many places such as in the North Sea, off the coast of South California and Texas, in the Mediterranean Sea, Persian Gulf, Bombay High in the Arabian Sea.

The common salt or sodium chloride is extracted from sea water. Apart from salt, magnesium and bromine have long been extracted from sea water. The mineral wealth of the seas also include metals. All the metallic elements are present in the seawaters in some degree. However waters and sediments of ocean are heavily saturated with such metals as zinc, copper, lead, silver and gold, especially in the volcanic region of the oceanic ridge. The technology to exploit these minerals has not yet developed.

The most significant are mineral nodules found on the deep sea floor. The important ones are phosphorites and manganese nodules.

(d) Ocean and Energy

The energy resources of the oceans are of various types - tidal power, geothermal energy and energy from the ocean temperature.

Tidal energy was in use even in the 12th Century. Water wheels driven by the tides were used for grinding grain. Today, efforts are being made to harness the energy to run electric generators. There are difficulties in the. use of tidal power because of the irregularities of tides, However, a few tidal power stations are working in Russia, France and China.

(e) Ocean Transportation and Trade

Ocean were originally considered as barriers but today they act as natural link among continents and nations of the world. They provide natural highways at low cost for international trade. They facilitate movement of bulky goods. The water is buoyant and needs less motive power. Oceans are a great boon to international trade.

INTEXT QUESTIONS 8.5

1. Which one of the following statements is not true?

   (a) Oceans control the distribution of pressure in the upper atmosphere.

   (b) Oceans receive large amount of solar energy in seasons of excessive insulation and pay them back in season of short supply.

   (c) Oceans currents help to redistribute heat over thousands of kilometres.

   (d) Oceans provide natural highways but are a big hindrance to international trade.

   (e) energy due to the rise and fall of the sea water is called geothermal energy.

WHAT YOU HAVE LEARNT

All living organisms on the earth depend on water. About 71 % of the earth's surface is covered by water. The earth is the only known planet in the solar system with abundant water. The oceans are the single largest continuous body of water encircling land. The oceans contain 97.2% of the world's water. There are four oceans - the Pacific oceans, the Atlantic oceans, the Indian ocean and the Arctic ocean. The ocean floor which once was considered to be flat has variety of features such as continental shelf; continental slope, abyssal plains and the deeps.

Pacific ocean is the largest ocean. It comprises of thousands of islands. The greater part of the ocean comprises of the deep seas. Mariana trench in the Pacific Ocean is the deepest known part of the ocean with a depth of 11022 metres. The Atlantic Ocean is almost half the size of the Pacific Ocean. The world's widest shelves like Dogger Bank and Grand Bank are found here. The largest continuous Mid Atlantic Ridge is the important feature of the Atlantic ocean. Indian ocean is smaller than the other two ocean.

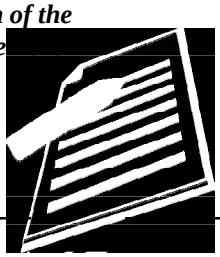
The temperature of the surface water of the oceans varies from one part of the ocean to the other. It is generally high near the equator and low near the poles. There is variation in the vertical distribution of temperature too

Temperature decreases with the increase in depth. Salinity is defined as the weight in grammes of solid material left after the evaporation of 1000 grammes of sea water. The salinity of the ocean water is caused by a large number of dissolved chemical compounds. The salinity is not uniform everywhere in the ocean. Equatorial and Polar water are less saline than the tropical seas. Ocean waters are in constant motion. There are three type of movements in the oceans waters - waves, tides and currents. Waves are 'caused by winds. They move roughly in circular path. Tides are the periodic change in the elevation of the oceans surface at a particular place. They are produced as a result of gravitational attraction of the moon and the centrifugal force produced due to rotation of earth. Currents are distinct and generally horizontal flow of a mass of water in a fairly defined' direction. Currents are formed due to the density of water rotation of the earth and planetary winds. These currents form a clockwise pattern in the northern hemisphere and move in anti clockwise pattern in the southern hemisphere. The currents of the Indian ocean are influenced by Monsoon winds.

Oceans are of great importance to man. They influence the climate of the earth's surface 'and provide rich source of marine food and minerals. They are also helpful in international trade by providing free highways.

TERMINAL QUESTIONS

1. Describe the important relief features of the ocean floor with the help of a diagram.
2. Distinguish between the following terms:
   (a) Continental shelf and continental slope.
   (b) Submarine trench and submarin Ridge.
3. Describe the difference between a seamount and a guyot.
4. Explain the importance of continental shelf to humans.
5. Write short notes on:
   (a) Submarine canyons
   (b) Continental rise
6. Define the term salinity and how is it expressed?
7. Why does temperature of ocean decrease with depth?



8. What are tides? How are they caused?

9. Distinguish between spring tide and neap tide with the help of a diagram.

10. Give reasons to account for the following.

    (a) Spring tides occur on new moon and full moon.

    (b) In the lower latitudes the eastern sides of the land masses are warmer than the western sides.

    (c) In the higher latitudes the eastern sides of the landmasses are cooler than the western side.

11. Describe the circulation of ocean currents In the Atlantic Ocean with the help of a diagram. Compare it with that of the currents of the Pacific Ocean.

12 Write a short essay to show the importance of oceans for man.

ANSWERS TO INTEXT QUESTIONS

8.1

1. (i) (a) The Pacific Ocean (b) The Atlantic Ocean (c) The Indian Ocean (d)The Arctic Ocean.

   (ii) (a) The continental shelf(b) The continental slope (c) Abyssal plains (d) and the deeps.

   (iii) The continental shelf

   (iv) (a) oozes (b) red clay (v) submarine trench

   (vi) seamount

   (vii) The Mariana

2. (i) (a) continental slope

   (ii) (b) continental shelves

3. (i) False (ii) False (iii) True

8.2

1. Salinity is the weight in grammes of solid material left after the evaporation of 1000 grammes of sea water.

2. $250^{0}/_{00}$

3. (a) maximum, minimum (b) 35%/(c) high.

Notes

8.3

1. (a) winds, (ii) period, (iii) 6 hours 13 minutes
2. Periodic charge in the elevation of the ocean surface at a particular place.
3. The horizontal distance between two crests or two troughs.
4. 9.51 A.M

8.4

	Warm currents		Cold currents
1.	Okhotsk Current	2.	North Pacific Current
3.	California Current	4.	North Equational Current
5.	Counter Equatorial Current	6.	South Equatorial Current
7.	East Australian Current	8.	West Wind Drift
9.	Peru Current	10.	Falk and Current
11.	West Wind Drift	12.	Brazil Current
13.	Benguela Current	14.	North Equatorial Current
15.	Canaries Current	16.	Norwegian Current
17.	East Greenland Current	18.	Labrador Current
19.	Agulhas Current	20.	West Australian Current
2.	Mozambique Current	3.	(iv)

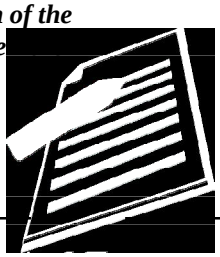
8.5

1. (a), (d), (e)

HINTS TO TERMINAL QUESTIONS

1. Refer to section to 8.2
2. Refer to section 8.2(a) and (b)

   Refer to section 8.2(d) and (c) (i)
3. Refer to section 8.2(c) (ii)
4. Refer to 8.2(a)
5. See under continental shelf and continental slope.
6. See para 8.3 (ii)
7. See para 8.3 (ii)



8. See para 8.4 II

9. See para 8.4 II(a)

10. (a) See para 8.4 II(a)

    (b) In the equatorial region the warm ocean currents flow from east to west direction carrying with them warm water, in the process warming the coastal regions. Whereas the western coast are affected by cold currents. Give examples with your explanation.

    (c) In the higher latitudes the eastern sides are generally washed by cold current and western coast by warm current. Give examples with your explanation.

11. Refer to section 8.5 and 8.6

12. Refer to section 8.9