Lesson - 19

Ocean: Relief, Temperature and Salinity

71% of the Earth is covered by water and it is called Hydrosphere. It includes seas and oceans. There is no other planet except earth where water exists in such quantity. This is the reason why it is also called planet of water. The ocean bottoms are also as complex as the land mass. The average depth of the oceans is much more than the highest peaks on the landmass. The highest peak of the landmass is Mount Everest which is 8850 m in height, whereas the deepest trench, Mariana trench in Pacific Ocean is 11,033 m deep. The average elevation of the continents is 840 m where as the average depth of the oceans is 3808m.

Relief features of oceans

Similar to land mass there are mountains plateaus, Plains and deep trenches in the ocean bottom. In topography, the relief features of a place are described. There is no uniformity of relief features in all the oceans of the world.

Pacific Ocean

It is the largest ocean which covers1/3rd part of the earth. It is triangular in shape and extends 18000 km from east to west and 16740 km long from north to south.

Volcanic mountain ranges, earthquake zones and island groups are found on its coasts. There are more than 20,000 islands which are divided into three parts-

(1) Melanesia
(2) Micronesia
(3) Polynesia

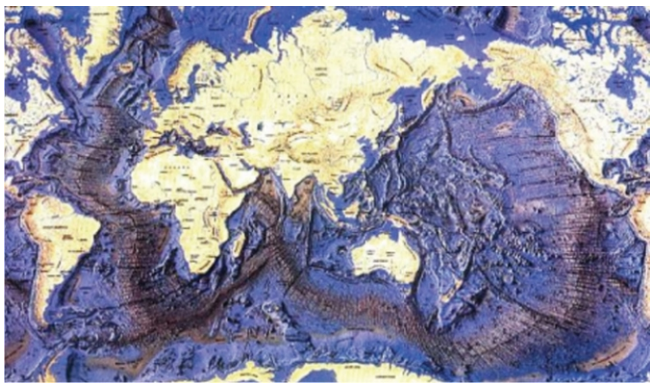


Fig. 19.1 : Ocean relief features

Many trenches, long ridges plateaus , ocean platforms are found here.

In the same way on both the sides of the Atlantic Ocean which is the most busiest ocean of the world, most developed countries of the world are situated. It's shape is similar to english alphabet 'S'. The gulf of Mexico, Mediterranean sea, North sea Gulf of Biscay, Baltic Sea ,Caribbean Sea ,Black Sea are it's maginal seas. This ocean is quite narrow at the equator. It is divided into two parts -North and South Atlantic Ocean. North Atlantic Ocean is 5400 km in width and South Atlantic Ocean is 9600 km wide. There are many trenches found here like Brazilian basin, Cannery basin, Guinea basin and North America basin. Besides these basins, the other major deeps are Puerto Rico basin and Romanche.

Relief features of Indian Ocean

Peninsular India, plateau of Africa, western part of Australia and Continental shelfs are the part of Gondwana land and they are located in the north of Indian ocean. The major basins are Sidmali basin, Andaman-Nicobar, zanzilar and Reunion are main islands. Arabian basin, Mauritius basin, Andaman basin and Sunda basin. Many submerged faults and rift valleys are found here.

Relief features of Arctic Ocean

As maximum portion of this region remains covered with snow throughout the year, not much is known about this Ocean which is situated near the northern pole. The continental shelf of this ocean is very wide. There are many islands like Barents,Hope, Spitsbergen islands, Novaya, etc. The major seas are Norway sea, Laptev sea, East Siberian sea and Greenland Sea. There are many ridges which are submerged here.

Topography

The relief features on the earth surface that include mountain, plateau and Plains means landscapes are called topography of a region. This term is used often to explain the similarities and variations in the forms of landforms. The bottom relief features found in the oceans ,are caused due to four major activities. This results due to the interactions between tectonic activities, volcanic activities and depositional processes.

The ocean bottom , beneath the surface of the water, is formed due to the configuration of the ocean bottom and elevation processes, that indicates, what is the extent of heights and depths on the ocean floor. Oceans similar to the continents are the first order landforms. The height of a place and depth of the ocean is depicted through hypsographic curve. On the basis of this the ocean bottom relief features are categorised into following divisions:-

1. Continental shelf
2. Continental slope
3. Deep sea plain
4. Ocean deeps

1. Continental shelf

This refers to the submerged Continental coast. Therefore those Continental coasts which are submerged in the sea are called as Continental shelves. It's maximum depth is 100 fathom and its slope varies between 1°to 3°. The continental shelf with gentle slope has greater width whereas the continental shelf with steep slope has less width. Its average width is 75 km. It covers about 7.6% of area of the entire Ocean. There is growth of vegetation and living creatures as the sun rays penetrate in this part. There is also the deposition of sediments brought by the rivers. Therefore this region of the oceans are usefull for human beings. Many minerals, fishes, food products, mineral oil, gas etc. are mainly found here.

2.Continental slope

At the outer edge of continental shelf. The slope suddenly steepens. The most important characteristic of these slopes is that it extends upto 3600 m to 8100 m of depth. The deposition of Alluvial soil is found in much lesser quantities. In the absence of sun rays and lack of food material very less quantity of living creatures and vegetation is found here. It occupies about 8.5 % of the entire area of the oceans. The slope varies between 2°to 5°.

3. Deep Sea Plains

The end of the continental slope marks the beginning of deep sea plains. It is an extensive plain region of the oceans which has negligible slope. There is almost absence of erosional activities here.

4. Ocean Deeps

It refers to deep depressions and trenches found on ocean basins. On the basis of size they are divided into two parts-1) Deeps and 2) Trenches. Long ,narrow and very deep depression existing on the deep ocean basin is Ocean Deeps. They are formed due to folds or faults. Its average depth is 5500 m. They are also called ocean canyons. Its major examples are Mariana, Challenger ,Tonga and Sunda.

Oceanic temperature

The temperature of the ocean is important for vegetation as well as living creatures. The temperature of the oceans not only affect the living creatures and vegetation of the oceans but it also affect the climate (as a result, organisms and vegetation too) of the coastal areas. This is the reason why the study of temprature of sea water has

gained importance. The most important source of temperature for Ocean is the Sun. Besides this negligible amount of temperature is also contributed by the interior of the earth beneath the ocean bottom and the pressure of the water.

The factors that affect the temperature of the oceans.

1. Latitude

The temperature starts decreasing from the equator towards the poles as the rays of the sun become oblique towards the poles, therefore the amount of solar radiation keeps on decreasing towards the poles. Therefore the temperature of the ocean water between 40° north and south of the equator remains lower than the temperature of the winds but it increases beyond 40° latitude towards the poles.

2. Variation in the distribution of land and sea

Variation in distribution of temprature occur due to dominance of land mass in northern hemisphere and dominance of water in southern hemisphere.

3. Duration of the day

If the length of the day is longer, the amount of radiation recieved will be greater and the ocean water will be comparitively more warm, contrary to this the amount of insolation recieved by ocean water will be less if the length of the day is short.

4. Clear Atmosphere

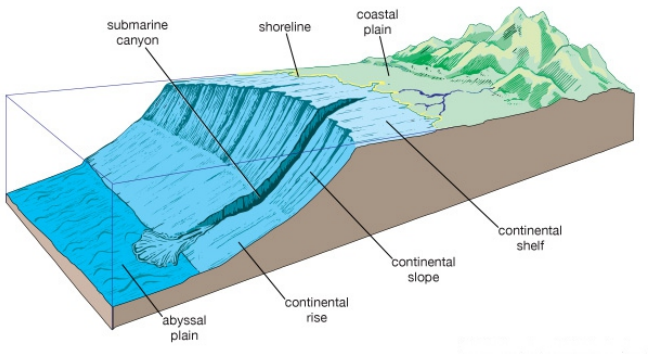


Fig.19.2 : Relief of the Ocean

When the atmosphere is clear, the insolation reaches in greater amount on the surface of water which warms water more. In the absence of transparency of weather, lower amount of insolation is recieved due to which the ocean water gets lesser heated.

5. Distance of Earth from the Sun

When the earth is closest to the sun, the sea water gets more heated, due to the reciept of solar radiation in greater amount.

6. Number of Solar Spots

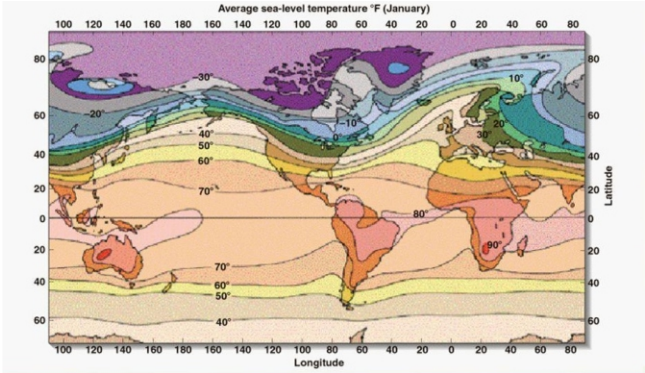
With the increase of number of sunspots on the sun towards the earth, the solar radiation increases and when its number is less, there is lesser solar radiation. The sun spots are related to sun's gravitational force.

7. Ocean Currents

The ocean currents affect the temperature of the sea water. Cold ocean currents reduce the temperature and warm ocean currents increase it.

Horizontal distribution of ocean temperature

Generally the temperature of ocean water decreases with the increase of latitudes.



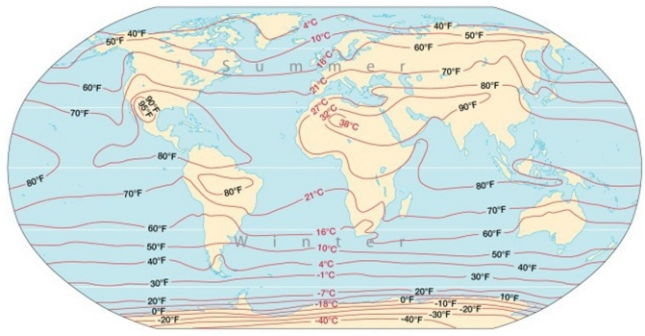


Table 19.1
Surface Temperature of the Oceans (in °C)

Latitude	Atlantic Ocean	Indian Ocean	Pacific Ocean
70-60 N	5.60	-	-
60-50 N	8.66	-	5.74
50-40 N	13.16	-	9.99
40-30 N	20.40	-	18.62
30-30 N	24.16	26.14	23.38
20-10 N	25.81	27.23	26.42
10-0 N	26.66	27.88	27.20
0-10 S	25.18	27.41	26.01
10-20 S	23.16	25.85	25.11
20-30 S	21.20	25.53	21.53
30-40 S	16.90	17.00	16.98
40-50 S	8.68	8.67	11.16
50-60 S	1.76	1.63	5.00
60-70 S	1.30	1.53	.03

Fig.19.3 : Temperature of January and July

A detailed description of horizontal distribution of temprature of the ocean water is given in the Table 19.1.

On the basis of the above table, it is observed that the temperature decreases towards the poles. There is minor increase in temperature between 20° to 30° North latitudes and the sequence of decrease in temperature continues again only in atlantic ocean. Due to the lesser extension between 20° to 30° latitude in the Indian Ocean, the rate of temperature decrease is very low.

Broadly, the rate of decrease of temperature from equator towards the poles is 1\2° degree per latitude.

Vertical distribution of temperature

The vertical distribution of temperature depends on the amount of solar radiation absorption, horizontal displacement and vertical movement of water.

The sun rays provide heat up to 25 m depth by entering in ocean water. Beyond this depth, the heat received by the solar radiation is almost negligible. Therefore the surface of the ocean water is more heated. The cold water of the poles becomes heavier, and it settles in the bottom, on the other hand the equatorial warm waters being lighter flows in the form of surface currents towards the poles. This way the temprature of ocean water remains in circulation constantly.

The temperature of ocean water decreases at a rapid rate upto 2000 m of depth. After this the rate of decrease of temperature slows down. This fact can be observed in open oceans. In partially surrounded oceans such as the Mediterranean Sea and the Red Sea, the decreasing rate of the temperature is much lower than the nearby open oceans

Oceanic salinity

Generally, 'the ratio between the weight of the water and the weight of the dissolved material in it' is called oceanic salinity.

Sea water is salty due to salinity present in ocean water. About 4.10 million tonne of salt is present in 1 cubic km of ocean water. On this basis, if the salt of the entire hydrosphere is laid uniformly on the earth, a layer of 150 m thick of salt will cover the whole Earth. The salinity of the ocean is expressed in in terms of amount of salt present per

Table 19.2
Salts found in ocean Water

Sr. No.	Name of the Salt	Amount per thousand gram	%age of total Salt
01	Sodium Chloride	27.213	77.8
02	Magnesium Chloride	3.807	10.9
03	Magnesium Sulphate	1.658	4.7
04	Calcium Sulphate	1.260	3.6
05	Potassium Sulphate	0.863	2.5
06	Calcium Carbonate	0.123	0.3
07	Magnesium Bromino	0.076	0.2
	Total	35,000	100

thousand grams of water (°\00). The salinity of the ocean water is 35 per thousand (°\00) or one thousand grams of ocean water contains of 35 gm of salt. The main source of salinity of the ocean is the earth. The major sources of salinity are rivers, sea waves ,winds and volcanic eruptions.

Although the amount of salt varies in the ocean water but the relative ratio of salts almost remains similar.

According to W.Dittmar (1884), there are 47 different types of salts present in the ocean water. The percentage of main salts is given in table 19.2.

Approximately the total amount of different salts present in ocean water is 50 lakh billion tonnes, in which the quantity of sodium chloride is highest.

Sources of salts

The rivers are the most important source of salt in ocean water, as it deposits 16 million tons of salt every year brought from the terrestrial regions to the oceans.Ocean water keeps evaporating but the salinity is accumulated in it. According to some scholars, most of the salts were received from the layers of the crust, during the formation of the oceans.

Factors affecting salinity of the oceans

1. Evaporation

There is a direct relationship between evaporation and salinity thus it means, as the rate and intensity of evaporation increases , the salinity will also increase in the same proportion. Low humidity in the wind, is essential along with the evaporation. The rate of evaporation and salinity is higher in the areas with high temperatures, like regions near Tropic of Cancer and Capricorn.

2. Availability of water by rain

The salinity decreases due to availability of a higher amount of the fresh water. Salinity is reduced in the regions ,which receive high amount of rainfall. Despite of high temperature in the equatorial regions, salinity is low in due to heavy rainfall on the other hand in the tropics which receive comparatively low rainfall and high range of temperature, have higher salinity. The excess water in the temperate regions, is supplied by the melting of the glaciers from the polar areas which increases the volume of water and decreases the salinity.

3. Influx of river water

The rivers bring salt along with them despite this, the extensive volume of water of the rivers, decreases the salinity at their mouths. For example low salinity is found at the mouth of the rivers Ganga ,Congo Niger , Amazon and St. Lawrence.

4. Prevailing winds

The winds blowing from the tropical and arid regions, towards oceans increase the rate of evaporation. Thus , highest salinity is found in these regions. Contrary to this, lesser salinity is found in the regions where cold, humid and low velocity winds prevail.

5. Ocean currents

The ocean currents flowing from areas with low salinity tend to decrease the salinity along their course. On the other hand the ocean currents flowing through the areas of the higher salinity, increase the salinity of the regions along their course.

6. Circulation of oceanic water

The distribution of salinity in the open seas is continuously effected by circulation of ocean water. The water with higher salinity gets heavier and descends downwards and moves towards lesser saline water. The surface water, which has low salinity moves along the surface of the ocean. In this way salinity balance is maintained in the ocean water.

Horizontal distribution of salinity in ocean water

Uneven distribution of salinity is found in tropics. Uneven distribution of salinity is also found in open seas, landlocked Seas or partially enclosed seas.

Distribution of salinity in open seas

Highest amount of salinity (36 per thousand) is found in the Tropical regions. High temperature, warm and dry prevailing winds, high rate of evaporation, less rainfall, lesser influx of fresh water are the main causes of higher salinity in these

regions. But the amount of salinity decreases towards poles and equator. But low amount of salinity is found in polar regions in comparision to equatorial regions. The melting of the glaciers in the polar regions provide freshwater and lower rate of evaporation are the major causes behind this. The influx of fresh water and rate of evaporation, both are more in equatorial regions. Local difference are found in the distribution of salinity along the coastal regions. For example low salinity is found at the mouth of rivers Amazon, Congo,Niger and Indus due to ample supply of fresh water.

The salinity of 38 °/00 is found in the Saragossa Sea of North Atlantic Ocean. The main cause of high salinity in this region, is the circular motion of the ocean currents, as this water does not mix with the water of nearby regions.

The lines joining the regions of equal salinity, are called Isohaline.

Distribution of salinity in partially enclosed Seas

The distribution of salinity in marginal seas depends on local conditions. The distribution of salinity in the mediterranean sea, varies to a great extent. The salinity in its north- eastern regions, is 39°/00 and in the south- east regions it is 41°/00. The northern part of Red Sea records 41°/00 salinity and in its southern part the salinity is 36°/00. The salinity of the Persian Gulf is 48°/00.

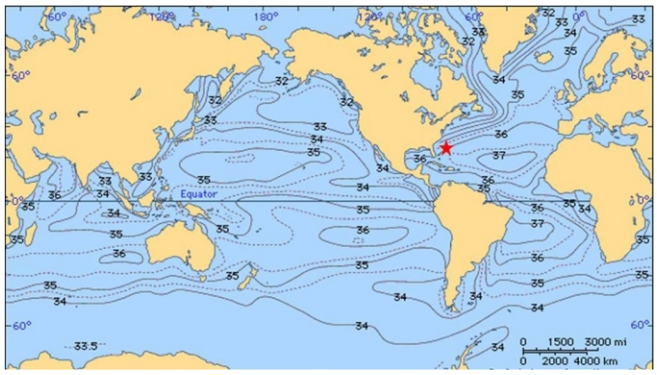


Fig. 19.4 Distribution of Salinity in the Oceans

Lack of rainfall, lower influx of freshwater and higher rate of evaporation etc are the main causes of higher salinity in this region.

The abundant influx of freshwater by rivers, supply of freshwater by melting of the glaciers, lesser rate of evaporation are some of the causes of low salinity in Black Sea(18°/00), Baltic Sea (15°/00.Gulf of Bothinia (8°/00) and Gulf of Finland (2°/00).

Distribution of salinity in Inland Seas

Inland Seas and lakes are completely surrounded by land. High temperature, very hot and dry winds, high rate of evaporation, lack of rainfall are some of the causes of high salinity (238°/00) in Dead Sea. The salinity in the southern part of Caspian Sea is 170°/00 , whereas in its northern part ,it is only 14°/00. The northern part of Caspian Sea is drained by rivers like Ural, Volga which provide influx of fresh water. Highest salinity (330°/00) is found in Lake Van of Turkey in the world.

Vertical Distribution of Oceanic Salinity

No distribution pattern of salinity is observed towards the depth of water. But still, some trends that have emerged regarding the distribution of salinity along the depth of the ocean are as follows:-

1. The salinity in the polar regions is lesser on the surface and it tends to increase with the increase in depth. The salinity at the surface of the ocean is low, as the fresh water is constantly available, as the melting of glaciers.
2. The salinity increases in mid latitudes upto the depth of 400 m, it start decreasing beyond this depth. This happens due to more of evaporation and lesser influx of fresh water.
3. In the equatorial regions, the salinity on the surface is low, then it increases upto the depth of 1000 m and beyond this, it start decreasing again.

The trends which are described above are generalized. The trends differs with different oceans. For example the salinity of the surface water of South Atlantic Ocean is 33 °/00, at the depth of 400m it is 34.5°/00 and it becomes 34.8 °/00 at the depth of 1200 m but near the 20° South latitude, the salinity on the surface is 37°/00 and it is 35 °/00 at ocean bottom. In the equatorial regions the salinity at the surface is 34°/00 and at its bottom it is 35 °/00. the salinity on the surface of Atlantic Ocean is 35.5 °/00 and at its bottom it is 34 °/00. There is lot of variation found in the distribution of salinity in partially enclosed seas.

Important points

1. The ocean bottom relief feature consists of four major parts- Continental shelf,

Continental slope, Deep Sea plains, and oceans deeps.

2. Atlantic Ocean- it occupies 16 percent area of the entire world and is half of Pacific Ocean. Its average depth is more than 3 kms. It is similar to 'S' shape alphabet. The continental shelf are comparatively broader, Dogger and Grand Bank are the major ones. Many ridges are found on its floor, one of the major ridges, is Mid Oceanic Ridge. Many trenches are found here like Guyana Trench in terms of depth and North America trench, as the most extensive trench. There are 19 ocean deeps and many islands.
3. Pacific Ocean-it is the largest ocean and extends on one third of the entire world area, triangular, surrounded by new folded mountains. The continental shelf narrow, number of ridges few in comparison to its extension, trenches are more and deeper, Philippines trench is deepest, the number of trenches is 32 and they are deeper, Mariana Trench is the deepest of all, there are more than 20 thousand islands.
4. Indian Ocean- It is small in extension, it is surrounded by land in the north, it is also surrounded by ancient plateaus on all its sides, it consists of broader Continental shelves, Chaigosa- Lakshadweep Ridge is the longest ridge, 90° East ridge is an important ridge and extends in north to south direction, it also has many basins, islands and have 6 trenches.
5. The factors affecting the temperature of ocean water are- slanting rays of the Sun, duration of the day, clarity in the atmosphere, distance between sun and the earth, number of solar spots etc.
6. The average density of ocean water is 36°/00. Major salts are- Sodium Chloride, Magnesium Chloride, Magnesium Sulphate, Calcium Sulphate, Calcium Carbonate and Potassium Sulphate.

Exercise

Multiple choice questions

1. What percentage of the Earth is covered with water?
   (A) 29 (B) 67 (C) 71 (D) 81
2. The average height of the continents is-
   (A) 10m (B) 400m
   (C) 840m (D) 1000m
3. The amount of salinity found per kilogram of ocean water is -
   (A) 35 gm (B) 45 gm
   (C) 15 gm (D) 25 gm
4. Where is Mariana Trench situated?
   (A) Pacific Ocean
   (B) Indian Ocean
   (C) Atlantic Ocean
   (D) Mediterranean sea
5. The ocean water receives heat from-
   (A) Sun
   (B) Moon
   (C) Warm Ocean Currents
   (D) On its own

Very short type questions-

6. In which ocean Mariana Trench, is located?
7. What are relief features?
8. What is topography?
9. What is the average salinity of ocean water?
10. What is the source of salinity of ocean water?

Short type questions

11. Describe relief features of Pacific Ocean.
12. What are the different parts of the relief features found in oceans?
13. What is continental slope?
14. What are the factors that affect the temperature of ocean?
15. What are the factors that affect ocean salinity?

Essay type questions

16. Explain the concept of topography and describe the topography of the oceans in detail.
17. Explain the factors that affect the distribution of temperature of ocean water.
18. Explain the concept of salinity and describe the factors that affect it.

Answer key

1. C. 2.C. 3.A. 4.A. 5.A.