

Introduction to Ocean

Three Major Components of the earth include the hydrosphere, the lithosphere, and the atmosphere. Oceans constitute the hydrosphere; the lithosphere is the layer of rocks; the atmosphere is the layer of air. The biosphere encompasses parts of these three layers. It extends several meters into the soil (lithosphere) several hundred meters (over 6 miles) into the atmosphere, and more than 11,000 meters into the ocean. The world's oceans occupy roughly 71 percent of the earth's surface. The average depth of ocean is four km. Oceans are predominant in the Southern Hemisphere, often referred as the marine hemisphere. Landmass, on the other hand, dominates in the northern Hemisphere, which is known as the land hemisphere. The land hemisphere includes the continental masses of Eurasia, North America and Africa above the equator. The marine hemisphere comprises South America, Africa below the equator, Australia, New Zealand, and Antarctica.

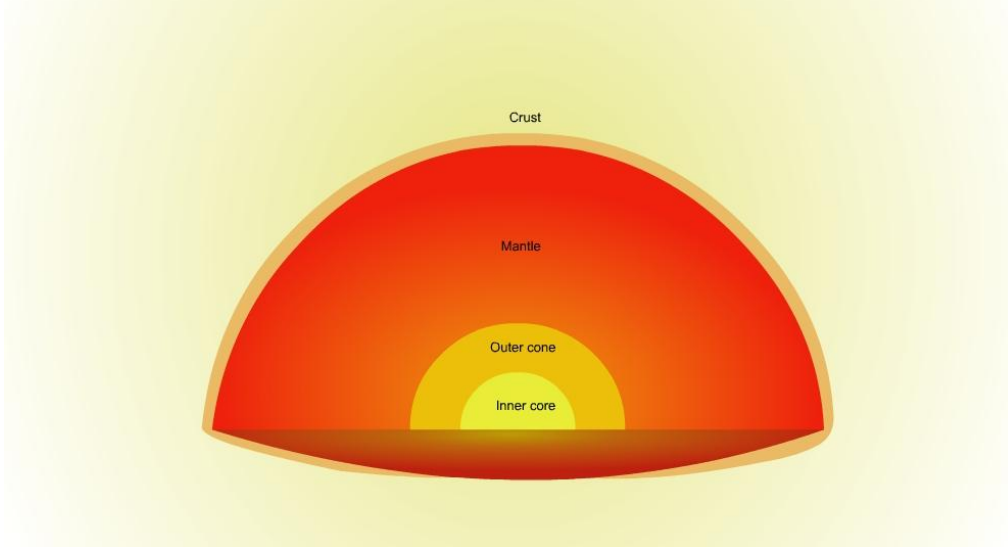
The Earth and Ocean basin

<u>Earth</u>	
Mass	5.9760×10^{27} grams
Volume	1.083×10^{12} cubic kilometers
Area	510.100×10^6 square kilometers
Equatorial radius	6378.163 kilometers
Polar radius	6356.177 kilometers
Oceans	
Volume	1.350×10^9 cubic kilometers
Area	362.033×10^6 square kilometers
Mean depth	3729 kilometers

The Earth's Interior

The earth's interior is divided into three distinct layers: the core, the mantle, and the crust.

Earth interior



The Core

Core is the innermost portion of the earth . The core of the earth begins 2,900 kilometers below earth surface and extends up to 3,480 kilometers to the center of the earth. Seismic studies have shown the existence of two cores: the outer liquid core and the inner solid core. The inner core is comprised of an alloy of iron and nickel. The iron alloy constitutes about 80 to 85 percent of the inner core; nickel and other unknown elements comprise the remainder percent.

The Mantle

Mantle is the intermediate layer between the earth's core and crust. It accounts for 84 percent of the earth's volume and 67 percent of its weight. The mantle is complex in structure. It is about 2,900 kilometers thick and is subdivided into 10 or more layers. The mantle is composed of minerals rich in silica, magnesium and iron. The amount of magnesium increases toward the surface, and the amount of iron increases toward the core. The upper mantle is hotter than the lower mantle, because it has an extensive distribution of radioactive minerals such as uranium, thorium and potassium.

The Crust

Crust is the uppermost and thinnest segment of the earth. Thickness varies from 5 to 50 kilometers. It is enriched with basaltic content in the oceanic crust and granitic in the continental crust. The crust of the earth rests on the Moho and is 6 to 50 kilometers thick. The crust is thicker under continents and diminishes progressively under ocean basins. It may be 50 kilometers under mountainous regions of continents and may be lesser than 5 kilometers under ocean. The crust is divided into two principal layers: the lower layer, sima, which carries heavy concentrations of silica and magnesium, whereas the upper layer, sial, has heavy concentration of silica and aluminium.

Chapter 2: Ocean and Types

Theory of formation of the Oceans

Theories concerning the formation of the ocean varies on the characteristic topographic features of the ocean bottom. Different theory was put forth by various scientists they are

given below

1. Continental drift [theory](#):

This [theory](#) was developed by Alfred Wegener. For decades arguments for and against it did not come to an end, but precisely because of this, many branches of geosciences have been highly evolved by it. Many of Wegener’s arguments were found convincing, others were not, especially those concerning the mechanism of the drift. From the viewpoint of physics it seems unrealistic to assume that continents should be able to drift in the [earth](#)’s crust like ice flows through water.

The [theory](#) of permanent oceans:

The [theory](#) of permanent oceans dates the formation of the oceans back to the time of the solidification of the [earth](#)’s crust. **The [theory](#) of bridge continents** is a compromise between permanence and drift hypotheses. It tries to meet the demand of paleontology for land connections that might explain the different evolution of flora and fauna (e.g., the one that began between Africa and South America at the time of the Triassic).

Seafloor spreading

Vine and Hess in (1960) developed the [theory](#) of “**Sea Floor Spreading**”. It contains two concepts: The spreading of the oceans floor and the drifting of the primary crustal plates. The latter represents a form of the continental drift, although in contrast to **Wegener’s [theory](#)** it is not the continents that drift but the primary crustal plates over which the entire surface of the [earth](#) lies.

The World’s Oceans

The five major oceans in the world are the Pacific, the Atlantic, the Indian, the Arctic, and the Antarctic. The Pacific, South Atlantic and Antarctic occupy approximately 90 percent of the Southern Hemisphere. The Indian, North Atlantic, and Arctic cover the watermass in the Northern Hemisphere

TABLE-1

Ocean	Area (in millions) of square kilometers	Volume (in millions) of cubic kilometers	Depth (in meters)	Temperature	Salinity	Remarks
Pacific	166,241	696,184	4,188	3.36	34.62	Coldest, deepest, and largest ocean, occupying more than half of the volume of ocean basins
Atlantic	94,314	337,210	3,736	3.72	34.76	Received large amount of sediment from many rivers such as the Amazon, the Congo,

						the Mississippi .
Indian	77,118	284,608	3,872	3.73	34.90	Received large amount of sediment from the Indus, the Ganges, and the Brahmaputra
Total Ocean	362,033	1,349,929	3,729	3.52	34.72	Oceans occupy 70 percent of the earth 's surface

Pacific Oceans

The Spanish explorer Vasco Nunez de Balboa discovered and named the Pacific Ocean; “pacific” means peaceful. The Pacific is the largest, coldest, and deepest of all oceans. It occupies about one-third of the total surface area of the [earth](#) and contains 696 million cubic kilometers volume of water. Most of the Pacific flow is very deep where average depth exceeds 5000 meters. The Pacific Ocean forms a circular-shaped basin. Along its periphery are numerous volcanoes, faults, and trenches that form the ring of fire. The western border of the Pacific is irregular and encompasses several marginal seas: the sea of Okhotsk, the Sea of Japan, the East China Sea, the Yellow Sea, the South China Sea, the Sea of the East Indian Archipelago, the Coral Sea, and the Tasman Sea. The seas are relatively much smaller and shallower bodies of salt water. The Bering Sea and the waters of Antarctic Ocean mark the north and south boundaries of the Pacific. Hundreds of scattered volcanic islands, including Hawaii are found in Pacific ocean.

The Atlantic Ocean

The Atlantic ocean was named after the Atlas Mountains of North Africa. These mountains marked the limit of the then known world, the Mediterranean Sea. “Atlantic” probably designated their belief that the ocean lay beyond the Atlas Range. (The Atlantic Ocean is divided from [the Indian Ocean](#) by 20°E, which crosses Cape Agulhas and from the Pacific Ocean by 67°W, which runs through Cape Horn to the South Shetland Islands. The Atlantic Ocean is oblong from north to south and is irregularly shaped. It is approximately one-half the size of the Pacific and narrows considerably between the landmasses of western Africa and eastern Brazil. These protruding continental bulges on both of its sides separate the ocean into the North and South Atlantic.

The North Atlantic is surrounded by several marginal seas and bays including the Mediterranean Sea, the Baltic Sea, the North Sea, the Black Sea, the Bay of Biscay, Baffin Bay, Hudson Bay, the Gulf of Mexico, and the Caribbean Sea. The South Atlantic is bounded by west Africa, eastern South America, and the north Antarctic Ocean. The Mississippi, the Amazon.

The Indian Ocean

Historically the Indian Ocean was a well-known commercial route that linked the trade centres of Ujjain, India, Baghdad, and Alexandria. One contributing factor to the proliferation of sea trade among these cities was the monsoon currents that helped the sailors to undertake long voyages in the Indian Ocean.

The Indian Ocean is roughly triangular in shape and is enclosed by the Indian subcontinent, the east coast of Africa, and the northern and western coasts of Australia. India's three largest rivers, in terms of volume of water and length, the Ganges, the Indus, and the Brahmaputra, discharge the world's largest amount of terrestrial sediment into the Indian Ocean. The periphery of the Indian Ocean includes the Red Sea, the Persian Gulf, the Arabian Sea, and the Bay of Bengal. Madagascar and Sri Lanka are the largest-sized islands in the Indian Ocean.

Monsoon: Winds of the Arabian Sea in the Indian Ocean that flow from the ocean to the land (i.e., from southwest) during summer and from land to the ocean (i.e. north east) in winter time.

The Arctic Ocean

The Arctic Ocean, the smallest and shallowest of all oceans, exists literally "On top of the world". Its basin is almost circular shape and is bordered by Russia, Scandinavia, Greenland, Canada, and Alaska. The North Pole is located about 500 miles from its center. The surface area of arctic ocean is 5450 meters.

Floating masses of ice, the polar ice pack, cover most of the ocean during most of the year. The topography and structure of the Arctic Ocean are dominated by three submarine ridges, which result in a number of basins and deeps. The Lomonosov Ridge is a prominent structure in the Arctic Ocean. The Arctic Ocean is separated from the Pacific by the **Bering Stratis**. The ocean connect with the Atlantic via small seas on either side of Greenland; the Greenland and Norweigan seas and the Denmark Strait provide the connection to the east, and the Baffin Bay, Davis Strait, Labrador Sea provide connections to the west.

The Antarctic Ocean

The Antarctic Ocean, at times referred to as the "southern ocean", dominates the entire Southern Hemisphere with no landmass interruptions. The Antarctic Ocean extends to 40°S, touching the southern tips of Africa and Australia. It thus encompasses approximately 75 million square kilometers and accounts for over 20 percent of the total area of all oceans.

The Antarctic Ocean was intensively studied during the International Geophysical Year in 1957. Since then the United States, Russia, Australia, New Zealand, and other countries have maintained research stations for continuing study of the Antarctic Ocean. This ocean is in the path of the west winds, which trigger the powerful westwind drift, a west-east current of the upper layers of water.

List of Oceanic basins

The following are the list of oceanic basins :

1. Aleutian Basin
2. Agulhus Basin
3. Amerasian Basin, Arctic Ocean
4. Angola Basin
5. Arabian Basin
6. Argentine Basin
7. Bauer Basin

8. Blake Basin , Atlantic Ocean
9. Brazil Basin
10. Canada Basin , Arctic Ocean
11. Canary Basin
12. Cape Basin
13. Central Pacific Basin
14. Central Polar Basin
15. Chile Basin
16. Cocos Basin
17. Eurasian Basin , Arctic Ocean
18. Fram Basin , Arctic Ocean
19. Guatemala Basin
20. Guiana Basin
21. Iceland Basin
22. Labrador Basin
23. Makarov Basin , Arctic Ocean
24. Madagascar Basin
25. Melanesian Basin
26. Mexico Basin
27. Mid-Indian Basin
28. Nansen Basin , Arctic Ocean
29. Natal Basin
30. Newfoundland Basin
31. North Polar Basin
32. Northwest Pacific Basin
33. Norwegian Basin
34. Penrhyn Basin
35. Perth Basin
36. Peru Basin
37. Roggeveen Basin
38. Sierra Leone Basin
39. Somali Basin
40. South East Pacific Basin
41. South West Pacific Basin
42. South Fiji Basin
43. South Indian Basin
44. South West Pacific Basin
45. Tsushima Basin (Ulleung Basin)
46. West Australian Basin

Chapter 3: History and Composition of ocean

Distribution of land and water in the earth

- Land and water are unevenly distributed on the [earth](#)
 - Continents cover 29.2% of [earth](#) surface
 - The ocean is divided in to three basins called Atlantic, Pacific and Indian.
 - Ocean basin covers 70.8% of [earth](#) surface
 - The southern hemisphere is dominated by oceans (80.4%)
 - Northern hemisphere contains most of the land and is still dominated by ocean (60.7%)
- (Map) Northern and southern hemisphere

Chemical History of the Ocean

As conditions on the [earth](#) changes during the course of geologic time, there must have been corresponding changes in the chemical composition of the ocean. These chemical adjustments would have stemmed from the regulatory processes, much indirect evidence has been obtained by studying ancient sedimentary rock strata on the continents. These continental rocks have weathered under the attack of water containing dissolved atmospheric gases. As a result, most of the major cations have found their way to the ocean. Calcium reached saturation quite early, judging from ancient calcium carbonate and calcium sulfate deposits existing on land today. Potassium accumulated in appreciable quantities as early as 1.2 billion years ago because sediments of that age contain glauconite, a potassium-rich claylike mineral. An abundance of magnesium caused the formation of strata of dolomite, a calcium magnesium carbonate mineral. The earliest water-laid sediments appear to be about three billion years old.

The first form of life must have been anaerobic, but eventually an organism capable of photosynthesis evolved. Photosynthesizing organisms produced an excess of oxygen that gradually escaped in to the atmosphere. The amount of carbon dioxide in the atmosphere and dissolved in the sea decreased by being incorporated into organic matter. The hydrogen ion concentration (acidity) of seawater was established and held constant by the buffering action of the dissolved silica-clay mineral system and the dissolved carbon dioxide-solid carbonate system. As oxygen accumulated the ocean and terrestrial portions of the [earth](#) changed from the primordial reducing condition to an oxidizing one. Only in locations removed from contact with air or oxygenated water do reducing conditions persist today. One such location is in the sediments on the [ocean floor](#). Not only are the bulk of bottom sediments isolated from contact with oxygenated seawater, but organic matter incorporated in these sediments decomposes and consumes whatever oxygen may have become trapped in interstitial water when the sediment settled to the bottom. The oxidizing state at the interface of sediment and water has led to the formation of ferromanganese precipitates. These and organic detritus must have begun adsorbing trace metals soon after an excess of oxygen accumulated in the ocean and atmosphere.

Considerable geological evidence leads us to conclude that the volume of seawater in the ocean has been increasing throughout the [earth](#)'s history. The chemical composition of the [world ocean](#), however became very nearly what it is at present shortly after the advent of photosynthesizing organisms that is, about 1.5 billion years ago. The advent of carbonate-secreting organisms and with temperature, for instance, would have caused a decreased solubility of gases and a concomitant decrease in biological activity. Under such conditions, nutrient concentrations would have increased and carbonates would have precipitated. Nevertheless, except for the possible appearance of some new substance capable of ion exchange or chemisorptions, the effects on regulatory processes in the [world ocean](#) today are limited to changes in the rates of inorganic and biochemical reactions.

Quantity of Materials Dissolved in the [World Ocean](#)

If we assume that the amount of dissolved material in the ocean remains unchanged even today, we must also assume that the amount of dissolved material entering the sea each year is equivalent to the amount lost in sediment. Actually, the assumption cannot be validated, because scientists have measured the composition of the oceans for only a few decades. If no ions were removed from the sea, the ions added by rivers in 100 years would increase the concentrations of substances dissolved in the [world ocean](#) by only 0.0005 per cent. Rivers transport approximately 2.5×10^{15} g of dissolved material (5×10^{22} g) already present in the [world ocean](#) (this is 20,000,000 times the amount added every year). In any case, the rate of change is so small that the assumption of a steady state is reasonable.

Every kilogram of seawater in the open ocean contains about **35g of ions**. In oceanography, this concentration is expressed as parts per thousand and can be written 35‰. The measure of the concentration of total ions in seawater is called the salinity. A salinity of 35 parts per thousand is an average value for water in the open ocean.

In near shore coastal regions, bays, and especially in river estuaries, salinity is highly variable. Near river mouths the salinity of surface water may vary from nearly zero to 34 parts per thousand, but low values generally prevail. These variations are also seasonal and depend on river conditions. During summer months when rivers carry less water, near shore salinities may be close to 34 parts per thousand. During the winter rainy season or spring thaw, the seawater in the near shore region frequently becomes diluted by flood water.

Exactly the opposite conditions prevail in hot, dry regions of the world where excess evaporation causes salinities to be higher than average. Salinity values as high as 40 parts per thousand may be found in places like the Mediterranean and Red seas.

The surface layer of the ocean is separated from the deeper layers of the ocean by a permanent thermocline 100 to 700m deep that persists between the 50° to 60° north and south latitudes. It is shallow and steep at the equator but deeper and more gentle in mid-latitudes. It rises to the surface at **50° to 60° latitude** and marks the largest continental rises which extend seaward more than **500km**.