Definition: **ocean** from *Merriam-Webster's Collegiate(R) Dictionary*

(14c) **1 a** : the whole body of salt water that covers nearly three fourths of the surface of the earth **b** : any of the large bodies of water (as the Atlantic Ocean) into which the great ocean is divided **2** : a very large or unlimited space or quantity

Summary Article: **ocean**

From *The Columbia Encyclopedia*

interconnected mass of saltwater covering 70.78% of the surface of the earth, often called the world ocean. It is subdivided into four (or five) major units that are separated from each other in most cases by the continental masses. See also oceanography.

**The World Ocean**

Of the major units that comprise the world ocean, three—the Atlantic, Indian, and Pacific oceans—extend northward from Antarctica as huge “gulfs” separating the continents. The fourth, the Arctic Ocean, nearly landlocked by Eurasia and North America and nearly circular in outline, caps the north polar region. The Southern Ocean (also called the Antarctic Ocean) is now often considered a fifth, separate ocean, extending from the shores of Antarctica northward to about 60°S. The major oceans are further subdivided into smaller regions loosely called seas, gulfs, or bays. Some of these seas, such as the Sargasso Sea of the North Atlantic Ocean, are only vaguely defined, while others, such as the Mediterranean Sea or the Black Sea, are almost totally surrounded by land areas. Large and totally landlocked saltwater bodies such as the Caspian Sea are actually salt lakes.

The boundaries between oceans are usually designated by the continental land masses bordering them or by ridges in the ocean floor, which also serve as geographic boundaries. Where these features are absent (such as the ill-defined northern boundary of the Antarctic Ocean), the boundary is somewhat arbitrarily fixed by fluctuating zones of opposing currents that act as partial barriers to the mixing of waters between the two adjacent oceans.

The oceans are not uniformly distributed on the face of the earth. Continents and ocean basins tend to be antipodal, or diametrically opposed to one another, i.e., continents are found on the opposite side of the earth from ocean basins. For example, Antarctica is antipodal to the Arctic Ocean; Europe is opposed by the South Pacific Ocean. Furthermore, over two thirds of the earth's land area is found in the Northern Hemisphere, while the oceans comprise over 80% of the Southern Hemisphere.

The world ocean has an area of about 361 million sq km (139,400,000 sq mi), an average depth of about 3,730 m (12,230 ft), and a total volume of about 1,347,000,000 cu km (322,280,000 cu mi). Each cubic mile of seawater weighs approximately 4.7 billion tons and holds 166 million tons of dissolved solids. One of the most unique and intriguing aspects of ocean water is its salinity, or dissolved salt content. The measurement of salinity is essentially the determination of the amount of dissolved salts in 1 kg of

[107x589]Image from: **ocean**
The Conamara Chaos region of Jupiter's... in *Astronomy Encyclopedia*
ocean water and is expressed in parts per thousand (per thousand). Ocean salinities commonly range between 33 per thousand to 38 per thousand, with an average of about 35 per thousand. Thirty-five parts per thousand salinity is equivalent to 3.5% by weight. Six elements (chlorine, sodium, magnesium, sulfur, calcium, and potassium) constitute over 90% of the total salts dissolved in the oceans. Pressure in the ocean waters increases with increasing depth due to the weight of the overlying water. The pressure increases at the rate of 1 atmosphere for every 10 m (33 ft) of depth (1 atm=15 lb per sq in. or 1,016 dynes per sq cm). The average temperature of the oceans is 3.9 degrees Celsius (39 degrees Fahrenheit).

It now appears that the waters making up the present oceans (and the gases that make up the present atmosphere) were not of cosmic origin, i.e., were not present in the primordial atmosphere. Instead, they were derived from the interior of the earth sometime in the first one or two billion years after the earth's formation. It is now also generally accepted that a new ocean crust has been forming more or less continuously for at least the past 200 million years through a process of volcanic activity along the midocean ridge system (see seafloor spreading), which consists of a series of underwater mountains. On the basis of present knowledge it seems highly probable that all ocean waters and atmospheric gases were gradually released by the separation of these volatile components from the silicate rocks of the crust and upper mantle through volcanic activity. (Molten lava is known to contain appreciable amounts of water and other volatiles that are released upon solidification.) With the passage of time, water released by volcanic activity gradually filled oceanic depressions.

**Continental Shelves, Slopes, and Rises**

Virtually all continents are surrounded by a gently sloping submerged plain called the continental shelf, which is an underwater extension of the coastal plain. The continental shelves are the regions of the oceans best known and the most exploited commercially. It is this region where virtually all of the petroleum, commercial sand and gravel deposits, and fishery resources are found. It is also the locus of waste dumping. Changes in sea level have alternatingly exposed and inundated portions of the continental shelf. Continental shelves vary in width from almost zero up to the 1,500-km-wide (930-mi) Siberian shelf in the Arctic Ocean. They average 78 km (48 mi) in width. The edge of the shelf occurs at a depth that ranges from 20 to 550 m (66 to 1,800 ft), averaging 130 m (430 ft). The shelves consist of vast deposits of sands, muds, and gravels, overlying crystalline rocks or vast thicknesses of consolidated sedimentary rocks. Although there is a great variation in shelf features, nonglaciated shelves are usually exceptionally flat, with seaward slopes averaging on the order of 205 m per km (10 ft per mi), or less than 1° of slope. The edge of the shelf, called the shelf break, is marked by an abrupt increase in slope to an average of about 4°.

The continental slopes begin at the shelf break and plunge downward to the great depths of the ocean basin proper. Deep submarine canyons, some comparable in size to the Grand Canyon of the Colorado River, are sometimes found cutting across the shelf and slope, often extending from the mouths of terrestrial rivers. The Congo, Amazon, Ganges, and Hudson rivers all have submarine canyon extensions. It is assumed that submarine canyons on the continental shelf were initially carved during periods of lower sea level in the course of the ice ages. Their continental slope extensions were carved and more recently modified by turbidity currents—subsea “landslides” of a dense slurry of water and sediment. Many continental slopes end in gently sloping, smooth-surfaced features called continental rises. The continental rises usually have an inclination of less than 1/2°. They have been found to consist of thick
deposits of sediment, presumably deposited as a result of slumping and turbidity currents carrying sediment off the shelf and slope. The continental shelf, slope, and rise together are called the continental margin.

**Trenches, Plains, and Ridges**

One of the most surprising findings of the early oceanographers was that the deepest parts of the oceans were not in the centers, as they had expected, but were in fact quite close to the margins of continents, particularly in the Pacific Ocean. Further exploration showed that these deeps were located in long V-shaped trenches bordering the seaward edge of volcanic island arcs. These trenches are one of the most striking features of the Pacific floor. Trenches virtually encircle the rim of the Pacific basin. The trenches have lengths of thousands of kilometers, are generally hundreds of kilometers wide, and extend 3 to 4 km (1.9–2.5 mi) deeper than the surrounding ocean floor. The greatest ocean depth has been sounded in the Challenger Deep of the Marianas Trench, a distance of 10,911.5 m (35,798.6 ft) below sea level.

The deep ocean floor begins at the seaward edge of the continental rise or marginal trench, if one is present, and extends seaward to the base of the underwater midocean mountains. Many relief features of great importance are present in this region. Vast abyssal plains cover significant portions of the deep ocean basin. Such plains are occasionally broken by low, oval-shaped abyssal hills. The abyssal plains cover about 30% of the Atlantic and nearly 75% of the Pacific ocean floors. They are among the flattest portions of the earth's crust and appear to be formed by the deposition of fine sediment carried by turbidity currents that have covered and smoothed out irregularities in the ocean floor.

One of the most significant features of the ocean basins is the midocean ridge. First discovered in the Atlantic Ocean on the Challenger expedition, its relief features were further investigated during the German *Meteor* expedition of 1925–26. By the early 1960s it had been confirmed that the Mid-Atlantic Ridge was only part of a continuous feature that extended 55,000 km (34,000 mi) through the Atlantic, Indian, South Pacific, and Arctic oceans. The ridge is a broad bulge in the ocean floor that rises 1 to 3 km (0.6–2 mi) above the adjacent abyssal plains. It has a variable width averaging more than 1,500 km (c.900 mi). It is crossed by a number of fracture zones (transform faults) and displays a deep rift 37 to 48 km (23–30 mi) wide and about 1.6 km (1 mi) deep at its very crest.

**Relationship of the Ocean and the Atmosphere**

The atmosphere affects the oceans and is in turn influenced by them. The action of winds blowing over the ocean surface creates waves and the great current systems of the oceans. When winds are strong enough to produce spray and whitecaps, tiny droplets of ocean water are thrown up into the atmosphere where some evaporate, leaving microscopic grains of salt buoyed by the turbulence of the air. These tiny particles may become nuclei for the condensation of water vapor to form fogs and clouds.

In turn, the oceans act upon the atmosphere—in ways not clearly understood—to influence and modify the world's climate and weather systems. When water evaporates, heat is removed from the oceans and stored in the atmosphere by the molecules of water vapor. When condensation occurs, this stored heat is released to the atmosphere to develop the mechanical energy of its motion. The atmosphere obtains nearly half of its energy for circulation from the condensation of evaporated ocean water.

Because the oceans have an extremely high thermal capacity when compared to the atmosphere, the
ocean temperatures fluctuate seasonally much less than the atmospheric temperature. For the same reason, when air blows over the water, its temperature tends to come to the temperature of the water rather than vice versa. Thus maritime climates are generally less variable than regions in the interiors of the continents.

The relationships are not simple. The pattern of atmospheric circulation largely determines the pattern of oceanic surface circulation, which in turn determines the location and amount of heat that is released to the atmosphere. Also, the pattern of atmospheric circulation determines in part the location of clouds, which influences the locations of heating of the ocean surface.

**Currents and Ocean Circulation**

*Surface Circulation*

The surface circulation of the oceans is intimately tied to the prevailing wind circulation of the atmosphere (see wind). As the planetary winds flow across the water, frictional stresses are set up which push huge rivers of water in their path. The general pattern of these surface currents is a nearly closed system of currents, called gyres, which are approximately centered on the horse latitudes (about 30° latitude in both hemispheres). Major circulation of water in these gyres is clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. In the North Pacific and North Atlantic oceans, smaller counterclockwise gyres are developed partly due to the presence of the continents. These are centered on about 50°N lat. The most dominant current in the Southern Ocean is the West Wind Drift, which circles Antarctica in an easterly direction. The northern and southern hemispheric gyres are divided by an eastward flowing equatorial countercurrent, which essentially follows the belt of the doldrums. This countercurrent is caused by the return flow of water piled up along the eastward portion of the equatorial seas, and its return flow is uninhibited by the weak and erratic winds of the doldrums. Analysis of current records shows that a number of major currents, such as the Gulf Stream, have strong fast-moving currents beneath them trending in the opposite direction to the surface current. Such undercurrents, or countercurrents, appear to be as important and pervasive as the surface currents. In 1952 the Cromwell current was found flowing eastward beneath the south equatorial current of the Pacific. In 1961 a similar current was discovered in the Atlantic. See also tide.

*Thermohaline Circulation*

Thermohaline circulation refers to the deepwater circulation of the oceans and is primarily caused by differences in density between the waters of different regions. It is mainly a convection process where cold, dense water formed in the polar regions sinks and flows slowly toward the equator. Most of the deep water acquires its characteristics in the Antarctic region and in the Norwegian Sea. Antarctic bottom water is the densest and coldest water in the ocean depths. It forms and sinks just off the continental slope of Antarctica and drifts slowly along the bottom as far as the middle North Atlantic Ocean, where it merges with other water. The circulation of ocean waters is vitally important in dispersing heat energy around the globe. In general, heat flows toward the poles in the surface currents, while the displaced cold water flows toward the equator in deeper ocean layers.

The Ocean as a Biological Environment

The oceans hold the answers to many important questions about the development of the earth and the history of life on earth. For instance, within the rocks and sediment of the ocean floors the geological history of the earth is recorded. Fossils in this sediment record a portion of the biological history of the earth at least back to the Jurassic period, which ended about 140,000,000 years ago. The first
appearance of life on the earth is thought to have occurred in the oceans 2 or 3 billion years ago. The modern marine environment is divided into two major realms, the benthic and the pelagic, based upon the ecological characteristics and marine life associated with them. See also marine biology.

The Benthic Realm

The benthic realm refers to the floor of the oceans, extending from the high tide line to the greatest ocean depths. The organisms that live in or on the bottom are called benthos. The benthic realm is subdivided on the basis of depth into the littoral zone, which extends from high tide to a depth of about 200 m (660 ft), and the deep-sea realm. The benthic life forms are both sessile (attached) and motile (mobile). They are distributed from near-shore littoral regions to the ocean depths and play an important role in the food chain. Some benthic life forms live by predation, others sift organic matter from the water, and others scavenge the bottom for organic debris that has settled there. Benthic plants can live only in the euphotic zone, the uppermost 100–200 m (330–660 ft) of the ocean, where sunlight penetrates. Benthic animals that live below the euphotic zone often must depend on the rain of organic debris from above to supply their food needs, and thus the deep regions of the benthic realm are not highly populated except in the areas around hydrothermal vents where chemosynthesis provides an alternative food source.

The Pelagic Realm

The pelagic realm consists of all of the ocean water covering the benthic realm. It is divided horizontally into the neritic, or fertile near-shore, province and the oceanic province. Vertically it is divided into the euphotic, or photic, zone and the aphotic (without sunlight) zone. Drifting, free-floating organisms, called plankton, and organisms with poor mobile ability populate the euphotic zone. Most plankton are microscopic or near-microscopic in size. Phytoplankton are photosynthetic bacteria (cyanobacteria) and floating algae, such as diatoms, dinoflagellates, and coccolithophores. Heterotrophic plankton (zooplankton) are floating animals and protozoans of the sea and rely on the phytoplankton as food sources. Foraminifera and radiolaria are the dominant protozoan zooplankton that secrete tests (shells), which become incorporated into the sediment of the ocean floor. Many juvenile forms of swimmers (such as shrimp) or bottom dwellers (such as barnacles) pass through a planktonic phase. Marine organisms capable of self-locomotion are called nektonic life forms. Fish, squid, and whales are examples of marine nekton.

Importance of the Ocean

Throughout history humans have been directly or indirectly influenced by the oceans. Ocean waters serve as a source of food and valuable minerals, as a vast highway for commerce, and provide a place for both recreation and waste disposal. Increasingly, people are turning to the oceans for their food supply either by direct consumption or indirectly by harvesting fish that is then processed for livestock feed. It has been estimated that as much as 10% of human protein intake comes from the oceans. Nevertheless, the food-producing potential of the oceans is only partly realized. Other biological products of the oceans are also commercially used. For example, pearls taken from oysters are used in jewelry, and shells and coral have been widely used as a source of building material. Ocean water is processed to extract commercially valuable minerals such as salt, bromine, and magnesium. Although nearly 60 valuable chemical elements have been found dissolved in ocean water, most are in such dilute concentrations that commercial extraction is not profitable. In a few arid regions of the world, such as Ascension Island, Kuwait, and Israel, ocean water is desalinated to produce...
freshwater.
The shallow continental shelves have been exploited as a source of sands and gravels. In addition, extensive deposits of petroleum-bearing sands have been exploited in offshore areas, particularly along the Gulf and California coasts of the United States and in the Persian Gulf. On the deep ocean floor manganese nodules, formed by the precipitation of manganese oxides and other metallic salts around a nucleus of rock or shell, represent a potentially rich and extensive resource. Research is currently being conducted to explore nodule mining and metallic extraction techniques. Ocean water itself could prove to be a limitless source of energy in the event that nuclear fusion reactors are developed, since the oceans contain great quantities of deuterium.

The oceans also are important for recreational use, as each year more people are attracted to the sports of swimming, fishing, scuba diving, boating, and waterskiing. Ocean pollution, meantime, has escalated dramatically as those who use the oceans for recreational and commercial purposes, as well as those who live nearby, have disposed of more and more wastes there (see water pollution).

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