History of Oceanography

Oceanography may be one of the newest fields of science, but its roots extend back several tens of thousands of years when people began to venture from their coastlines in rafts. These first seafaring explorers, navigators and oceanographers began to pay attention to the ocean in many ways. They observed waves, storms, tides, and currents that carried their rafts in certain directions at different times. They sought fish for food. They realized that although ocean water didn’t look different from river water, it was salty and undrinkable. Their experiences and understanding of the oceans were passed down over thousands of years from generation to generation in myths and legends.

But it wasn’t until about 2,850 years ago (850 BC) that early naturalists and philosophers started trying to make sense of the enormous bodies of water they saw from land. Because people could see only endless ocean from the shoreline, they believed the world was flat. That didn’t keep Columbus and others exploring the oceans in the late 1400s and early 1500s and finally discovering that the world is not flat, but round—a sphere whose surface is nearly 3/4—covered by oceans.

Modern oceanography began as a field of science only a little less than 130 years ago, in the late 19th century, after Americans, British and Europeans launched a few expeditions to explore ocean currents, ocean life, and the seafloor off their coastlines. The first scientific expedition to explore the world’s oceans and seafloor was the Challenger Expedition, from 1872 to 1876, on board the British three-masted warship HMS Challenger.

But modern oceanography really took off less than 60 years ago, during World War II, when the U.S. Navy wanted to learn more about the oceans to gain fighting advantages, especially in submarine warfare. This section of Deeper Discovery will give you some background and history on the science of oceanography. It will show you how important early studies were and how far we have come since then in understanding the oceans and seafloor—Earth’s inner space.

About 30,000 years ago, human cultures along the western coastline of the Pacific Ocean—in the area between what is now Australia and China—started to migrate eastward across the great expanse of the Pacific Ocean. We are not sure exactly why the migrations started, but tribal wars, disease epidemics, the search for food, or natural disasters such as large volcanic eruptions and earthquakes, may have been factors.

Polynesian Seafarers

Over about 25,000 years, these people, called the Polynesians, eventually colonized the islands of the south and western Pacific, from New Guinea in the west to Fiji and Samoa in the middle. Then they moved onward to Tahiti and finally Easter Island in the eastern south Pacific. The Polynesians colonized the Hawaiian Islands about 500 years ago. The Hawaiian Islands are among the world’s most remote island groups and were one of the last major island groups to be colonized by native cultures. How did the Polynesians manage to travel across thousands of miles of ocean without compasses, sextants, clocks, or other tools of modern navigation? Their
migration was truly one of the great achievements of early seafaring cultures, and it marks the start of oceanographic observations by people who lived in harmony with the ocean.

The Polynesians were very observant. They noted the directions that waves came from and how they affected or rocked their canoes. They had a keen sense of ocean currents and variations in bird and sea life in different places in the Pacific. They also were among the first people to use astronomical observations of the stars to help them navigate across the ocean.

They made the earliest form of navigational or oceanographic map, called stick charts. These were made of pieces of bamboo or other wood that were tied together. The locations of islands were often marked with shells or knots, and curved pieces of wood represented the bending of ocean waves around the islands and the way waves rocked their canoes. Polynesians handed down their lore of the sea in both the oral and stick map traditions.

**Mediterranean Sea Entry**

The people who lived around the Mediterranean Sea began exploring this nearly landlocked sea several thousand years ago. Sailors from Egypt, Phoenicia and Crete mapped the regional coastlines to establish some of the earliest trading routes. Early Mediterranean civilizations, including the Greeks, have passed down many myths that include gods and goddesses who ruled over nature, such as Poseidon with his triton. Many Mediterranean legends, such as Jason and the Argonauts, also involved adventures on large and dangerous seas.

Many of our earliest maps of the oceans and coastlines come from this region. These early mapmakers, or cartographers, were probably Mediterranean traders who made the maps to help them get back and forth to different cities on the Mediterranean coast.

About 2,900 years ago, the Greeks began to venture outside the Mediterranean, past the Straits of Gibraltar at the western end of the Mediterranean Sea. This narrow channel separates Europe from Africa, and the Mediterranean from the Atlantic Ocean. Just outside of the Straits of Gibraltar, early Greek sailors noticed a strong current running from north to south. Because the sailors had only seen currents in rivers, they thought this great body of water on the other side of the Straits was a very big river. The Greek word for river was okeano, which is the root of our word for ocean.

**Age of Discovery**

About 650 years ago, European explorers turned to the sea to find faster trade routes to cities in Asia and Europe. Prince Henry the Navigator of Portugal recognized the oceans’ importance to trade and commerce and he established a center of learning for the marine sciences. You could think of it as the first oceanographic institution. Mariners came to the center in Sagres, Portugal, to learn about the oceans and currents and how to make maps. These early maps provided the basis for important expeditions. In the late 1400s, Cristopher Columbus became the first European to sail westward across the Atlantic Ocean and return home. In the early 1500s Ferdinand Magellan sailed all the way around, or circumnavigated, the globe.
In the early 1700s, several European countries (mainly Spain, France and Britain) sought to expand their empires and discover new lands for raw materials, colonies or trade, and for spices from the East Indies, which they believed would help cure the Plague. They launched expeditions to survey faraway lands across the Atlantic, Pacific and Indian Oceans, and in doing so also explored the Arctic and Antarctic Oceans.

One of the most famous voyages of discovery of this time began in 1768 when the HMS Endeavour left Portsmouth, England, under the command of Captain James Cook. Over 10 years Cook led three world-encircling expeditions and mapped many countries, including Australia, New Zealand and the Hawaiian Islands. He was an expert seaman, navigator and scientist who made keen observations wherever he went. He was also one of the first ship captains to recognize that a lack of Vitamin C in sailors’ diets (due mostly to a lack of fresh fruit) caused scurvy, a serious disease that killed many sailors in those times. Cook always sailed with lots of pickled cabbage, which he insisted that the sailors eat. Scurvy was never a problem on his ships because the cabbage contained lots of Vitamin C.

In 1728, John Harrison, a British cabinetmaker and inventor, started working on an important instrument to aid seafarers navigating across large areas of ocean, far away from land or coastlines. At the time, pendulum clocks kept time. Obviously, these clocks did not work well on a ship on the rolling ocean! In 1736, after years of work, Harrison invented a clock that used a spring instead of a pendulum. It was the first marine chronometer, an instrument that could give accurate time on a rolling ship. With it, sailors could figure out how far east or west they had gone from 0° Longitude, or the prime meridian, and what longitude they were sailing past. By 1761, Harrison had built four clocks, each better than the one before. The last clock was tested on a voyage between England and Jamaica, and it kept excellent time. It ran only about 5 seconds slow per day, and the ship steered a clear course to Jamaica, a true feat in those days.

**Benjamin Franklin**

Besides being a famous statesman and diplomat, Benjamin Franklin was a well-known American scientist. He contributed to oceanography in the mid- to late 1700s by making and compiling good observations of ocean currents off the US East Coast. He was particularly interested in the Gulf Stream, a fast-moving current of warm surface water that sweeps up from Florida, along the continental slope off the US East Coast, and then bends eastward across the North Atlantic all the way to Europe. Franklin was the first to refer to the Gulf Stream as a “river in the ocean.” As Deputy Postmaster General of the American colonies, Franklin promoted using the Gulf Stream to speed up delivery of mail from America to Europe, as well as to improve other commercial shipping.

The Gulf Stream is not really a “river in the ocean” as Franklin thought. But the waters that make up the Gulf Stream are “channeled” into a certain direction and speed by many factors-including prevailing winds, the rotation of the planet, and colder currents around and below the Gulf Stream.

The amount of water carried in the Gulf Stream is equal to almost 100 million cubic meters per second, which is nearly 100 times the combined flow of all the rivers on Earth! The speed of the
Gulf Stream can be as high as 5 knots. Now you can see why ships heading north and eastward across the North Atlantic tried to stay in the current. It would nearly double their speed, so they could complete their voyages more quickly.

**Charles Darwin**

Charles Darwin’s scientific career began humbly. In 1831, and in the teeth of a gale, the HMS *Beagle*, a British warship, left Devonport, England, for an expedition to map the South American coastline and to carry out chronometer surveys all over the globe. Darwin embarked as a naturalist, although he had no formal training and had recently left Cambridge University because he grew disinterested in his studies. But he was a very sharp observer of the natural world, and he lived at a time when a revolution in thinking was going on. Scientists were feverishly re-examining age-old questions, such as how old was the Earth? How did various features of the planet form? How old and diverse was Earth’s animal life?

Darwin was also fortunate that the *Beagle* took him to the Galapagos Islands, where he observed various animals and birds that had evolved in an isolated environment. His observations led him to his famous theory of natural selection. According to Darwin’s theory, variations within species occur randomly and the survival or extinction of an organism is determined by its ability to adapt to its environment. (Another young naturalist of the time, Alfred Russell Wallace, had independently come to similar conclusions about evolution and natural selection.)

Darwin also made important observations about the geology of the islands and coastlines he visited. He proposed a theory about the formation of atolls. Atolls are coral reefs that form small islands that enclose a lagoon. They are found mostly in the Pacific. An example is Bikini Atoll located northwest of Hawaii. Darwin proposed that the foundation for the atoll was a volcano that was sinking because of its weight. As the volcano sinks, coral reefs that rim the volcano grow upwards. As long as the rate at which corals grow kept up with how fast the island was sinking, then small coral islands would remain in a ring around the now sunken volcano.

**Challenger Expedition**

Modern oceanography began with the Challenger Expedition between 1872 and 1876. It was the first expedition organized specifically to gather data on a wide range of ocean features, including ocean temperatures seawater chemistry, currents, marine life, and the geology of the seafloor. For the expedition, HMS Challenger, a British Navy corvette (a small warship) was converted into the first dedicated oceanographic ship with its own laboratories, microscopes and other scientific equipment onboard. The expedition was led by British naturalist John Murray and Scottish naturalist Charles Wyville Thompson. Thompson had previously dredged some curious creatures from the ocean depths in the North Atlantic and the Mediterranean Sea, and these discoveries persuaded the British government to launch a worldwide expedition to explore the ocean depths. The Challenger Expedition left Portsmouth, England, just before Christmas in 1872. The ship had many different types of samplers to grab rocks or mud from the ocean floor, and nets to capture animals from different levels in the ocean. Challenger also had different winches—mechanical engines used to lower and hoist sounding lines to measure how deep the ocean was. At each sampling station, the crew lowered trawls, nets and other samplers to
different depths, from the surface to the seafloor, and then pulled them back on board loaded with animals or rocks.

Challenger first traveled south from England to the South Atlantic, and then around the Cape of Good Hope at the southern tip of Africa. It then headed across the wide and very rough seas of the southern Indian Ocean, crossing the Antarctic Circle, and then to Australia and New Zealand. After that, Challenger headed north to the Hawaiian Islands, and then south again around Cape Horn, at the southern tip of South America where the Pacific and Atlantic Oceans meet. After more exploration in the Atlantic, Challenger returned to England in May of 1876.

Among the Challenger Expedition’s discoveries was one of the deepest parts of the ocean—the Marianas Trench in the western Pacific, where the seafloor is 26,850 feet, or more than 4 miles deep (8,200 meters). The deepest place in all the oceans is near where the Challenger took its sounding. It is now called the Challenger Deep and it is 37,800 feet deep (11,524 meters). The expedition also revealed the first broad outline of the shape of the ocean basin, including a rise in the middle of the Atlantic Ocean that we now know is the Mid-Atlantic Ridge. Scientists compiled the first systematic plots of currents and temperatures in the oceans. The Challenger Expedition’s exciting discoveries encouraged other countries to take interest in the oceans and to mount their own expeditions.

**Mapping Currents**

In the mid- to late-1800s, Matthew Fontaine Maury became head of the US Navy’s Department of Charts and Instruments—only to discover that the Navy had very few charts of the oceans! But it did have a big storeroom of dusty logbooks from Navy ships. In these logbooks, sea captains traveling the North Atlantic had recorded their daily locations, as well the speeds and directions of winds and currents.

Maury realized the books contained a gold mine of information. By compiling records from many ships, he saw patterns. He made charts of ocean currents and winds that helped captains plot the best sea lanes for their voyages. He added more details to these charts by asking merchant captains to make more observations and send them to him. He also asked sailors to put messages in bottles. The message noted the ship’s location when the bottle was thrown overboard. When the bottles washed ashore, the finders were asked to send Maury a note telling him where they found the bottle. In this way, Maury could figure out more detailed ocean current patterns and add them to his charts.

In the late 1800s and early 1900s, Prince Albert of Monaco used a similar method to figure out what happened to the Gulf Stream as it approached Europe. By compiling the notes he received from people who found washed ashore bottles, he determined that the Gulf Stream splits in the northeastern Atlantic. One branch heads toward Ireland and Great Britain, while another part of the Gulf Stream heads south past Spain and Africa, and then back west.

Prince Albert’s knowledge of currents proved valuable during World War I. He was able to tell military officials how explosive mines would drift in the ocean and where they would land.
Authorities found mines just where Prince Albert had predicted and disarmed them before they exploded.

**Oceans as Battlefields**

The oceans have always played a big role in wars. Ships transported armies and supplies, blockaded harbors, besieged cities, and attacked enemy ships doing the same things. But the Civil War helped launch a stealthy new seagoing weapon that became common in 20th century warfare—submarines.

To combat this new threat, Navy leaders soon realized that they could detect submarines using sound transmitted through water. Huge efforts began to develop sonar, a word that is a combination of abbreviations (an “acronym”) for “sound,” “navigation” and “ranging.” (Interestingly, sonar was first developed to help avoid icebergs after the *Titanic* sank.)

For oceanographers, sonar provided a much easier way to measure the ocean depths accurately. On the 1872-76 Challenger Expedition, for example, crew members threw overboard a 200-pound weight attached to miles of hemp rope. They waited until it hit bottom, measured the rope length, and then had to haul it back on board—a process that took hours for one measurement!

Sonar allows scientists to use sound waves to measure the distance from the ocean surface to the seafloor. Ships’ hulls are equipped with devices called transducers that transmit and receive sound waves. Echo sounders were first used for oceanographic studies during the epic German expedition exploring the South Atlantic in the mid-1920s aboard the Meteor. Today echo sounding remains the key method scientists use to make bathymetric maps of the seafloor. For the last 30 years, marine scientists have used multi-beam sonar, which can automatically make very detailed contour maps of large areas of seafloor as a research ship travels fast (about 12 knots) over the ocean surface. Today, many different types of sophisticated sonar’s exist. They can tell us not only about seafloor depths, but also about the structure of the ocean floor and even about currents and life in the ocean.

The military also developed other tools that also proved useful to oceanographers, such as the magnetometer, which measures magnetic fields. The Navy uses it to detect the large metal hulls of submarines. Oceanographers use it to learn about magnetic properties of seafloor rocks. As it turned out, these properties provided key clues that completely changed our thinking about how our planet works.

**Continental Drift**

Until only recently, geologists had thought that Earth’s surface hadn’t changed much since the planet formed 4.6 billion years ago. They believed that the oceans and continents were always where they are now.

But less than 100 years ago, a German scientist named Alfred Wegener took notice of some interesting findings. Similar plant and animal fossils were found in both Africa and South
America and on other continents separated by oceans. Similar rock formations were also found on distant continents. This suggested that the formations were once whole and later divided.

Wegener also noticed that if you could shove western Europe and Africa together with North and South America, their coastlines would fit together very neatly. All this evidence led Wegener to believe that the continents were once connected but had separated and drifted apart.

In 1915, Wegener proposed his continental drift theory. He said that the continents floated atop the mantle—a heavier, denser layer of rocks deep within the earth. Wegener predicted that heat rising within the hot mantle created currents of partially melted rocks that could move the continents around the earth’s surface.

Like many revolutionary theories, Wegener’s was not initially accepted by scientists. The “good fit” of the continents and the fossil and rock evidence did not provide enough proof. For decades afterward, scientists still did not understand how massive continents could be transported across the face of the Earth, and they had no evidence of any process that could cause continents to move.

In the 1950s and 1960s, marine geologists such as Bruce Heezen, Marie Tharp, and Henry Menard used data from echo sounders to map ocean ridges in the North Atlantic and the Pacific. They noticed first that these ridges stretched on for thousands of kilometers in long, continuous mountain chains that wound around the Earth’s surface, almost like the stitches on a baseball. The scientists also observed that the crest of the ridges had a topography that closely resembled volcanic rift zones on land. At their crests, they had V-shaped central valleys with steep faults on either side. This evidence led early marine geologists to deduce that the mid-ocean ridges were formed by seafloor volcanoes.

When these volcanoes erupted, they spewed out lava that cooled and solidified to become new seafloor. It was soon discovered that when this lava cooled, magnetic particles within it aligned with Earth’s magnetic field. After World War II, when magnetometers began to be used to survey the seafloor’s magnetic properties, scientists were surprised to learn that Earth’s magnetic field had flip-flopped many times over its history, with the north and south poles exchanging places! So depending on when seafloor rocks were formed, their particles are aligned in either one direction or the other, and they are said to have either positive or negative magnetic anomalies.

In the late 1960s, magnetometer data revealed an alternating “striped” pattern of seafloor rocks. Rocks that formed when Earth’s magnetic field was in one position alternated with rocks that formed when the field was reversed. The stripes ran parallel to the mid-ocean ridges and extended out hundreds of miles on either side of them. The seafloor’s permanent magnetic signatures showed that new ocean crust was created at the ridge crests and then spread outward in both directions.

This seafloor spreading hypothesis had been proposed a few years earlier by Harry Hess, a petrologist at Princeton University, and Robert Dietz, an oceanographer in the US Coast and Geodetic Survey (the federal department that made maps of the oceans and US coastlines). Hess
went on to say that as the ocean crust spreads and cools over millions of years, it becomes denser and eventually sinks down into oceanic trenches, or subduction zones, a long way from where it forms at the mid-ocean ridge crest. As ocean crust descends toward the hot mantle, it melts and becomes recycled into the mantle.

Volcanoes and earthquakes are common in subduction zones, which often occur at the edges, or margins, of continents. The Rim of Fire, which is named for its volcanoes and earthquakes, is created by a series of subduction zones along the coastlines surrounding the Pacific Ocean—from western South and Central America to the Aleutian Islands in Alaska, down the western Pacific, from Japan and the Philippines, all the way to Indonesia and New Zealand.

In 1965, a Canadian geophysicist, J. Tuzo Wilson, combined the continental drift and seafloor spreading hypotheses to propose the theory of plate tectonics. Tuzo said that Earth’s crust, or lithosphere, was divided into large, rigid pieces called plates. These plates “float” atop an underlying rock layer called the asthenosphere. In the asthenosphere, rocks are under such tremendous heat and pressure that they behave like a viscous liquid (like very thick honey). The term “continental drift” was no longer fully accurate, because the plates are made up of continental and oceanic crust, which both “drift” over Earth’s face.

Tuzo Wilson predicted three types of boundaries between plates: mid-ocean ridges (where ocean crust is created), trenches (where the ocean plates are subducted) and large fractures in the seafloor called transform faults, where the plates slip by each other. Plate tectonics has provided a unifying theory that explains the fundamental processes that shape the face of the Earth.

Ocean Drilling

Oceanographers had been able to collect sediment and rock samples from the ocean bottom ever since the Challenger Expedition. But they did not have the technology to enable them to probe very far beneath the seafloor.

In 1968, an international group of oceanographic institutions and the U.S. National Science Foundation created a program of ocean drilling. Its initial goal was to test Tuzo Wilson’s hypothesis of plate tectonics.

For 25 years, the Deep Sea Drilling Project (DSDP) operated the Glomar Challenger, a research ship 400 feet (122 meters) in length that was equipped with a drilling platform and scientific laboratories. From this platform, a string of pipes descended through water 20,000 feet (about 6,000 meters) deep into the ocean bottom. At the end of the pipes was a drill that cut into the seafloor. The system collected long, thin cylinders (meters long and centimeters wide) of sediment and rock from beneath the seafloor, called cores.

The cores provided evidence to confirm seafloor spreading and plate tectonics, but they also revealed much more. The long sections of sediments that accumulated layer by layer on the seafloor also provided a record of how the Earth’s climate has changed during its history. The sub seafloor sediments and rock also contained a treasure trove of clues that reveal the Earth's
structure and evolution. Many of these clues cannot be found in rocks on land, because they are eroded away. But they are well-preserved below the seafloor.

The DSDP was so successful that a new international Ocean Drilling Program (ODP) was created in 1985. Ocean floor drilling continues today with a larger and more technologically advanced ship, the JOIDES Resolution. This 469-foot (143-meter) ship can drill in water that is 27,018 feet (8,234 meters) deep! It can dangle 30,030 feet (9,150 meters) of drill pipe through the hole in the center of the ship (called the "moon pool"). In addition, it has 10 laboratories where scientists can analyze the cores during cruises that typically last two months.

On drill ships, the sediment and rock cores are brought up from the bottom through the inside of the drill pipe in 30 feet long (9.5 meter) sections. Once on the deck of the ship, they are split in half. One half is studied in the ship's laboratories. The other is stored in special repositories, often called core libraries. There are three such libraries in the United States, on the East, West and Gulf coasts, and one in Bremen, Germany. Scientists from all over the world can come to these libraries and examine cores from all over the oceans—much the way you might go to a library to find a book. These core repositories will be a very valuable scientific resource for many years to come.

21st Century

Most of the major discoveries in oceanography have occurred only within the last 50 years. We have found that while rocks and sediments on land are usually wiped away by weather and erosion, rocks and sediments on the seafloor are a well-preserved archive of information that allows us to unravel Earth’s geological processes and history. We have learned that oceans play a crucial role in driving and shaping Earth’s atmosphere and climate. We have discovered hydrothermal vents on mid-ocean ridge crests, which support previously unimagined ecosystems and exotic communities of life. Heat from the Earth’s interior, rather than the sun, supports these life forms, which may hold clues to the origin of life on Earth and possibly to life on other planetary bodies.

The oceans cover 71% of Earth’s surface, and so far we have only studied a very small percentage of the ocean floor and the global ocean. Many new discoveries await us as we use new instruments and deep submergence vehicles to explore “inner space” in the 21st century.

In the future, oceanographers want to go beyond learning what’s down there in the ocean and learn what’s going on down there. They want to observe oceans processes that change over days, weeks, seasons, years or decades. But it is difficult and expensive to send research ships back to the same sites for repeat measurement. Sometimes rough seas and stormy weather make it impossible to send ships to certain parts of the oceans at certain times.

Today oceanographers are launching a new era of ocean exploration. They want to establish long-term ocean floor observatories with arrays of sensors and instruments that make continuous measurements of various ocean properties and events. Data from the observatories will be sent to shored-based laboratories via submerged fiber-optic cables or via cables linked to moored buoys that can transmit data via satellite. The data can then be made available via the Internet.
Oceanographers will use different types of remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs) that can “fly” in the oceans or along the seafloor, collecting measurements. The data can be downloaded when the AUVs surface, or when they dock at an underwater docking site and download data there. Oceanographers are also developing instrumented buoys moored thousands of miles from shore, and free-floating drifting instruments that can transmit data to scientists in their laboratories using satellites and the Internet.

Ocean observatories will greatly extend oceanographers’ reach, allowing scientists to make more measurements over larger areas of the oceans over longer periods of time.

All information has been obtained from
www.divediscover.whoi.edu/history-ocean/index.html

http://www.whoi.edu/alvin50th/