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Water and Me Series

Understanding Oceans, Gulfs & Tides

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The dictionary defines the ocean as the "whole body of saltwater that covers nearly three-fourths of the surface of the globe." Actually, there are four major ocean systems — the Atlantic, Pacific, Indian and Arctic. These oceans are easily found on a world map or globe. (See the figure on page 2).

The word pacific means peaceful. How do you think the Pacific Ocean get its name?

The word atlantic means strong. How do you think the Atlantic Ocean get its name?

What continents border the Pacific Ocean?

What continents border the Atlantic Ocean?

What continents border the Indian Ocean?

What continents border the Arctic Ocean?

The oceans are tremendous, containing nearly 330 million cubic miles of water. A single cubic mile of water contains about 9.5 trillion gallons of water. There is enough water in the ocean to fill a cylinder 75 miles in diameter and 70,000 miles high. If the earth was made smooth, oceans would completely cover the earth to a depth of 12,000 feet.

Why Are Oceans Salty?

Natural salts and minerals dissolve in water and are carried to rivers and streams by surface run-off and through groundwater discharges to the rivers or streams. The rivers and streams then carry the dissolved salts and minerals to the ocean. Much of the mineral content of seawater also comes from the seafloor itself. There has been a slow increase in the ocean's **Salinity** (salt content). The present ocean salinity is about **35 Parts Per Thousand** (PPT). In other words, a thousand buckets of seawater contain enough salt to fill 35 buckets with salt; however, ocean salinity varies with location, season and depth.

Seawater is a complex mixture of more than 70 elements and thousands of compounds. Many of these compounds are the products of natural processes of living organisms. Many are produced by chemical reactions that occur in seawater itself. In the past century, however, human technology has added other chemicals to the ocean. Some of these chemicals can be harmful to oceans and affect the quality of seawater.

Activity

You will need one-half cup of salt, two cups of sand, one cup of warm water, and a glass microscope slide.

1. Mix the sand and salt and pour in a shallow pan, forming a pile. The pan represents the ocean floor. What does the sand and salt represent?

2. Slowly pour the water over the sand-salt pile. What happens to the pile?

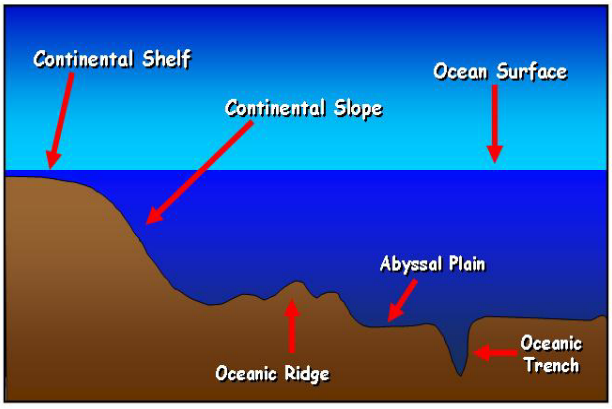
3. Place a drop of tap water and a drop of water from the pan on the glass slide. Allow it to evaporate. Describe what remains in place of the two drops. Are there differences? Why not?

What is the Ocean Floor Like?

The oceans occupy large depressions in the earth's surface called **basins**.

Picture a canyon larger than 10 Grand Canyons, a 40,000 mile-long mountain chain or a 3,000 mile-long cliff over one mile high. These are some of the awesome features hidden on the ocean floor.

The surface of oceans show several general features. A shallow rim, called the **continental shelf**, surrounds the continents. This area is usually less than 600 feet in depth and may extend from a few hundred feet to hundreds of miles from the shore. It is the most productive part of the ocean and the most readily affected by human activity.



Moving seaward, the continental shelf slopes downward, forming the **continental slope**. It may plunge uninterrupted for two to three miles to the ocean floor and is one of the most impressive features of the ocean basin. The face of the continental slope is cut by deep gorges and canyons.

The deep ocean floor, called the **abyssal plain**, averages two miles in depth and occupies 71 percent of the total sea area. In many areas, it is completely flat, covered by sediments. This vast, flat plain is often interrupted by towering mountains and mountain ranges called **oceanic ridges**.

A continuous, undersea mountain range runs along the Atlantic, Indian, Arctic and Pacific Oceans, stretching nearly 40,000 miles. It is the longest mountain range in the world, averaging more than one mile high. Another interesting feature of the ocean floor is the deep openings called **oceanic trenches**. They are V-shaped and very deep, extending more than 30,000 feet below the surface.

What Causes Tides?

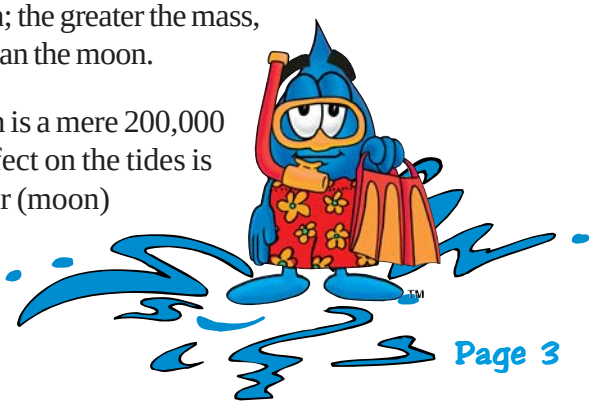
Nearly everyone who has visited a coastal beach has noticed the gradual, daily change in the water level along the shore. These changes are called **tides** and are caused by the gravitational pull of the moon and sun on the earth's surface. **Gravity** is the attractive force between bodies. The earth's gravity keeps the moon in orbit around the earth, while the moon's gravity causes tides on the earth. The sun's gravity holds the earth in orbit around it and also influences the tides.

The distance between objects affects their gravitational attraction; the closer the objects, the greater the attraction. Tides will be higher or lower when the moon is closest to the earth because it has a greater gravitational attraction on the earth's surface.

The mass (amount of matter) of objects affects their gravitational attraction; the greater the mass, the greater the attraction. The sun is several million times more massive than the moon.

The sun is approximately 93 million miles from the earth, while the moon is a mere 200,000 miles away. Because the sun is so far from the earth, its gravitational effect on the tides is about half that of the moon. Because of this, tidal cycles follow the lunar (moon) cycles.

The moon's gravitational pull on the earth causes a bulge in the ocean on opposite sides of the earth. The crest (top) of the wave is **high tide**,



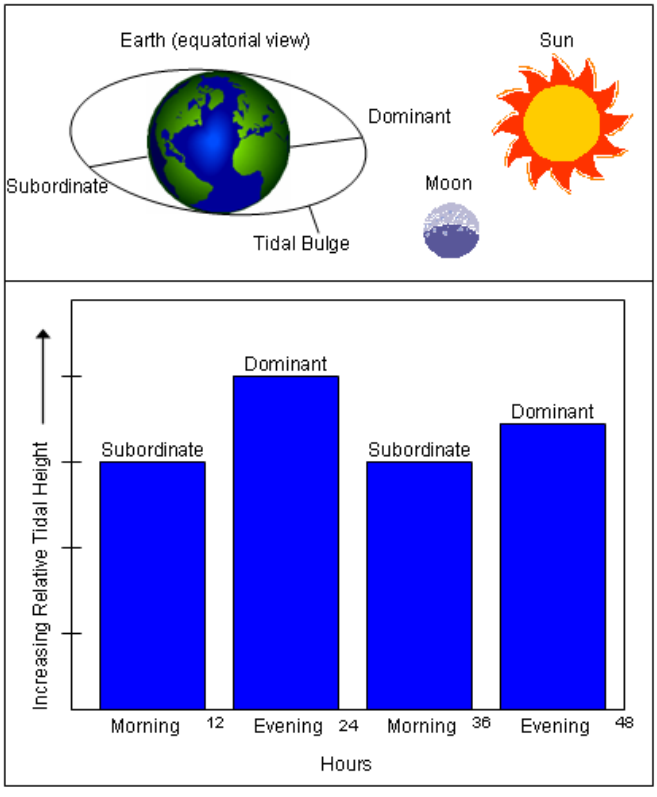
while the trough (bottom) of the wave is **low tide**. While the water directly under the moon is pulled toward it, the earth is pulled away from the water on the opposite side. The result is high tides on sides of the earth opposite the moon and low tides on sides of the earth that are right angles to the moon.

The rotation of the earth on its axis also affects the tides by increasing the building effect on the ocean through **centripetal force**. Objects moving in a circular path want to keep moving in a straight line. Remember the last time you were sitting in a car making a sharp turn? You were pulled toward the side. This is an example of centripetal force. Likewise, the ocean is thrown outward from the earth's surface by the spinning motion of the earth.

The earth's rotation on its axis causes the huge tidal bulges on the ocean's surface to travel over the earth. This usually results in two high tides and two low tides each day for any one place. However, due to the irregular shape of the continents and the ocean basin, many coastal areas have fewer daily tides or extremes between high and low tide levels. The **tidal range** is the difference between high and low tide levels. The Great Lakes in the United States and the Mediterranean Sea in Europe have tide ranges of only a few inches. The Bay of Fundy in Nova Scotia has a tidal range of over 40 feet.

The **ebbing** (outgoing) and **flowing** (incoming) tides often produce strong currents, especially in channels, rivers and inlets. The ebbing tides move sediments and carry nutrients from the shoreline. The flowing tidal currents bring in fresh food supplies and fresh seawater.

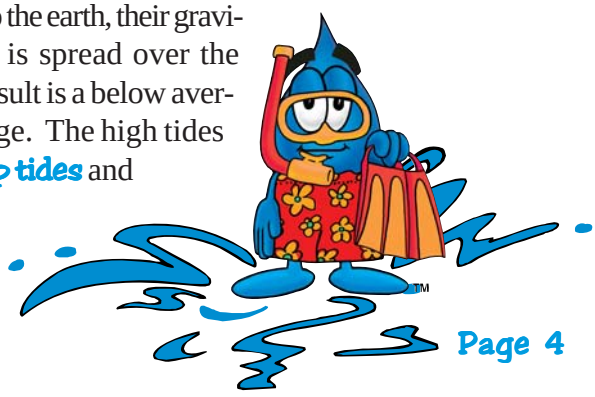
What are Tidal Cycles?



Sun, Earth, Moon tidal system

If you look at a tide chart, you will notice that the tides run about 50 minutes later each day. This is because the moon revolves around the earth as the earth rotates on its axis. During the time the earth completes one rotation (24 hours), the moon has travelled more than 54,000 miles in its orbit around the earth. If a given point on the earth is directly under the moon, it takes approximately 24 hours and 50 minutes for it to pass under the moon again. You have probably noticed that the moon appears in the same place in the sky 50 minutes later each evening.

The daily changing water levels of high and low tides are caused by the sun. The sun also influences the tides, but since it is so far from the earth, its effect is much less than that of the moon. When the sun and moon line up on the same or opposite sides of the earth, their gravitational pull on earth combines, and the tidal ranges gradually increase. Called **spring tides**, the high tides are higher than average and the low tides are lower than average. **Spring tides** occur during **new** and **full moons**. When the sun and moon are at right angles to the earth, their gravitational pull is spread over the earth. The result is a below average tidal range. The high tides are not very high and the low tides are not very low. These are called **nap tides** and occur during quarter moons.



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