

Earth Systems, Structures, and Processes

Earth Systems, Structures, and Processes

8.E.1 Understand the hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans.

8.E.1.1 Explain the structure of the hydrosphere including: Water distribution on earth Local river basin and water availability

8.E.1.2 Summarize evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms:

- Estuaries
- Marine ecosystems
- Upwelling
- Behavior of gases in the marine environment
- Value and sustainability of marine resources
- Deep ocean technology and understandings gained

8.E.1.3 Predict the safety and potability of water supplies in North Carolina based on physical and biological factors, including:

- Temperature
- Dissolved oxygen
- pH
- Nitrates and phosphates
- Turbidity
- Bio-indicators

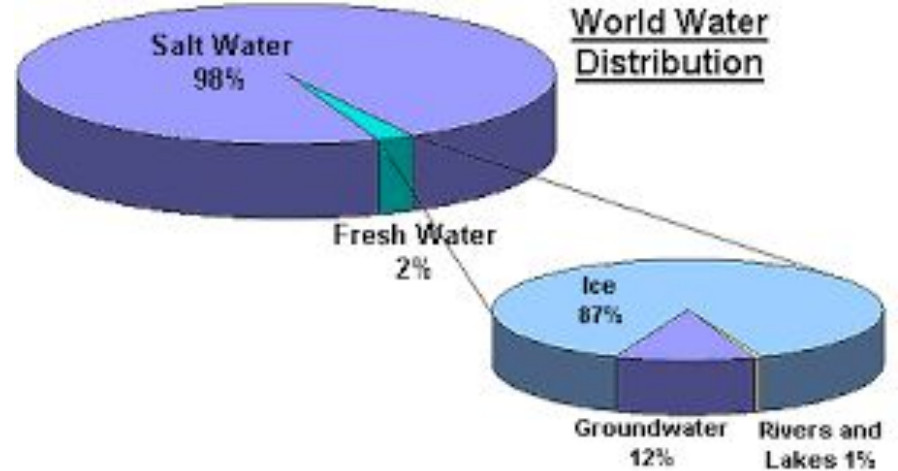
8.E.1.4 Conclude that the good health of humans requires:

- Monitoring of the hydrosphere
- Water quality standards
- Methods of water treatment
- Maintaining safe water quality
- Stewardship

Watered Down

What are some of water's roles on Earth?

- Water shapes Earth's surface and weather, and it is vital for life. A human is over 70% water.
- Only 3% of Earth's water is drinkable, and of that, over 75% is frozen in the polar icecaps and not readily available for our use.
- It is therefore important to protect our water resources.



What are some of water's roles on Earth?

- All weather is related to water.



- Water constantly moves from Earth's surface to the atmosphere, and returns back to Earth's surface as rain, snow, hail, or sleet.
- Weather also depends on the amount of moisture in the air.

What are some of water's roles on Earth?

- Over time, water can completely reshape a landscape.
- Rain, rivers, and ocean waves slowly wear away rock and carry away sediment and soil.
- Glaciers scrape away rock and soil, depositing sediment elsewhere when the glacier melts.

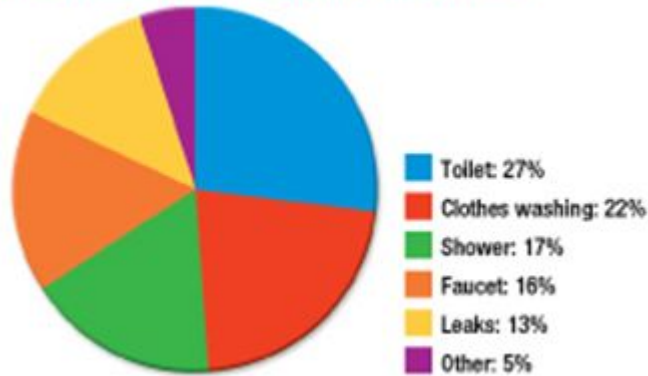
What are some of water's roles on Earth?

- Every living thing is largely made up of water, and nearly all biological processes use water.
- Water is needed for an organism's cellular chemistry, and to regulate temperature and transport substances within the body.
- For humans, clean water is vital for survival and good health. Contaminated water sources are a major public health problem.

What are some of water's roles on Earth?

- Household uses of water include drinking, bathing, flushing toilets, and washing clothes and dishes.

Household Water Use in the United States



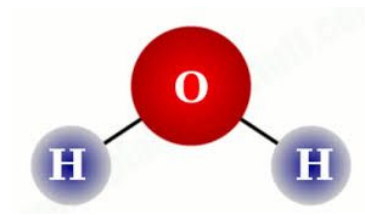
Source: American Water Works Association Research Foundation, 1999

What are some of water's roles on Earth?

- Industrial uses of fresh water include the manufacture of goods, cooling of power stations, extraction of minerals, and generation of energy.
- Water is also used for agriculture, particularly to irrigate crops and care for farm animals.



Molecular Attraction

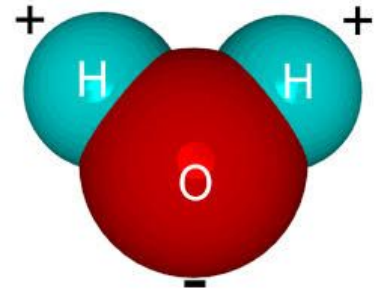


What is the structure of a water molecule?

- Matter is made up of tiny particles called *atoms*, which can join with other atoms to make molecules.
- A water molecule is made up of two hydrogen atoms and one oxygen atom—in other words, H_2O .
- Each hydrogen atom is linked to the oxygen atom, forming a shape like a cartoon mouse's ears sticking out from its head.

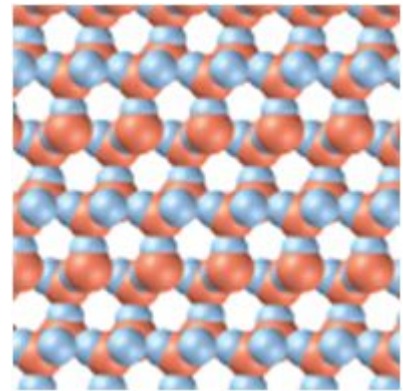
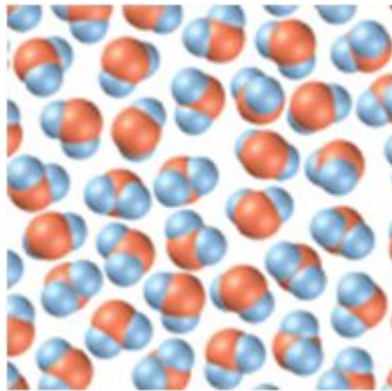
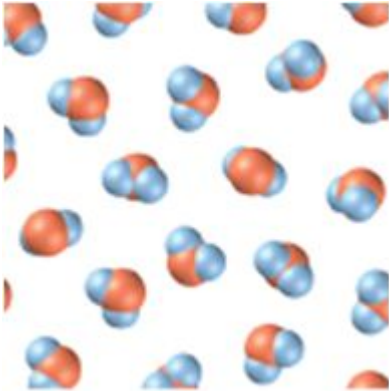
What makes water a polar molecule?

- The water molecule has a partial positive charge around the hydrogen atoms and a partial negative charge at the oxygen atom.
- Anything that has a positive charge at one end and negative charge at the other end is said to have **polarity**. A water molecule is polar.
- In liquid water, the negative end of each water molecule is attracted to the positive end of another water molecule.



What states of water occur on Earth?

- Most of Earth's water is in liquid form.
- Liquid water can change into an invisible gas called water vapor, or it can freeze into solid ice or snow.



The Universal Solvent

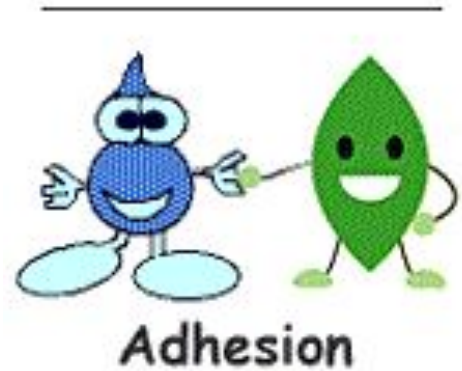


What are four properties of water?

- The property that holds molecules of a substance together is called **cohesion**.
- Water molecules stick together tightly because of their polarity, so water has high cohesion.
- Because of cohesion, water forms droplets and can fill a glass above the rim. Also because of cohesion, some insects can walk on still water.

What are four properties of water?

- The property that holds molecules of different substances together is called **adhesion**.
- Water molecules can stick to the molecules of other polar substances, which are said to be “wetable.”
- Conversely, water rolls off unwettable or “waterproof” materials, which are made of non-polar molecules.

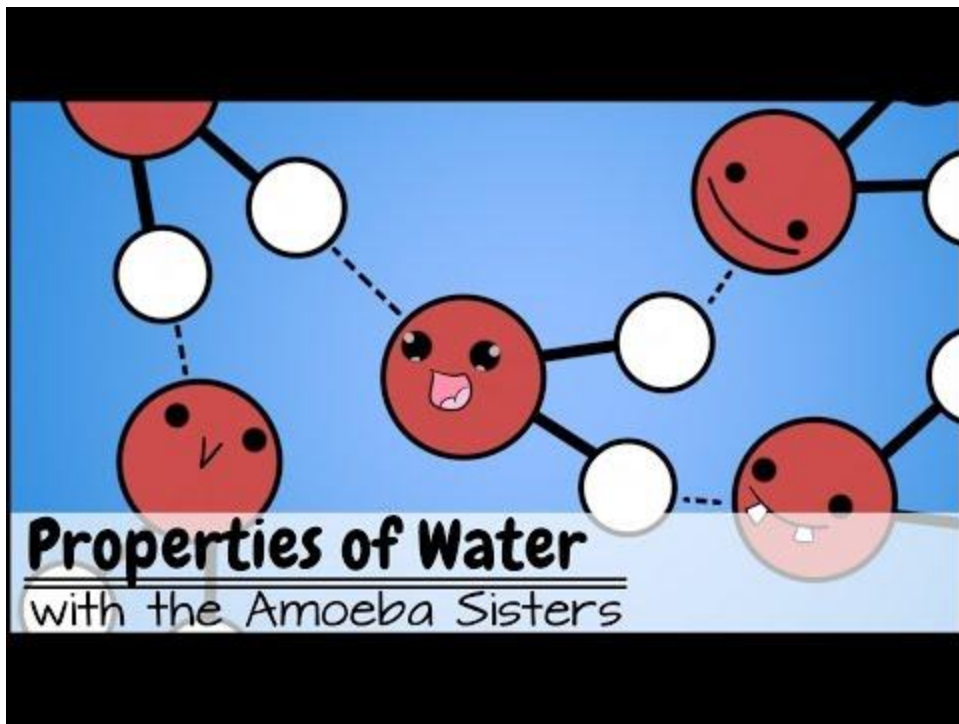


What are four properties of water?

- The energy needed to heat a substance by a particular amount is called its **specific heat**.
- Because of its polarity, water has high specific heat and can absorb more energy than many other substances can.
- Water has the ability to store and release heat, which is very important in regulating the weather and climate.

What are four properties of water?

- A liquid that dissolves substances is called a **solvent**.
- Because of its polarity, water dissolves many substances and is often called the universal solvent.
- As a solvent, water is very important for living things, transporting dissolved substances and enabling chemical reactions within organisms.



Properties of Water

with the Amoeba Sisters

Feelin' Blue

What are Earth's five main oceans?

- Almost three-fourths of Earth is covered by ocean water. On a map, the continents appear as huge islands surrounded by a vast global ocean.
- Earth's global ocean is divided into five main oceans.
- In decreasing order of size, they are the Pacific Ocean, Atlantic Ocean, Indian Ocean, Southern Ocean, and Arctic Ocean.



What are some characteristics of ocean water?

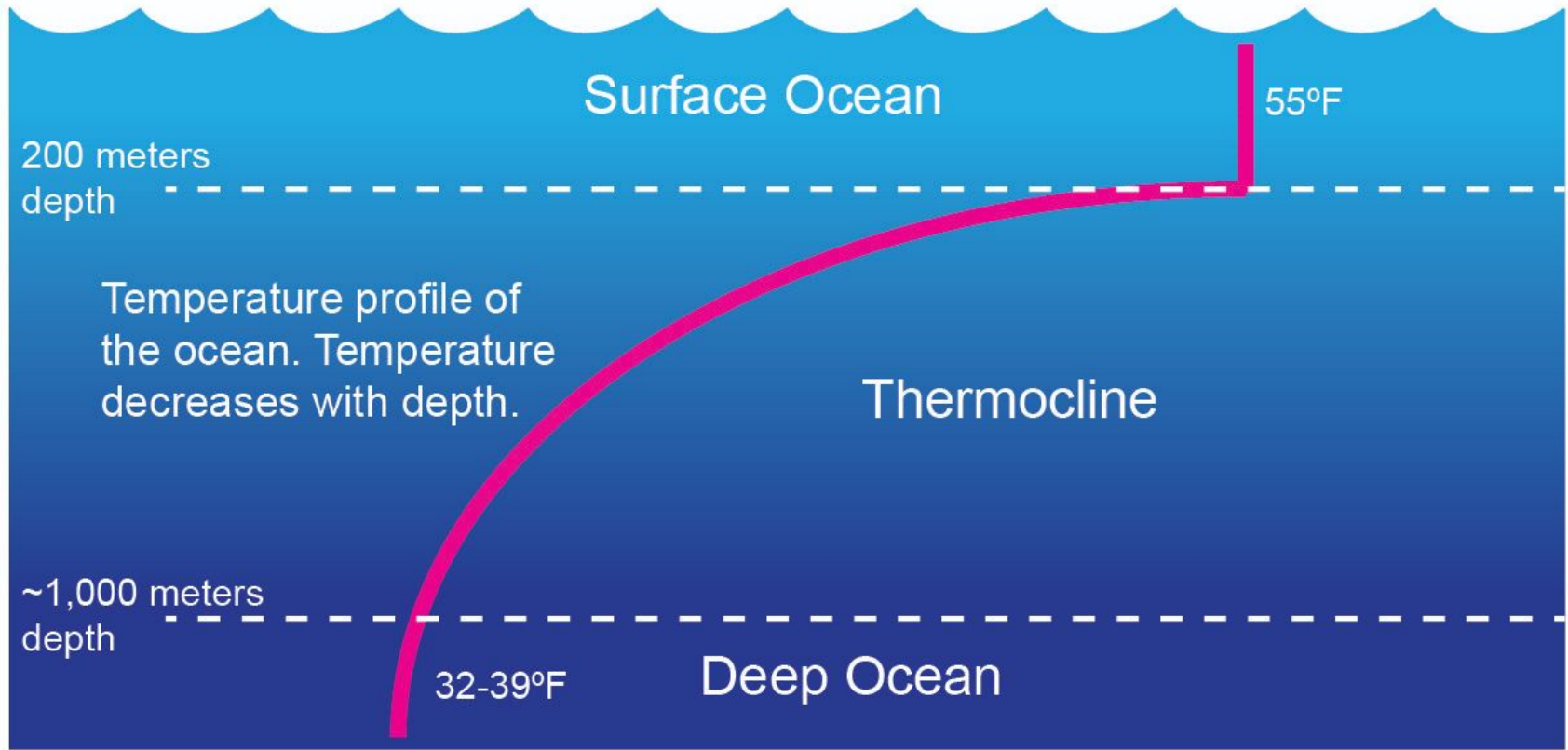
- The chemical characteristics of ocean water include **salinity**, or the amount and type of dissolved salts.
- Chemical characteristics also include the amount and type of gases in the seawater.
- The physical characteristics of ocean water include temperature and density.

What are some characteristics of ocean water?

- The overall salinity of seawater is about 3.5 percent.
- Dissolved salts come from water flowing on or under Earth's surface, and from underwater volcanoes and vents.
- The salinity of seawater has remained relatively steady, but it varies from place to place depending on the entry of freshwater streams, precipitation, and rate of evaporation.

What are some characteristics of ocean water?

- The ocean has three temperature layers by depth. The top layer, or surface zone, is the warmest layer.
- In the next layer, the **thermocline**, water temperature drops with increased depth faster than it does in other layers.
- The deep zone is the deepest layer and the coldest.



What are some characteristics of ocean water?

- By latitude, surface water is warmest near the equator and coldest near the poles.
- By season, surface water is warmest in summer and coldest in winter.

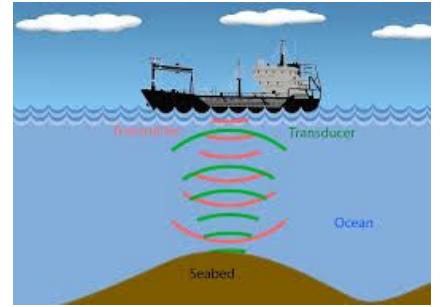
What are some characteristics of ocean water?

- *Density* is a measure of the mass of a substance divided by its volume. The density of ocean water depends on temperature and salinity.
- Salt water is denser than fresh water because salt water contains a larger amount of dissolved solids.
- Temperature affects the density of ocean water more than salinity does. Cold water is denser than warm water.

Seeing the Sea

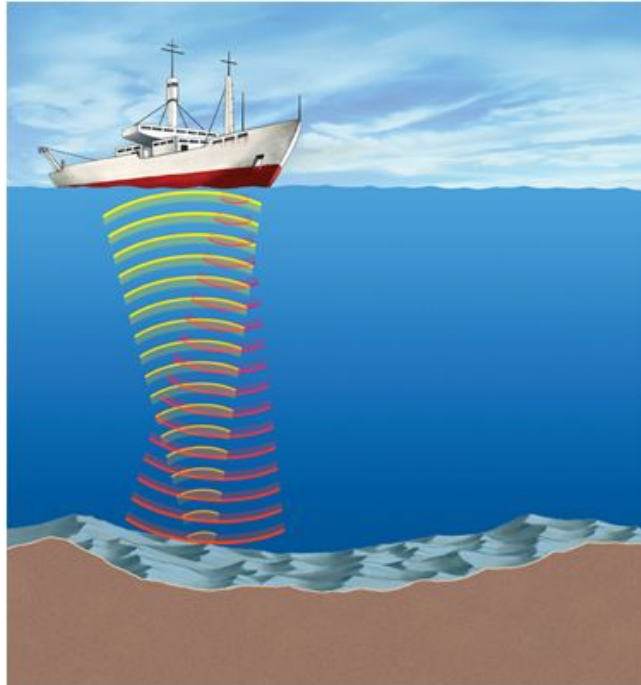
How is the ocean floor studied?

- To learn about the ocean floor, scientists use technology such as sonar, drills, underwater exploration vessels, and satellites.
- *Sonar*, which stands for *sound navigation and ranging*, uses sound waves to measure distances.
- Sonar data can be used to make maps of the ocean floor.



How is the ocean floor studied?

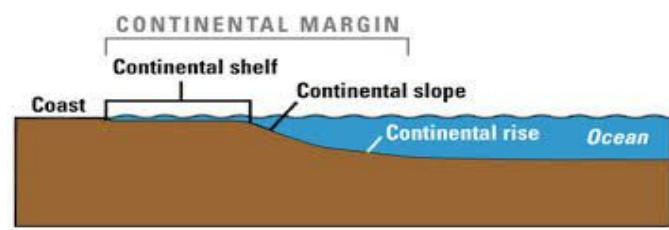
- What is this ship doing and why?



How is the ocean floor studied?

- Satellites can measure variations in the height of the ocean's surface. The ocean floor's features can affect the height of the water above them.
- To explore the oceans, scientists use underwater vessels, some of which have pilots and researchers. Other vessels are remotely operated.
- Using equipment on large ships, scientists can drill and collect cores, or long tubes of rock and sediment, from the sea floor.

In Deep Water



What are the two main regions of the ocean floor?

- The two main regions of the ocean floor are the continental margin and the deep-ocean basin.
- The **continental margin** is the edge of the continent that is covered by the ocean.
- The continental margin is divided into the continental shelf, the continental slope, and the continental rise.

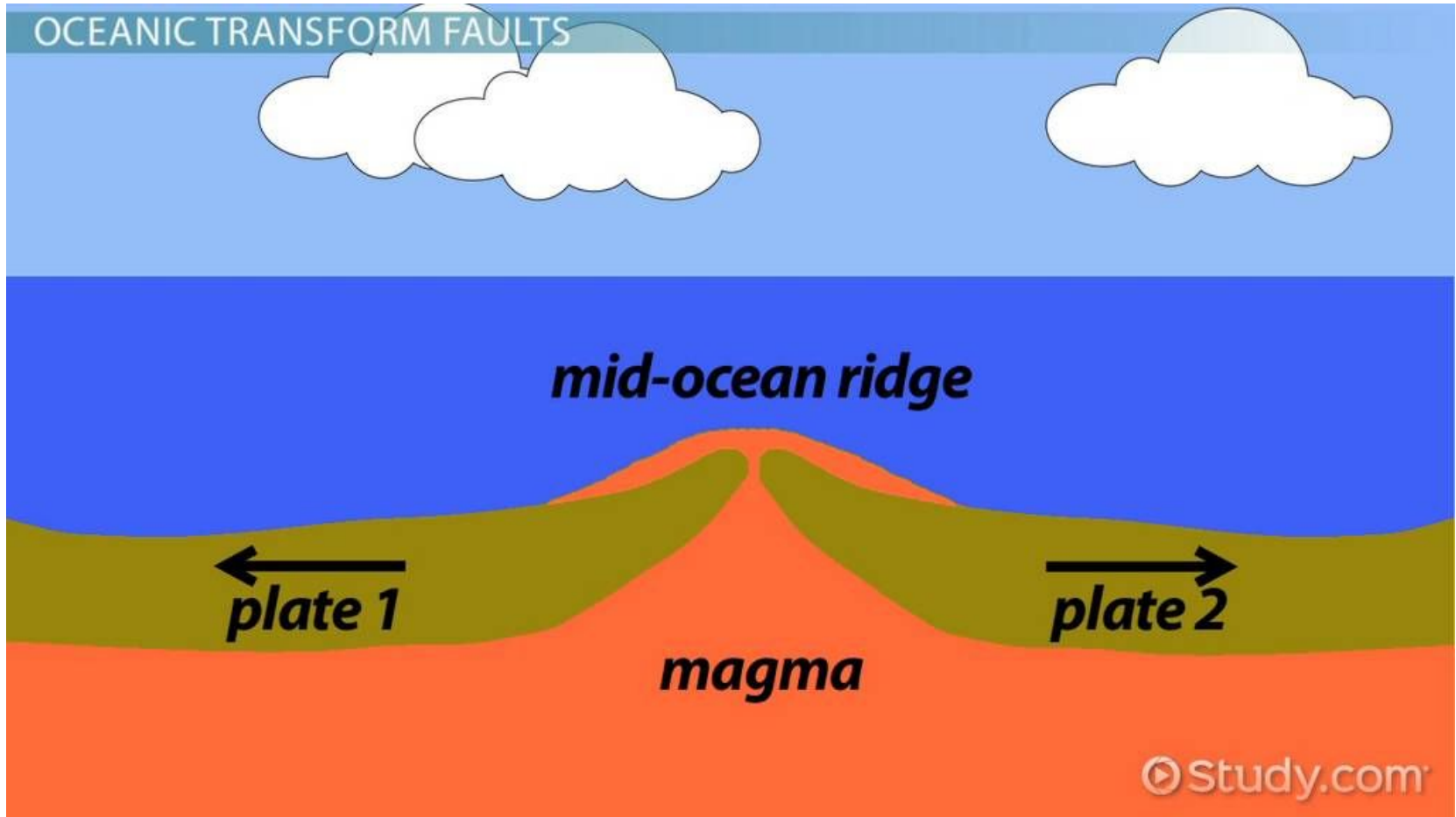
What are the two main regions of the ocean floor?

- The **deep-ocean basin** begins at the end of the continental margin and extends under the deepest parts of the ocean.
- The deep-ocean basin includes narrow depressions and flat, smooth plains.

What are the features of the ocean floor?

- A long, undersea mountain chain that forms along the floor of the ocean is called a **mid-ocean ridge**.
- Mid-ocean ridges occur at the boundaries of Earth's tectonic plates, where plates move apart from each other.
- This motion creates a crack in the ocean floor called a rift, allowing hot magma to move upward through the rift and cool to form new rock.

OCEANIC TRANSFORM FAULTS



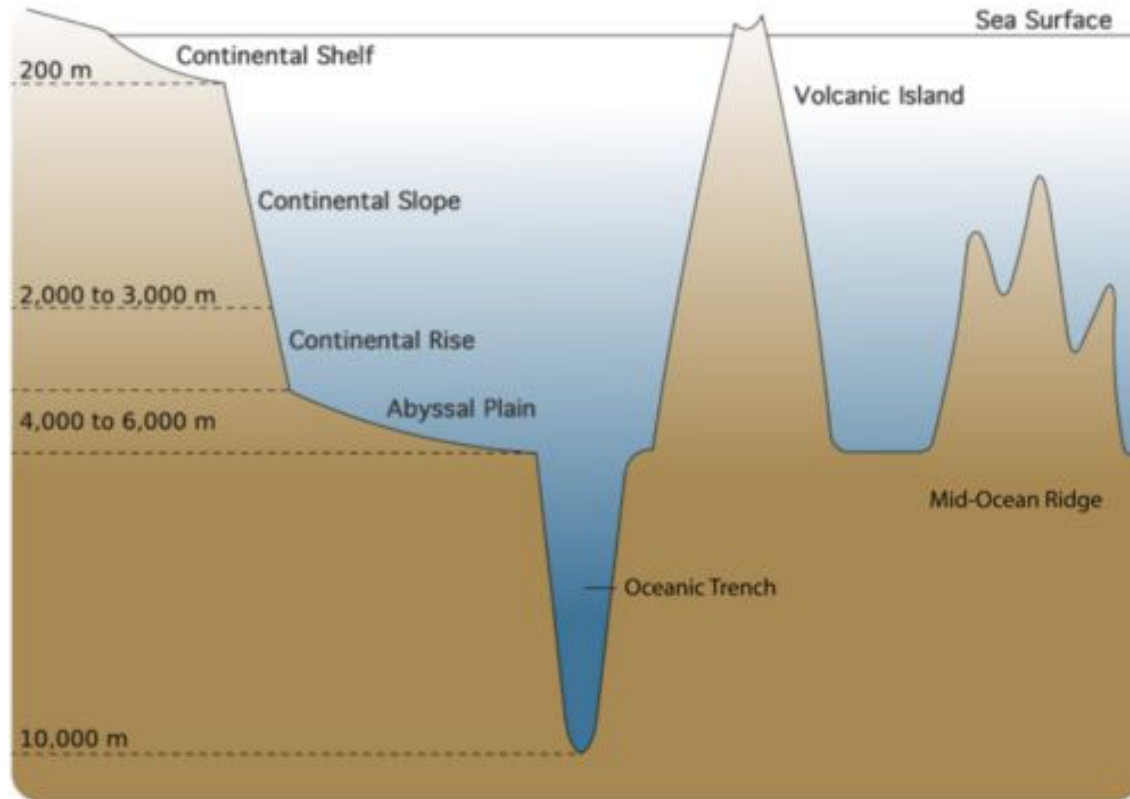
What are the features of the ocean floor?

- The large, flat, almost level area of the deep- ocean basin is called the *abyssal plain*. This area is covered with layers of fine sediment.
- A long, narrow depression in the deep-ocean basin is called an **ocean trench**. It forms where one tectonic plate subducts another plate.
- Volcanoes and earthquakes are common in and along subduction zones.

What are the features of the ocean floor?

- Submerged volcanic mountains on the ocean floor are called seamounts.
- They may form at tectonic plate boundaries and also far from plate boundaries over places called hot spots.
- If a seamount grows above sea level, it becomes a *volcanic island*.

Major Features on the Ocean Floor



That's Swell

What is upwelling?

- **Upwelling** is the process by which winds blow warm water away from a shore, allowing cool, nutrient-rich water to rise to the surface.
- Upwelling supplies the nutrients that support the growth of phytoplankton and zooplankton.
- These tiny organisms are food for larger organisms, such as fish and seabirds.



Traveling the World

What do ocean currents transport?

- Convection currents in the ocean transport energy in the form of heat.
- Ocean currents can release energy into the atmosphere, making currents an important influence on climate.
- Ocean water also transports dissolved solids, including nutrients, and dissolved gases that support the growth of many marine organisms.

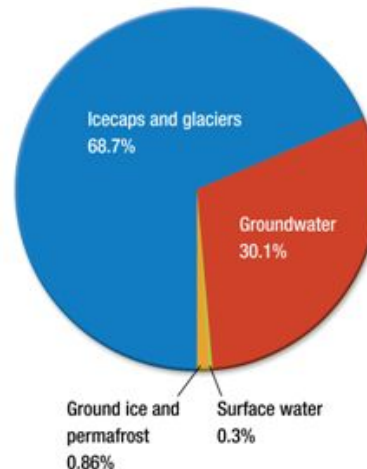
Water, Water Everywhere ...

Why is water important?

- Water shapes Earth's surface and affects Earth's weather and climates.
- Most life processes use water.
- For humans and other organisms, access to clean water is important for good health.

There is lots of water, so what's the problem?

- Less than 1 percent of Earth's fresh liquid water is on the surface.
- The small volume of fresh surface and groundwater is a limited resource.



There is lots of water, so what's the problem?

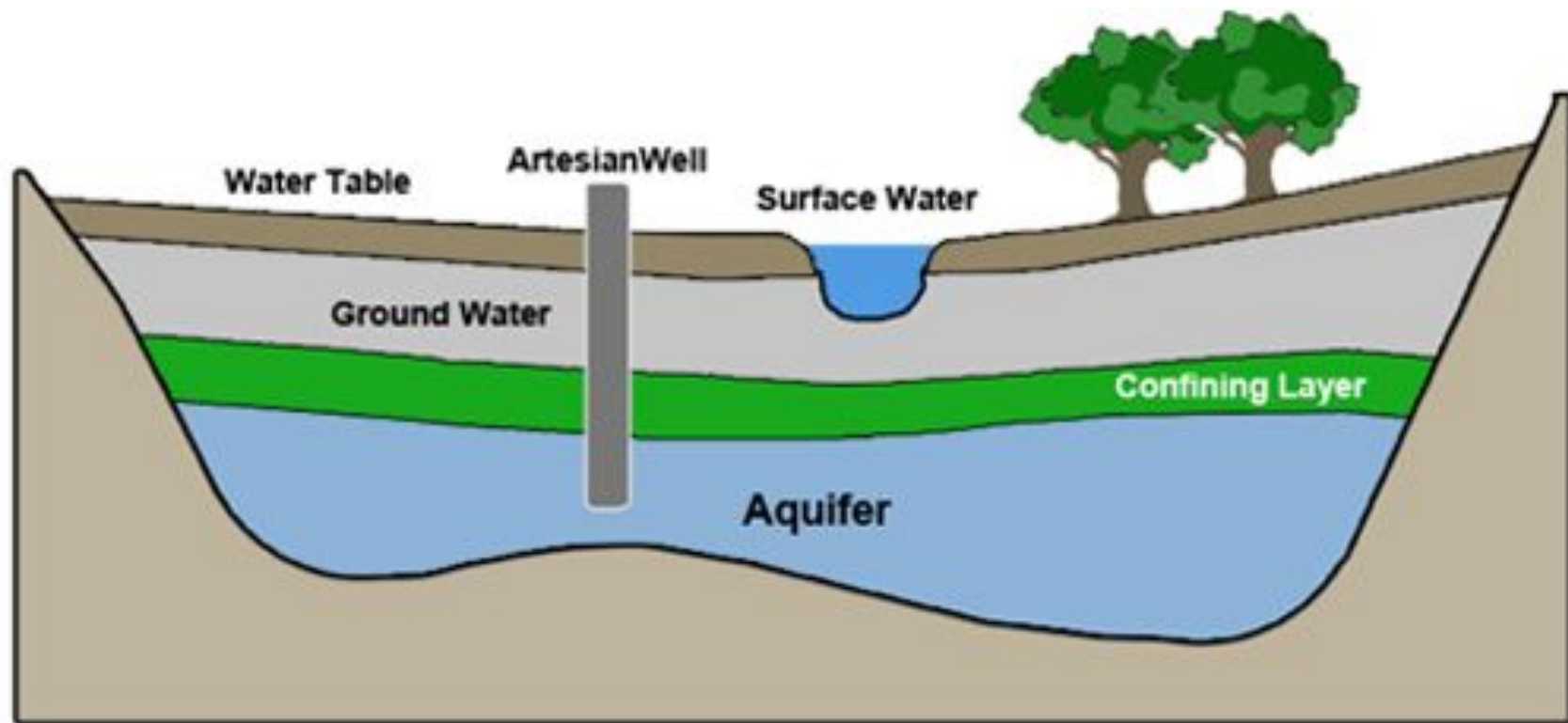
- *Urbanization* is the growth of towns and cities that results from the movement of people from rural areas into the urban areas.
- Urbanization means that there is a greater demand for water in the cities.
- Fresh water is becoming a natural resource that cannot be replaced at the same rate as it is used.

Where do we get freshwater?

- Earth's fresh liquid water is found as surface water and groundwater.
- *Surface water* is any body of water above the ground. It includes liquid salt or fresh water, as well as solid water, like snow and ice.
- Water may seep below the surface to become *groundwater*. It is found in spaces in rocks or in soil, where it can be liquid or frozen.

Where do we get freshwater?

- An *aquifer* is a body of rock or sediment that can store a lot of water and allows water to flow easily through it. Aquifers store water in spaces called *pores*.
- In polar regions, water is often frozen in a layer of soil called *permafrost*.
- Rivers, streams, and most lakes are fresh surface waters. Millions of people depend on freshwater taken from rivers and lakes.



What are water quality and supply?

- *Water quality* is a measure of how clean or polluted water is. It is vital for living things to have clean water.
- *Water supply* is the availability of water. It influences where people can farm and build cities.
- *Water supply systems* carry water from groundwater or surface waters so people can use the water. Many people do not have access to clean, fresh water.

Under Threat

What threatens freshwater quality?

- When waste or other material is added to water so that it is harmful to organisms that use it or live in it, **water pollution** occurs.

- Point-source pollution** comes from one specific site. It can usually be controlled once its source is found.

- Nonpoint-source pollution** comes from many small sources and is more difficult to control.



What threatens freshwater quality?

- Any heating of natural water that results from human activity is called **thermal pollution**.
- It includes the heating of water used for cooling some power plants.
- When the warm water is returned to the river or lake, it has less oxygen available for organisms that live in the water.

What threatens freshwater quality?

- *Chemical pollution* occurs when harmful chemicals are added to water supplies.
- Two major sources of chemical pollution are industry and agriculture.
- Acid rain is also a form of chemical pollution.

What threatens freshwater quality?

- *Biological pollution* occurs when live or dead organisms are added to water supplies.
- *Wastewater* is any water that has been used by people for such purposes as flushing toilets, showering, or washing dishes.
- Wastewater may contain disease-causing microbes from human or animal wastes.

What threatens freshwater quality?

- **Eutrophication** is an increase in the amount of nutrients in water.
- *Artificial eutrophication* occurs when human activity increases nutrient levels in water.
- The extra nutrients cause an overgrowth of algae and aquatic plants, reducing oxygen levels and killing fish and other organisms in the water.

How is water quality measured?

- Scientists can test water to find small quantities of toxic chemicals or harmful organisms in water.
- Water in nature usually contains dissolved solids.
- Measurement of water quality includes testing the levels of dissolved oxygen, pH, temperature, dissolved solids, and microbial content.

How is water treated for human use?

- Water that is to be used as drinking water is treated to remove harmful chemicals and organisms.
- Water that is suitable to drink is called **potable** water.
- Once water is used, it becomes wastewater. It enters the sewage system, where pipes carry it to a wastewater treatment plant.

Who monitors and protects our water quality?

- Public water supplies are closely monitored so that any contamination can be fixed quickly.
- The Safe Drinking Water Act is the main federal law that ensures safe drinking water for people in the United States.
- The Environmental Protection Agency enforces this law and sets the standards that drinking water must meet.

Supply and Demand

How does water get to the faucet?

- The urbanization of cities is possible because fresh water can be supplied safely by water supply systems.
- Water supply and storage systems are expensive to build and maintain.

How does water get to the faucet?

- Water supply systems change how water flows in natural systems—for example, by stopping rivers to build a reservoir.
- A **reservoir** is a body of water that usually forms behind a dam.
- The water in a reservoir would have naturally flowed to the sea. Instead, it can be diverted into a pipeline or into artificial channels called *canals* or *aqueducts*.

What threatens our water supply?

- In many areas of the world, demand for water is greater than supply.
- Water shortages can be caused by increased demand for use, droughts, and leaking water pipes.
- Water shortages threaten human health and crops grown for food.

How do efforts to supply water to humans affect the environment?

- Building dams and irrigation canals changes the natural flow of water and the local ecology.
- When more water is taken from an aquifer than can be replaced, the water table can drop, rivers and streams may dry up, and soil may collapse, or *subside*.
- In coastal areas, the overuse of groundwater can cause seawater to seep into the aquifer in a process called *saltwater intrusion*.

How do efforts to supply water to humans affect the environment?

- The more people using a water supply, the greater the amount of wastewater produced.
- More pollutants can seep into surface water and groundwater, possibly entering the water supply.
- This pollution could also enter the water cycle and be carried far from the initial source of the pollution.

Death of a Sea

- The Aral Sea in Central Asia was once one of the world's largest salty lakes.
- In the 1940s, the rivers that fed the Aral Sea were changed to supply farmers with water for crops.
- Since then, the sea became too salty to sustain life. The sea shrank to 10 percent of its original size, and split into three.
- The sea is also heavily polluted. Dust blown from the dried seabed is a serious health hazard.