Hydrosphere

The **hydrosphere** is often called the "water sphere" as it includes all the earth's water found in the oceans, glaciers, streams, lakes, the soil, groundwater, and in the air. The hydrosphere interacts with, and is influenced by, all the other earth spheres. The water of the hydrosphere is distributed among several different stores found in the other spheres. Water is held in oceans, lakes and streams at the surface of the earth. Water is found in vapor, liquid and solid states in the atmosphere. The biosphere serves as an interface between the spheres enabling water to move between the hydrosphere, lithosphere and atmosphere as is accomplished by plant transpiration. The hydrologic cycle traces the movement of water and energy between these various stores and spheres.

The Structure of Hydrosphere

Oceans—96.5% of water found here

Fresh water—3.5% of water found here

Fresh water distribution:

- Ice: 1.762%
- Groundwater: 1.7%
- Surface Fresh Water: 0.014%
- Atmosphere and soil: 0.002%

Distribution and quantity of the Earth's waters

Ocean waters and waters trapped in the pore spaces of sediments make up most of the present-day hydrosphere (see Table 1). The total mass of water in the oceans equals about 50 percent of the mass of sedimentary rocks now in existence and about 5 percent of the mass of the Earth's crust as a whole. Deep and shallow ground waters constitute a small percentage of the total water locked in the pores of sedimentary rocks—on the order of 3 to 15 percent. The amount of water in the atmosphere at any one time is trivial, equivalent to 0.013×10^6 cubic kilometers of liquid water, or about 0.001 percent of the total at the Earth's surface. This water, however, plays an important role in the water cycle.

Water masses at the Earth's surface		
reservoir	volume (in millions of cubic kilometers)	percent of total
oceans	1,370.0	97.25
ice caps and glaciers	29.0	2.05
deep groundwater* (750–4,000 meters)	5.3	0.38
shallow groundwater (less than 750 meters)	4.2	0.30
lakes	0.125	0.01
soil moisture	0.065	0.005
atmosphere**	0.013	0.001
rivers	0.0017	0.0001
biosphere	0.0006	0.00004
total	1,408. 7	100

At present, ice locks up a little more than 1 percent of the Earth's water and may have accounted for as much as 3 percent or more during the height of the glaciations of the Pleistocene Epoch (2,600,000 to 11,700 years ago). Although water storage in rivers, lakes, and the atmosphere is small, the rate of water circulation through the rain–river–ocean–atmosphere system is relatively rapid. The amount of water discharged each year into the oceans from the land is approximately equal to the total mass of water stored at any instant in rivers and lakes.

Soil moisture accounts for only 0.005 percent of the water at the Earth's surface. It is this small amount of water, however, that exerts the most direct influence on evaporation from soils. The biosphere, though primarily H_2O in composition, contains very little of the total water at the terrestrial surface, only about 0.00004 percent. Yet, the biosphere plays a major role in the transport of water vapor back into the atmosphere by the process of transpiration.

As will be seen in the next section, the Earth's waters are not pure H_2O but contain dissolved and particulate materials. Thus, the masses of water at the Earth's surface are major receptacles of inorganic and organic substances, and water movement plays a dominant role in the transportation of these substances about the planet's surface.

BIOGEOCHEMICAL PROPERTIES OF THE HYDROSPHERE

Rainwater

About 110,300 cubic kilometres of rain fall on land each year. The total water in the atmosphere is 0.013 $\times 10^6$ cubic kilometres, and this water, owing to precipitation and evaporation, turns over every 9.6 days. Rainwater is not pure but rather contains dissolved gases and salts, fine-ground particulate material, organic substances, and even bacteria. The sources of the materials in rainwater are the oceans, soils, fertilizers, air pollution, and fossil-fuel combustion.

River and ocean waters

River discharge constitutes the main source for the oceans. Seawater has a more uniform composition than river water. It contains, by weight, about 3.5 percent dissolved salts, whereas river water has only 0.012 percent. The average density of the world's oceans is roughly 2.75 percent greater than that of typical river water. Of the average 35 parts per thousand salts of seawater, sodium and chlorine make up almost 30 parts, and magnesium and sulfate contribute another four parts.

Water-rock interactions as determining river water composition

Generally speaking, the composition of river water, and thus that of lakes, is controlled by water–rock interactions. The attack of carbon dioxide-charged rain and soil waters on the individual minerals in continental rocks leads to the production of dissolved constituents for lakes, rivers, and streams. It also gives rise to solid alteration products that make up soils or suspended particles in freshwater aquatic systems. The carbon dioxide content of rain and soil waters is of particular importance in weathering processes. The pH of rainwater equilibrated with the atmospheric carbon dioxide partial pressure of $10^{-3.5}$ atmosphere is 5.7. In industrial regions, rainwater pH values may be lower because of the release and subsequent hydrolysis of acid gases—namely, sulfur dioxide and nitrogen oxides (NO_x) from the combustion of fossil fuels. After rainwater enters soils, its characteristics change markedly. The usual few parts per million of salts in rainwater increase substantially as the water reacts. The upper part of the soil is a zone of intense biochemical activity. The bacterial population near the surface is large, but it decreases rapidly downward with a steep gradient

Lake waters

Although lake waters constitute only a small percentage of the water in the hydrosphere, they are an important ephemeral storage reservoir for fresh water. Aside from their recreational use, lakes constitute a source of water for household, agricultural, and industrial uses. Lake waters are also very susceptible to changes in chemical composition due to these uses and to other factors.

In general, fresh waters at the continental surface evolve from their rock sources by enrichment in calcium and sodium and by depletion in magnesium and potassium. In very soft waters the alkalines may be more abundant than the alkaline earths, and in the more concentrated waters of open river systems Ca > Mg > Na > K. For the anions, in general, HCO_3^- exceeds SO $^2/_4{}^-$, which is greater in concentration than Cl^-. It is worthwhile at this stage to consider some major mechanisms that control global surface water composition. These mechanisms are atmospheric precipitation, rock reactions, and evaporation-precipitation.

The mechanism principally responsible for waters of very low salinity is precipitation. These waters tend to form in tropical regions of low relief and thoroughly leached source rocks. In these regions rainfall is high, and water compositions are usually dominated by salts brought in by precipitation. Such waters constitute one end-member of a series of water compositions for which the other end-member represents water compositions dominated by contributions of dissolved salts from the rocks and soils of their basins. These waters have moderate salinity and are rich in dissolved calcium and bicarbonate. They are, in turn, the end-member of another series that extends from the calcium-rich, medium-salinity fresh waters to the high-salinity, sodium chloride-dominated waters of which seawater is an example. Seawater composition, however, does not evolve directly from the composition of fresh waters and the precipitation of calcium carbonate; other mechanisms that control its composition are involved. Such factors as relief and vegetation also may affect the composition of the world's surface waters, but atmospheric precipitation, water–rock reactions, and evaporation–crystallization processes appear to be the dominant mechanisms governing continental surface water chemistry.

Continental fresh waters evaporate once they have entered closed basins, and their constituent salts precipitate on the basin floors. The composition of these waters may evolve along several different paths, depending on their initial chemical makeup.

Water distribution..

Watersheds

River systems

Lakes and ponds

Aquifers

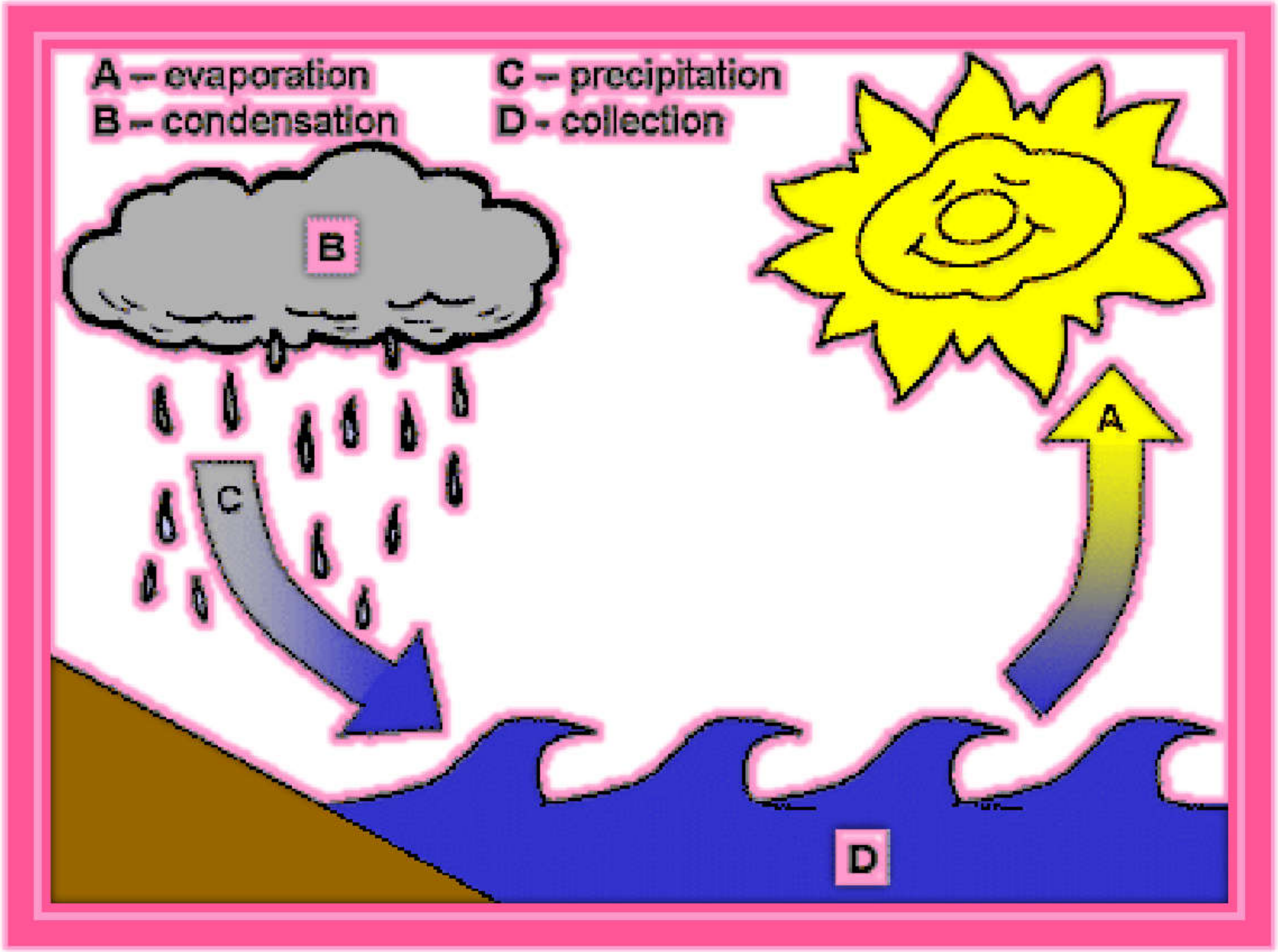
Icebergs and glaciers

The Water Cycle

The water or hydrologic cycle is the continuous movement of water from oceans and freshwater sources to the air, land, and back to the bodies of water which results in fresh water continuously being renewed.

MAIN PARTS

- evaporation (and transpiration)
- condensation
- precipitation
- collection


A – evaporation
B – condensation
C – precipitation
D - collection
B
C
A
D

Evaporation is when the sun heats up water in rivers or lakes or the ocean and turns it into vapor or steam. The water vapor or steam leaves the river, lake or ocean and goes into the air.

Condensation:

Water vapor in the air gets cold and changes back into liquid, forming clouds. This is called condensation.

You can see the same sort of thing at home... pour a glass of cold water on a hot day and watch what happens. Water forms on the outside of the glass. That water didn't somehow leak through the glass! It actually came from the air. Water vapor in the warm air, turns back into liquid when it touches the cold glass.

Precipitation:

Precipitation occurs when so much water has condensed that the air cannot hold it anymore. The clouds get heavy and water falls back to the earth in the form of rain, hail, sleet or snow

Collection:

When water falls back to earth as precipitation, it may fall back in the oceans, lakes or rivers or it may end up on land. When it ends up on land, it will either soak into the earth and become part of the “ground water” that plants and animals use to drink or it may run over the soil and collect in the oceans, lakes or rivers where the cycle starts.