

Ground Water

Ground-water hydrology
occurrence, movement, and quality of water beneath Earth's surface.

<1% of Earth's water is found underground - vast supply.

Ground-water - 2nd largest source of fresh water
1st - water trapped in glacial ice.
U.S. - drinking water for ~1/2 of population.

Distribution of Underground Water

When rain falls:
some runs off;
some evaporates;
the remainder soaks into the ground - infiltration.
primary source of almost all underground water.

Water gets distributed into 2 zones:

- 1) upper **zone of aeration**
belt of soil moisture and capillary fringe
area above water table

belt of soil moisture - molecular attraction holds water as film on surface of soil particles
capillary fringe zone -

Results from attraction between rocks and water.
Ground-water is lifted against gravity by surface tension in tiny threadlike passages
between grains of soil or sediment.

- 2) **zone of saturation**
zone where all open spaces in sediment and rock are completely filled with water.
water table - upper limit of this zone.
water in saturated zone - **groundwater**.

Water Table

Water table - upper limit of zone of saturation.
hydraulic pressure = atmospheric pressure.

determine elevation of water table and direction of ground-water movement with wells.

Gravity - dominant driving force in ground-water movement.
ground water moves downhill
discharges at a spring or in stream channel.

water table - rarely level.
shape replica of the surface topography
reaches highest elevations beneath hills

swamp - water table at surface
lakes and streams - water table above land surface.

Porosity and Permeability

Water soaks into ground because rock, sediment, and soil contain voids or openings - pore space.

porosity

percentage of total volume of rock that consists of pore spaces; or ratio of openings (voids) to the total volume.

Sediment - open space 10 - 50% of total volume.

Clay - max. 50% porosity; gravel 20%.

types of voids in rock.

primary openings - voids formed at same time as rock
e.g. pores in sand and gravel.

secondary openings - voids formed after rock was formed
e.g. fractures and caverns.

Porosity alone - not a satisfactory measure of a material's ability to yield ground-water. Rock with high porosity may still not allow water to move through it.

Permeability - ability to transmit fluid.

Ground-water moves by twisting/turning through small openings.
smaller the pore space, slower the water moves

Ground-water is divided into 2 categories:

1) **specific yield** - that portion which drains under the influence of gravity; **water actually available for use**

2) **specific retention** - that part retained as a film on particle and rock surfaces.

e.g. clay - ability to store water is high, but pore spaces too small to move it. high porosity, low effective porosity

Hydrogeologists classify all rocks that underlie Earth's surface either as

1) **Aquifer** - a rock (unconsolidated or consolidated) that will yield water in a usable quantity to a well or spring.

Permeable rock strata or sediment that transmit groundwater freely.

2) **Confining beds – Aquicludes:** Impermeable layers (e.g. clay) that hinder or prevent water movement.

Two types of aquifers:

1) **Unconfined aquifers** - where water only partly fills an aquifer, the upper surface of the saturated zone is free to rise and decline.

Also called water-table aquifers

2) **Confined aquifers** - where water completely fills an aquifer that is overlain by a confining bed. Also called artesian aquifers. water level stands above top of the aquifer above land surface - flowing artesian well.

Movement of Groundwater

exceedingly slow. e.g. 15 m/year; 4 cm/day.
 energy provided by force of gravity.
 water moves from high → low areas.

concepts of groundwater movement - Darcy's Law velocity of groundwater increases as: slope of water table (**hydraulic gradient**) increases.

hydraulic gradient - determined by dividing vertical difference between the recharge and discharge points (**head loss**) by length of flow between these points.

Wells

well - a hole drilled into the zone of saturation.
 water levels fluctuate considerably during year
 withdrawing water lowers the water table

drawdown

decreases with increasing distance from well.

cone of depression - depression in water table

Karst Topography

Develops in limestone terrains with abundant rainfall and weathering: caves, disappearing streams, sinkholes, etc.