Weathering

Weathering - the breakdown of rocks into soil

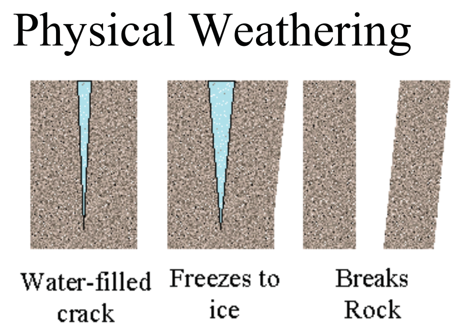
Types of Weathering:

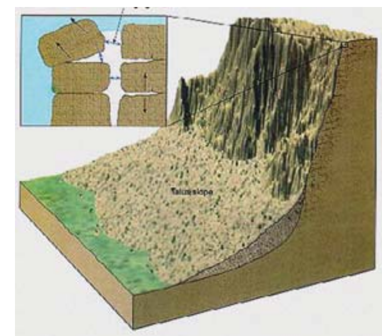
1. **Physical Weathering** - any process that causes a rock to crack or break into pieces without changing it
2. **Chemical Weathering** - any process that causes rocks to breakdown by chemical action
   - results in a change in composition

Types of Physical Weathering:

a. **Frost Action (Ice Wedging)** - water seeps into cracks in a rock

- when water freezes, it expands by 10% causing the rock to split apart



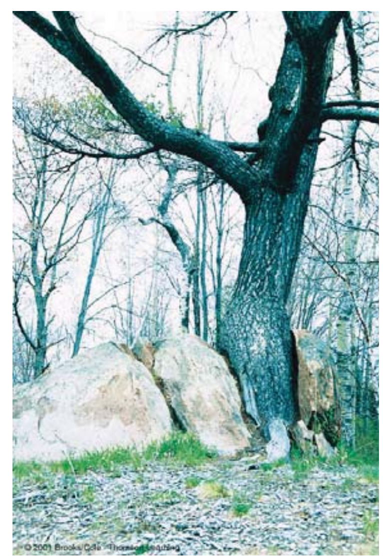


b. **Extreme Temperature Changes** (Exfoliation) - rocks are heated by the sun and expand; when temperatures fall, the rock cools and contracts

- this cycle of heating and cooling (expansion and contraction) causes the rock to break into slabs

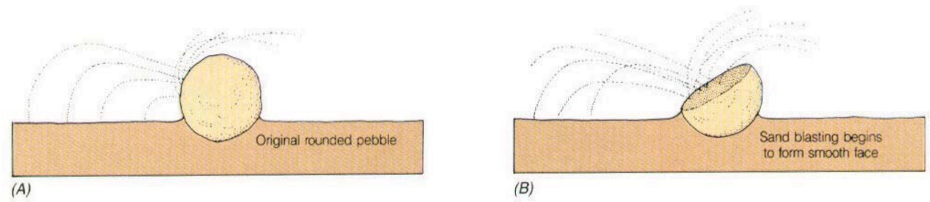
c. **Plant/Animal Action** - plants/roots will grow into cracks in rocks causing them to split as they grow

- moss and lichens produce acids that weaken rock (chemical breakdown)



Physical Weathering

d. **Abrasion** - sediments carried by streams and wind blown sand cause particles to collide into each other and the surrounding rock



e. **Pressure Unloading** - as a rock is eroded or glacial ice sheets melt, the rocks below are no longer under pressure

- they release this pressure causing the bedrock to crack

Chemical Weathering

Types of Chemical Weathering:

a. **Oxidation** - oxygen combines with certain minerals in rocks - the chemical change of the mineral weakens the rock and the rock crumbles

- ex.: rust

b. **Carbonation** - carbon dioxide dissolves into water and forms a weak acid which reacts with certain rocks and minerals (calcite, limestone, marble, chalk)

- forms sinkholes and caves

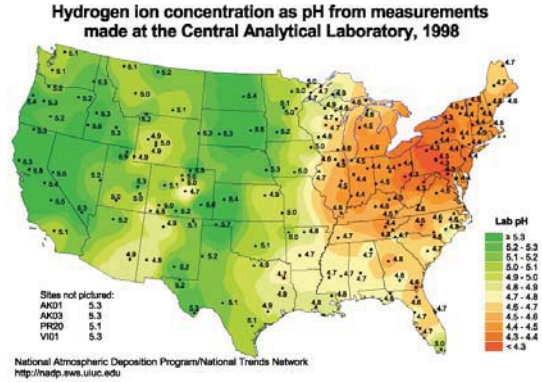
c. **Hydration** - certain minerals in rocks will dissolve in water and rock will crumble

- ex.: feldspar in granite - feldspar turns to clay

Chemical Weathering

d. **Acid Rain** - gases released from the burning of fossil fuels dissolve into water droplets in clouds to produce an acid

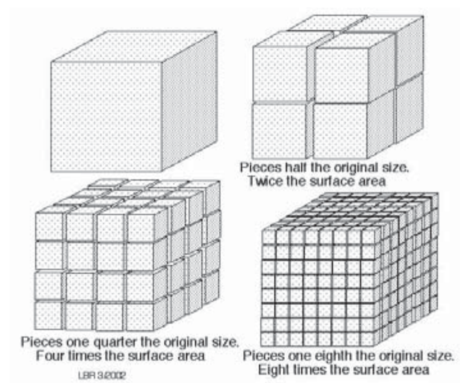
- ex.: sulfuric acid



Weathering

Factors that Effect Weathering:

1. Surface Area/Particle Size
2. Minerals in Rock
3. Climate

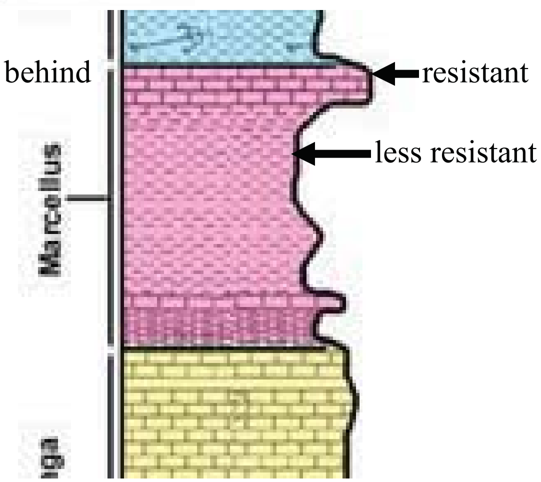


1. **Surface Area** - as surface area increases, weathering increases

- small particles have more surface area than large particles

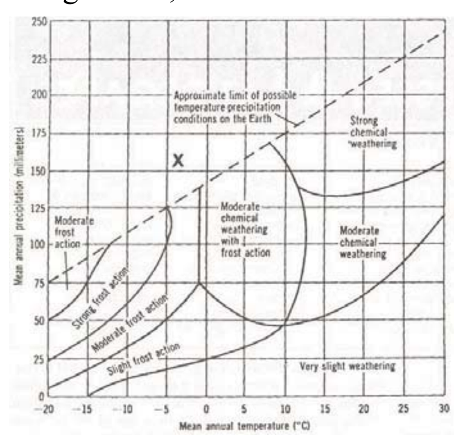
2. **Minerals in Rock** - as hardness of minerals increases, weathering rate decreases

- softer, less resistant minerals/rocks wear away leaving harder, more resistant minerals/rocks behind



3. **Climate** - the major factor that effects weathering

- as humidity increases, weathering increases
- as temperature increases, chemical weathering increases
  - warm, moist climates (mT)
- as temperature decreases, physical weathering increases
  - cold, moist climates (mP)



Weathering

Products of Weathering:

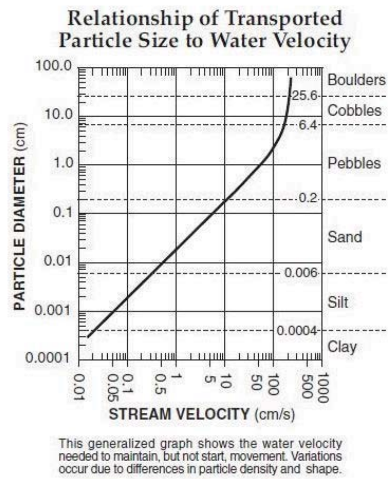
1. Solid Sediments
2. Dissolved Minerals
3. Soils



1. Solid Sediments (from largest to smallest):

- Boulders
- Cobbles
- Pebbles
- Sand
- Silt
- Clay
- Colloids

Reference Tables p.6

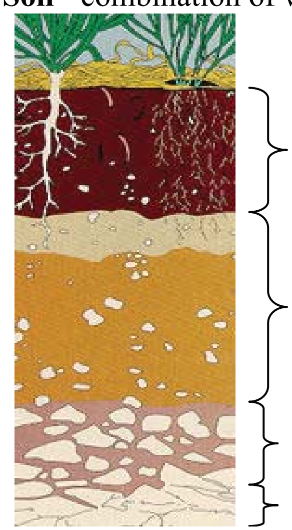


- colloids are the smallest particles and always remain suspended in water - never settle out

2. Dissolved Minerals - cause "hard" water

- when water evaporates, dissolved minerals will precipitate out and settle to the bottom

3. Soil - combination of weathered rock and organic matter (**humus** - decayed plant/animal remains)



Topsoil - contains humus

Subsoil - contains leached minerals

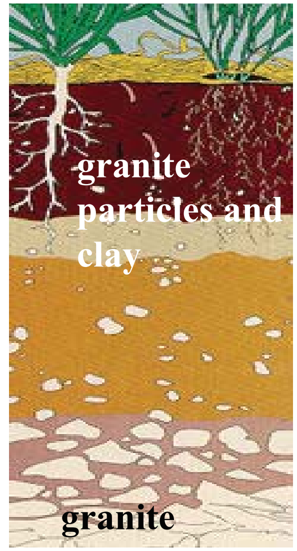
C-Horizon - partially weathered bedrock

Bedrock - often the parent rock of soil above

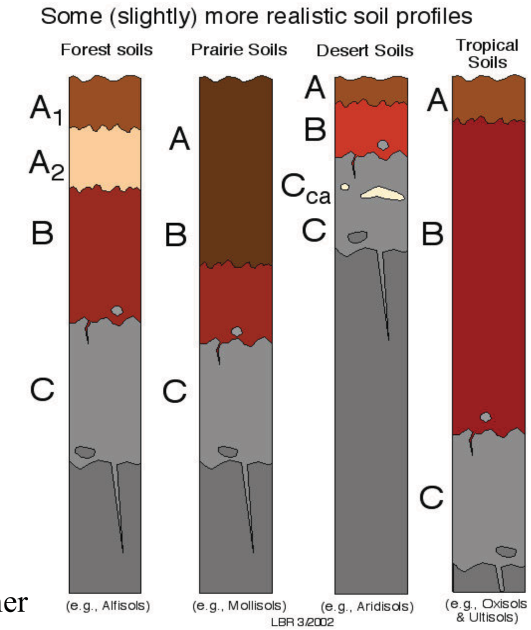
Sediments

Types of Soils:

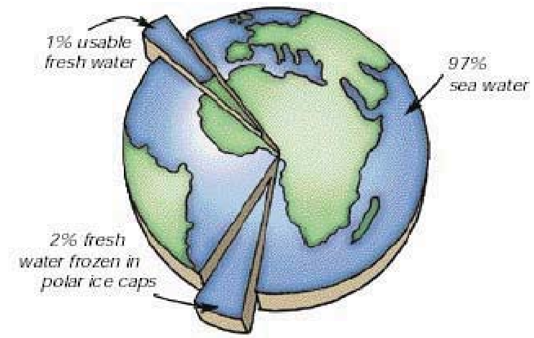
1. **Residual Soils** - weathered rocks/particles are the same as the underlying bedrock
2. **Transported Soils** - weathered rock/particles do not match the underlying bedrock (transported from elsewhere
   - ex.: soils in NYS formed from rocks that came from Canada and were transported by glaciers and deposited in NYS during the last ice age



- soil profiles that form in different environments will have very distinct differences from each other



Water Cycle

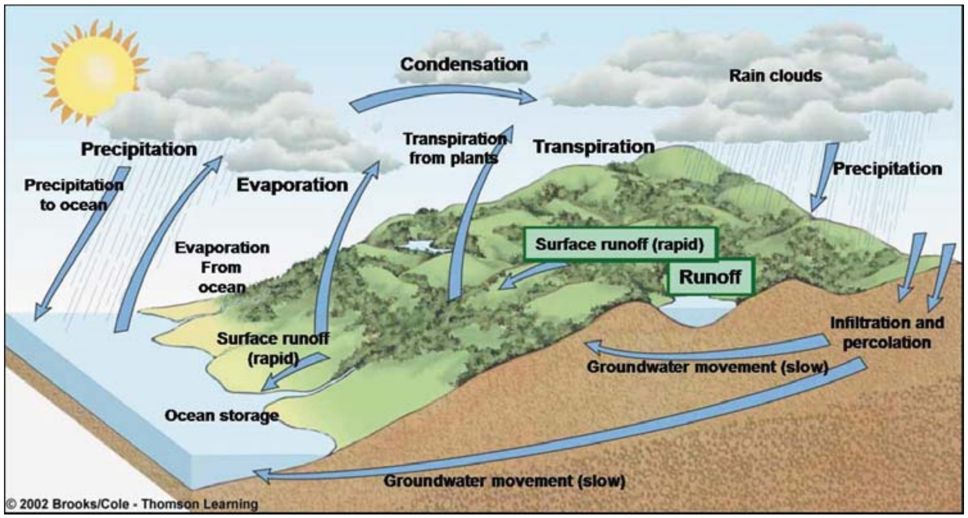


Most of Earth's water was created by volcanic out-gassing when the Earth formed and by impacts by comets early in Earth's history

- this water has remained since – the amount of water on Earth has not changed
- the majority of fresh water is unusable – frozen in glacial ice

Water on Earth is recycled from the atmosphere to the Earth and back to the atmosphere

- a model used to show the movement and phase changes of water at or near the Earth's surface is the **water cycle (hydrologic cycle)**:



The Sun is the source of energy for the water cycle

- the source of most water on land is the oceans
- water from the atmosphere reaches land through the process of **precipitation**

When precipitation reaches land it will:

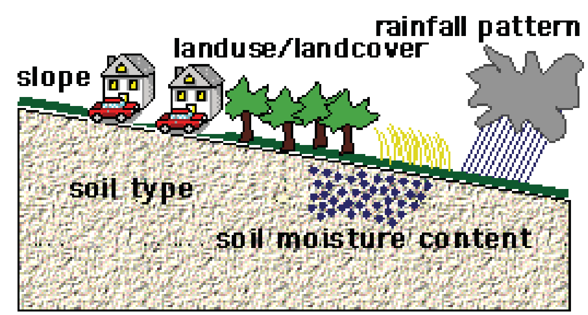
1. **infiltrate** into the ground – stored as groundwater
2. **runoff** the surface into streams, lakes and the ocean
3. stored at the Earth's surface as ice/snow
4. evaporated and transpirated (**evapotranspiration**) back into the atmosphere

Infiltration

Infiltration – process of water sinking into the ground under the influence of gravity

Factors Affecting Infiltration:

1. slope of the land
2. porosity
3. permeability
4. degree of saturation
5. capillarity
6. vegetation/land use

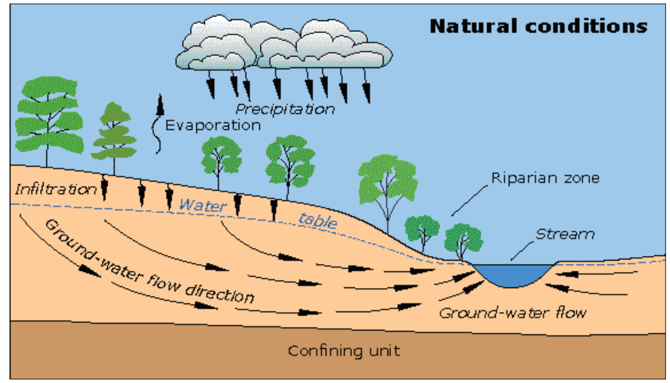


Major factors affecting infiltration

Slope of the Land

The steeper the slope of the land, the less water will infiltrate into the ground – water will runoff the surface

- the gentler the slope, the more water will infiltrate

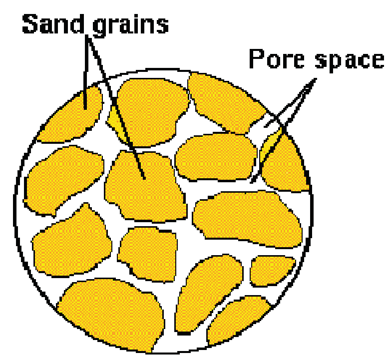


Porosity

Porosity – the percentage of open air space in a material

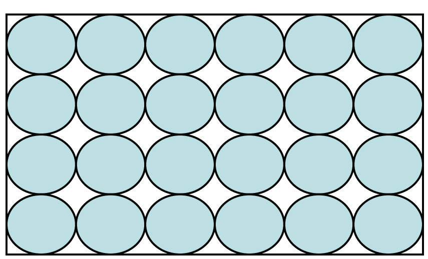
Factors that Effect Porosity:

1. shape of particles
2. packing of particles
3. sorting of particles

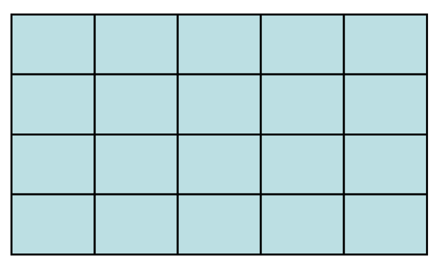


Shape of Particles – well rounded particles have greater porosity than angular or flat particles

- round particles do not fit together as tightly as other shapes



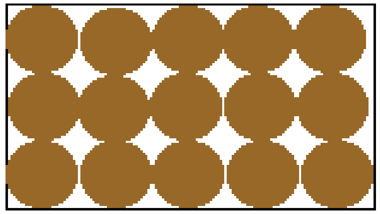
lots of pore space



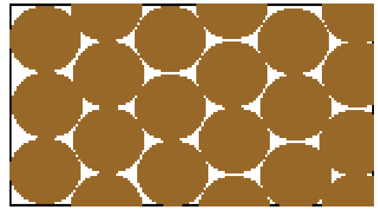
little/no pore space

Porosity

Packing of Particles – the more closely packed the particles are, the lower the porosity



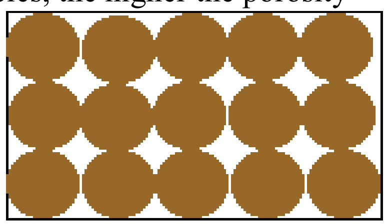
lots of pore space



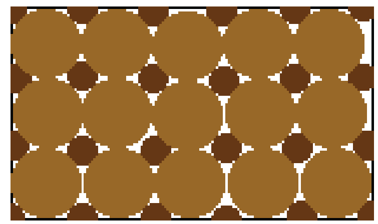
little pore space

Sorting of Particles – if all the particles of a material are of the same size, they are **sorted**; if they are different sizes, they are **unsorted**

- the more sorted the particles, the higher the porosity

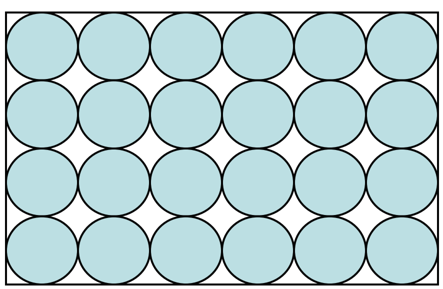


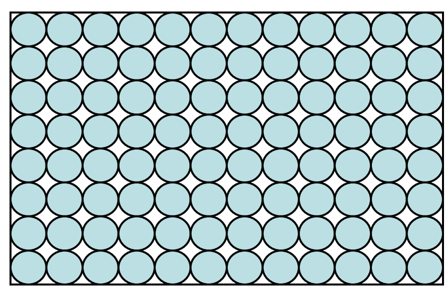
lots of pore space



little pore space

The size of particles DOES NOT effect porosity!!





- each of the samples have round particles that are sorted and are packed similarly
- each sample has the same porosity: ~40%

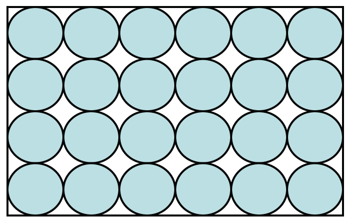
Permeability

Permeability – how easily a material allows water to pass through it

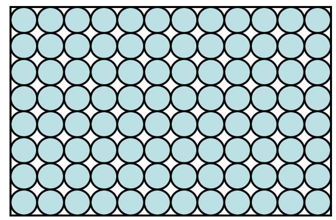
Factors that Effect Permeability:

1. size of particles
2. shape of particles
3. packing of particles
4. sorting of particles

Size of Particles – the bigger the particle size, the easier water can flow through a material



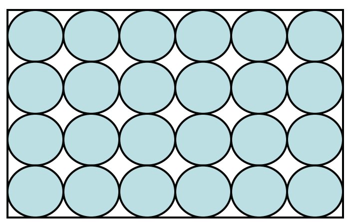
high permeability



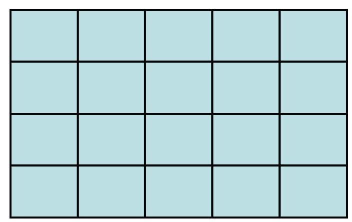
low permeability

- water has to move around/through many more particles for the same volume of material – takes longer

Shape of Particles – the rounder the particles are, the more pore space a material has and the easier water will flow through a material

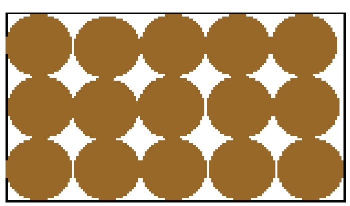


high permeability



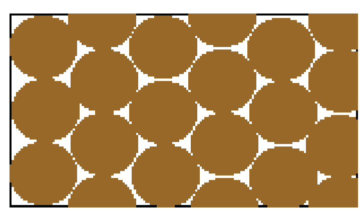
low permeability

Packing of the Particles – the more tightly packed the particles of a material are, the harder it is for water to flow through the material



loosely packed, uniform particle size

high permeability



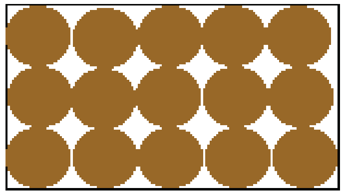
tightly packed, uniform particle size

low permeability

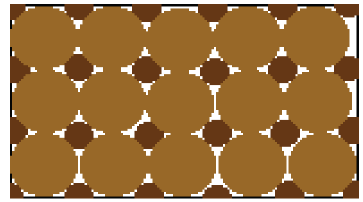
- loosely packed particles have more pore space

Permeability

Sorting of Particles – the better sorted the particles of a sample are, the easier it is for water to flow through the material



high permeability

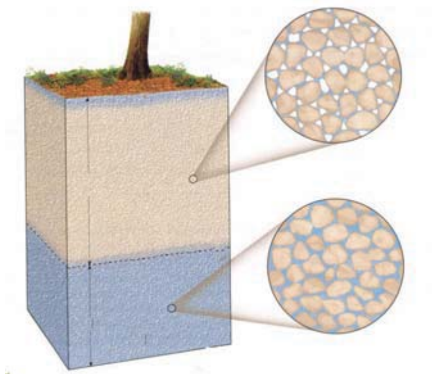


low permeability

Degree of Saturation

A material is **saturated** when the pore spaces in the material are completely filled with water

- the more saturated a material is, the less the infiltration of water there will be

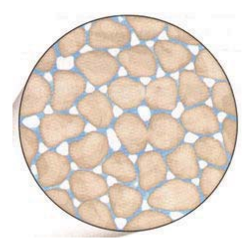


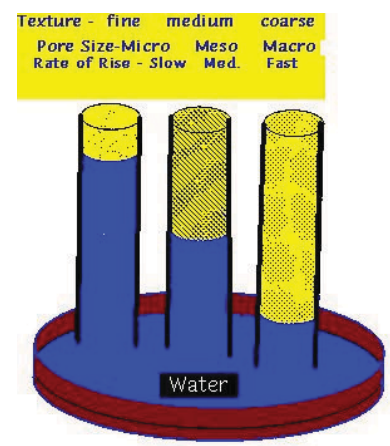
- has open pore spaces – water can flow easily
- pore spaces are filled with water – more water will not pass through

Capillarity

Capillarity – the attractive force of water molecules and particles of sediment

- causes some water to move upward against gravity within a material
    - smaller particles have a greater capillarity than large particles
    - the finer the particles of a material are, the faster and farther water can move upward through the material





Vegetation/Land Use

Grasses, plants and trees will slow water flow on the surface of the Earth – allows water time to infiltrate into the ground

- exposed ground/bedrock usually results in water easily running off the surface
- buildings, roads, parking lots etc. are impermeable - reduce infiltration
- farming and deforestation also reduce infiltration

Runoff

Runoff – water that flows on the Earth's surface

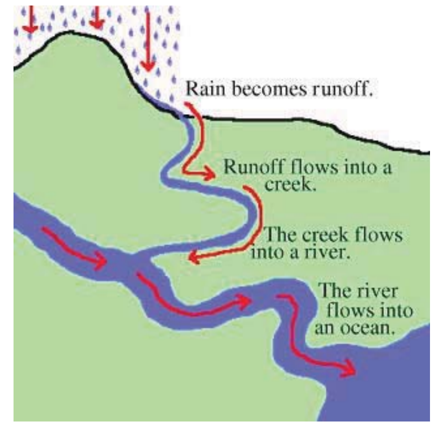
Runoff occurs when:

1. precipitation is greater than infiltration
2. ground is saturated
3. slope of the surface is great

- runoff eventually reaches streams

Stream Discharge – the volume of water flowing in a stream during a given amount of time

- the greater the amount of runoff, the greater the stream discharge



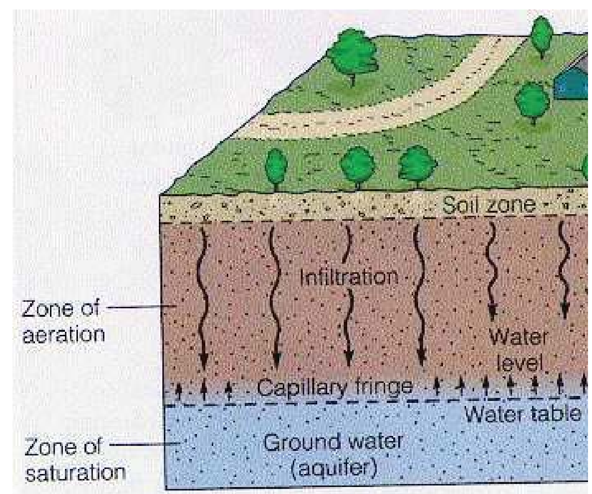
Groundwater

Earth's surface is divided into two zones:

Zone of Aeration – pore spaces are filled with air or are partially filled with water due to capillary action

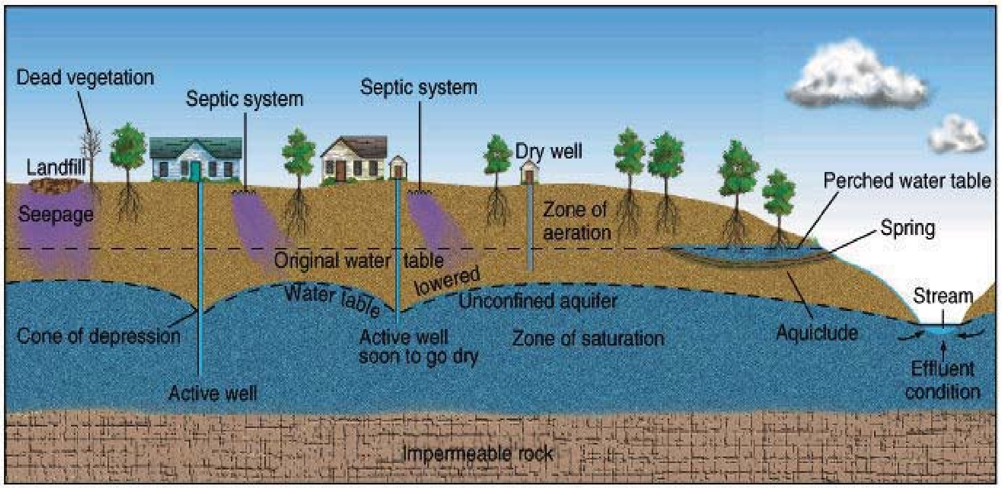
Zone of Saturation – pore spaces are filled with water

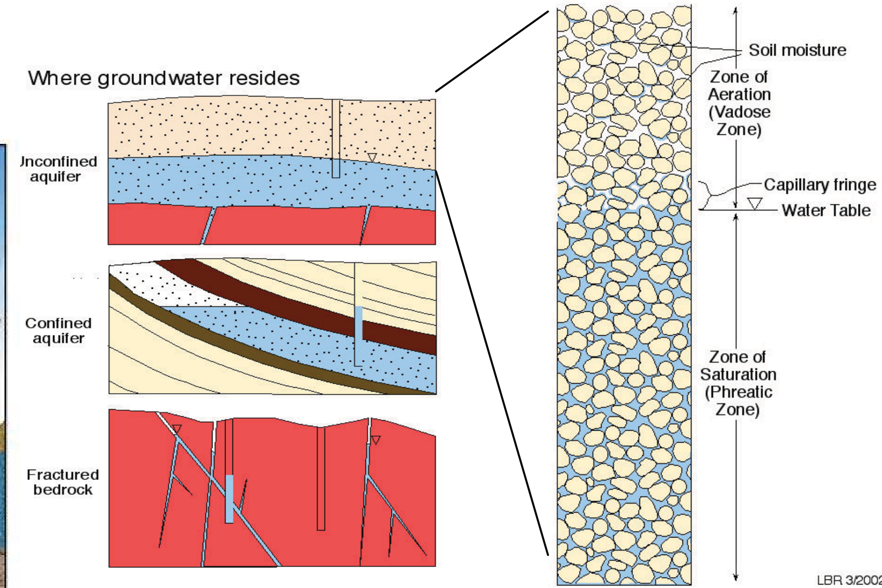
- the water held in the ground within this zone is called **groundwater** (water will flow to streams, rivers, etc.)
  - The interface between these two zones is called the **water table**
  - **aquifer** – a source of groundwater used as a drinking supply



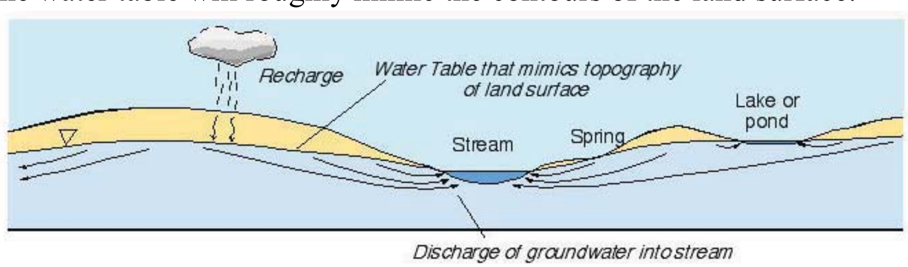
Groundwater

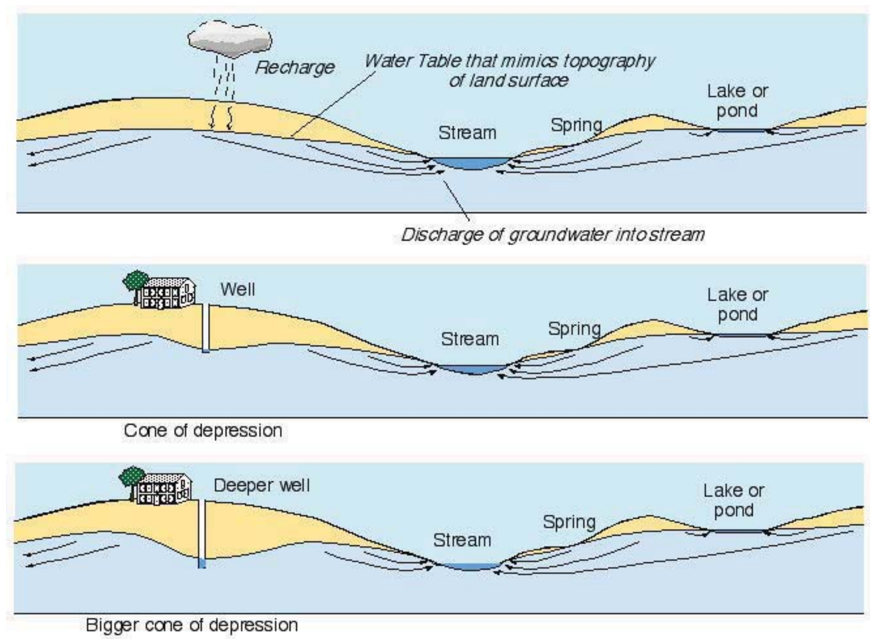
- any substantial source of groundwater can be used as an aquifer
- the water table will lower as wells withdraw water faster than can be replaced by infiltration





- the water table will roughly mimic the contours of the land surface:





- streams , rivers, lakes, ponds, and marshes are intersections of the water table with the land surface
- groundwater moves down slope due to gravity
- groundwater discharges into streams and the ocean – most water in streams and rivers comes from groundwater
- extensive pumping of the groundwater will lower the water table
    - this can lead to a “dry well”