Salahaddin university
Engineering college
Civil department
1st class
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Engineering Geology
Water, weathering and erosion

4th lecture
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Water

4th lecture

- **Occurrence of water**

1. 97.2 % of all water on earth is in oceans.
2. 2.15 % of the earth's water in ice caps & glaciers.
3. About 0.62% of earth's water is groundwater.
4. Water in rivers, lakes, and the atmosphere amounts to less than 0.02% of earth's water.

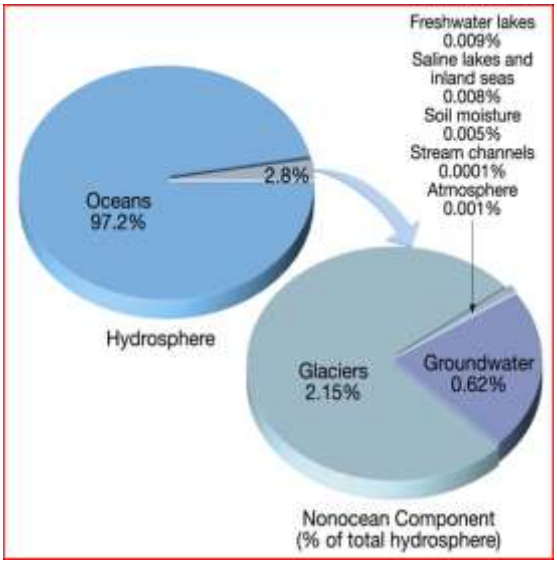

Figure 1

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Water

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- **Hydrologic Cycle** explains the origin of groundwater.

Depicts the occurrence and movement of water in the earth-atmosphere system.

- Water enters the GW system at **recharge areas**.
- Water leaves GW system at **discharge areas**.
- **Movement of Water**

1. **Precipitation:** Atmosphere to surface.
2. **Evaporation:** Surface to atmosphere, liquid to vapor.
3. **Sublimation:** Solid to vapor.
4. **Transpiration:** Release of \ vapor by plants.
5. **On surface:** Downslope movement to lakes, streams, and oceans**.**
6. **Below surface:** Movement of groundwater.

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Ground Water

4th lecture

- **Groundwater:** is water, which originates from the infiltration of fluids through the soil and accumulates below the earth's surface in a porous layer.
- **Porosity:** is the percentage of open void space in the subsurface material. It is expressed as a percent.
- **Permeability:** is how readily a fluid can flow through a material.

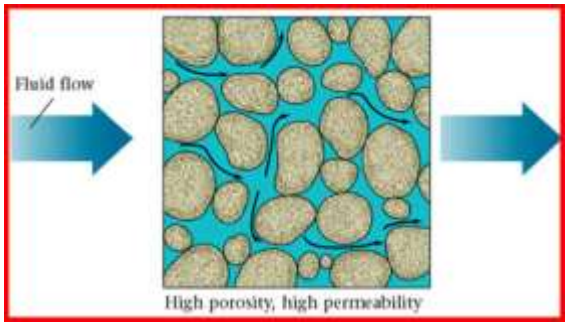

Figure 2

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Ground Water

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- **Piezometric surface:** is the surface in which water is pushed up by the pressure below.
- **Spring:** is where water flows out without the aid of pumping. It may be caused by hydrostatic pressure (pressure pushing upward), or the intersection of the piezometric surface with the ground surface.
- **An aquifer:** is the porous unit or layer of rock that is able to store or hold water and transmit enough fluid to be of economic value.
- **An aquitard:** is rock material that is low in porosity/permeability. Fluid flow is not good and the unit may often be termed a "cap rock", not allowing underlying water to flow upward.

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Ground Water

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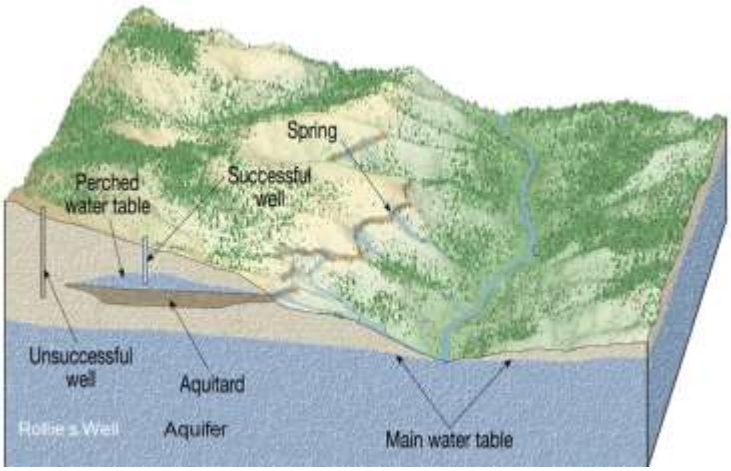

Figure 3

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Ground Water

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- **The distribution of groundwater is present in several distinct layers or zones:**

1. Soil moisture zone: usually top soil; much infiltration; much organic material
2. Zone of aeration: mostly air but some interstitial water
3. Capillary fringe: transition between unsaturated and saturated zone; top of aquifer
4. Zone of saturation: pores completely saturated with water; main aquifer storage zone.

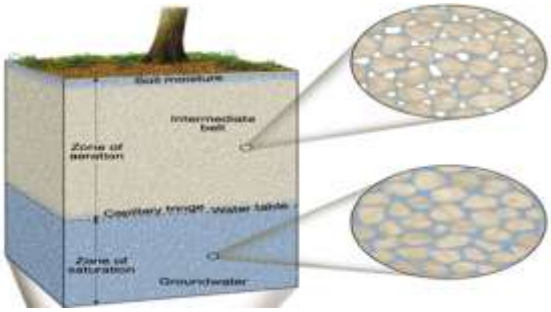

Figure 4

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Ground Water

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- In areas which soluble rock (i.e., limestone) is present in the layer near the groundwater, a situation often develops that is characterized by rock layer dissolving. This is referred to as **karst topography**.
- The area (karst topography) is characterized by:

a) Soluble bedrock near the surface.
b) Disappearing streams that feed downward with no end on the surface.
c) Sinkholes.
d) Frequent fluctuations in water table.
e) Caves.
f) Submerged caves.

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Ground Water

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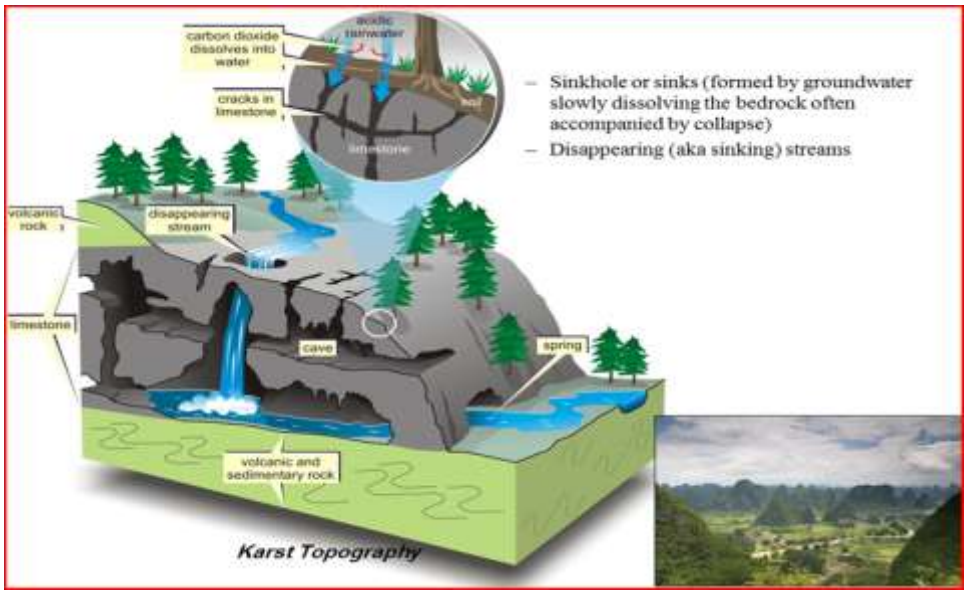

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Figure 5

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Ground Water

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- **Caves:** are formed by the dissolving nature of the rock fed by groundwater. Large cavities develop as well as solid drops of rock that precipitate from the groundwater solution.
- **Groundwater Contamination:**

Contamination results in a decline of water quality.

- There are several problems, which can develop, associated with the lowering of the groundwater surface due to overuse /over pumping:

1. Cone of depression develops.
2. Lowering of the piezometric surface, thus wells dry up.
3. Saltwater intrusion if near an ocean.

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Ground Water

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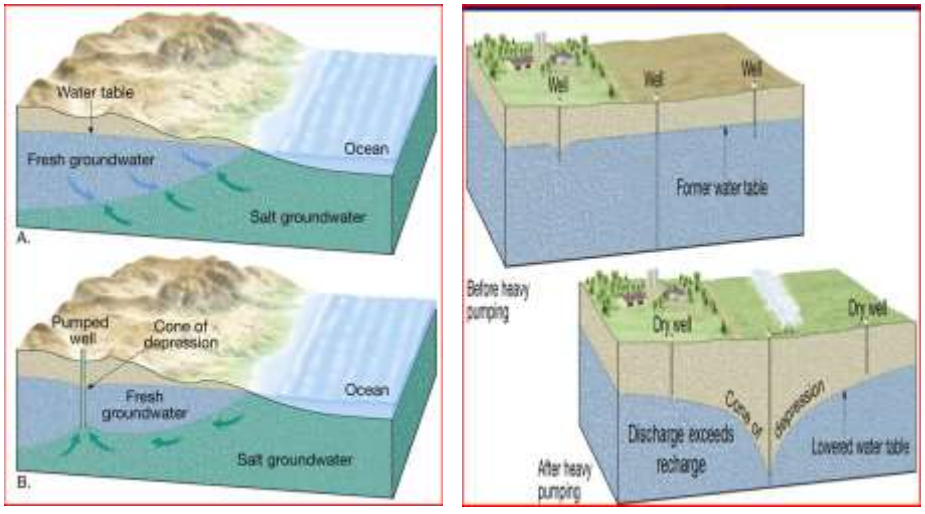

Figure 6

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Ground Water

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- **Protecting groundwater resources:**

1. Apply agricultural chemicals properly.
2. Build better landfills.
3. Regulate disposal of hazardous materials.
4. Regulate underground storage tanks (USTs).
5. Limit contaminant levels in drinking water supplies.

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Streams

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- **Gaining streams:** are those that take in water with time and tend to widen (If GW seeps into stream, stream is a **gaining stream**).
- **Losing streams:** are those that lose water with time and tend to become narrower (If water seeps from stream into subsurface, it is a **losing stream**).
- **Intermittent streams:** are those that are wet during the wet season and dry in drier times.

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Streams

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- Head of stream is starting point; Mouth of stream is "end".
- Channel shape is based on the velocity of the stream and resistance of rock it is cutting into.
- Water in streams tends to move quicker in the center of the stream and slower towards the outside.
- Wider streams move slower than narrow streams.
- Outside of meander is called a Cutbank and is associated with erosion.
- Inside of meander is called a Point Bar and is associated with deposition.

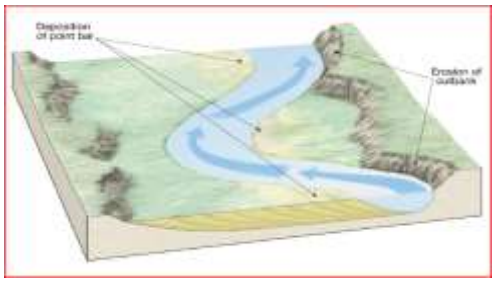

Figure 7

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Weathering and Erosion

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- **Weathering and erosion operate together.**
- **Weathering:** refers to the group of destructive forces that change the physical and chemical characteristics of rock at or near the earth's surface.
- Weathering is a fundamental component of the ROCK CYCLE.

Figure 8

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Weathering and Erosion

- **Two main types of weathering:**
- **Mechanical weathering:** physical forces break rock into smaller pieces without changing their chemical composition.
- Examples: frost action fig. (7), abrasion, Organic activity, and exfoliation.

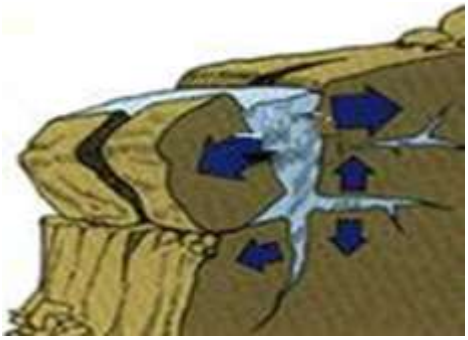

Figure 9

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Weathering and Erosion

- **Chemical weathering**: chemical transformation of rock into one or more new components
- Examples: rusting, acid breakdown, oxidation fig. (8), and solution weathering.

Figure 10

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Differential Weathering

- Weathering rates will not only vary depending on the type of weathering process, whether it is mechanical or chemical, but they will also vary depending on the rock material that is being weathered.
- Some rocks are harder than other rocks, and will weather slower than softer rocks.
- The differences in rates of weathering due to different types of rocks, textures, or other characteristics is referred to as differential weathering.
- Differential weathering processes contribute to the unique formation of many landforms, including waterfalls, and monadnocks.
- Climate can also produce differential weathering responses for the same rock type. For example, limestone weathers more quickly in wet climates than dry climates.

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Erosion

- **Erosion:** is the physical removal and transportation of weathered material by water, wind, ice, or gravity.

Figure 11

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Erosion

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- Water erodes rocks and the landscapes by transporting weathered materials from their source to another location where they are deposited.
- Wind erodes materials by picking them up and temporarily transporting them from their source to another location where they are deposited, and either stored or re-mobilized and transported to another location.
- Ice erosion occurs when particles are plucked up or incorporated by moving ice, such as a glaciers, and are transported downhill, or when friction between the ice and bedrock erodes materials and then transports them downhill.
- Gravity facilitates the down slope transportation of loosened, weathered materials and enables them to move without the aid of water, wind, or ice. Gravity related erosion is a major component of mass movement events.

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Mass movement

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- **Mass movement** is a rapid form of erosion that works primarily under the influence of gravity in combination with other erosional agents. Mass movement occurs very quickly and can result in either small or large scale changes to the landscape depending on the type of event.
  - Rock Falls.
  - Landslides.
  - Debris.
  - Slumps.
  - Creep.

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Mass movement

- **Rock fall:** A very rapid mass movement in which newly detached blocks of rock suddenly fall from a steep slope or cliff.

- **Landslides** are mass movement events where large amounts of weathered rock material slide down a hillslope or mountain side primarily by gravity related erosion.

Figure 12

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Mass movement

- **Debris** are mass-wasting events that form when heavy rainfalls produce large amounts of runoff that transport eroded soils, sediments, and plant debris down slope where the flows eventually spreads out across valley bottoms.

- **Slumps** are a fairly common form of mass movement where the rock or soil collapses, breaks off from the hill slope, rotates slightly, and slumps downhill.

Figure 13

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Mass movement

- **Creep** is the slowest mass movement process and involves a very gradual downhill movement of soil, bedrock, and weathered rock fragments.

Figure 14

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