Hydrogeology

Dr. Rebwar Nasir Dara
PhD in water sciences

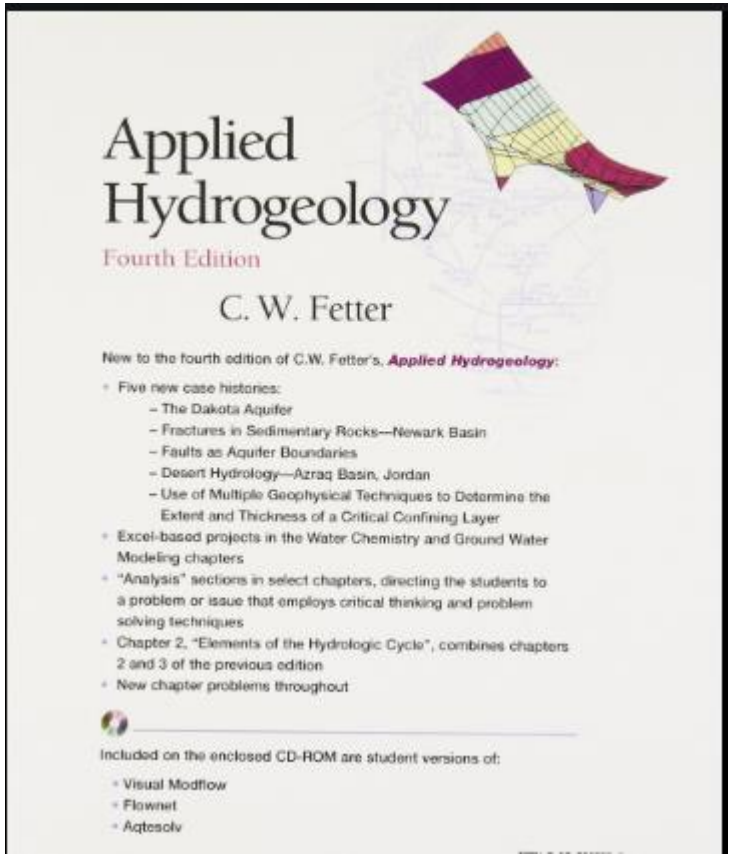
Lecture 1 – An Introduction to Hydrogeology

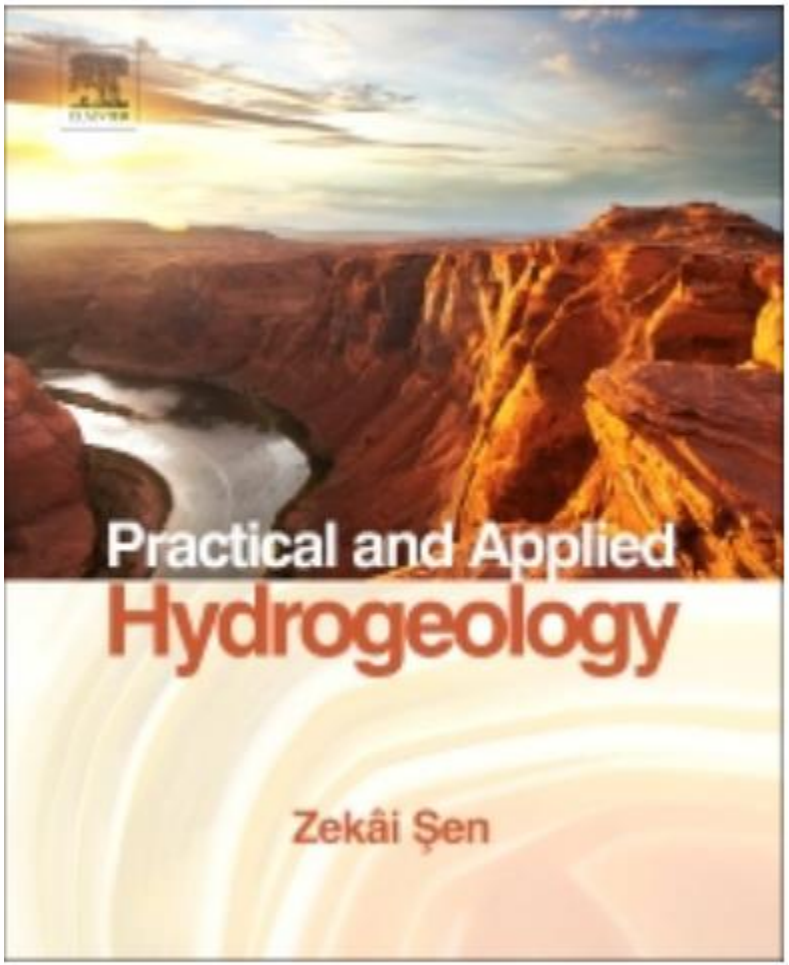
GROUND RULES

- **Read the textbook**

- FETTER, C. W. (2001). *Applied hydrogeology*. Upper Saddle River, N.J., Prentice Hall.

- Şen, Z., 2014. *Practical and applied hydrogeology*. Elsevier.





GROUND RULES

- **Attend lectures**
  - Hear topical overviews & ask questions
  - Do in-class assignments & turn in & pick up HW
  - Exams, quizzes & extra credit opportunities
- **In-class exercises and homework assignments (depend on your status!!!)**
  - Exercises weekly & homework every other week

GROUND RULES

- **Required by all students**

While in lecture, please DO NOT:

- Forget to turn off cell phones
- read different documents instead of course notes
- Talk and have conversations

While in the lecture, please DO:

- Ask questions when anything is not clear
- Engage in the discussions
- Fully participate in in-class exercises

An Introduction to Hydrogeology

- What is hydrogeology
- What is the hydrologic cycle
- What is the hydrologic equation
- Gaining and losing streams
- Origin and age of groundwater

What is Hydrogeology

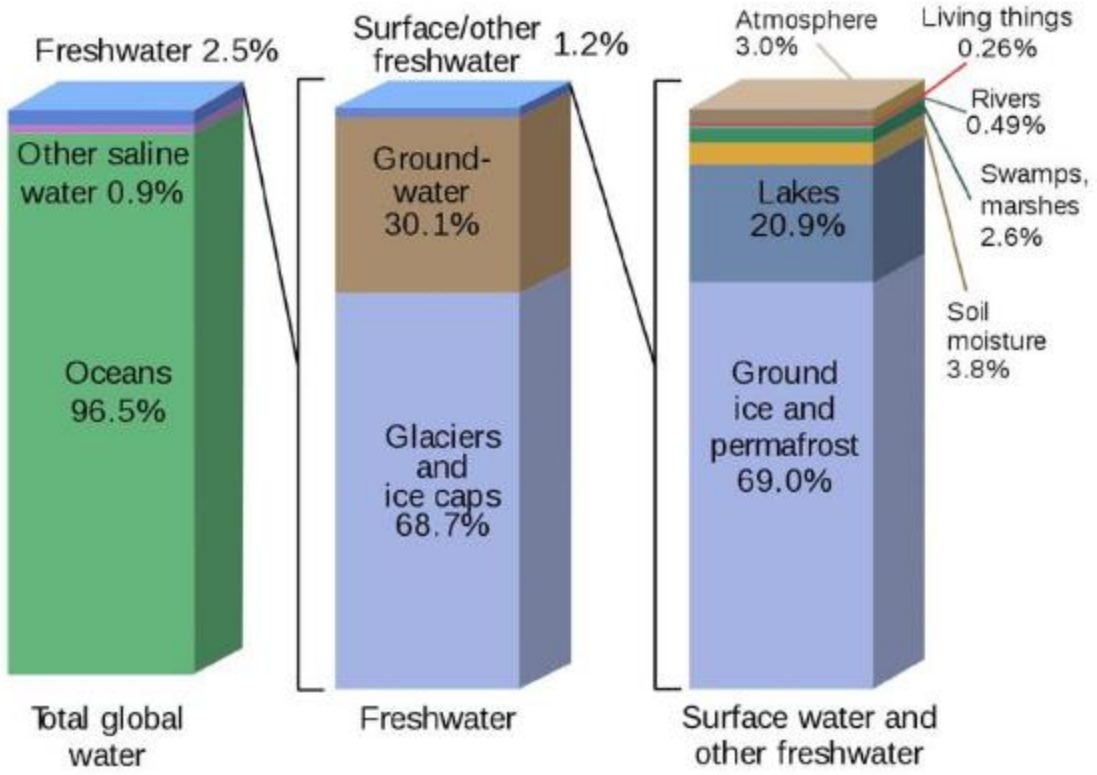
- Hydrogeology (hydro- meaning water, and - geology meaning the study of the Earth) is the area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers).

- The terms groundwater hydrology, geohydrology, and hydrogeology are often used interchangeably.

Introduction

- Groundwater is one of the most precious natural resource.
- It is the most important source of drinking water and supplies water for irrigation, agricultural and domestic usage.
- Of the total water available on earth, less than 2.5 % is fresh water of which 68.7% is found in the ice caps and glaciers (frozen state).
- Approximately 30% is groundwater and less than 1.2% is surface water (lakes, streams, permafrost, soil moisture etc.)

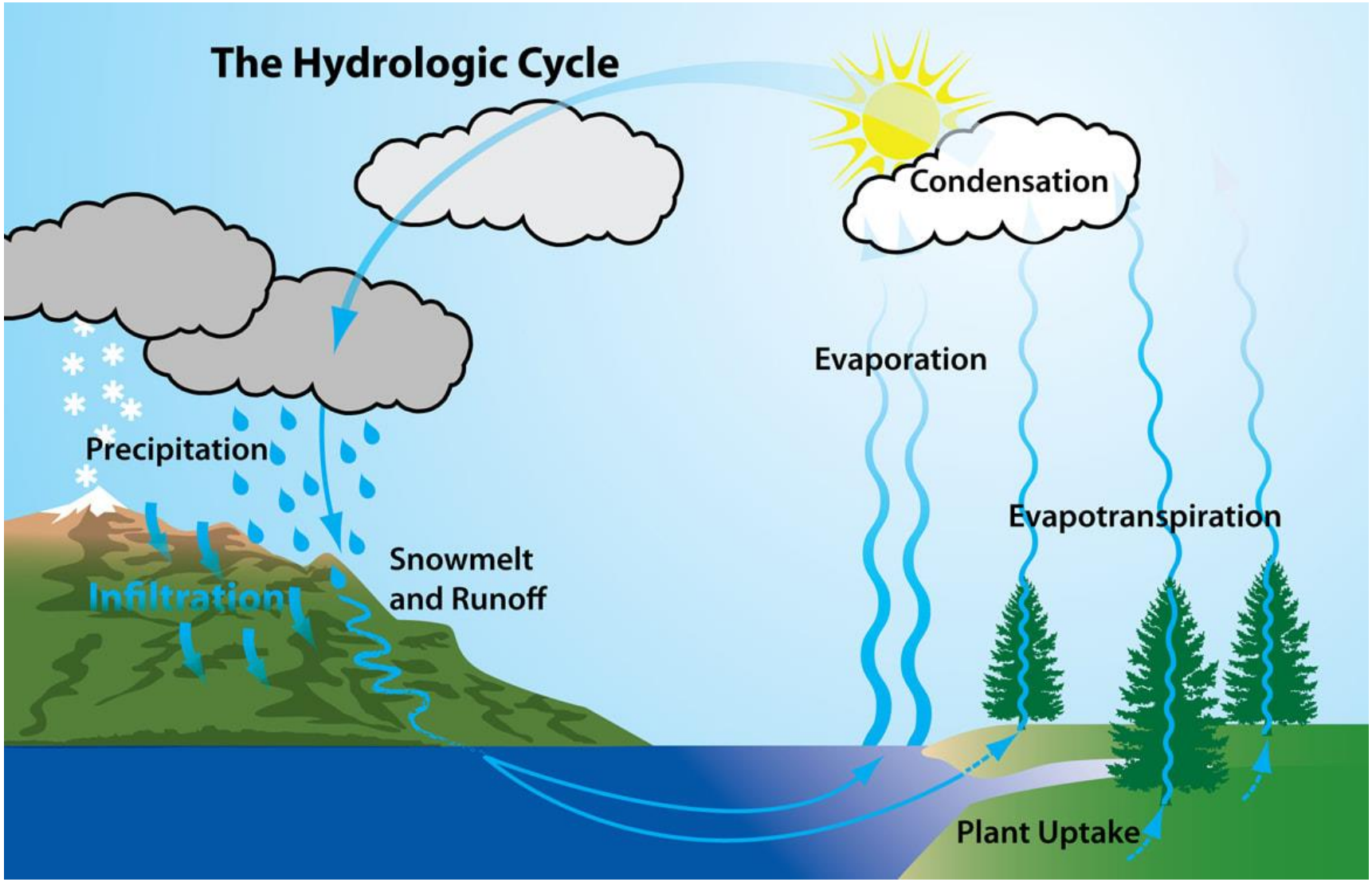
Distribution of Water on Earth

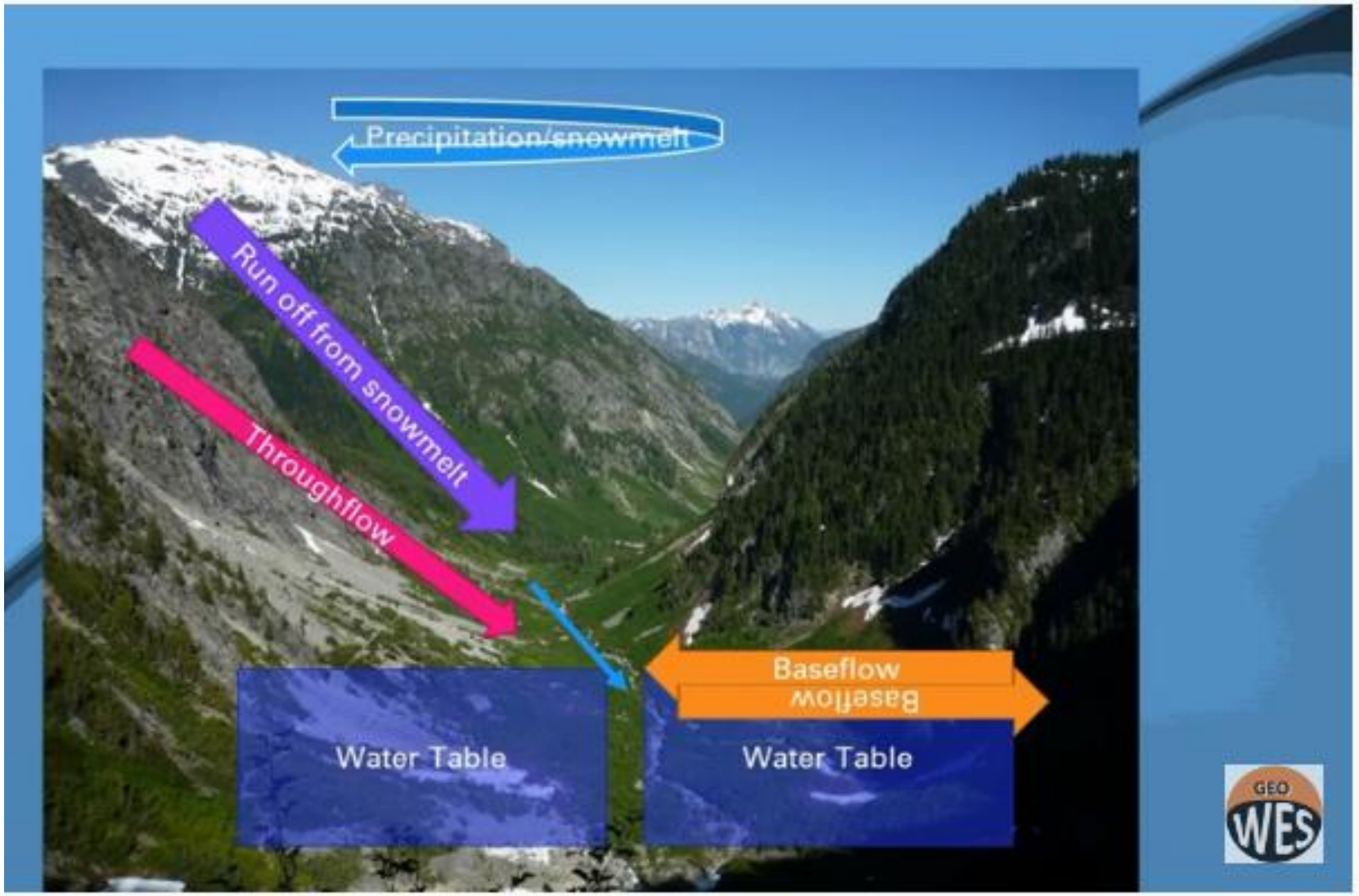


The Hydrologic cycle

- No beginning, no end. We can start in the ocean but that is not the origin of the water molecule.
- Evaporation vs Condensation vs Precipitation
- Runoff- ice/rain/snow – Overland flow
- Infliltration – seepage into the ground
- Vadose zone – soil pores, air and water
- Transpiration – soil water taken up by plant roots, released into the atmosphere.
- Interflow – vadose zone water movement.
- Capillary fringe – intermediate belt – pores filled with capillary water, saturation approaches 100%, water is held by capillary forces.
- Zone of saturation – water table – groundwater
- Baseflow - groundwater contribution to a stream – Throughflow- Water that infiltrates into the soil on a slope moves down slope as lateral unsaturated flow in the soil zone
- Evapotranspiration (ET)- transpiration by plants, evaporation from land surfaces
- Magmatic water – Could be origin of water molecules. Contained within magmas deep in the crust.

The hydrologic cycle




Precipitation/snowmelt
Run off from snowmelt
Throughflow
Baseflow
Water Table
Water Table

The Hydrologic Equation

The general equation: Is essentially a problem of conservation of mass:

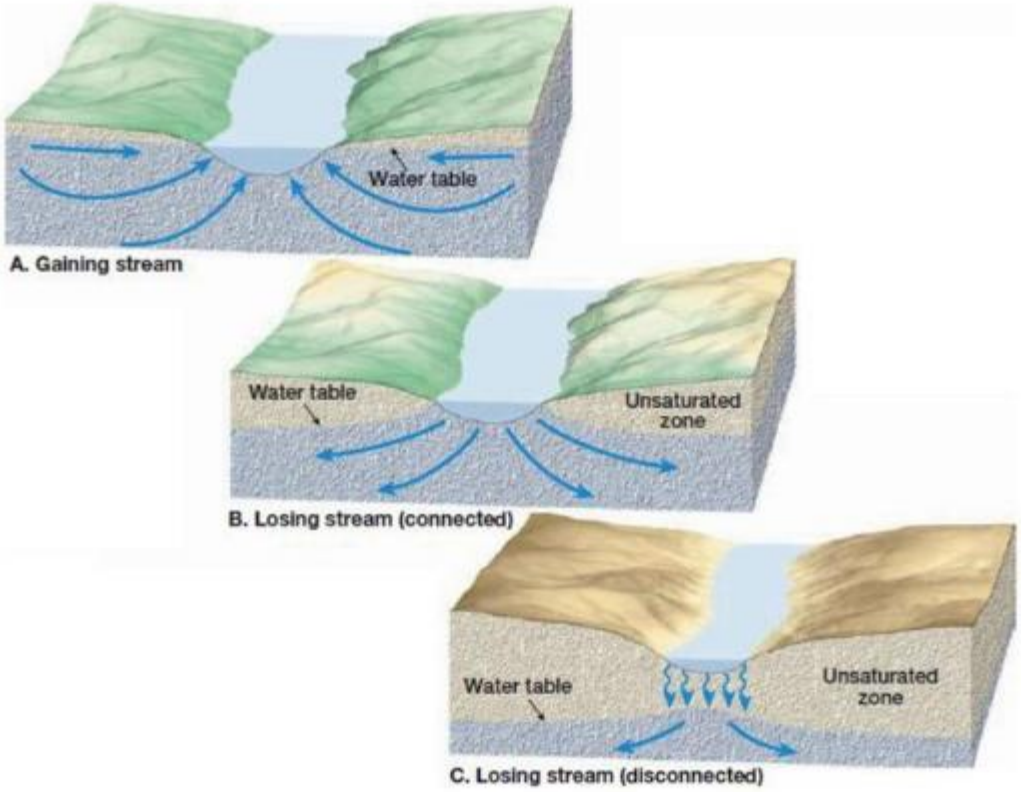
Inflow = outflow +/- storage OR: Inflow - Outflow = change in storage

Inflow = precipitation, surface inflow, loss from a body of surface water, subsurface inflow, overland flow, groundwater discharge into a body of surface water.

Interaction between groundwater and streams

- The interaction between the groundwater system and streams is a basic link in the hydrologic cycle.
- It can take place in one of three ways.
- 1) Streams may gain water from the inflow of groundwater through the streambed. Such streams are called gaining streams.
- For this to occur, the elevation of the water table must be higher than the level of the surface of the stream.
- 2)Streams may lose water to the groundwater system by outflow through the streambed. The term losing stream is applied to this situation
- When this happens, the elevation of the water table is lower than the surface of the stream. Losing streams can be connected or disconnected
- 3) The third possibility is a combination of the first two—a stream gains in some sections and loses in others.

Interaction between Groundwater and Streams



Origin and Age of Groundwater

- Almost all groundwater is a part of the hydrologic cylce, including surface and atmospheric waters.
- However minor amount of groundwater may be derived from other origins.
- Water that has been out of contact with atmosphere for an appreciable part of geologic period is termed as connate water. This water may have been derived from ocean or fresh water sources and is highly mineralized.
- Magmatic water is derived from magma. Where the separation is deep, it is known as plutonic water, while volcanic water indicates water from relatively shallow depths.

Origin and Age of Groundwater

- New water of magmatic or cosmic origin that has not previously been a part of the hydrosphere is referred to as juvenile water.
- Metamorphic water is the water that has been associated with the rocks during their metamorphism.
- Radioactive isotopes are helpful in determining the age of groundwater.
- Two most useful radioactive isotopes for determining the age of water are Hydrogen-3 (Tritium) and Carbon-14.
- Tritium (half life years) is used for estimating groundwater ages upto 50 years.
- Whereas Carbon-14 (half life-5730 years) is used for dating groundwater ranging from a few hundred years to about 50,000 years.