Ground water hydrogeology

(G306-Second semester 2022-2021)

Lecture -1

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Hydrology

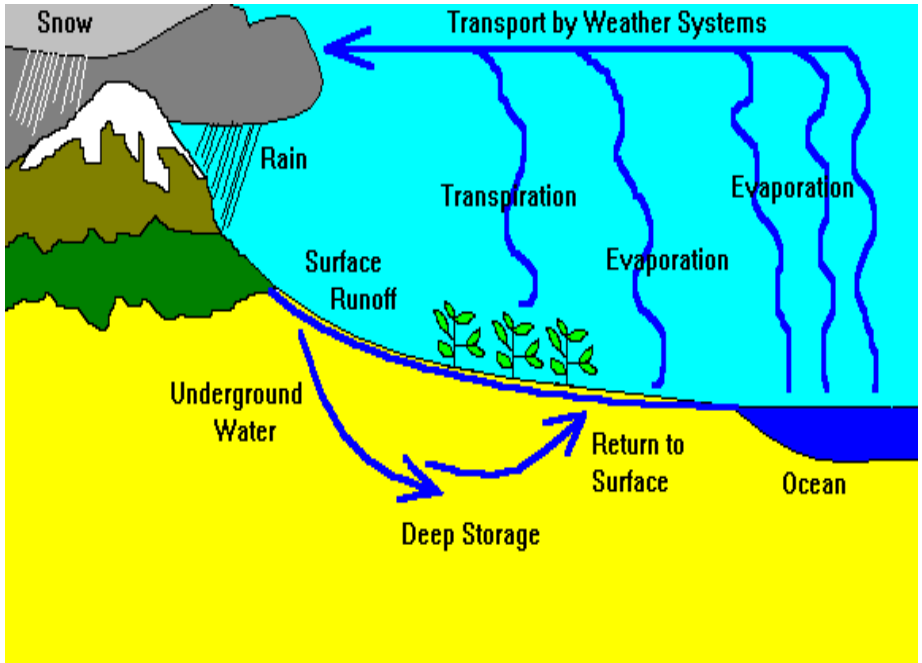
Is the study of water, by the occurrence, distribution, movement, and chemistry of all waters of the earth.

Hydrogeology

Encompasses the interrelationships of geological materials and processes with water

Geohydrology

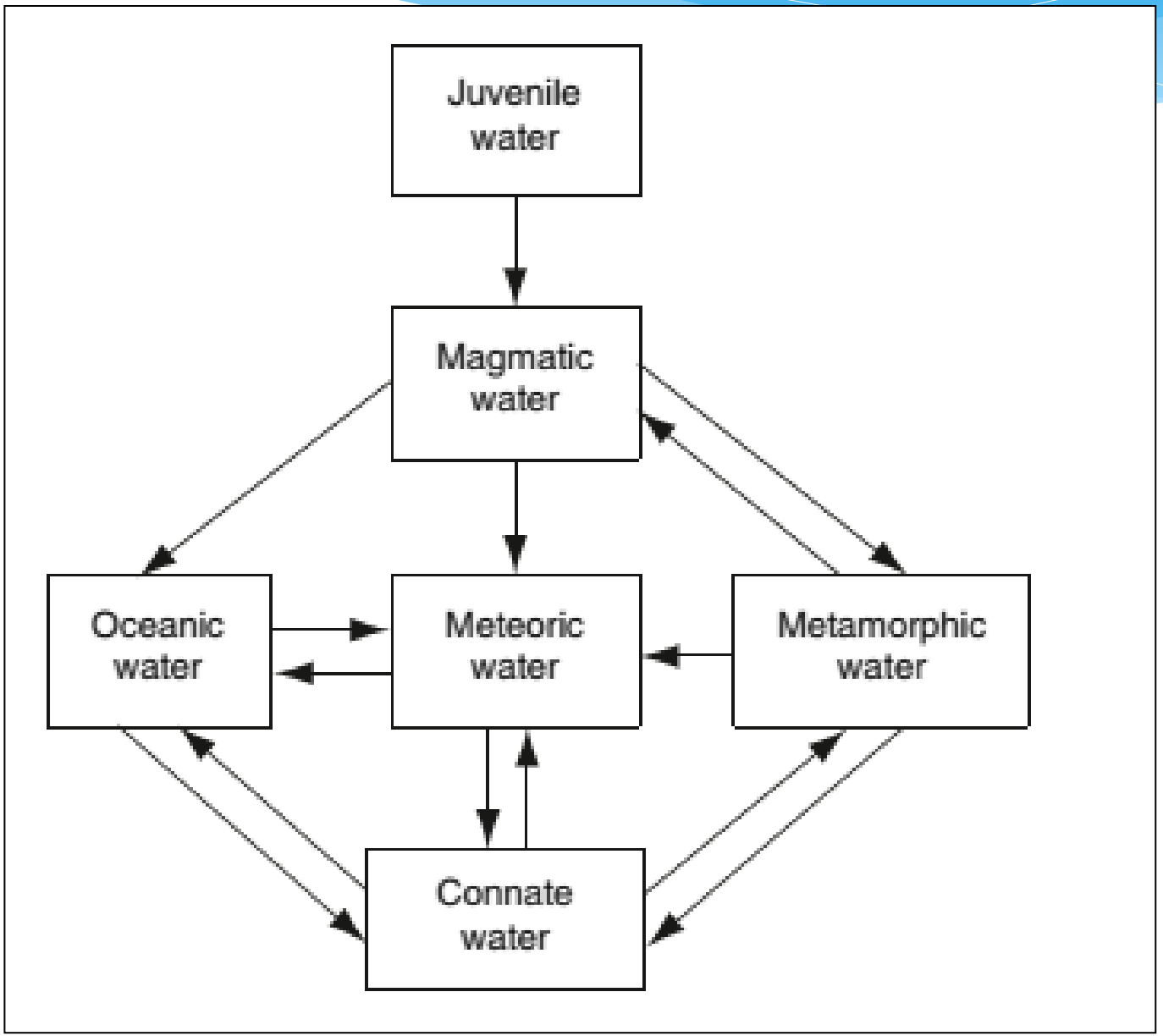
Describes an engineering field dealing with subsurface fluid hydrology



The objective of study hydrogeology

1. Development of save groundwater supplies for domestic and irrigation purposes
2. Contaminant migration studies, in order to estimate the movement of pollutants through porous and fractured media
3. Tapping of geothermal resources involving estimation of extractable amount of hot fluids from the natural geothermal gradients.
4. Development of petroleum and gas reservoirs.
5. Underground disposal of nuclear waste.
6. Construction of underground rock cavities for storing water, oil and gas etc. and underground passages like tunnels etc.
7. In several other geo technical problems, e.g. hydro-mechanical effects on stability of rock slopes, seepage from dams and tunnels, land subsidence and triggering of earthquakes etc.

Classification of water with respect to origin



- Most of the water is of **meteoric type** as it a result of atmospheric precipitation being a part of the present day hydrologic cycle.

- It is the main source of water to wells and springs.

- The other types of water are connate water, juvenile or magmatic water and metamorphic water.

- **Juvenile water** is know as new water, as it is introduced in the hydrosphere for the first time.

- **Magmatic water** is mainly of juvenile origin derived form either deep seated magma or may be of shallow volcanic origin.

- **Connate water** is the remnant of ancient water retained in the aquifers and is not in hydraulic continuity with the present day hydrological cycle.

- It is also known as fossil water

- It may be either of marine or fresh water origin.

- It is commonly associated with oil and gas where it is usually of marine origin.

- **Metamorphic water** or rejuvenated water is the term used for water derived from hydrous minerals like clays, micas, etc. due to the process of metamorphism.

* **Sources of ground water**
* **1- natural recharge include:**
* - precipitation
* - stream flow
* - lakes
* - reservoirs
* **2- artificial recharge include:**
* - irrigation
* - seepage from canals
* - water purposely applied to augment ground water supplies
* - sea water(where hydraulic gradients slope downward in an inland direction)

Most natural discharge from g.w occurs:

* 1-flow into surface water bodies (stream, lake, and ocean)
* 2-springs
* 3-evaporation
* 4-transportation – from plants
* 5-pumping from wells constitutes the major artificial discharge of ground water.

Rock properties affecting ground water:

* **Aquifer:** - a formation that contains sufficient saturated permeable material to yield significant quantities of water to well and springs like: unconsolidated sands or gravels. Fractured igneous and metamorphic rocks and carbonate rocks with soluble cavities also form good aquifers.

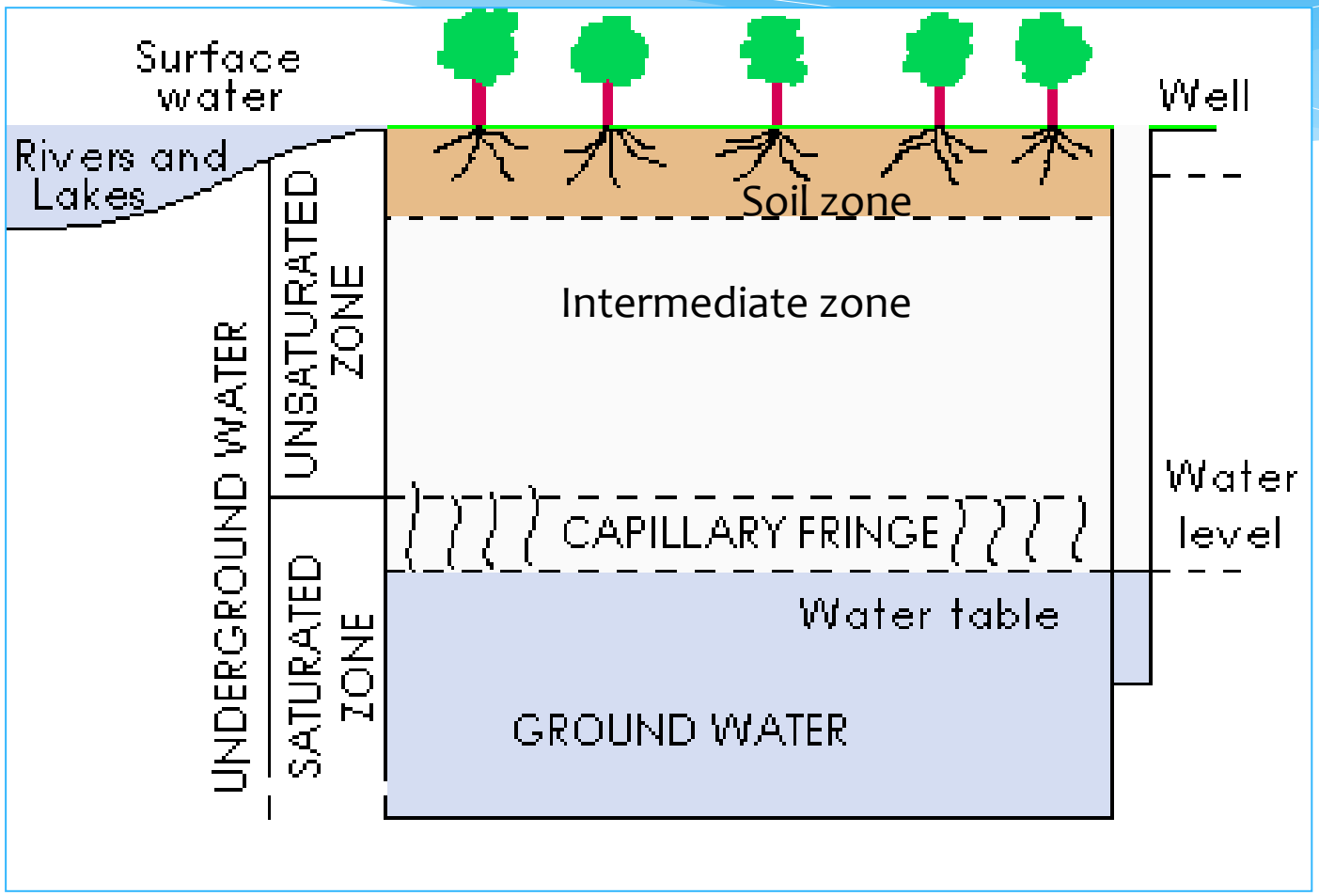
* **Aquiclude:** - Impermeable formation which may contains water but incapable to transmitting significant water quantities like: clay, shale.
* **Aquifuge:** - A relatively impermeable formation neither contain nor transmitting water like: solid granite

Aquitard: - A saturated but poorly permeable stratum serve as semi-confining layers like: sandy clay

Geological formation as aquifers:

* water courses
* abandoned or buried valleys
* plains
* the most geological structures which is very important in storage ground waters is
* -Limestone & dolomite (depends on degree of consolidation & development of permeable zones after deposition).
* -Gypsum beds may be consider as aquifer
* -Volcanic rocks can form highly permeable aquifer like:(flows, porous zones between lava beds, lava tubes , flow of breccia.
* -Shrinkage cracks
* -Joints
* -Conglomerate cemented forms (sand and gravels)
* - sandstone beds represents the main geological formation as a good aquifers .

Zones of Aeration and Saturation



Depending on the degree of saturation, two depths zones can be identified:

1- Unsaturated Zone (zone of aeration or vadose zone)

In vadose zone the intergranular space is only partly filled with water, the remaining space is occupied by air.

These zone is divided into three zones from top to bottom

-Soil water zone

It is of interest to agricultural scientists as it provides water for the growth of vegetation.The moisture content in soil water zone changes as a result of loss of water due to evapotranspiration

-Intermediate vadose zone

water of suspended subsurface water as it is held due to intermolecular force against the pull by gravity. The thickness of this zone may be zero when water table is close to the ground surface or it may be even more than 100 m under deep water table conditions as the arid regions.

-Capillary zone

It is extends above the water table up to the height of the capillary rise which mainly depends on the size of the intergranular openings.

2-Zone of saturation (phreatic of groundwater zone) The zone of saturation is saturated with water with exclusion of air. This forms the zone of reduction and deposition of mineral.

- The zone of aeration and zone of saturation is separated by water-table of phreatic surface, which is under atmospheric pressure.
- The water – table may be either very close to the groundwater surface in areas of intensive recharge or may be several hundred meters deep in arid regions.
- Fluctuations in water – table indicate changes in groundwater storage, either due to natural reasons or by man's activity.

The main type of aquifers

- **1-Confined aquifer** A confined aquifer, also known as artesian aquifer, is overlain and underlain by a confining layer.

- Water in a confined aquifer occurs under pressure which is more than the atmospheric pressure.

- The piezometric (potentiometric) surface, which is an imaginary surface to which water will rise in wells tapping confined aquifer.

- Confined aquifers are mainly recharged at the outcrops which form the intake areas.
- A confined aquifer may change to unconfined aquifer either with the time or space depending on the position of the potentiometric surface which in turn depends on the recharge and discharge from the aquifer.

- Confined aquifers with potentiometric surface above the land surface, support flowing wells.

2-Unconfined aquifer: An unconfined or phreatic aquifer is exposed to the surface without any intervening confining layer but it is underlain by a confining layer.

- It is partially saturated with water.
- The upper surface of saturation is termed water-table which is under atmospheric pressure.
- It is recharged directly over the entire exposed surface of the aquifer.

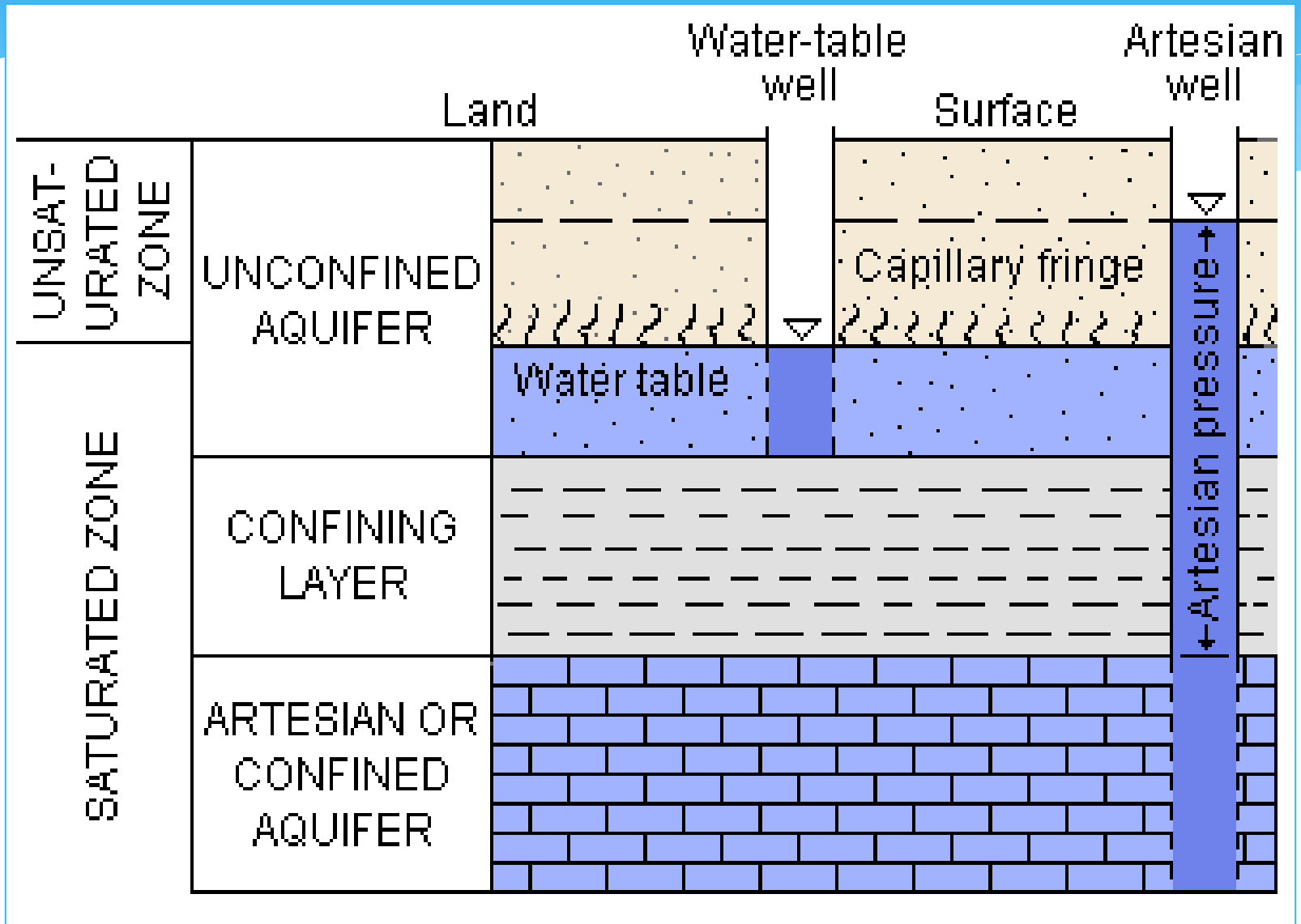
3-Leaky (semi-confined) aquifer :

- where the upper & lower boundaries are aquitard or one boundaries are aquitard and the other is aquiclude.The water level may also stand above or below the water table depending on the recharge and discharge conditions.

4-**Perched aquifer :**

- this occurs wherever a ground water body is separated from the main ground water by impermeable stratum of small areal extent and by the zone of aeration above the main body of ground water like clay lenses in sedimentary deposits have shallow perched water bodies overlying them.
- The thickness and lateral extent of perched aquifer is controlled by the shape and size of the clay layer. Being of limited extent, perched aquifers are only a source of limited water supply.

Confined aquifer and Unconfined aquifer



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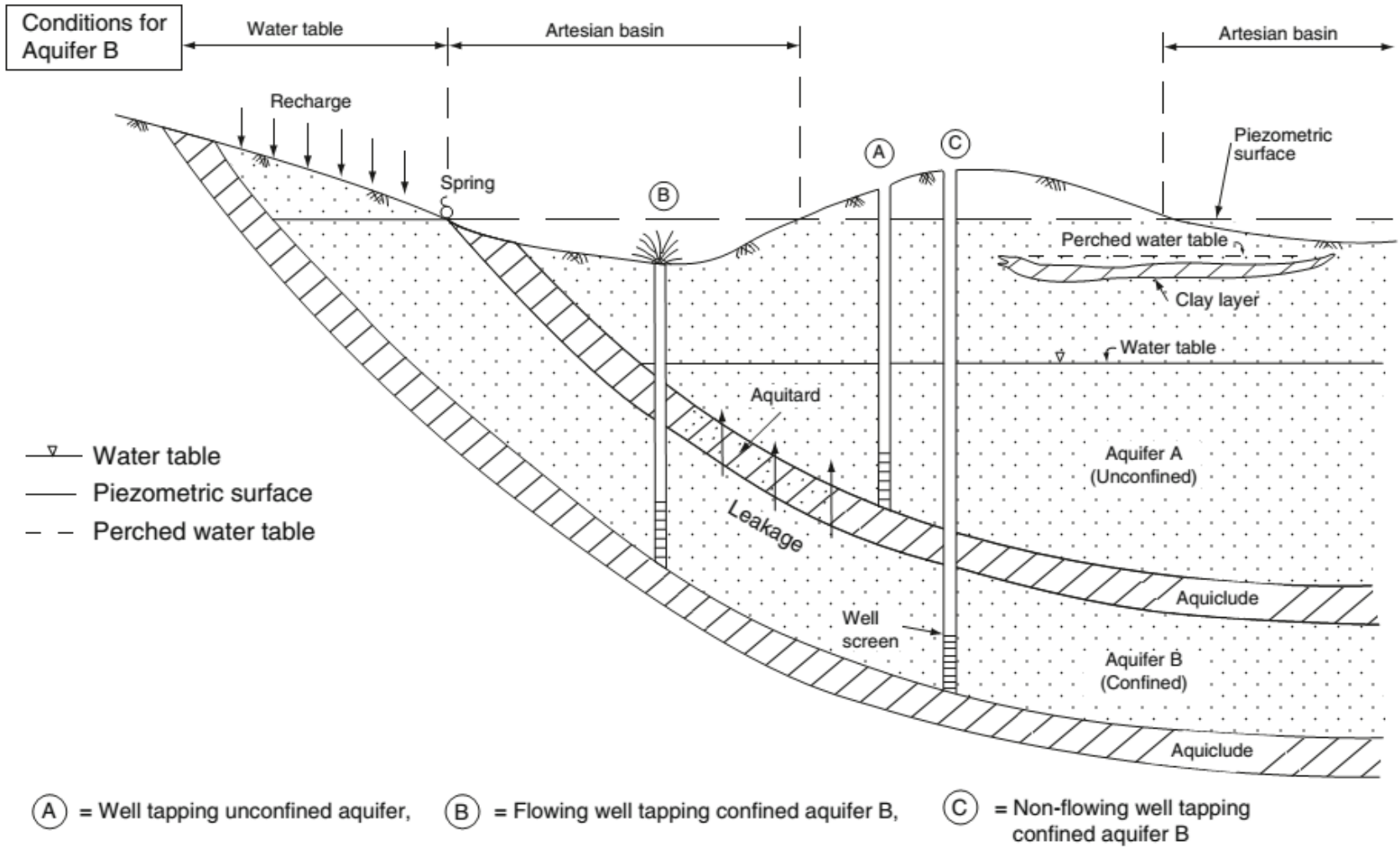


Fig. 1.8 Types of aquifers

Double porosity aquifer

- A double or dual porosity aquifer, viz. fractured rocks consists of two parts – the matrix blocks and the fractures.

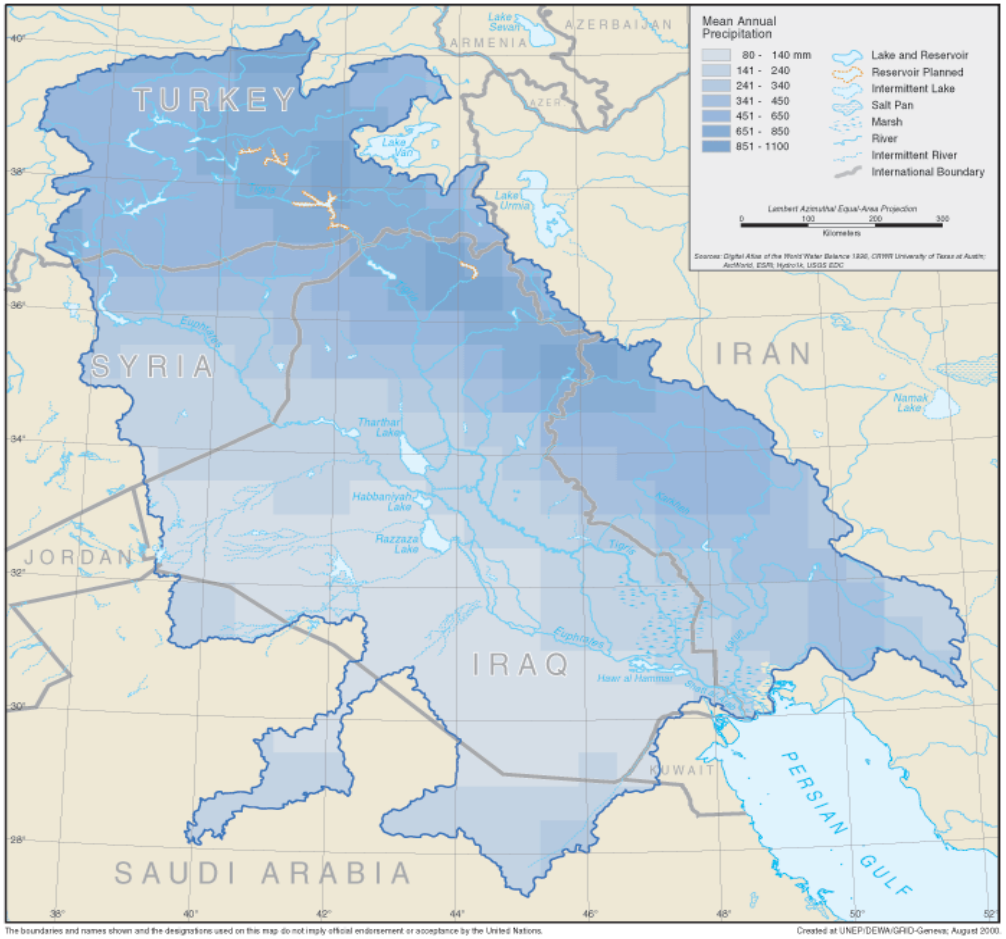
- The blocks have low permeability but high storativity while fractures have high permeability but lower storativity.

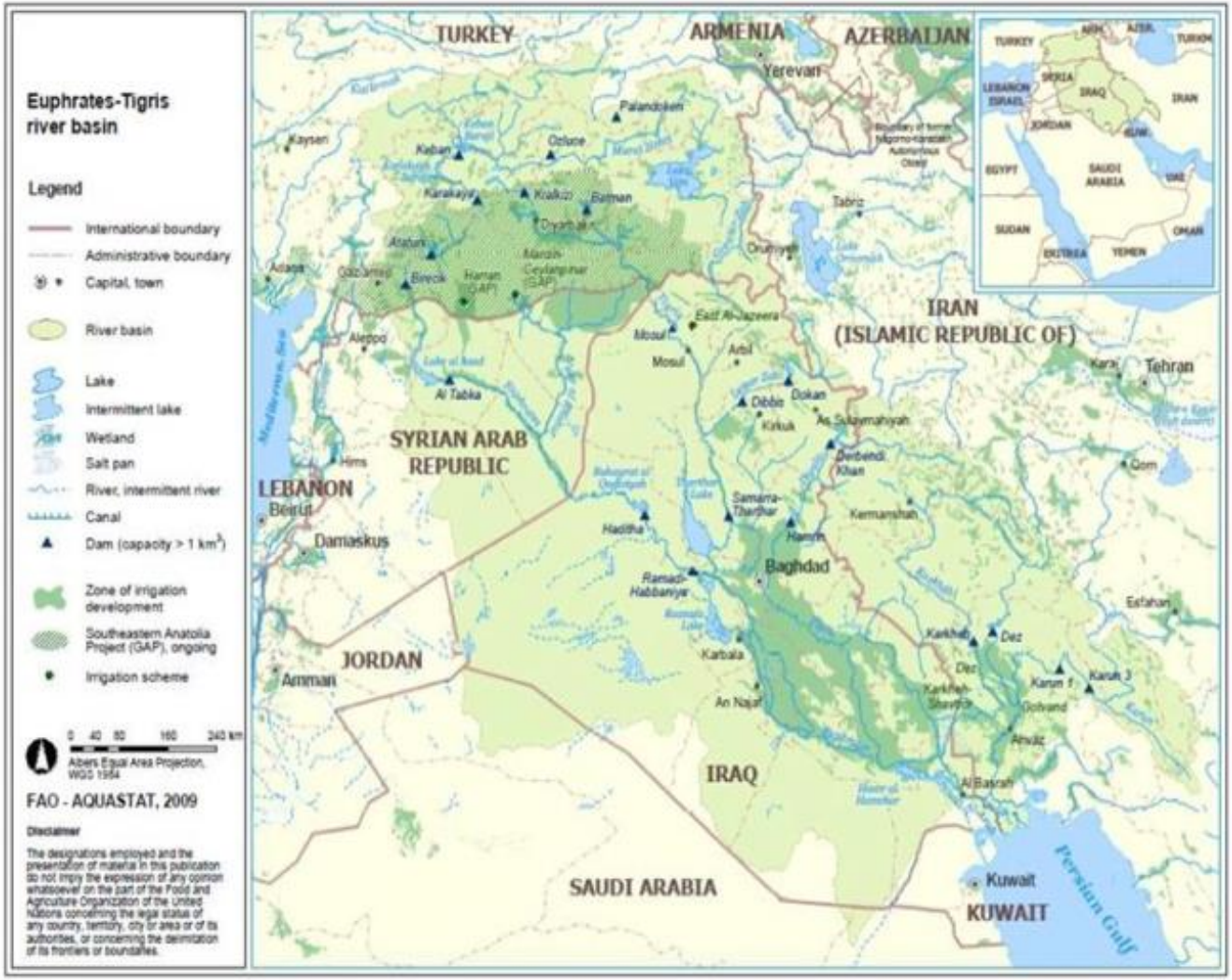
Triple porosity aquifer

- Karst aquifers are characterized by triple porosity consisting of matrix blocks, solution cavities and large solution conduits.

Ground water basins:

It is hydrological unit containing one large aquifer or several connected and interrelated aquifers.





More than 98% of Euphrates discharges came from Turkey
51% of Tigris River discharge came from Turkey
39% from Iraq
10% from Iran