

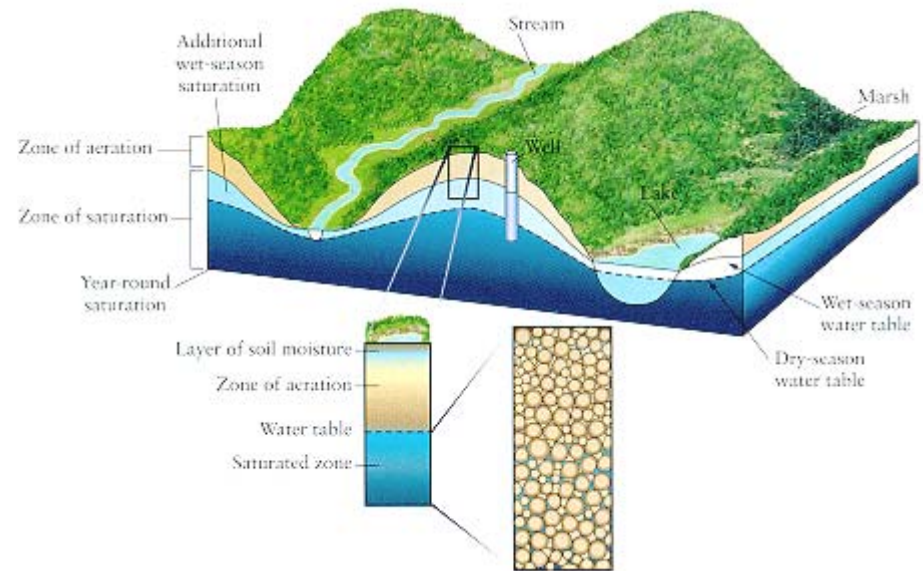


Geology and Groundwater

Hydrogeology & Porous Medium

- The porous media
 - Soils
 - Rocks

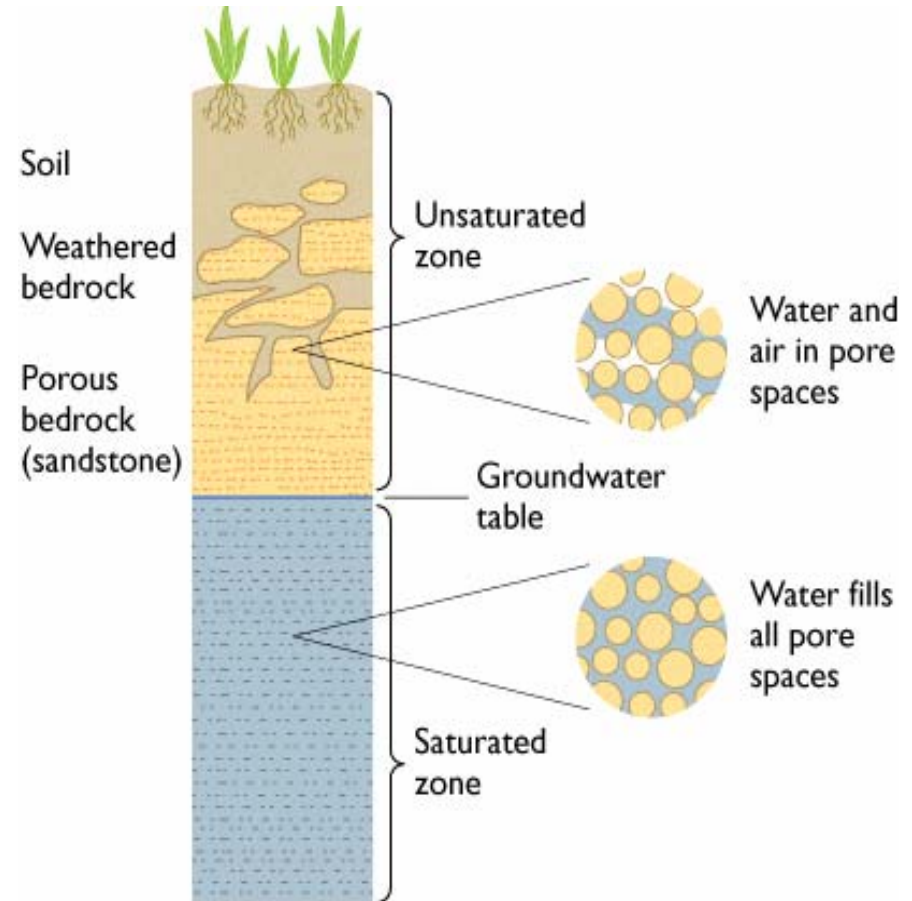
- Porous media hold
 - Water
 - Air
 - Dissolved solutes
 - Chemical pollutants
 - Dissolved and heavy metals
 - Hydrocarbons
 - Pathogens
 - Bacteria
 - Viruses



Ref: Murck & Skinner, 1999, Geology today: Understanding our planet, Fig. 12.22

Hydrogeology & Porous Medium

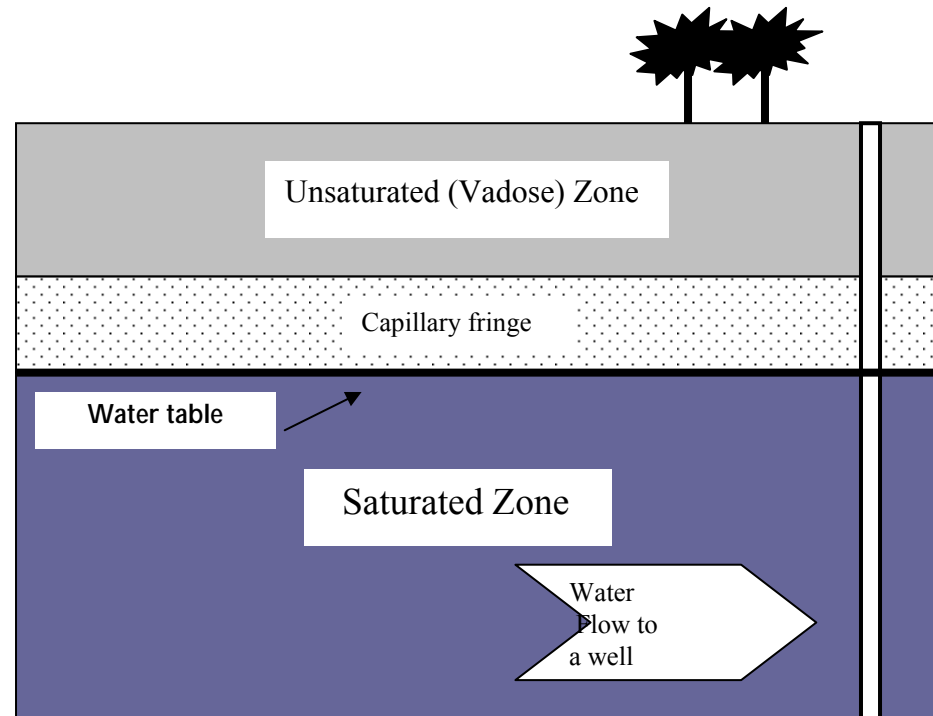
- Zones of porous medium
 - Vadose (unsaturated) zone
 - Saturated (groundwater aquifer) zone



What is an aquifer?

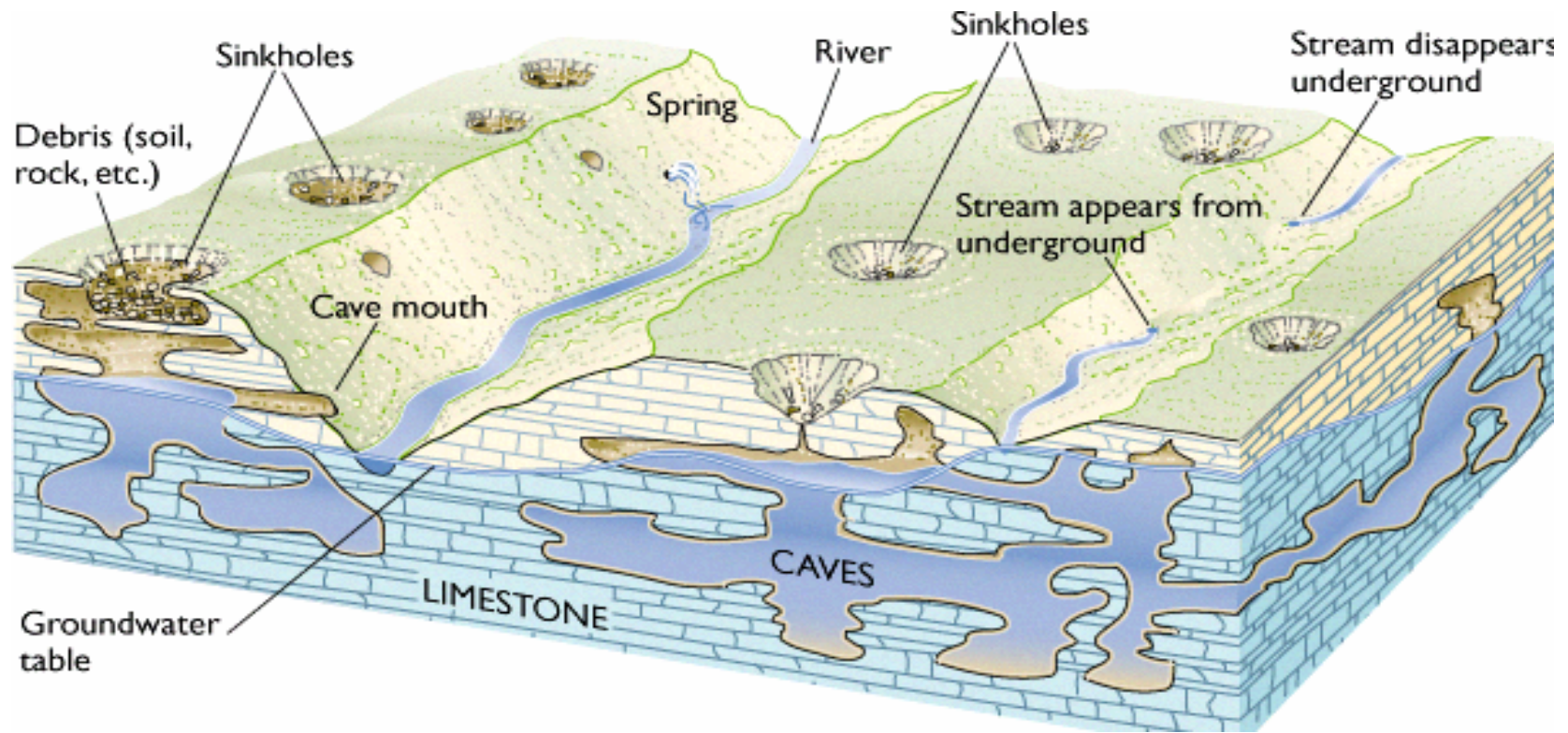
A saturated geologic unit that can

- Store and
- Transmit water at economic rates to wells.
- **Examples:**
 - Limestone aquifers
 - sandstone aquifers



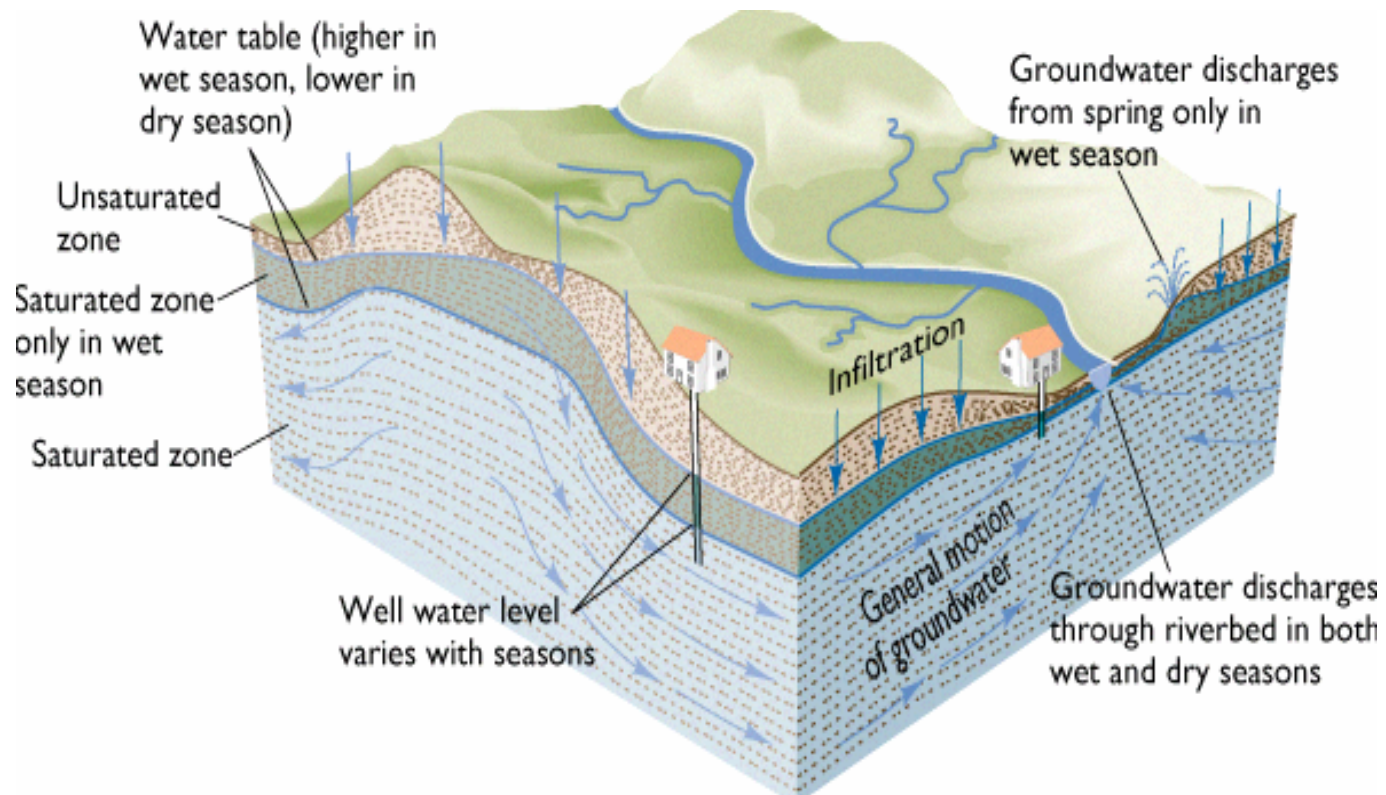
What is an aquifer?

Limestone aquifer



What is an aquifer?

Sandy aquifer



Geology & Aquifers

- Unconsolidated sediments
 - Sand & gravel aquifers (wadis)

- Consolidated & semi-consolidated sediments
 - Sandstone aquifers (Wasia)
 - Carbonate aquifers (UER) → chemical dissolution, karst features

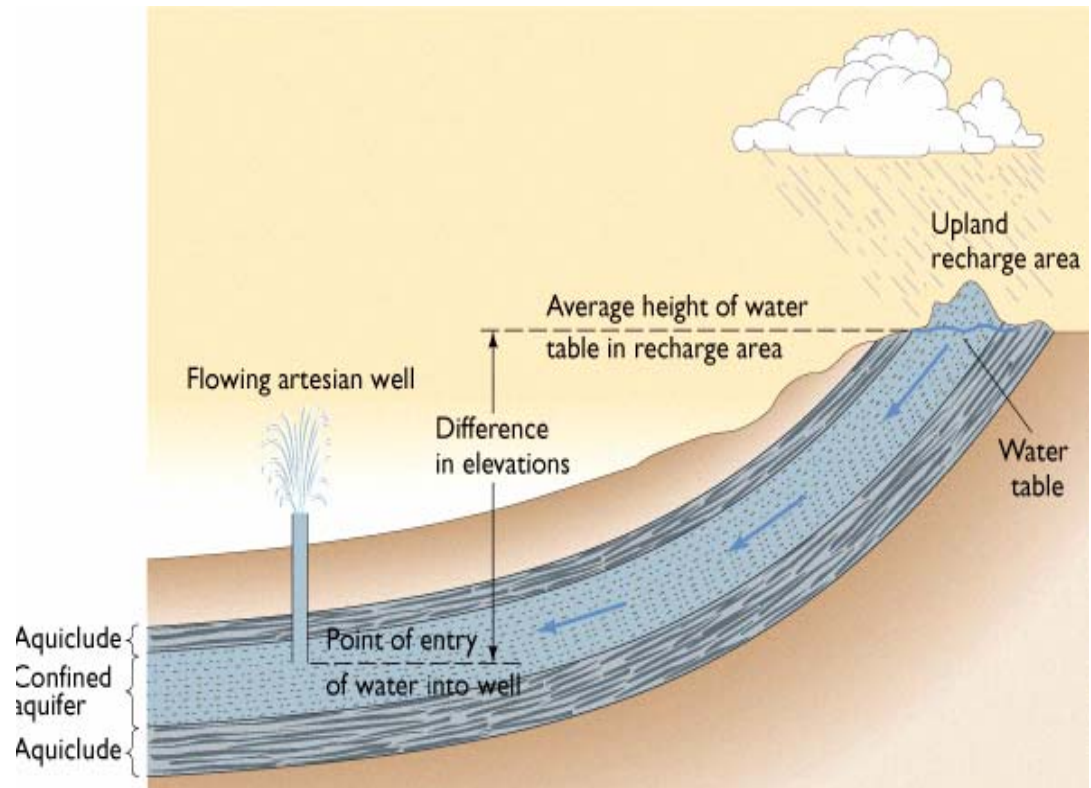
- Basaltic rocks
 - Madinah aquifers

- Granites & metamorphic rocks
 - Fractured & weathered aquifers (SW KSA)

Types of Aquifers

Confined aquifer

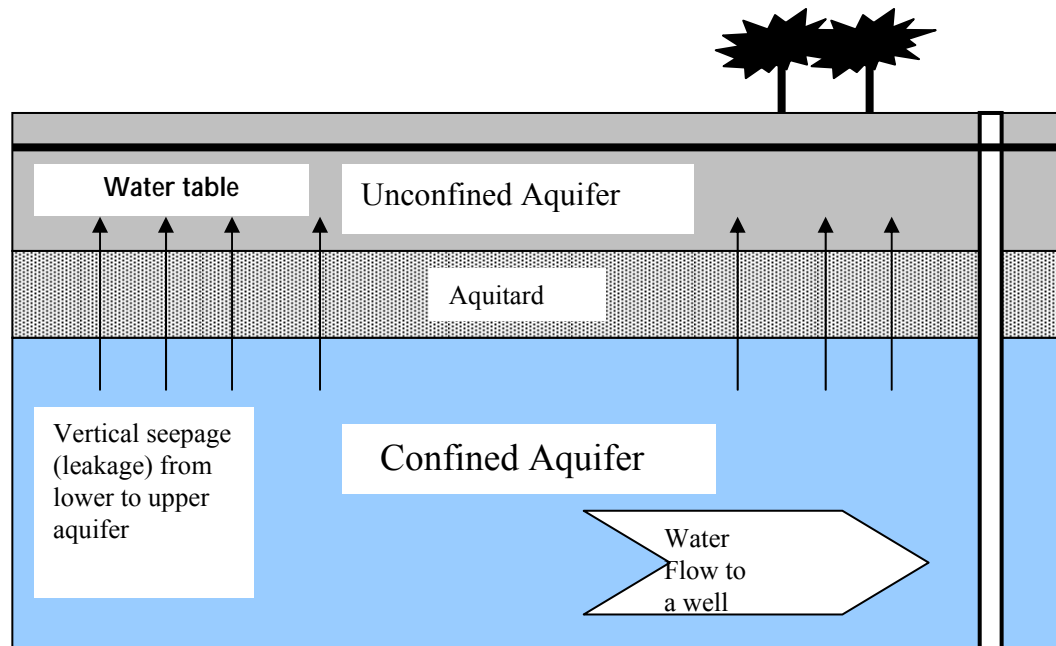
- Confining bed
- Recharge zone
- Potentiometric surface
- How it was formed?



Types of Aquifers

Semiconfined aquifer

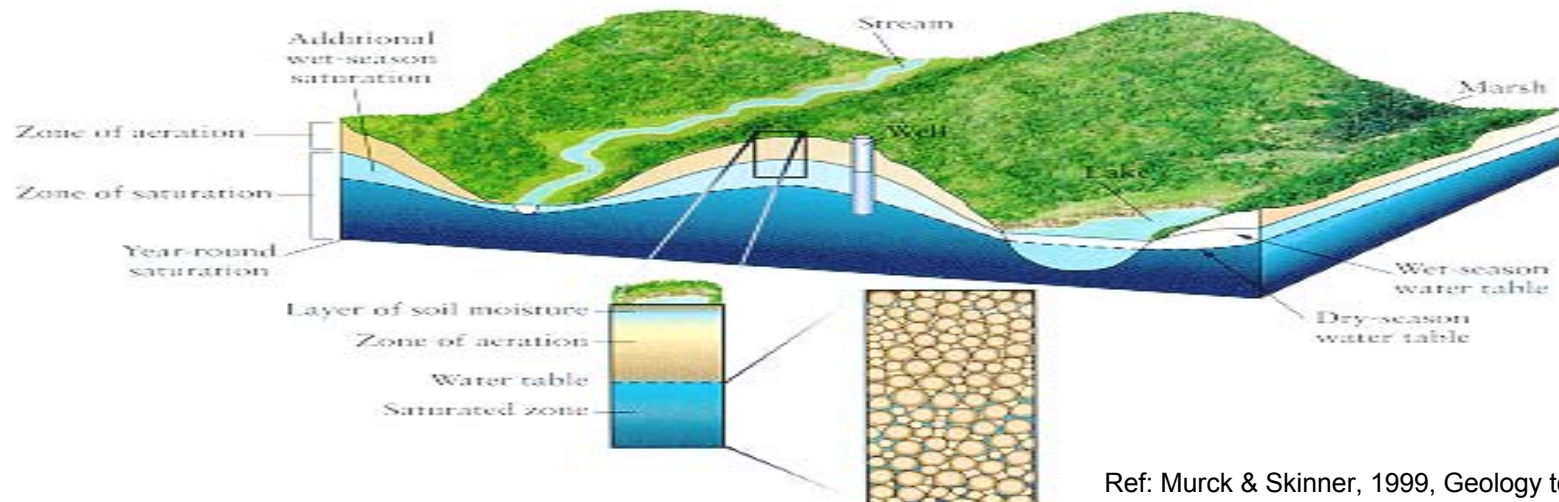
- Confined by low permeability Aquitard
- The role of Aquitard in recharging and discharging processes



Types of Aquifers

Unconfined aquifer

- Close to the surface
- Recharge zone
- Water table surface

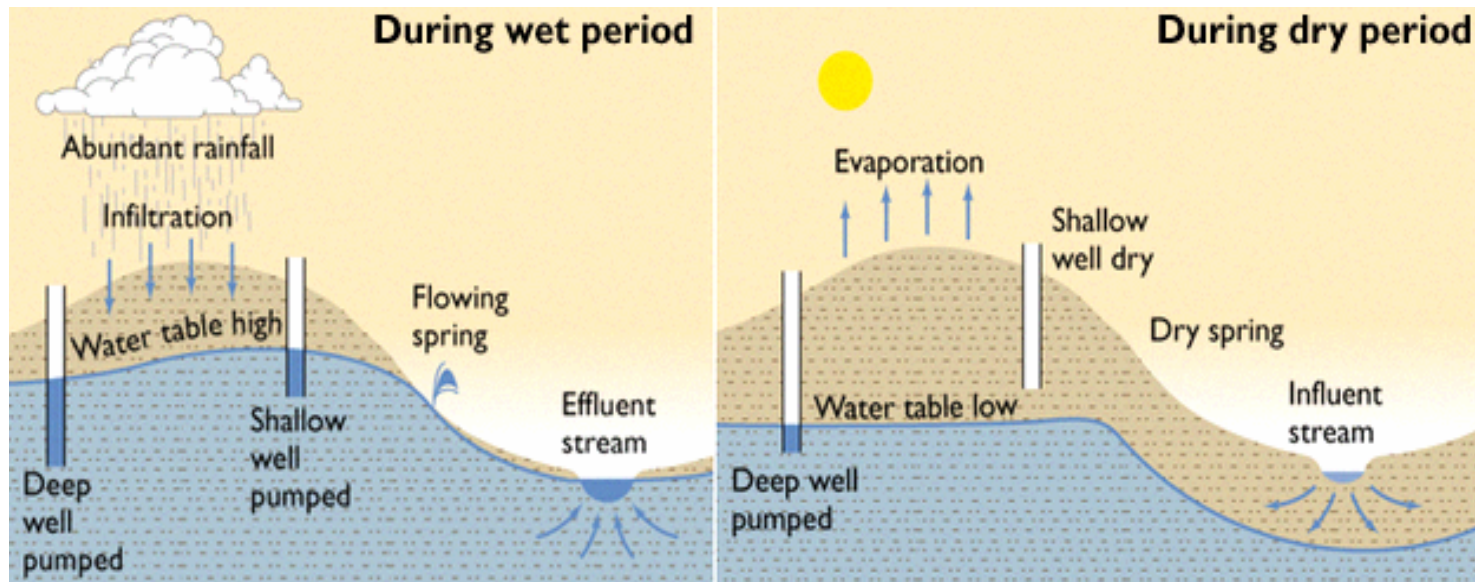


Ref: Murck & Skinner, 1999, Geology today: Understanding our planet, Fig. 12.22

Types of Aquifers

Unconfined aquifer

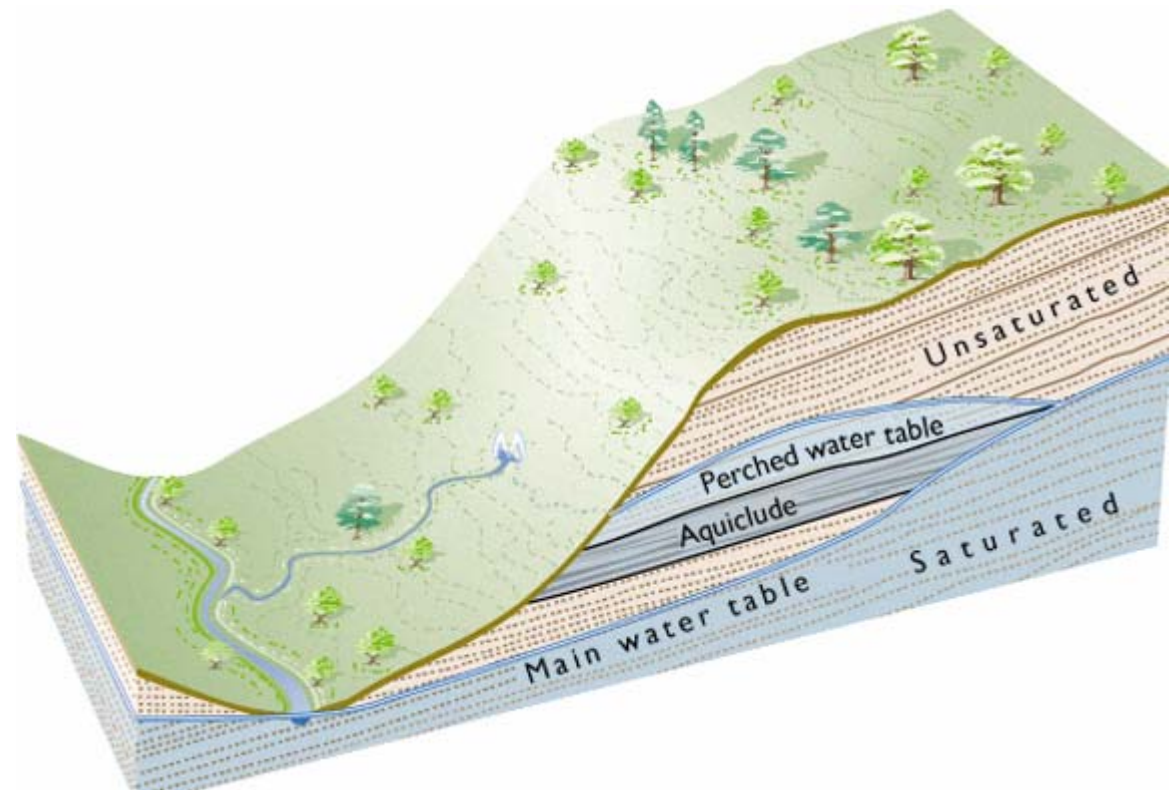
- Water level fluctuation



Types of Aquifers

Perched aquifer

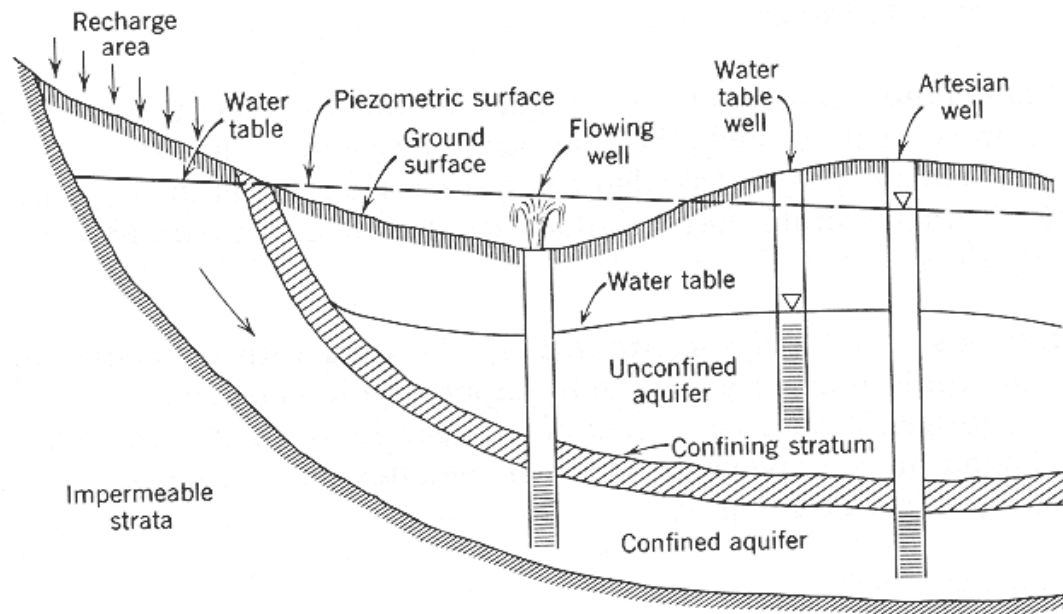
- In the unsaturated zone
- Local small aquifer



Types of Aquifers

Multiaquifer System

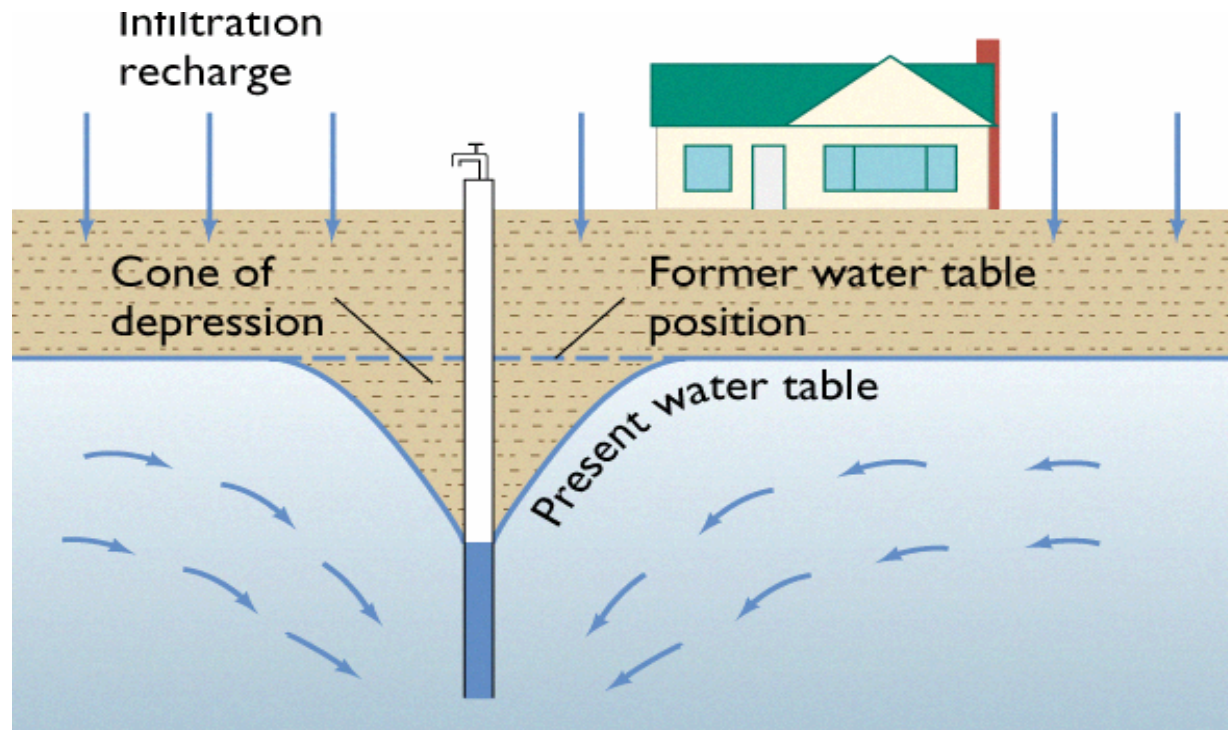
- A combination of different types of aquifers
- Complicated water-exchange system



Ref: Todd, 1980, Groundwater hydrology, Fig. 2.11

Pumping from an Aquifer

Cone of depression



Aquifer Properties

- What is the importance of identifying aquifer properties?
 - Planning & management of groundwater resources
 - Quantitative evaluation
 - Reliable interpretations
 - Descriptive understanding
 - Comprehensive idea about temporal variability of groundwater system.

Aquifer Properties

- Important aquifer properties

- Storage properties

- Storage: is the ability of an aquifer to store water

- Porosity
 - Specific yield
 - Storativity

- Transmission properties

- Hydraulic conductivity
 - Transmissivity

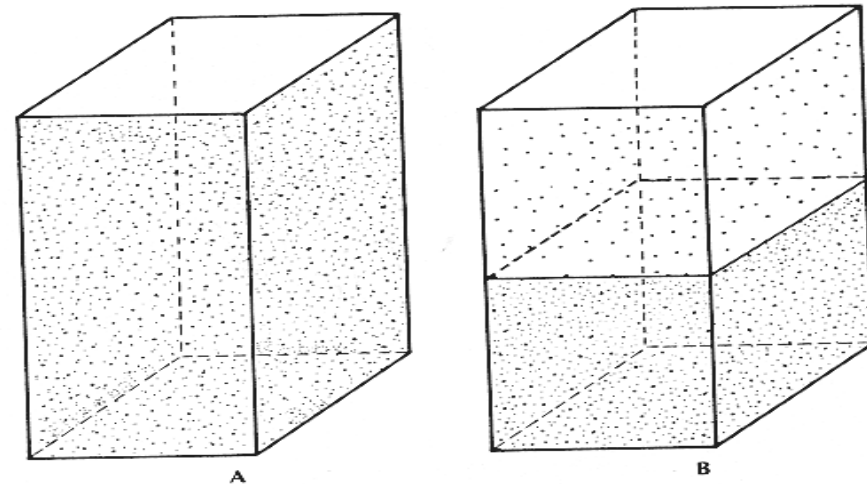
Quantitative Properties

Storage properties

Specific Yield and Retention

- Specific yield: the ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil

- $n = S_y + S_r$



Ref: Fetter, 1980, Applied hydrogeology, 3rd ed., Fig. 4.8

Quantitative Properties

Storage properties

Storativity (Storage coefficient)

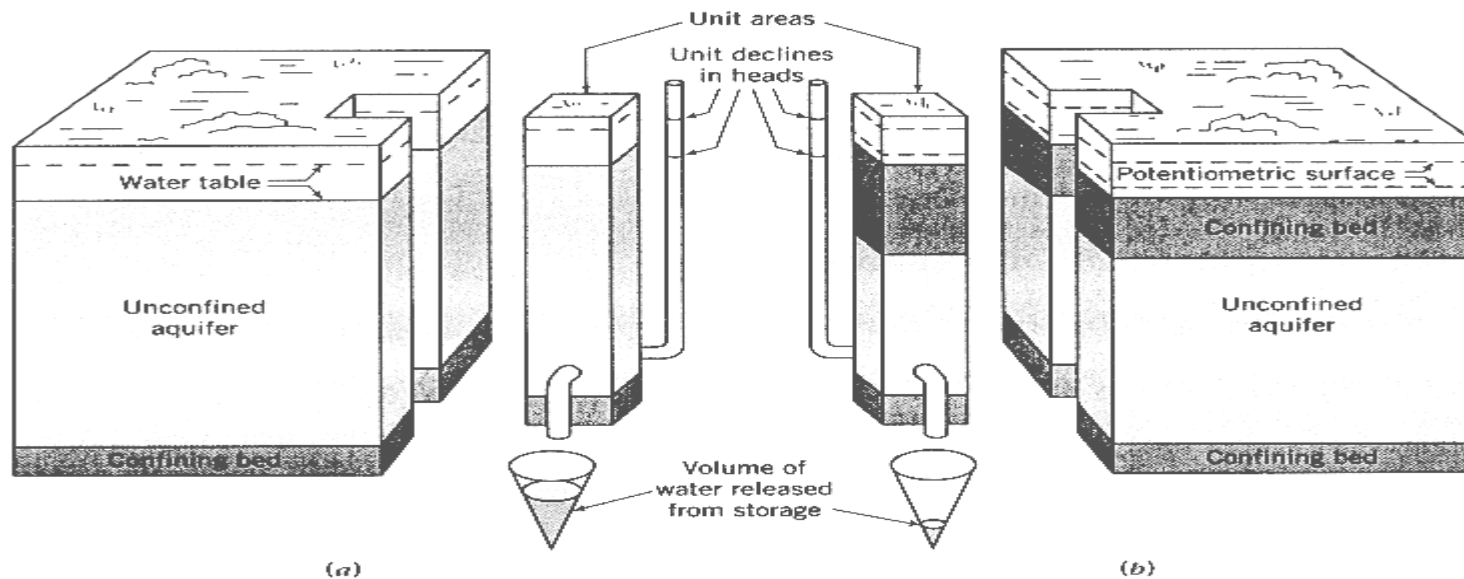
Storativity: the volume of water that an aquifer releases or takes into storage per unit surface area per unit change in head.

- $S = S_s \times b$

Quantitative Properties

Storage properties

Specific yield & Storativity (Storage coefficient)



Schwartz & Zhang, 2003, Fundamentals of groundwater, Fig. 4.4

Aquifers & Sink Holes



Quantitative Properties

Transmission properties

Transmissivity

- The ability of an aquifer to transmit water through a unit width under a unit hydraulic gradient.
- $T = K \times b$

Quantitative Properties

Transmission properties

Transmissivity

