Fundamentals of hydrogeology

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RQES

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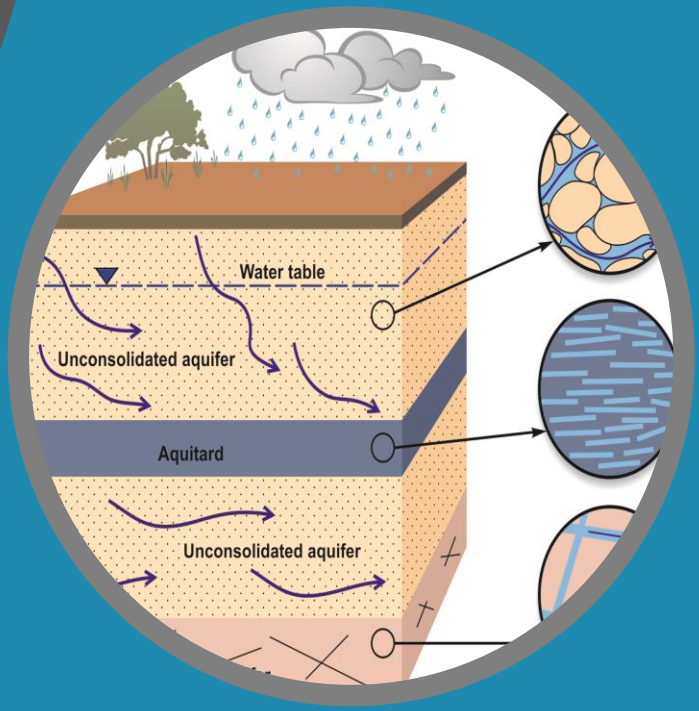

Fundamentals of Hydrogeology

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Presentation outline

1. Basic Definitions
2. Different Types of Aquifers
3. Types of Sediment
4. Confinement Conditions
5. Groundwater Flow
6. Recharge and Seepage
7. Aquifer Vulnerability
8. Hydrogeological Model Demonstrations

Terms in **BLUE** represent key concepts in hydrogeology defined in the **Key Concept Index**

GROUNDWATER

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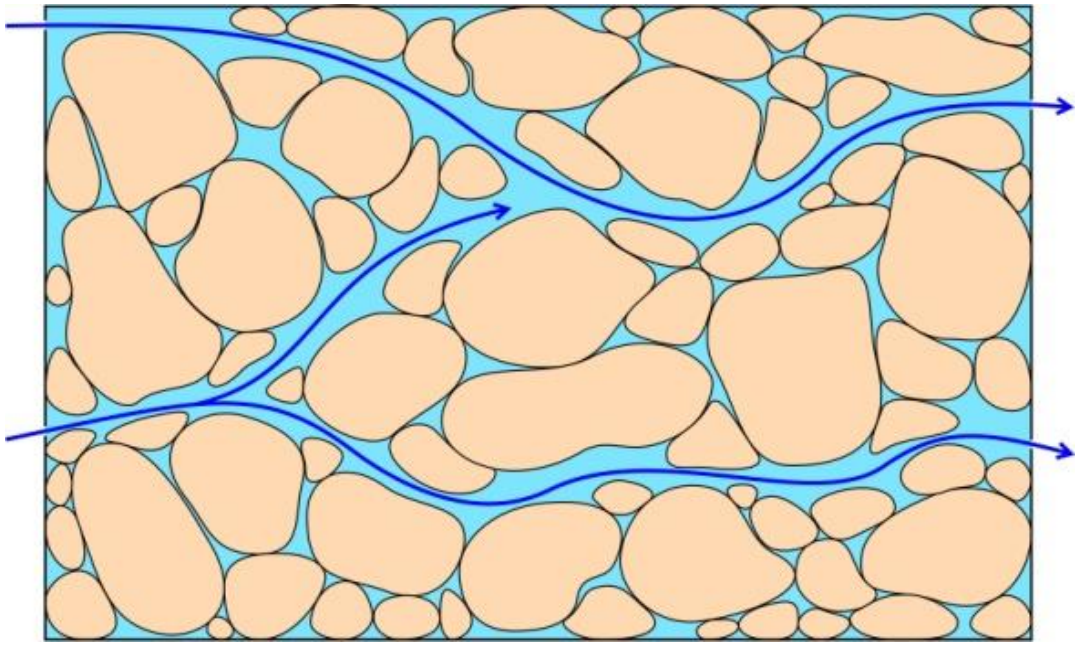
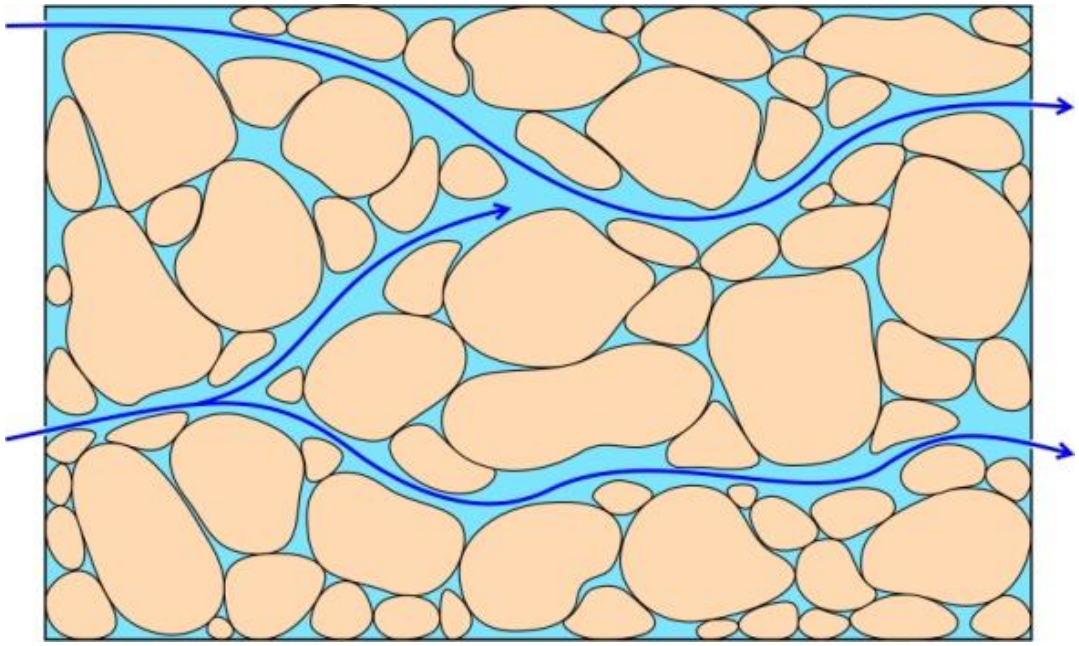
- **GROUNDWATER** is water present below the soil surface that fills up empty spaces of the geological environment
  - It is everywhere beneath our feet
  - Like surface water, groundwater flows through the aquifer, but much more slowly



POROSITY

- **POROSITY** is the ratio of openings (voids) to the total volume of a soil or rock
  - The higher the porosity, the more space is available to store water



HYDRAULIC CONDUCTIVITY

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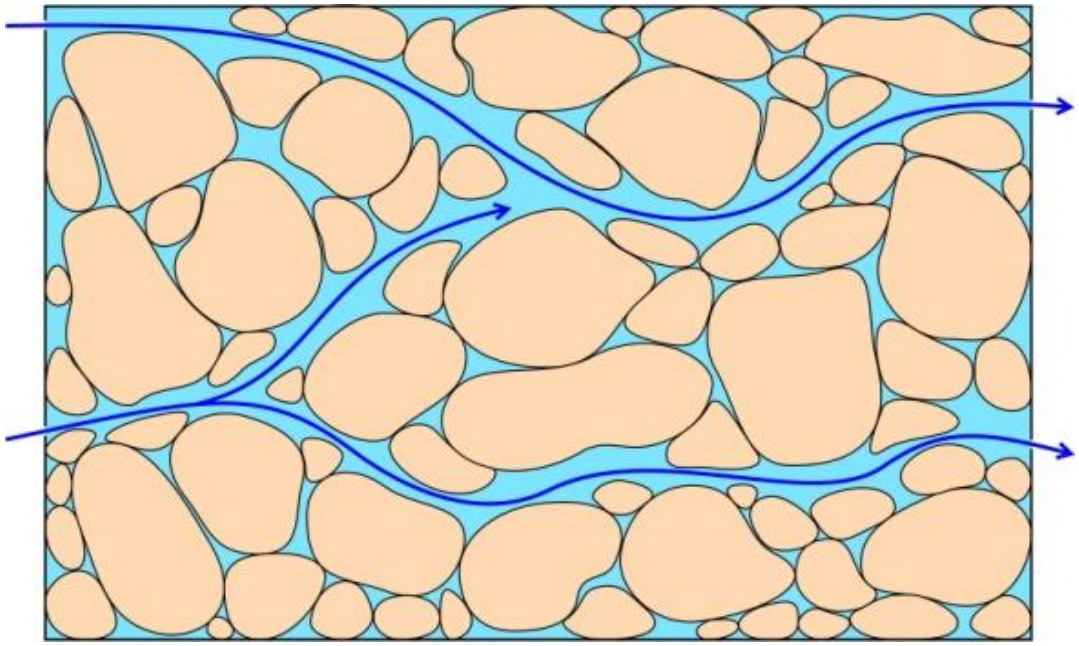
- **HYDRAULIC CONDUCTIVITY** is the ability of a material to transmit water
  - The more interconnected the **pores**, the more **permeable** the geological environment is and the easier the water can penetrate and circulate



AQUIFER

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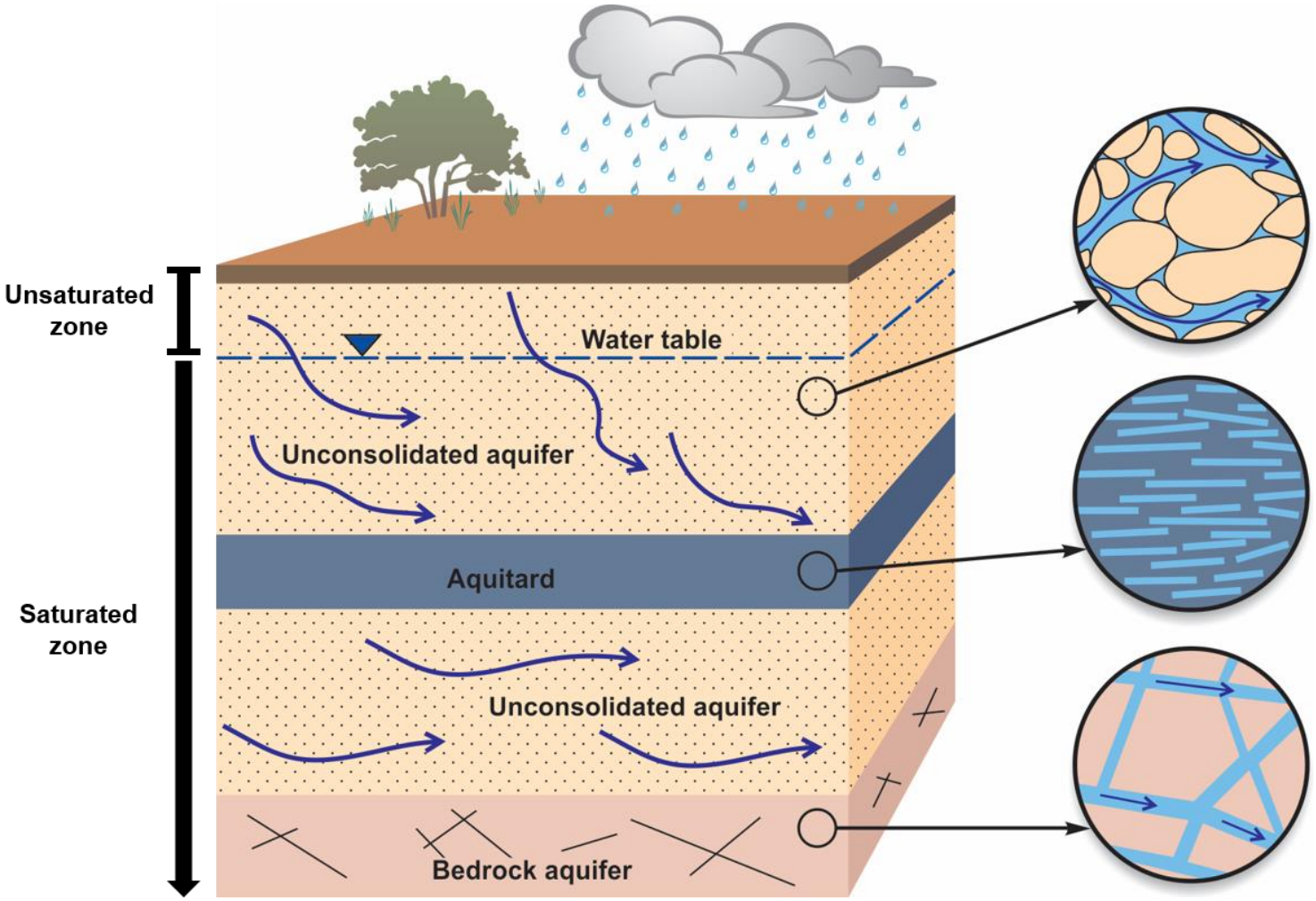
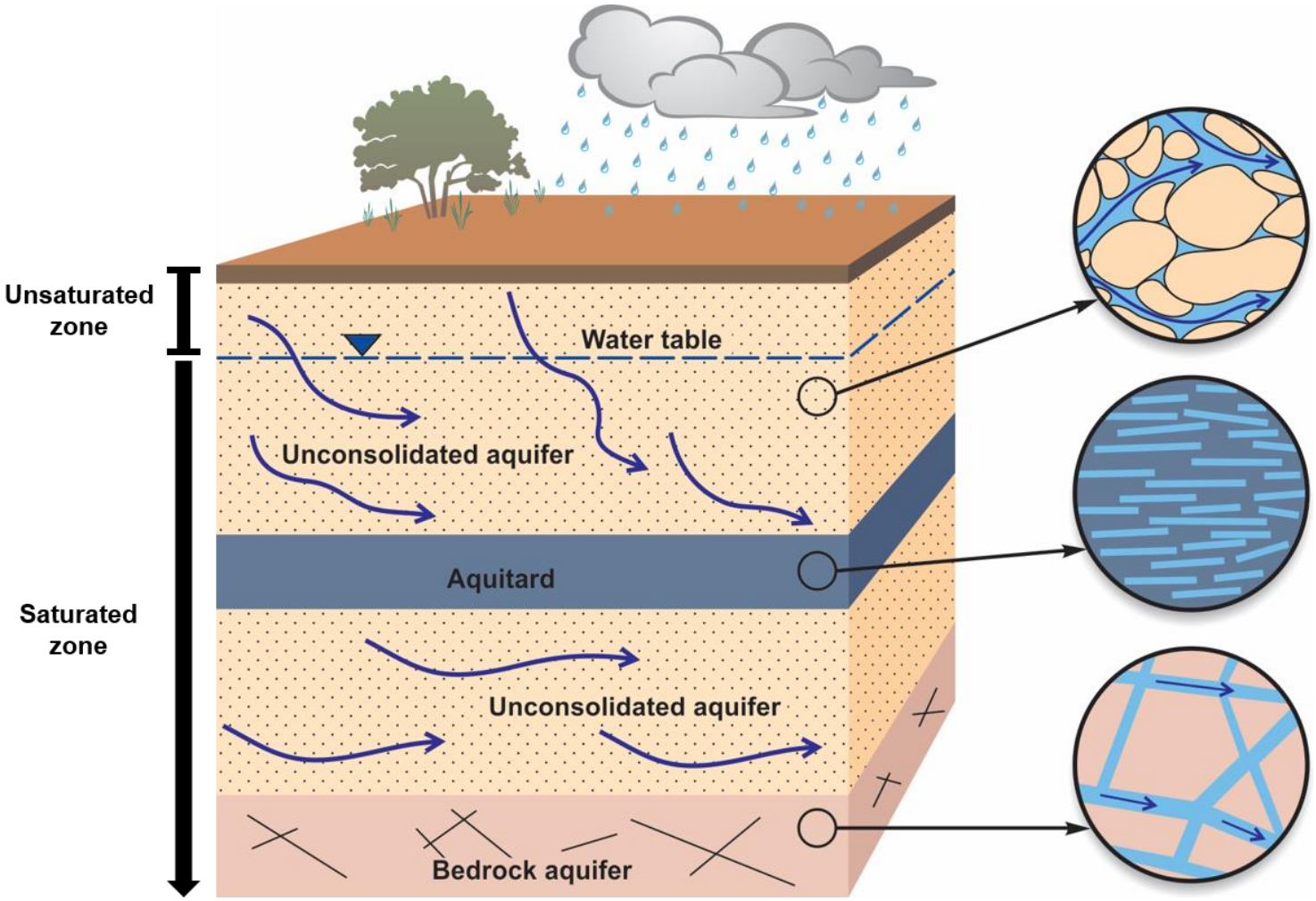
- An **AQUIFER** is a saturated geological unit that will yield water in a usable quantity to a well or spring → It is the **container**



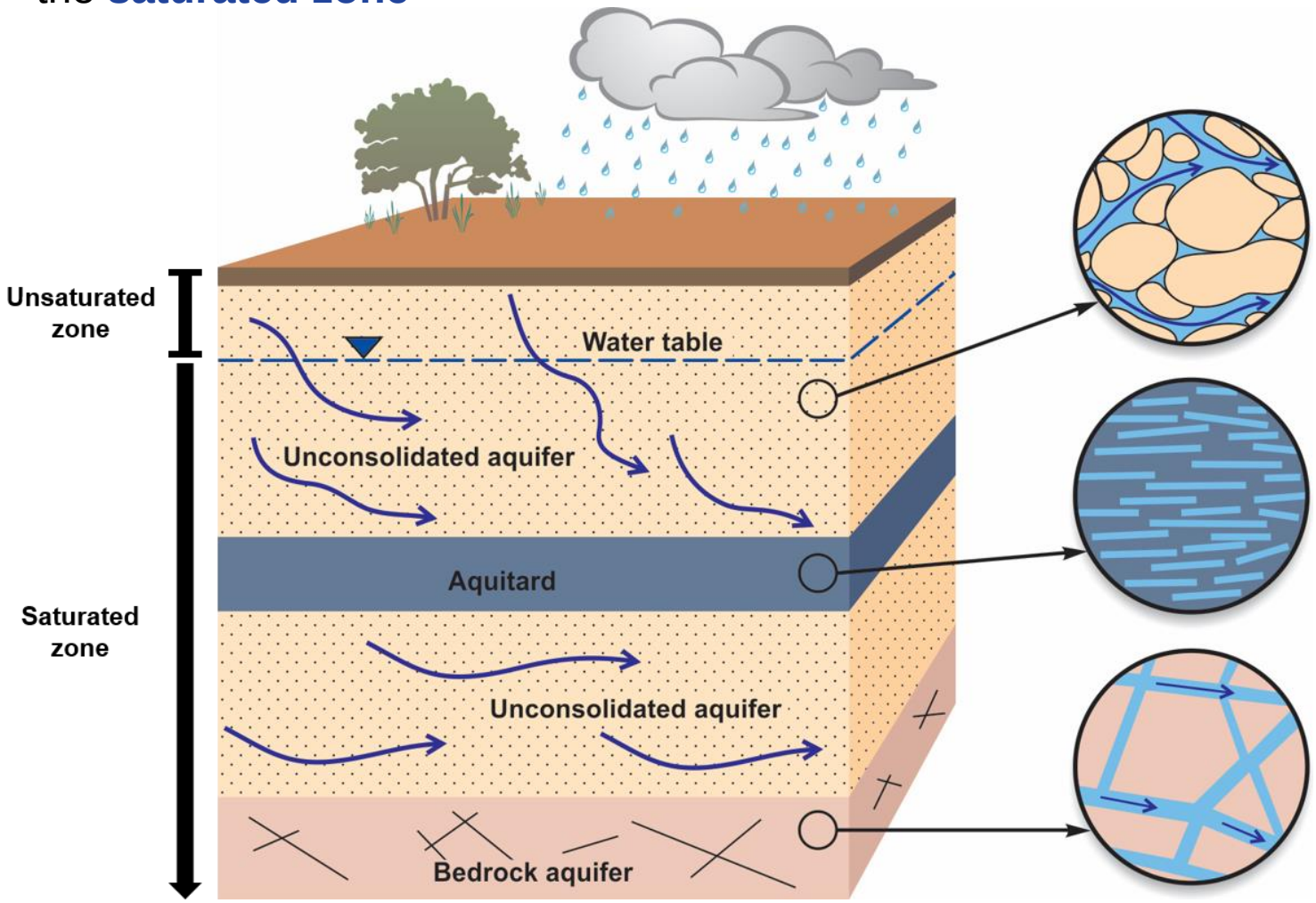
AQUITARD

- An **AQUITARD** is a geological unit that is not permeable enough to extract water → Forms a **barrier** to groundwater flow



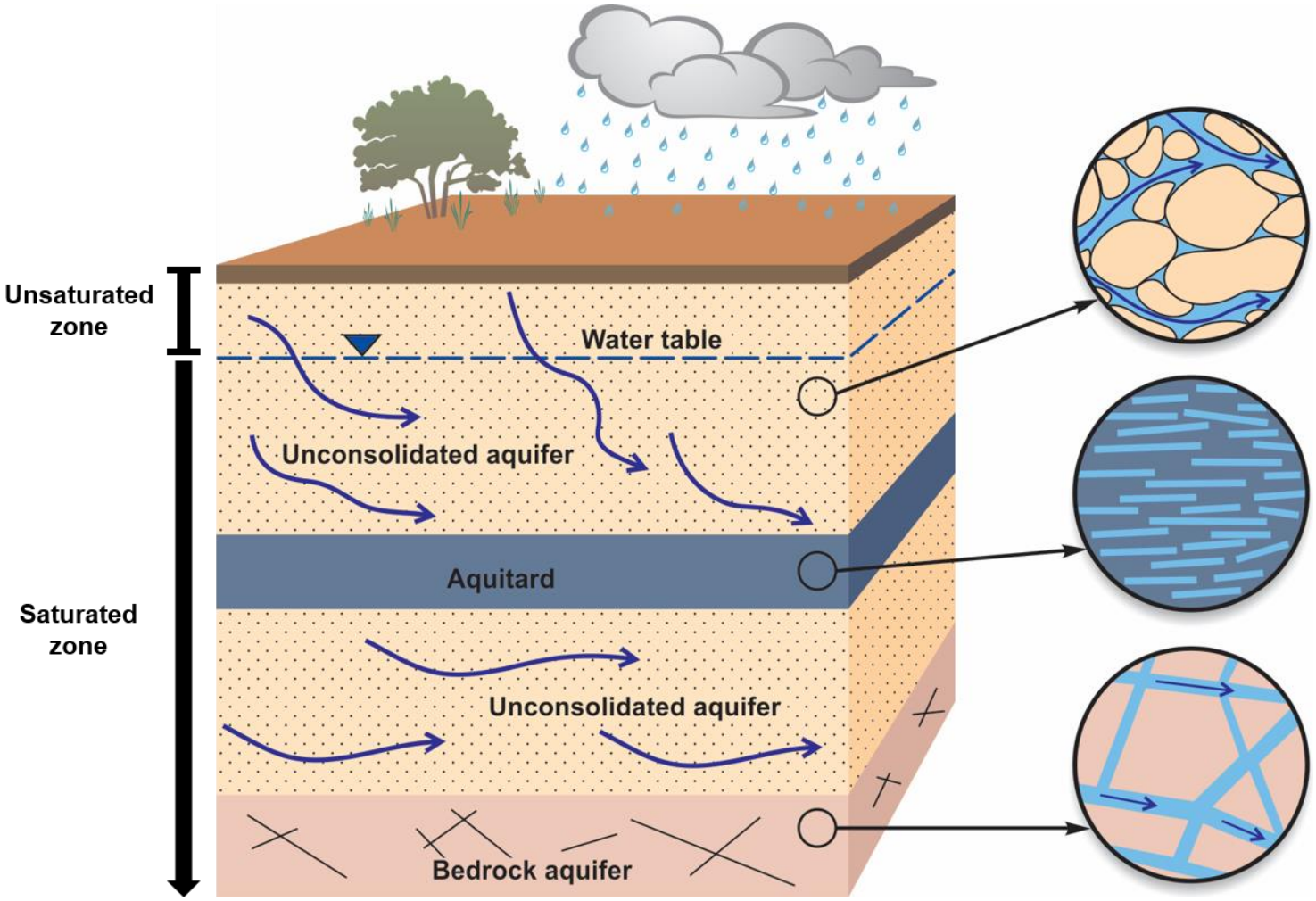
WATER TABLE

- The **WATER TABLE** is the level below which the ground is fully saturated with water → Seperates the **unsaturated zone** and the **saturated zone**



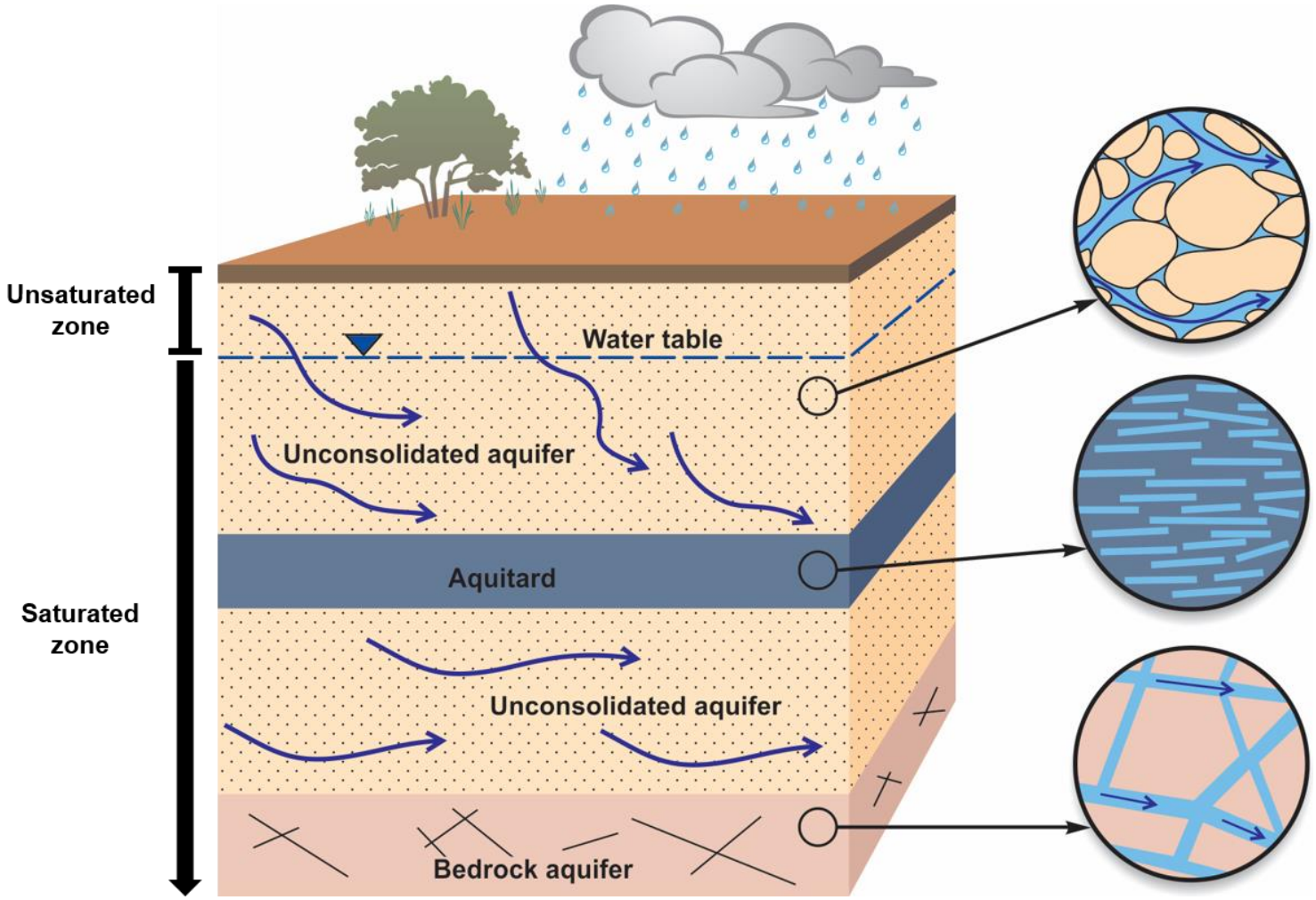
SATURATED AN UNSATURATED ZONES

- The **WATER TABLE** is the level below which the ground is fully saturated with water



BEDROCK AQUIFER

- **BEDROCK** consists of the top layer of the terrestrial crust



BEDROCK AQUIFER

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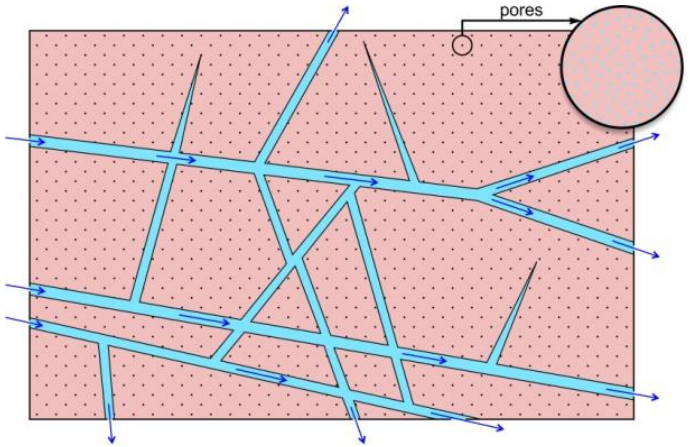
- Water is found :
  - In the rock **pores**, but their low interconnection does not allow water to be circulated efficiently
  - In **fractures**, which allow watercirculation sometimes sufficient for single residences



Protection Formation, Nanaimo Group, Medial Bedrock Aquifer System, Beachcomber Park near Parksville.

- By drilling a well in this type of aquifer, one seeks to encounter as many **fractures** as possible

UNCONSOLIDATED AQUIFERS

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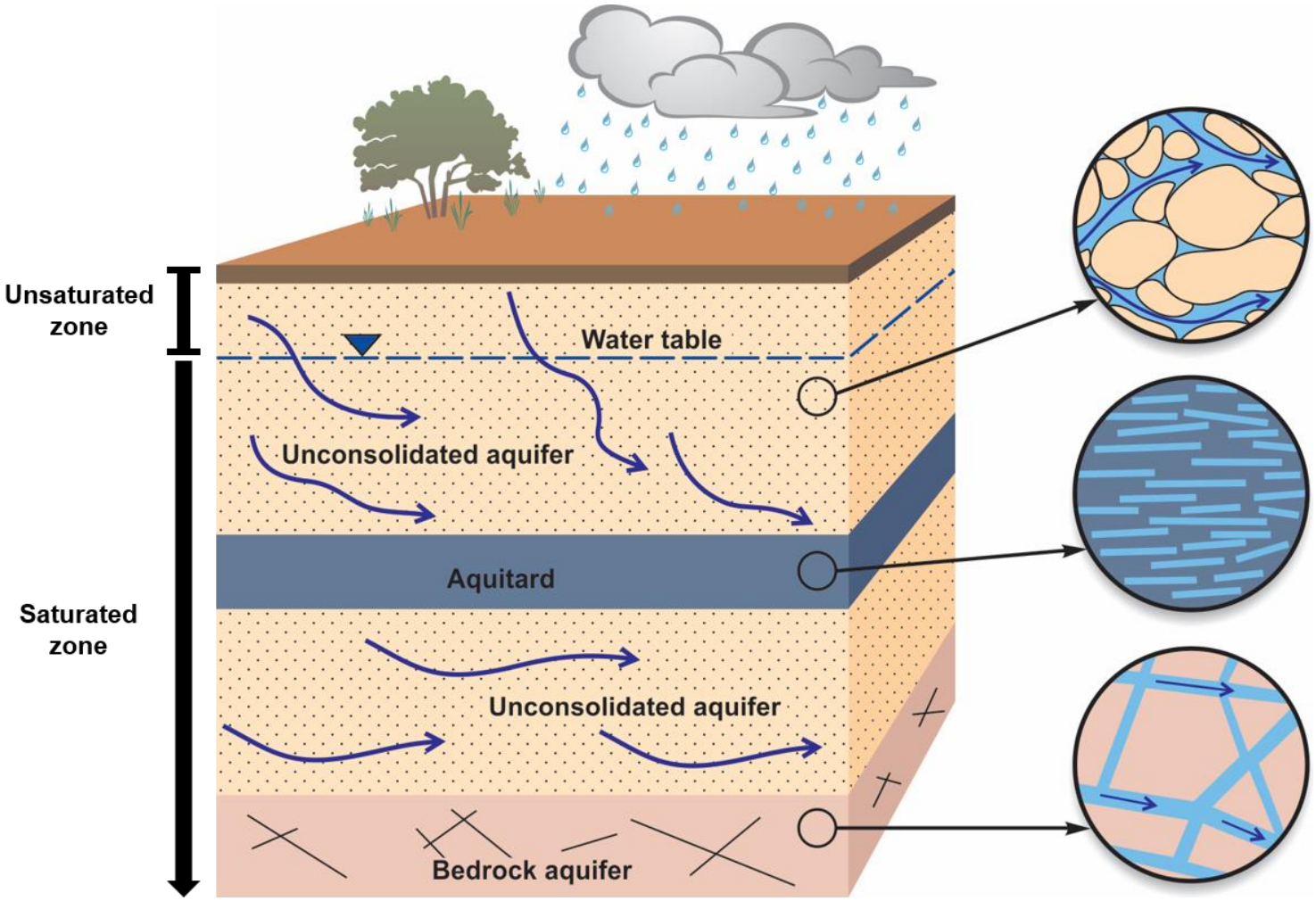
- **UNCONSOLIDATED DEPOSITS** consist of material derived from bedrock erosion

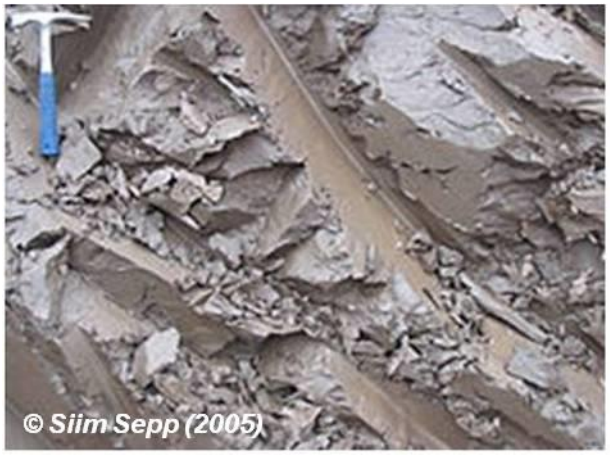


UNCONSOLIDATED AQUIFERS

- The coarser the particles, the larger the pores and the greater the interconnection between them → higher permeability

- **Sands** and **gravels** → **aquifer**
  - Pumping of large quantities of water is often possible

- **Clays** and **silts** → **aquitard**
  - Considered to be impermeable



Types of Sediment

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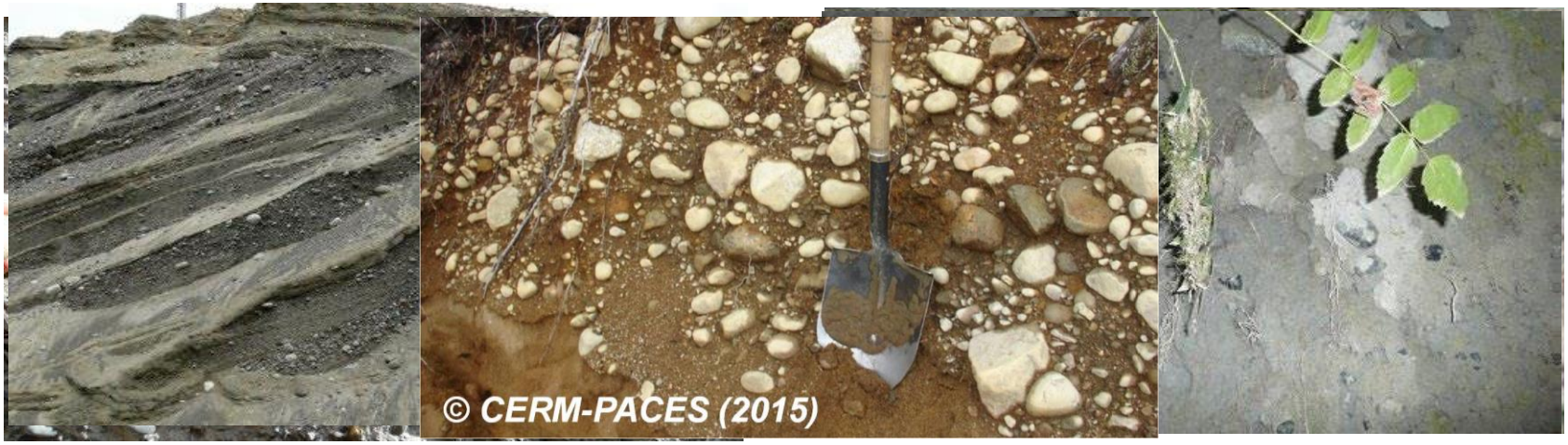
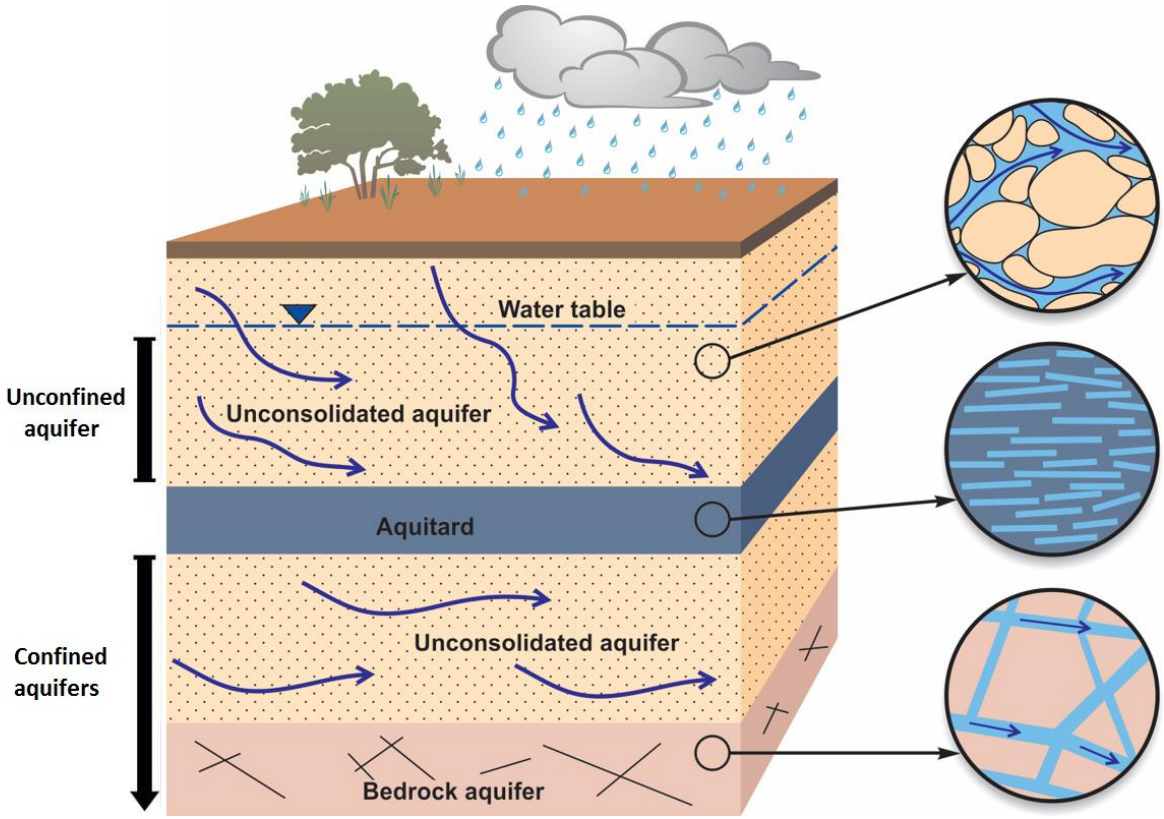
- Glacial till → **aquifer** or **aquitard**
- Glaciofluvial sediments → **aquifer**
- Marine and glaciomarine sediments → **aquitard** or **aquifer**
- Fluvial sediments → **aquifer**
- Organic sediments → complexe



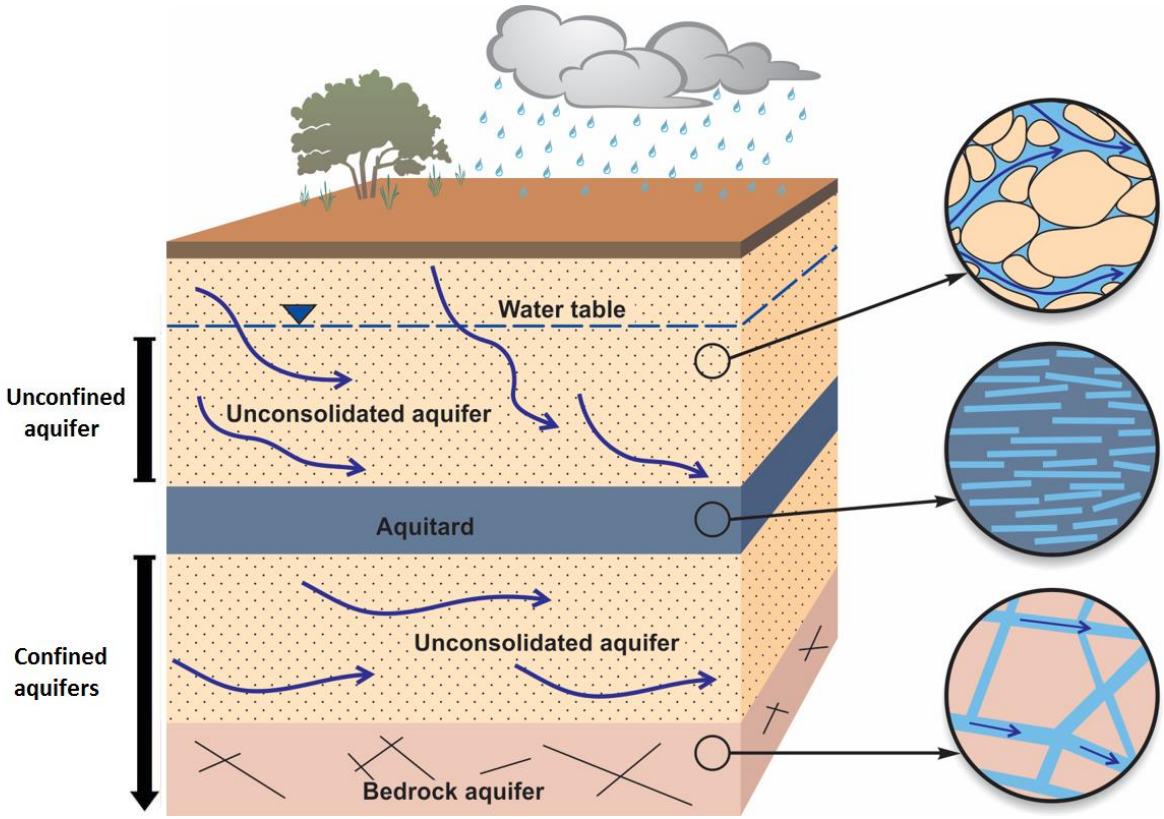
CONFINED AQUIFER

- A **CONFINED** aquifer is overlain by an **aquitard**
  - Not directly recharged by vertical infiltration
  - Protected from contaminants introduced at the ground surface



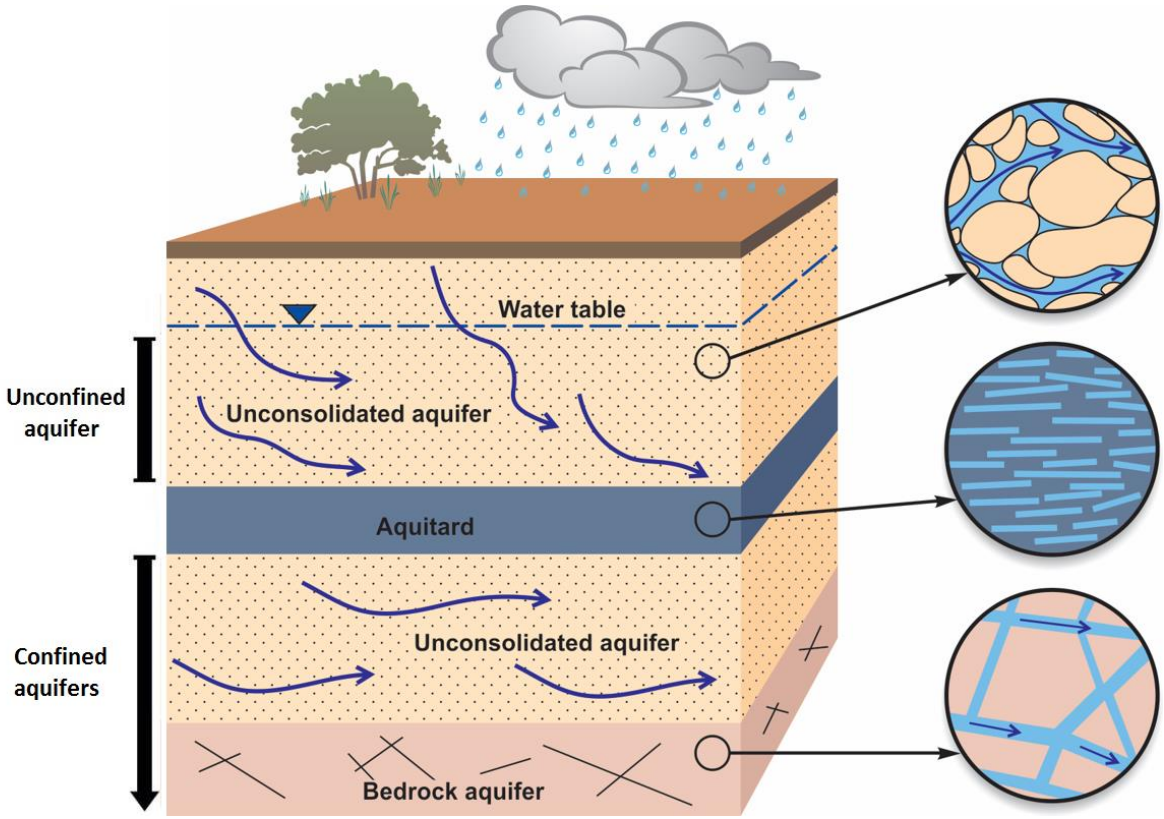
UNCONFINED AQUIFER

- An **UNCONFINED** aquifer is not overlain by an **aquitard**
  - Directly recharged by vertical infiltration
  - More vulnerable to contaminants at the ground surface



Other Confinement Conditions

- A **SEMI-CONFINED** aquifer is overlain by confining layers which are not completely impermeable
  - Moderately recharged by vertical infiltration
  - Moderately vulnerable to contamination



GROUNDATER FLOW

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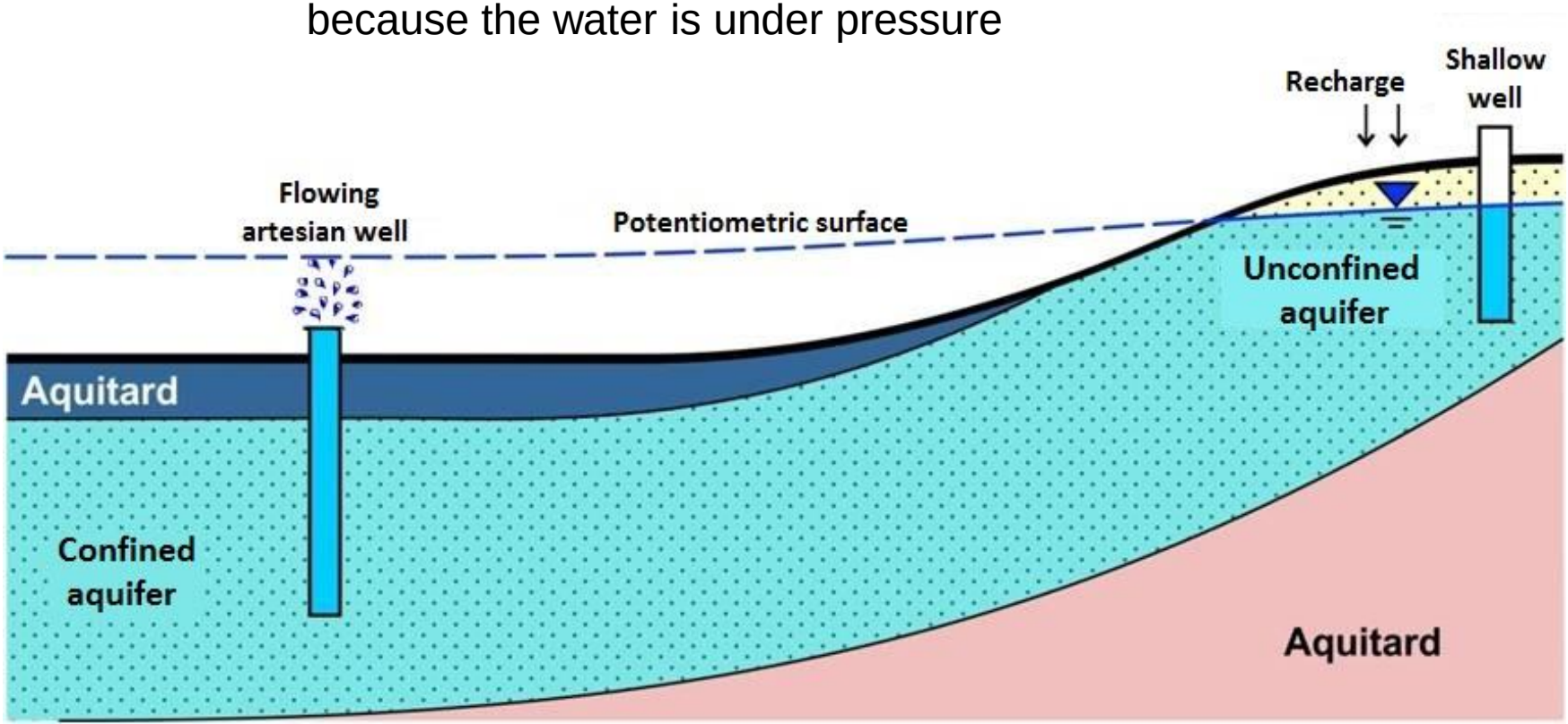
- The **POTENTIOMETRIC LEVEL** (or **hydraulic head**) corresponds to the level of water in a well
  - Unconfined aquifer: well water level = water table level
  - Confined aquifer: well water level ≠ water table level, because the water is under pressure



GROUNDATER FLOW

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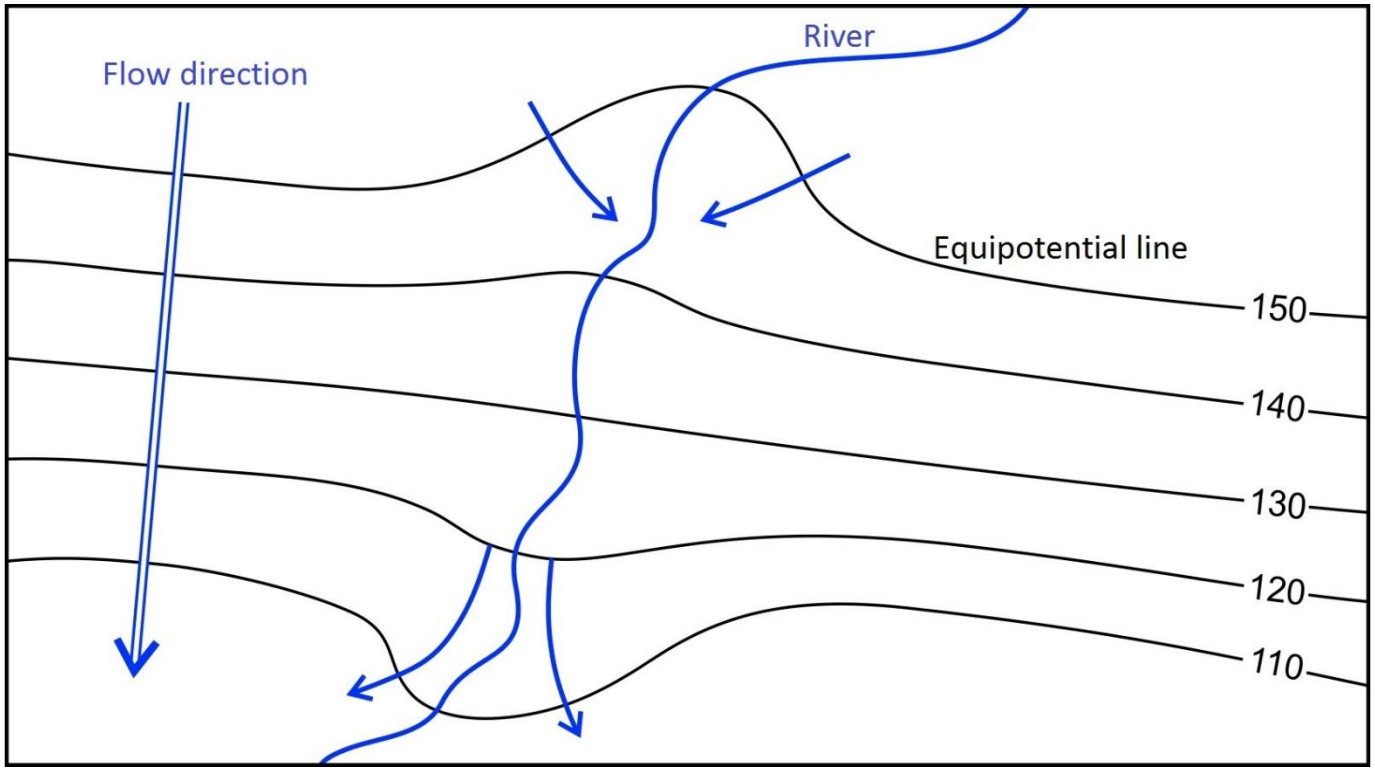
- The **POTENTIOMETRIC SURFACE** represents the water level elevation in an aquifer
  - Indicates groundwater flow direction, from higher to lower hydraulic heads



RECHARGE AND SEEPAGE

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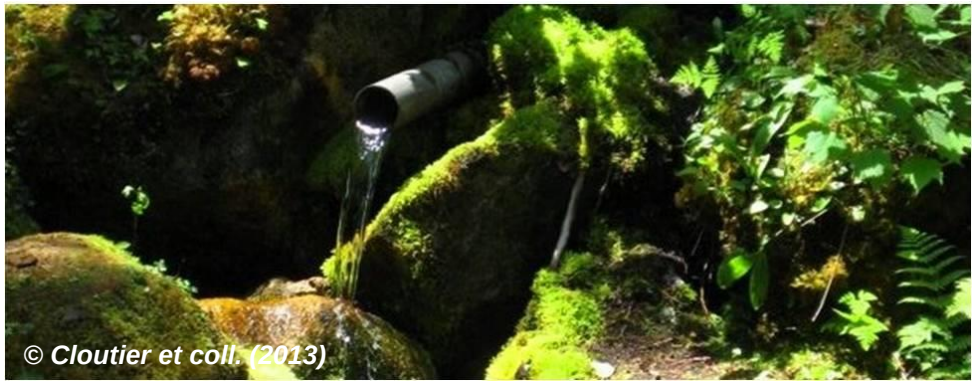
- **RECHARGE** is the renewal of groundwater by precipitation infiltrating at the surface

- Groundwater **SEEPAGE** corresponds to water emerging from the ground
  - Generally diffuse: in lakes, streams, and wetlands
  - Sometimes point-source: constitutes natural springs



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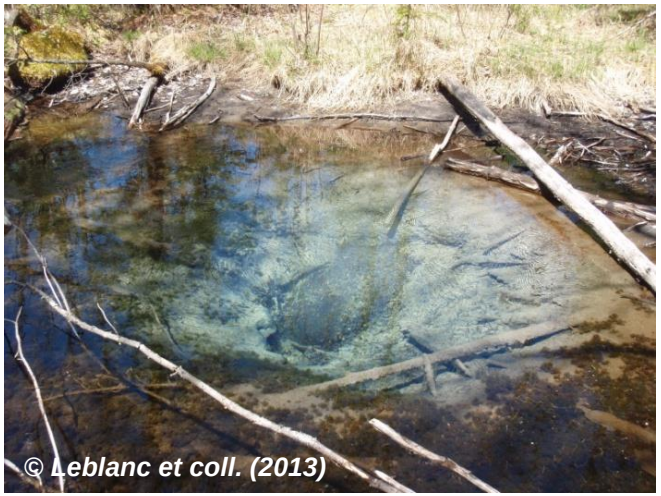

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DRASTIC METHOD

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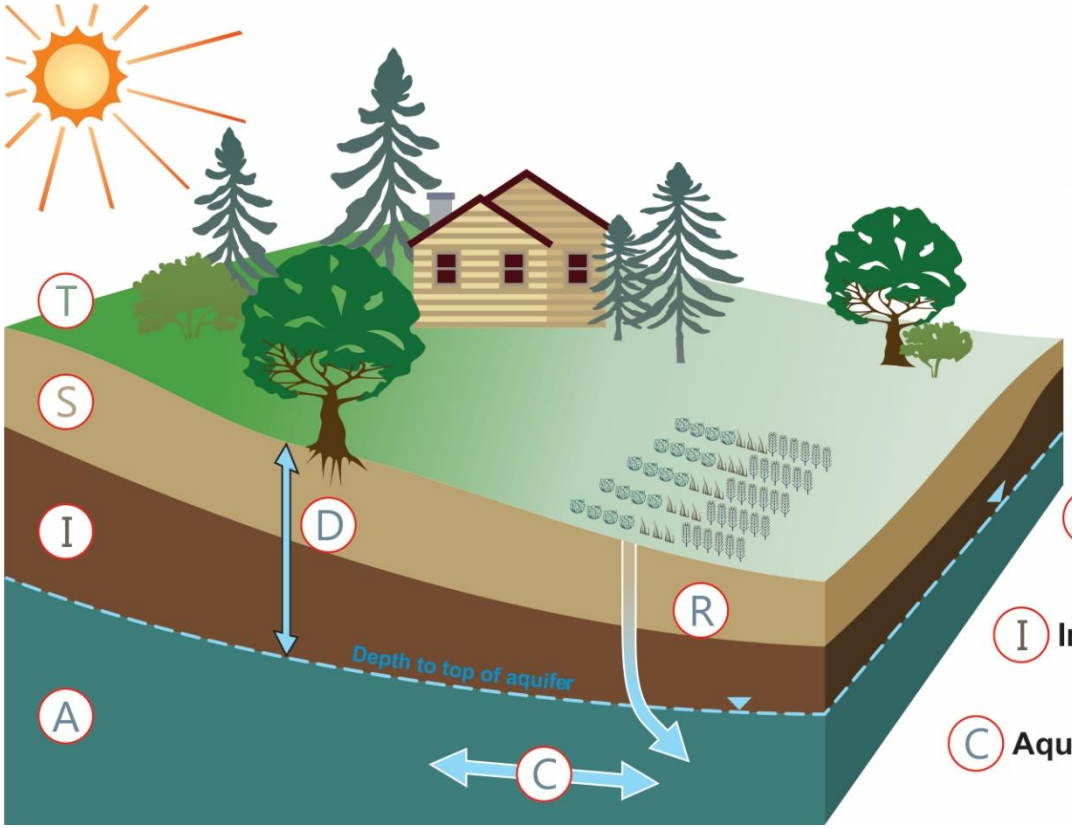
- **DRASTIC** is a common indexing method to determine intrinsic aquifer **vulnerability**
  - Evaluates the susceptibility of groundwater to pollution from contaminants at the soil surface



		Weight
D	Depth to water	5
R	Recharge	4
A	Aquifer media	3
S	Soil media	2
T	Topography	1
I	Impact of vadose zone media	5
C	Aquifer hydraulic conductivity	3

DRASTIC INDEX

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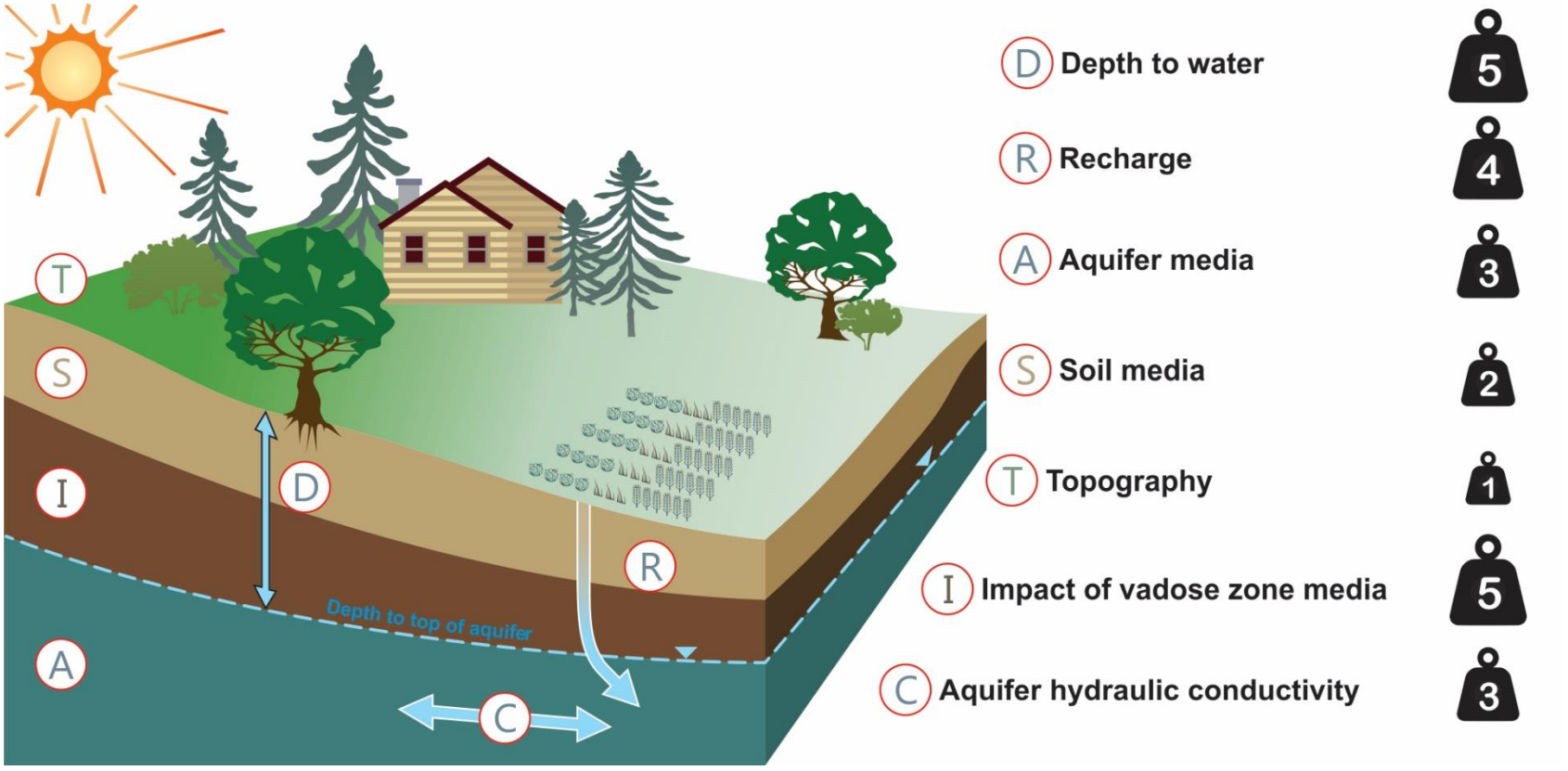
- **DRASTIC** index calculation uses seven parameters
  - Can range from 23 to 226
  - The higher the value, the greater the **vulnerability**



CONTAMINATION RISK

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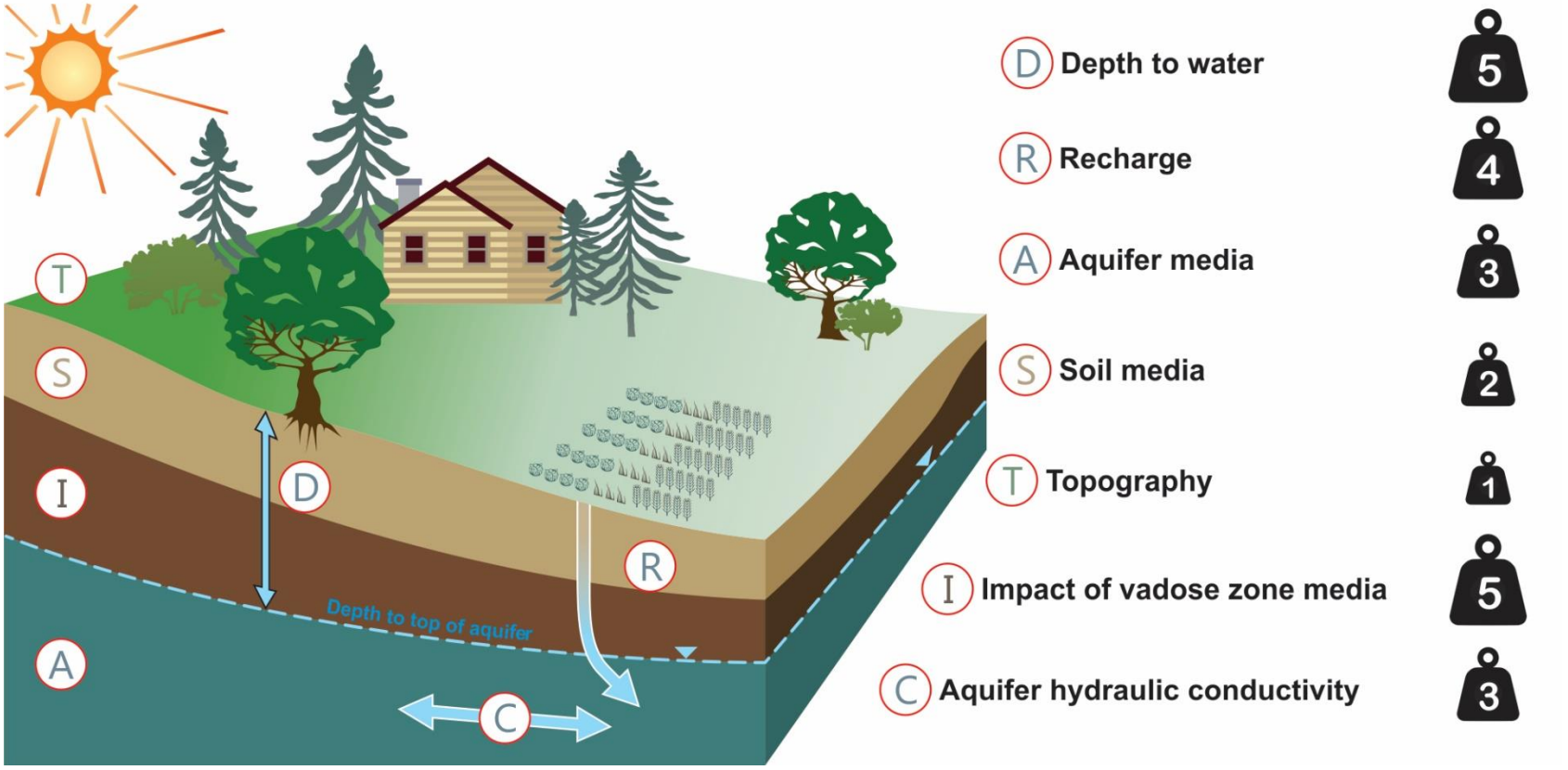
- The **risk of groundwater quality degradation** can be estimated by combining the **DRASTIC** index with:
  - the impact of potentially-contaminating human activities, and
  - the level of development (use) of an aquifer



Using a Hydrogeological Model to Understand Groundwater

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