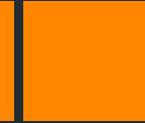




Groundwater

By C.D.Boch



What is Groundwater?

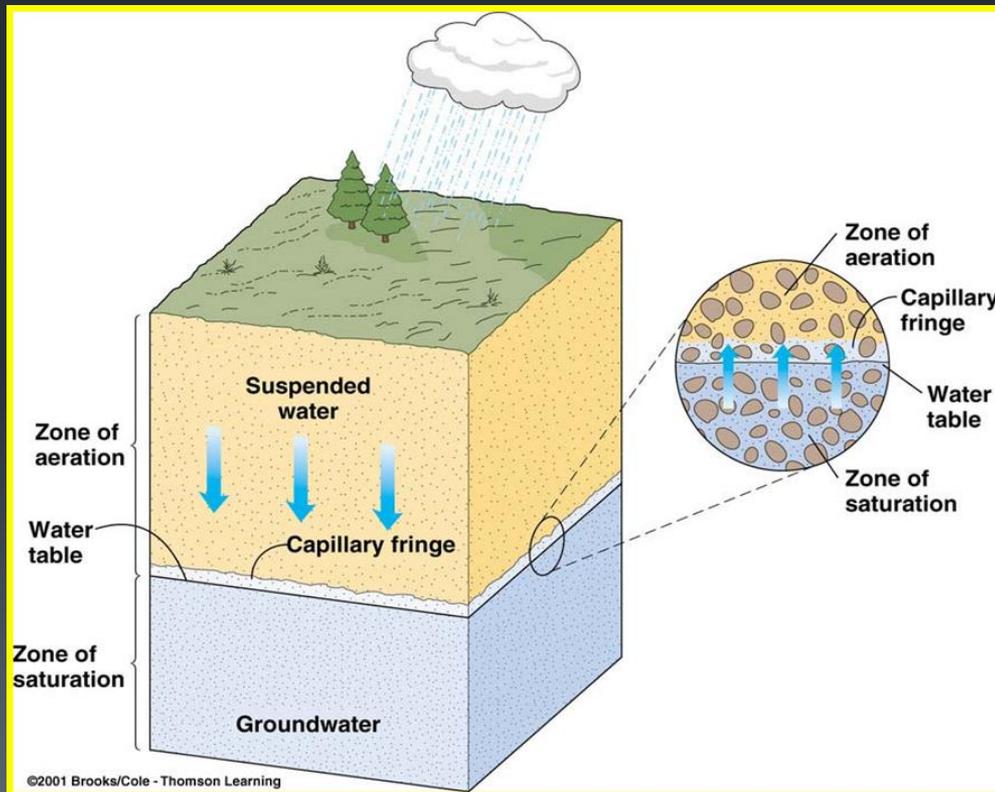
- Water filling open spaces in rock, sediment, and soil beneath the surface is called groundwater.
- Groundwater is one of the reservoirs of the hydrologic cycle and represents approximately 22% of the world's supply of freshwater.
- Fifty percent of the total U.S. population relies on groundwater for daily drinking water, and 37 percent of agricultural water use depends on groundwater.
- Many legal battles have resulted from claims and counterclaims of groundwater ownership.

How Does Water Flow Underground?

- **Porosity** is the percentage of the material's total volume that is pore space and determines the amount of ground-water a material can hold.
- **Permeability** is the capacity of a material to allow water to flow through it.
- A permeable layer transporting groundwater is an **aquifer**.
- Sand and gravel deposits, fractured granite, and limestone with solution cavities are good aquifers.
- Impermeable materials that prevent groundwater movement are known as **aquicludes**.
- Shale and unfractured igneous and metamorphic rocks are examples of aquicludes.

What Is the Water Table?

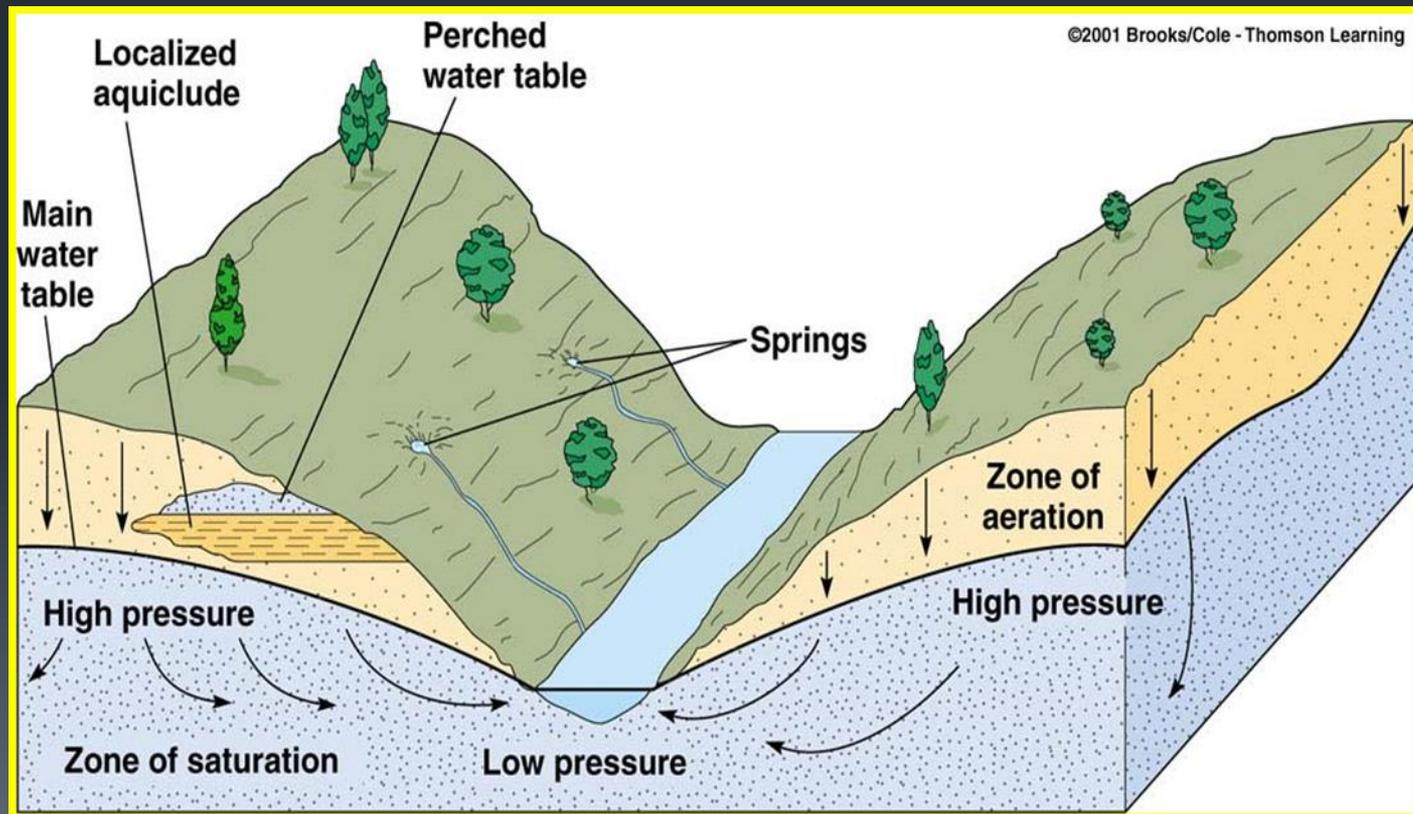
- The water table is the surface separating the zone of aeration (pores contain mostly air) from the zone of saturation (pores filled with water).

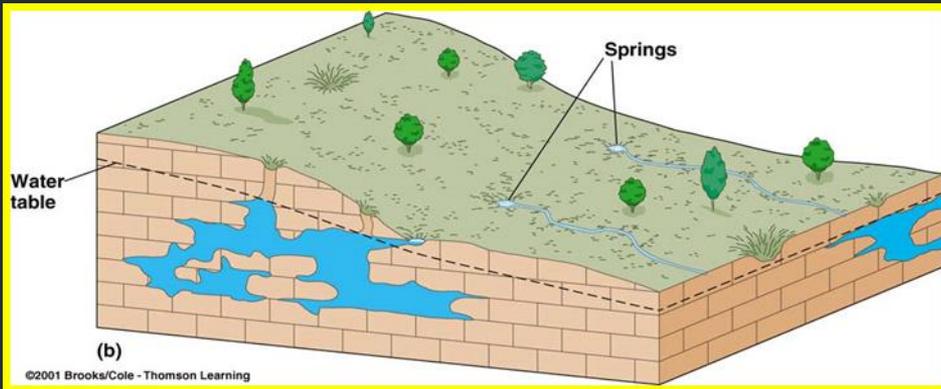


Surface tension produces the **capillary fringe**.

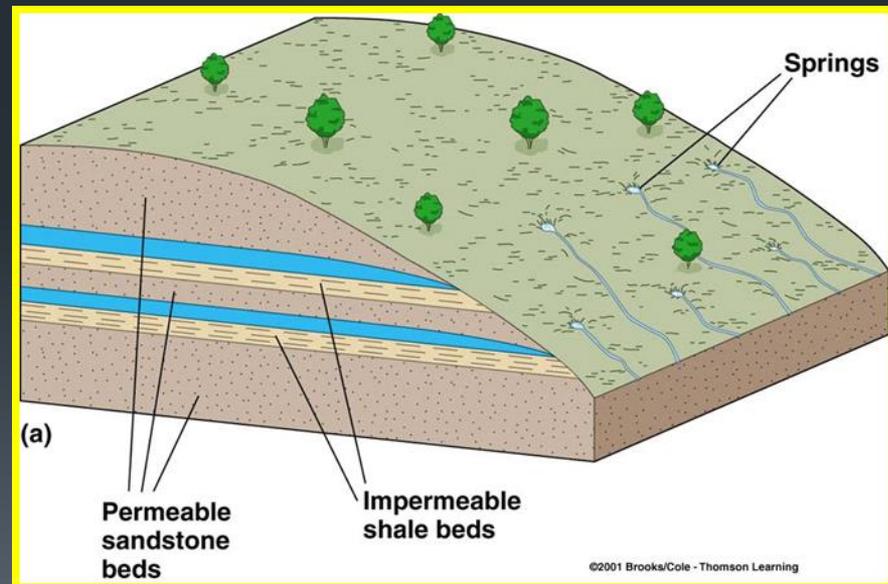
Springs

- Lenses of groundwater pooled above localized aquicludes form **perched water tables**. When these intersect with the ground surface they can create **springs**, which are sources of water flowing from underground.





Examples of Springs

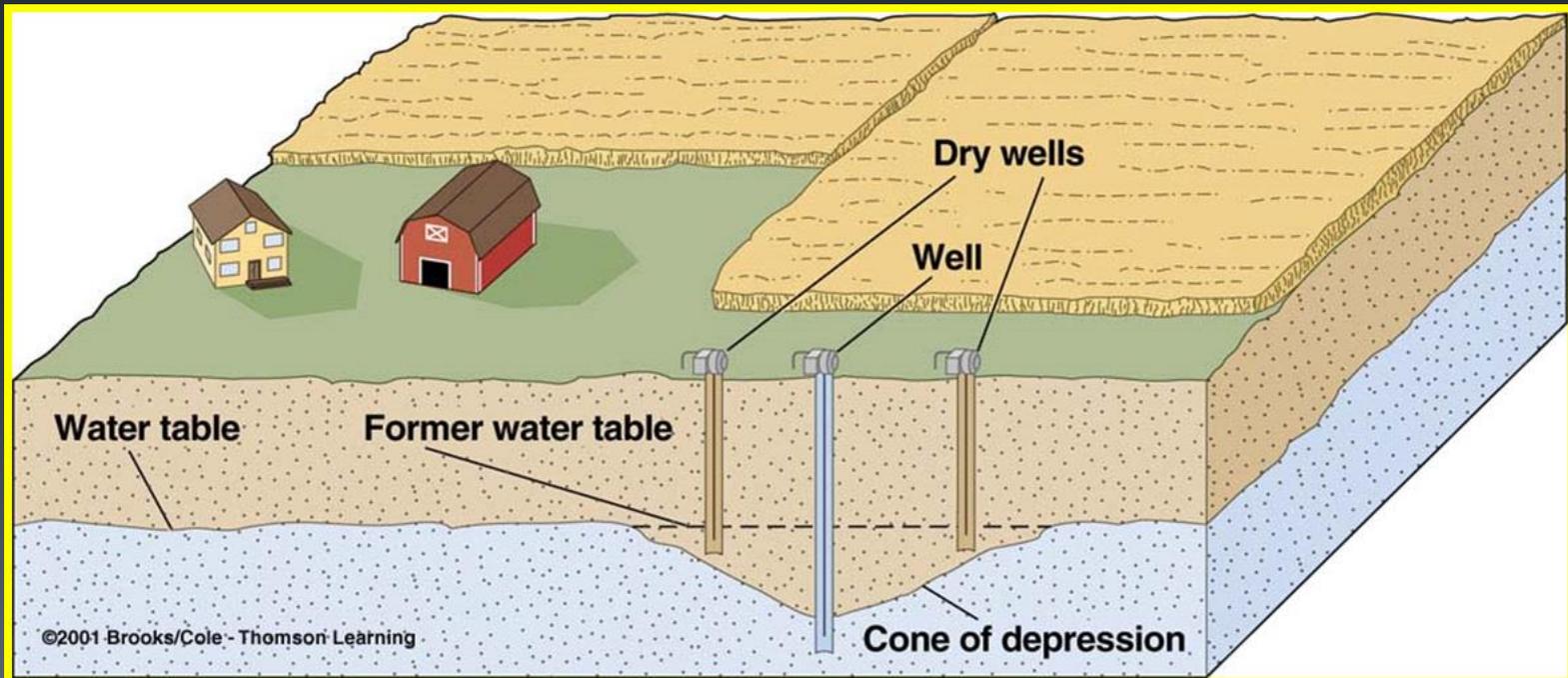


Fluctuations in the Water Table

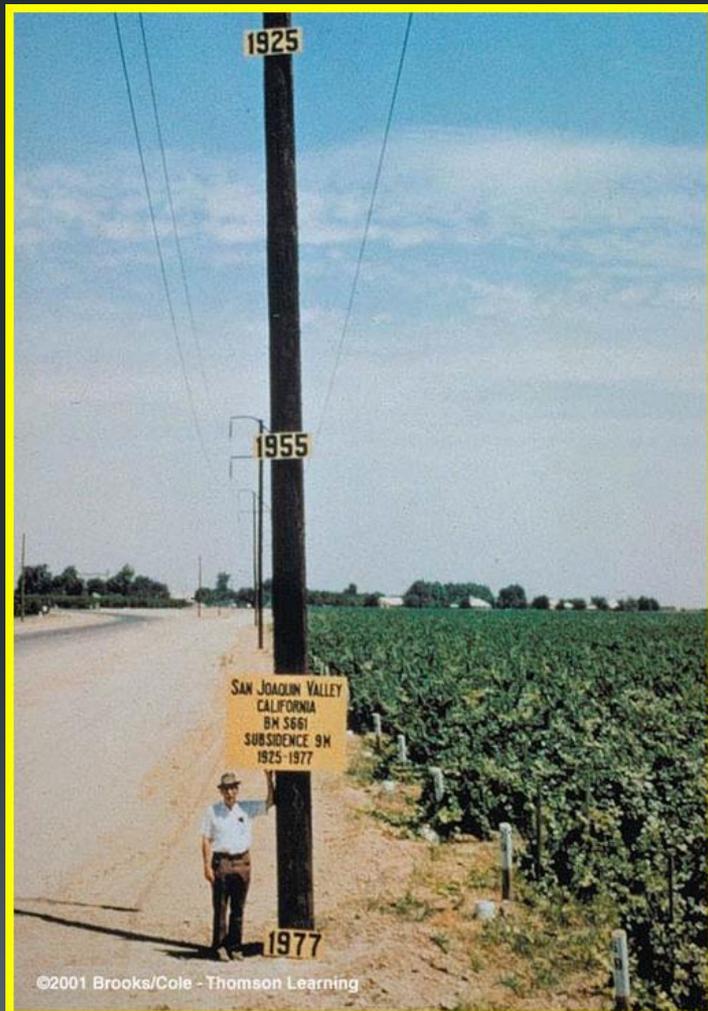
- **Discharge** refers to the removal of water and takes place where groundwater flows into streams, lakes, swamps, and springs, or is withdrawn at water wells.
- **Recharge** is the addition of water by infiltration of precipitation, snow melt, stream water, or water from artificial recharge ponds or water treatment systems.
- The water table rises or falls based on the ratio of recharge to discharge. Seasonal differences in precipitation or water use can change the depth of the water table drastically.

Water Wells

- Water wells are openings, either dug or drilled, that connect the zone of saturation with Earth's surface.
- In the vicinity of a well, the water table is lowered, forming a **cone of depression**.



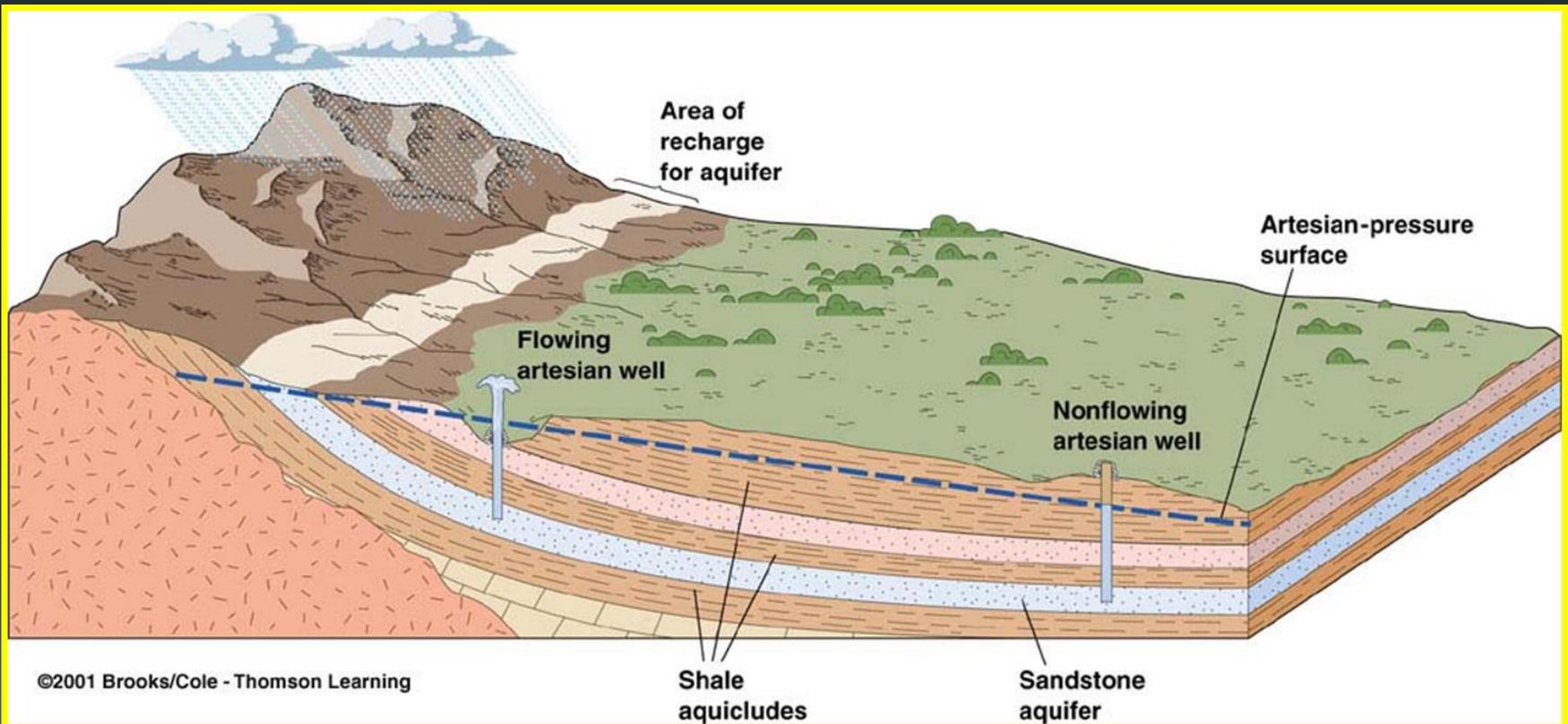
Subsidence



- The weight of overlying materials can cause the grains in poorly consolidated sediment or sedimentary rock to pack more closely together when excessive amounts of ground-water are withdrawn
- Withdrawal of groundwater for irrigation in the San Joaquin Valley of California resulted in lowering of the ground surface by as much as 9 meters (30 feet!) during the period 1925 to 1975.

Artesian Systems

- **Artesian systems** form where groundwater in sloping aquifers is confined by an overlying aquiclude. If recharge is sufficient to keep the aquifer filled, hydrostatic pressure builds up and allows groundwater to rise above the top of the aquifer in wells.

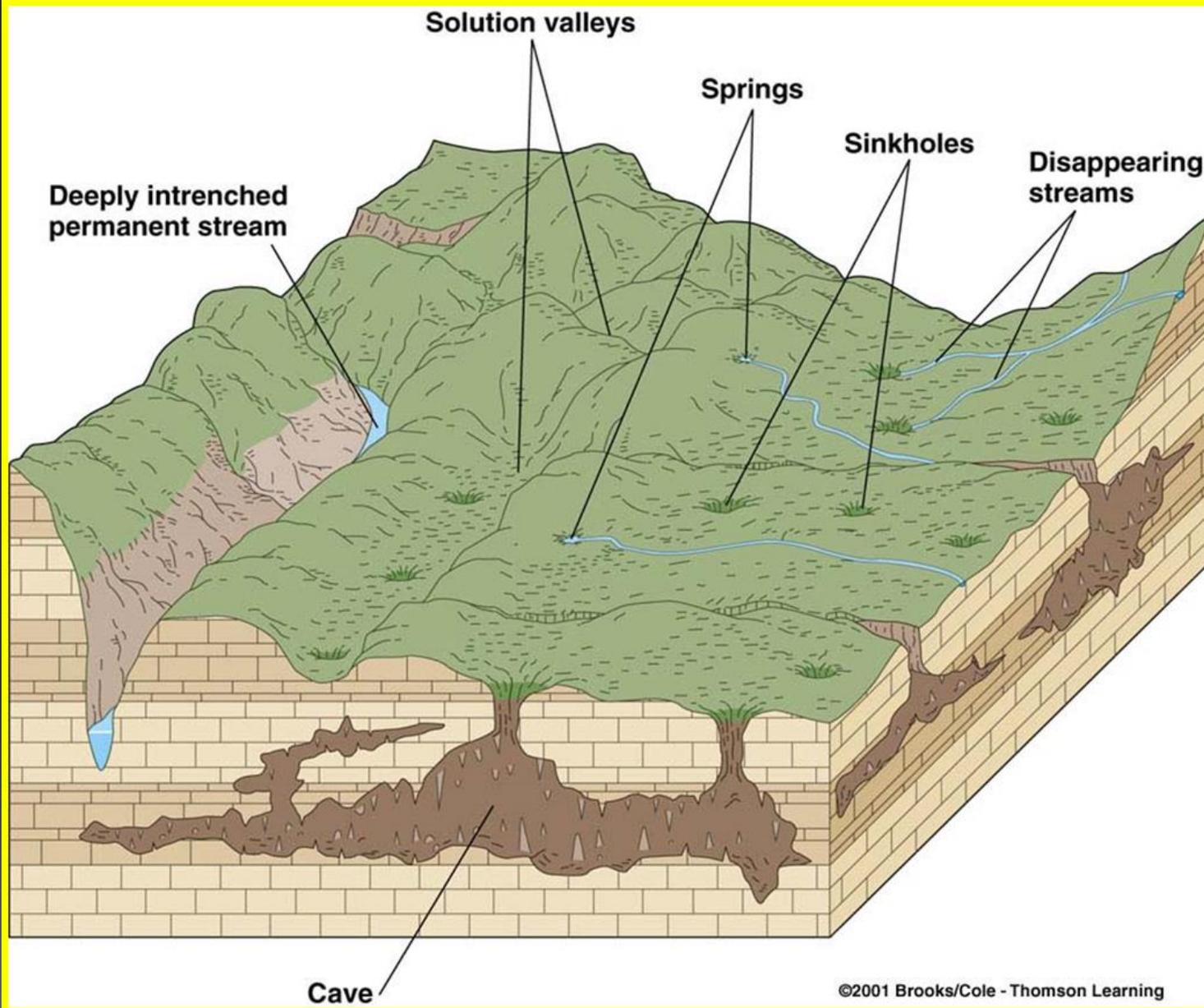


Karst Topography



Karst Topography

- Rainwater picks up CO_2 from the air to form carbonic acid (H_2CO_3). The acidic rainwater when underground, reacts with limestone and causes it to slowly, and unevenly dissolve. This creates cavities in the limestone.
- Landscapes with karst topography are characterized by numerous sinkholes, solution valleys, disappearing streams, caves, springs, and terra rosa.
- Karst topography forms in humid and temperate climates.



Sinkholes

- **Sinkholes** are depressions of various size and shape on the ground surface of regions underlain by soluble rock.
- They form when the roof of an previously unknown cave chamber gives way, and can present a serious danger in populated areas.





2010 Guatemala City



The National Corvette Museum Sinkhole

https://www.youtube.com/watch?v=Q0LzIBY7b_g

Blue Holes

- Sinkholes filled with water are called Blue Holes and can be entrances to vast underwater cave systems.



The Great Blue Hole of Belize



Blue Holes in the Bahamas



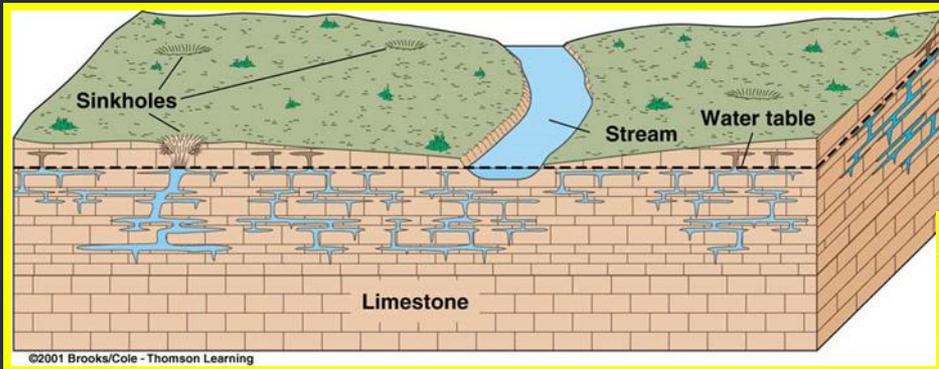
Disappearing Streams

- Streams that seem to disappear because they flow into an underground cave system.
- The most famous (and dangerous) is “The Bolton Strid” on the River Wharfe in Yorkshire, England. (pictured right) Many people have died trying to jump over the river there.

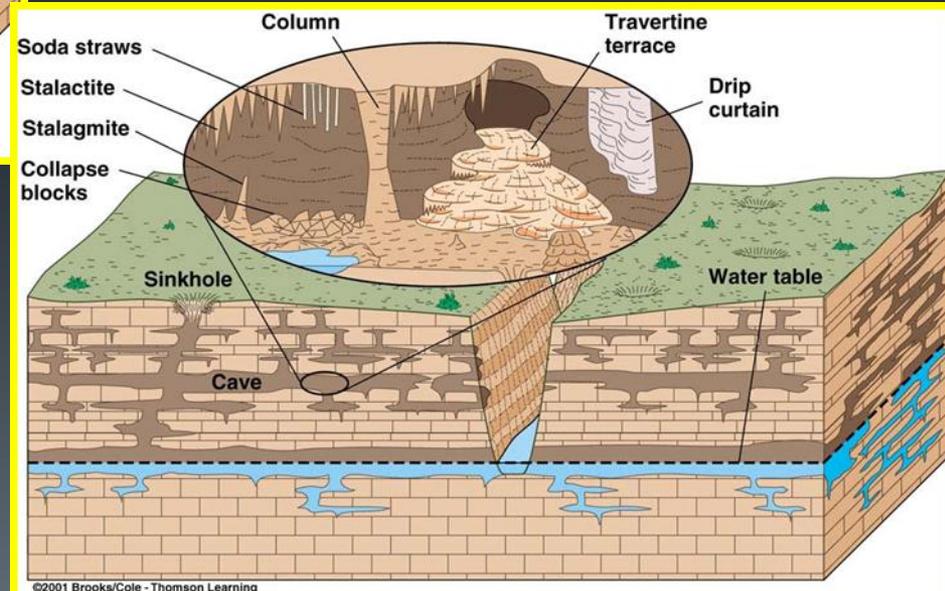


Caves

- A **cave** is a naturally formed subsurface cavity connected to the surface and large enough for a person to enter. A cavern is a very large cave or system of connected caves
- Groundwater infiltrating and flowing in the zone of saturation dissolves carbonate rock to form a system of solution cavities



A drop in the water table drains the previously formed cavities, leaving an interconnected system of caves and caverns. Water seeping into caves forms cave deposits.



Caves

- There are two types of limestone cave chamber caves (the most common) and catacomb caves.



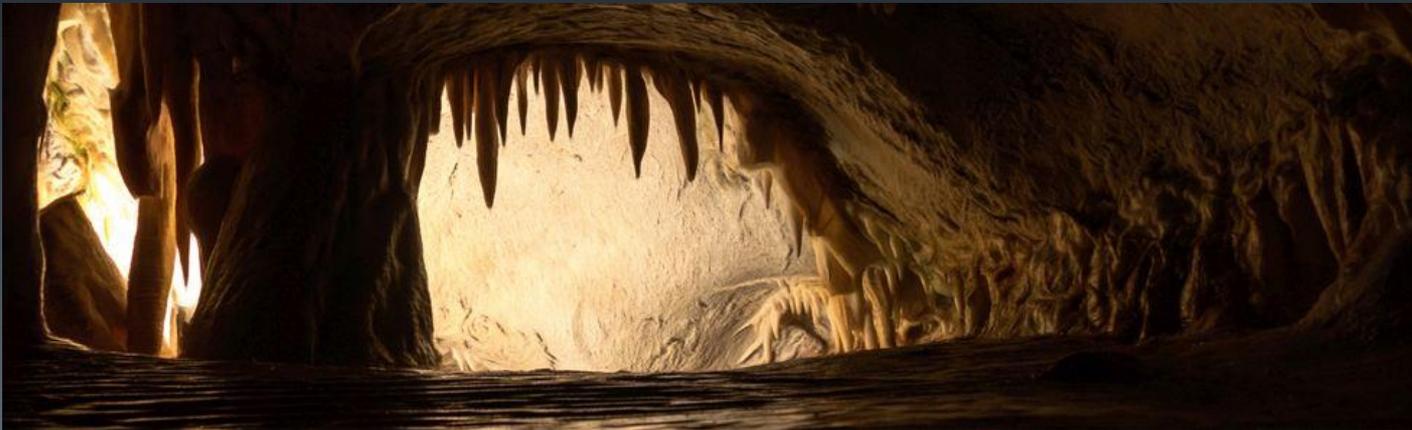
Chamber Cave (note dripstone)



Catacomb Cave (no dripstone)

Dripstone Formations

- As water seeps into caves, CO₂ in the water escapes and a small amount of calcite is precipitated. Almost all cave deposits form in this way and are collectively termed dripstone.
- **Stalactites** are icicle-shaped masses suspended from cave ceilings. **Stalagmites** are spires projecting upward from cave floors.
- Columns form where stalactites and stalagmites meet.
- Drip curtains are vertical sheets formed along cracks in cave ceilings.
- Travertine terraces are produced by water flowing across cave floors.





Other Types of Caves

- Lava flowing underground can leave chambers called Lava Tube Caves. Such caves may exist on Mars where volcanism once occurred.

