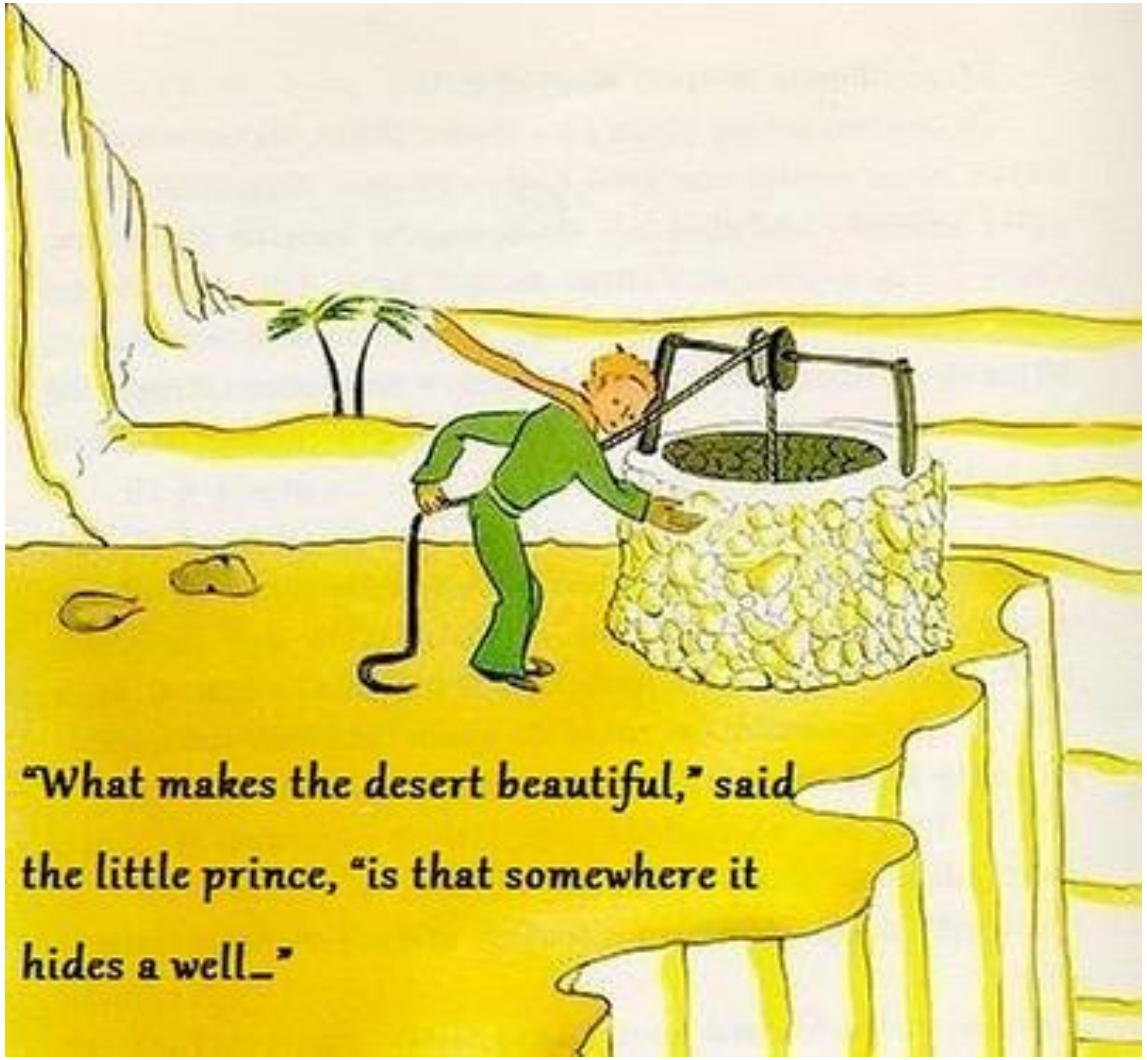
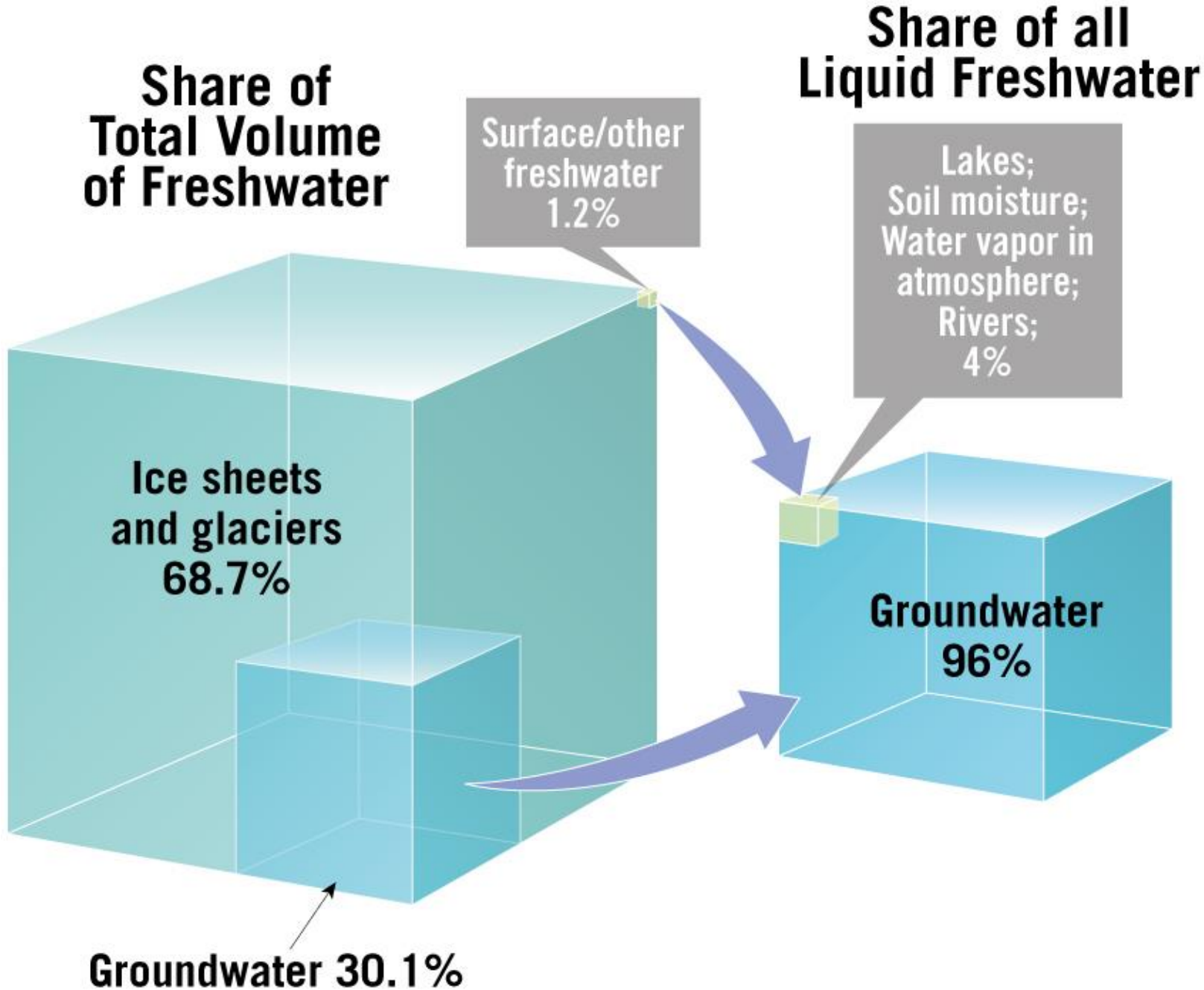
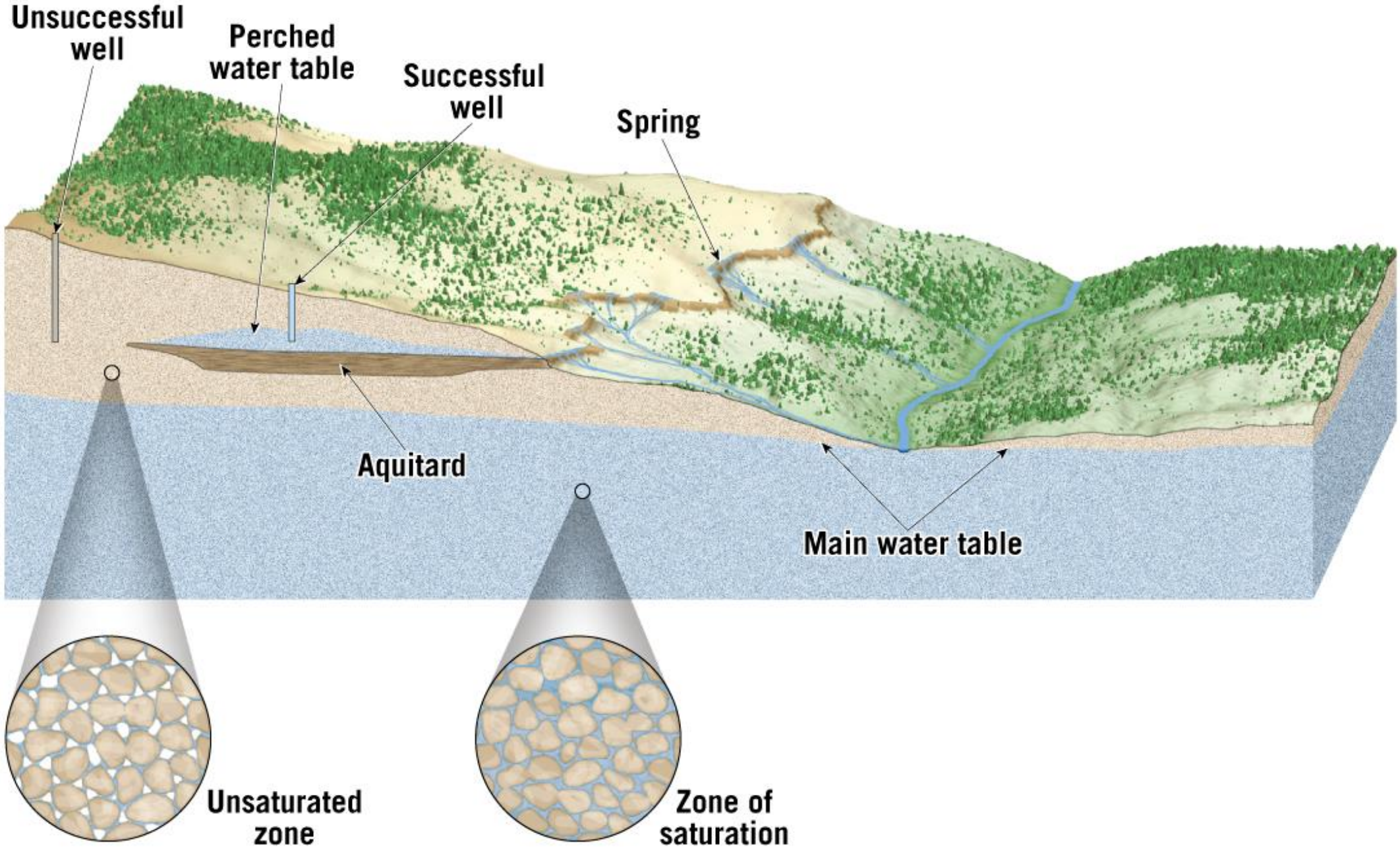


Ground Water

Water Beneath the Surface





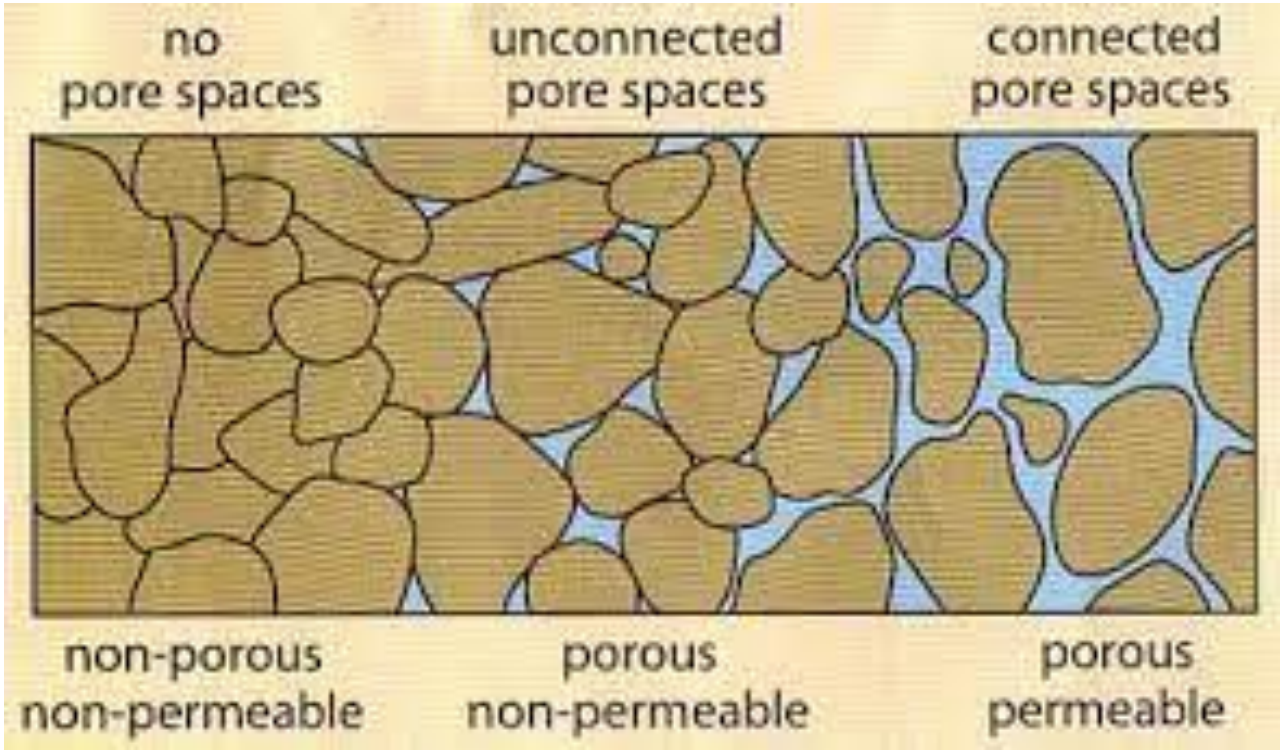
Groundwater Facts (from NGWA (ngwa.org)

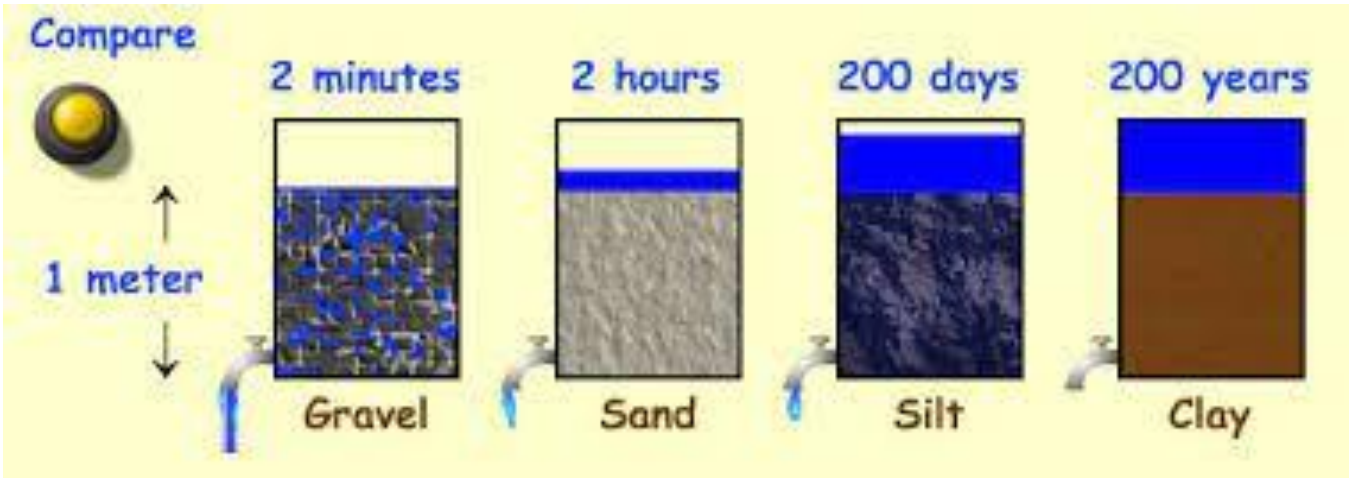
- Hydrologists estimate, according to the National Geographic Society, U.S. groundwater reserves to be at least 33,000 trillion gallons.
- The United States uses 82.3 billion gallons per day of fresh groundwater (2015)
- Most groundwater is used for irrigation.
- Adequate time is needed to allow replenishment of underlying groundwater reservoirs (aquifers); this must be properly managed.
- The Illinois water table generally occurs about 20 feet below the surface.

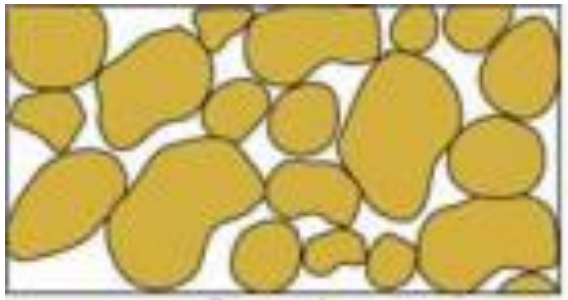
Springs

The beaker on the left is filled with 1000 ml of sediment. The beaker on the right is filled with 1000 ml of water.

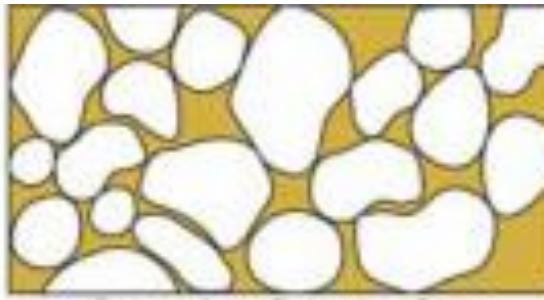
The sediment-filled beaker now contains 500 ml of water. Pore spaces (porosity) must represent 50 percent of the volume of the sediment.







Gravel
well sorted, high porosity



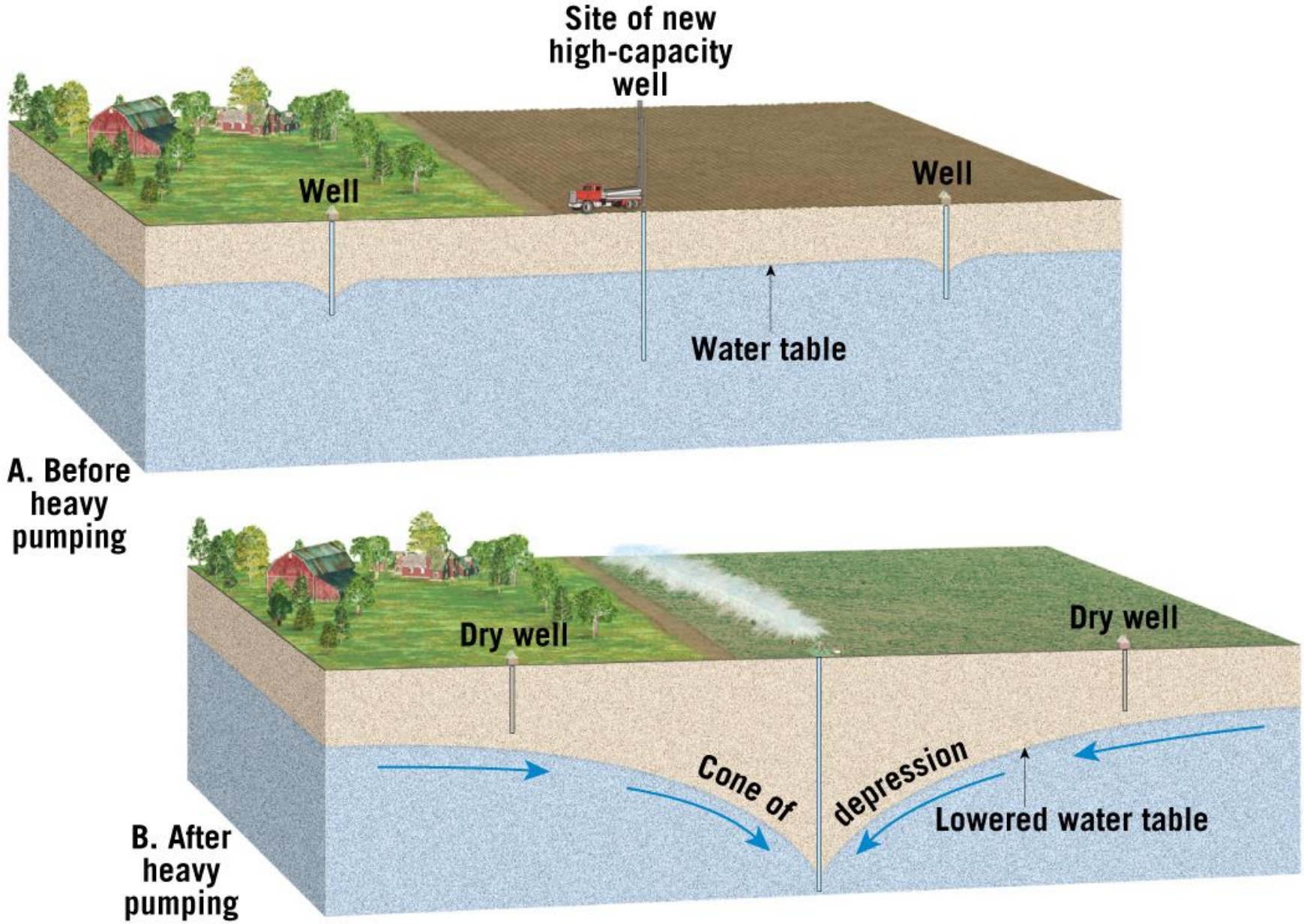
Gravel - Sand - Clay
poorly sorted, low porosity

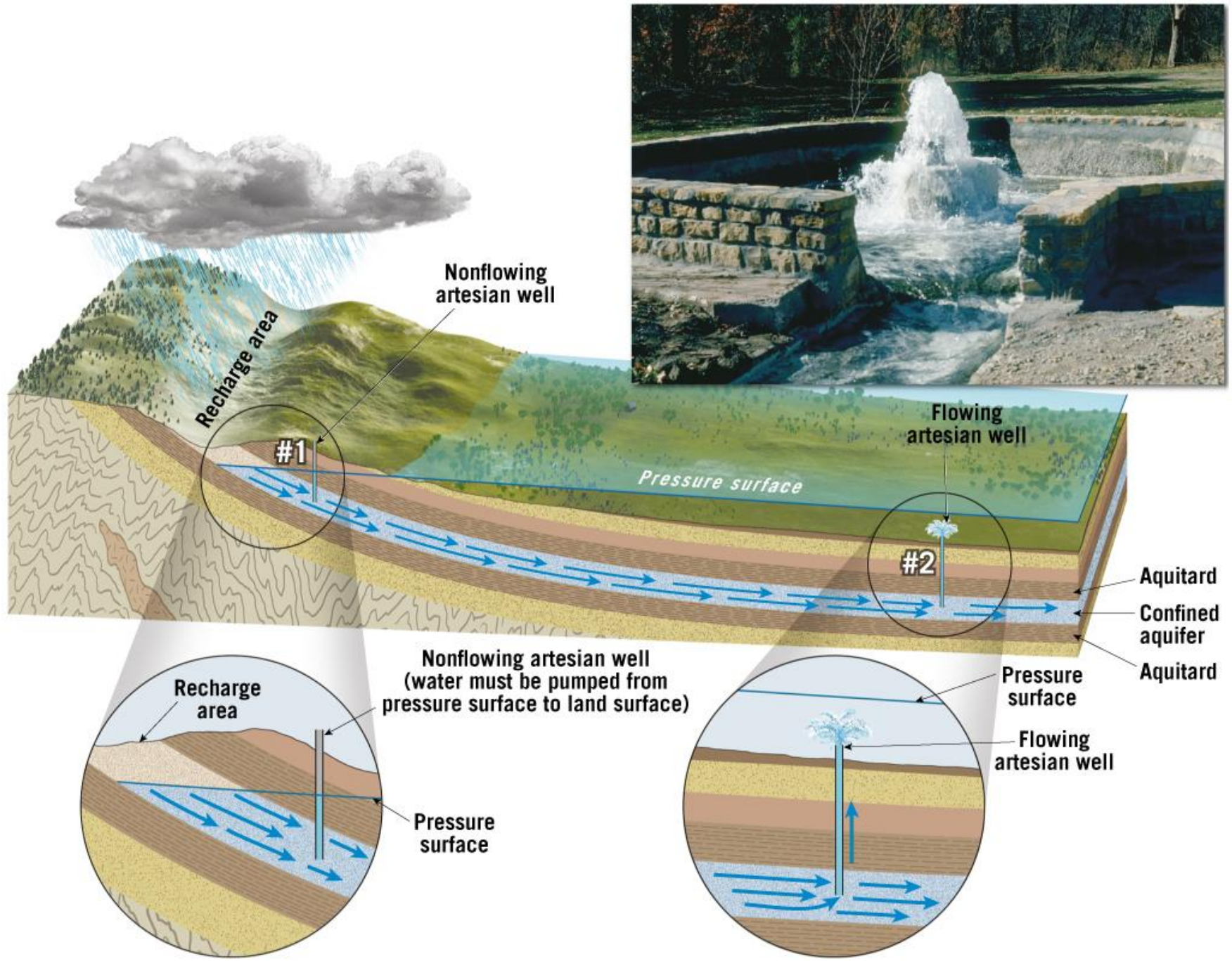
Cemented Sandstone
low porosity

Clay
high porosity

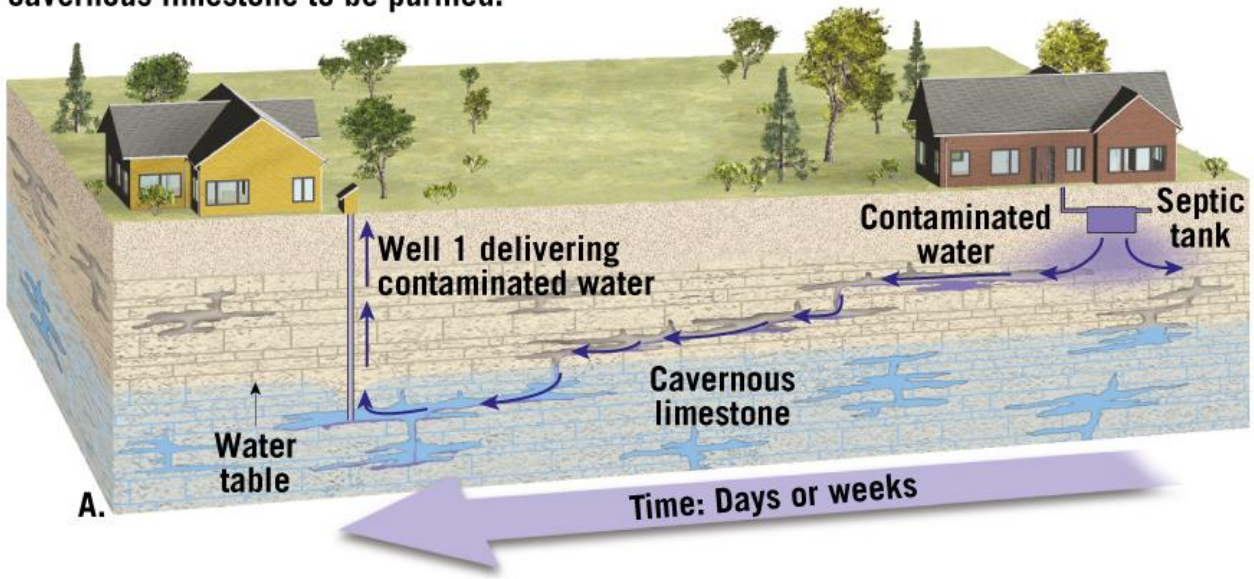
Limestone
low porosity

Shale
low porosity

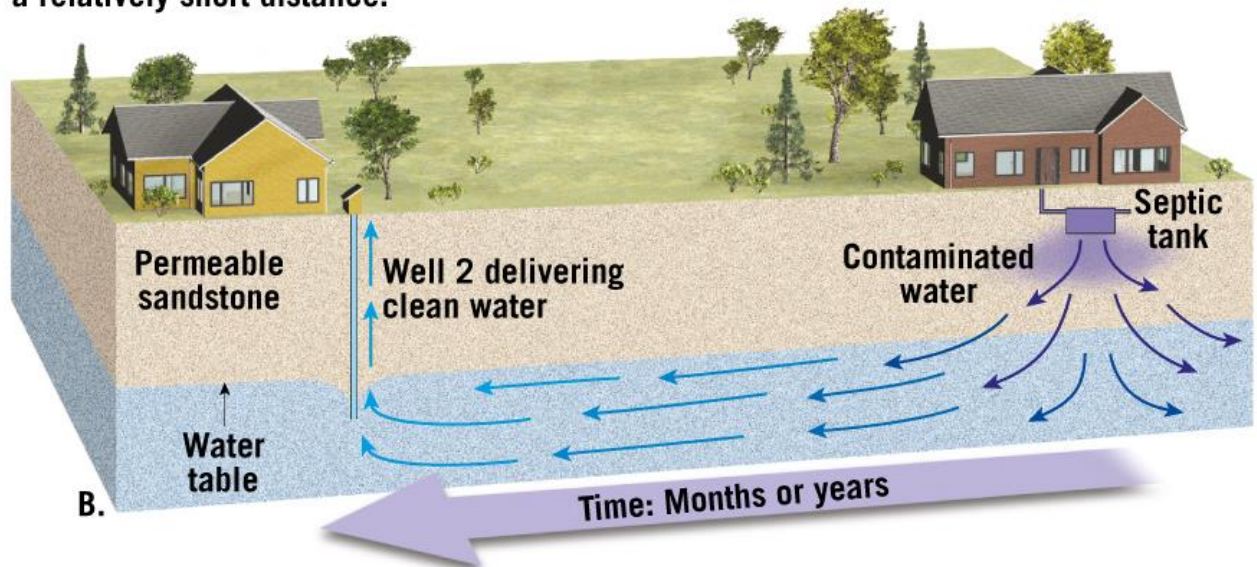


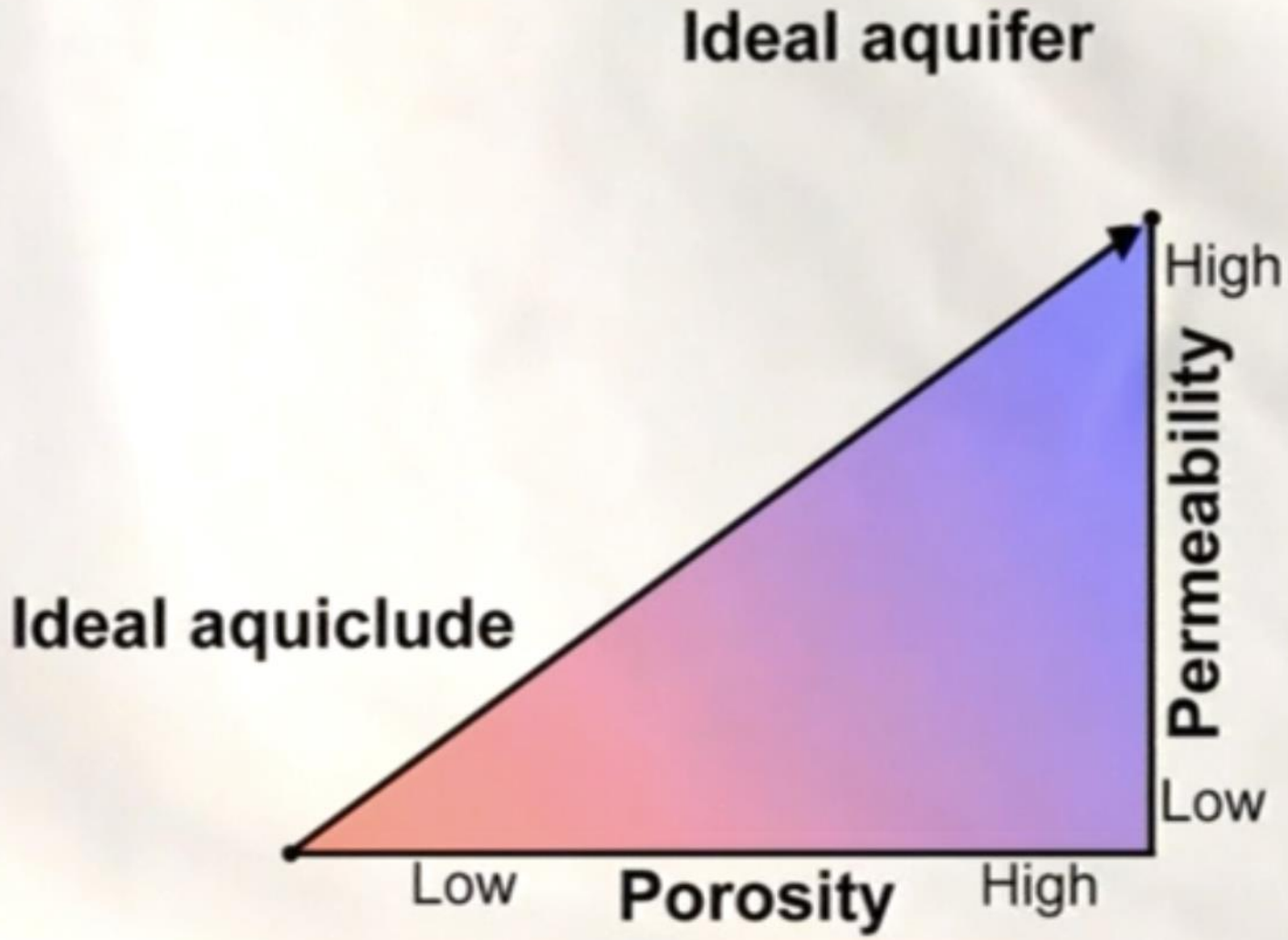

Nonflowing artesian well
Recharge area
#1
Pressure surface
Flowing artesian well
#2
Aquitard
Confined aquifer
Aquitard
Nonflowing artesian well (water must be pumped from pressure surface to land surface)
Recharge area
Pressure surface
Pressure surface
Flowing artesian well

Although the contaminated water has traveled more than 100 meters before reaching Well 1, the water moves too rapidly through the cavernous limestone to be purified.



As the discharge from the septic tank percolates through the permeable sandstone, it moves more slowly and is purified in a relatively short distance.

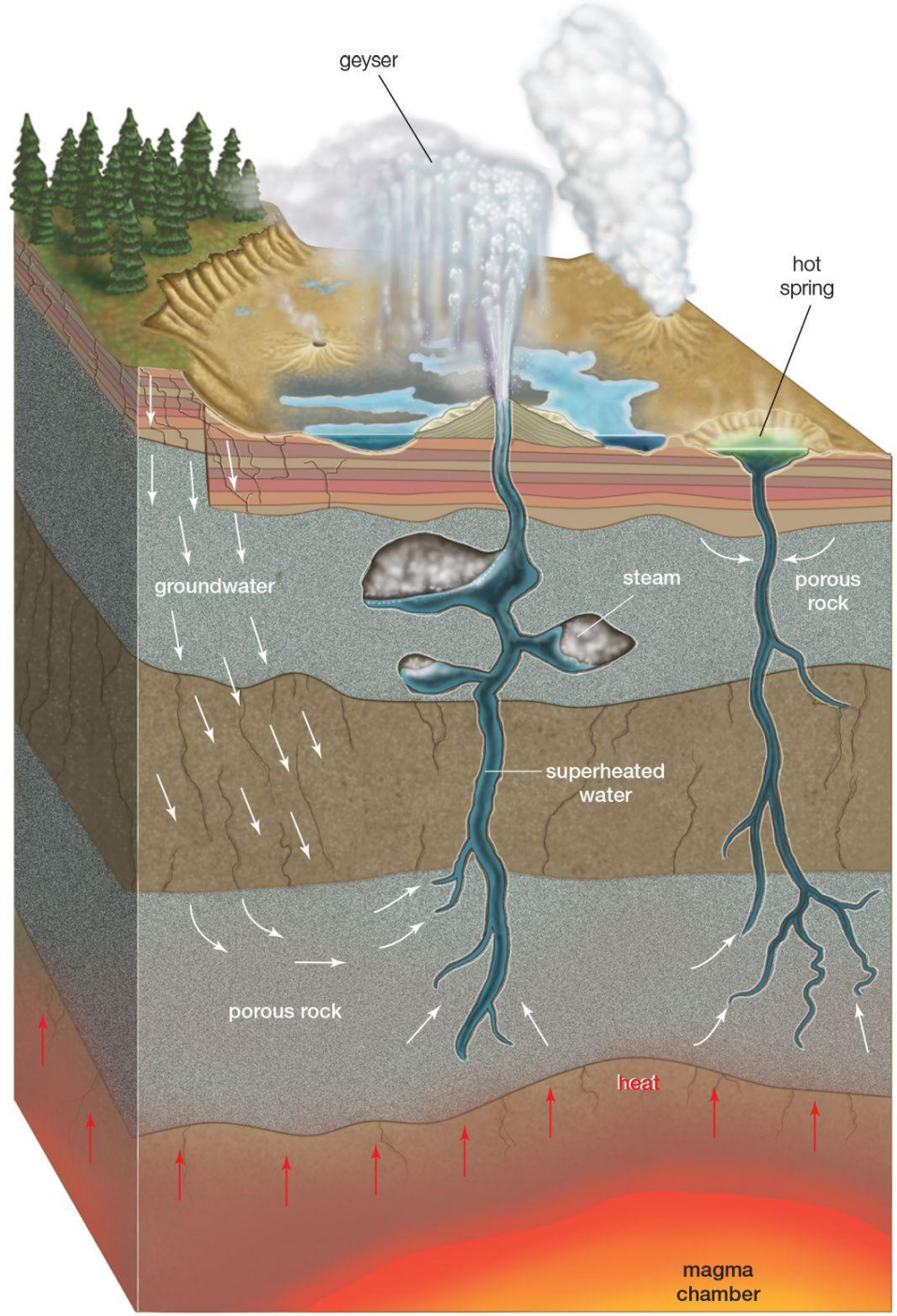


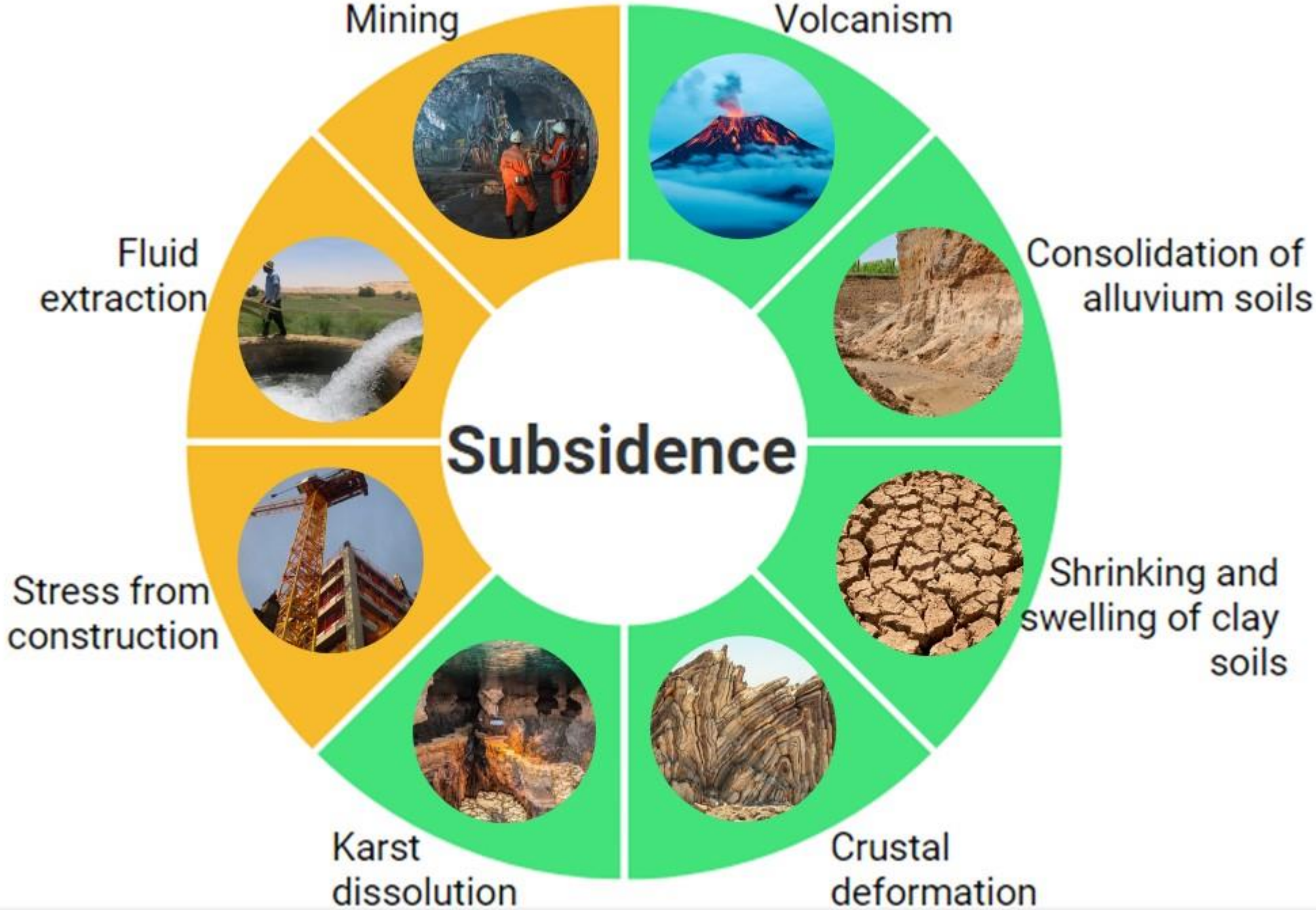

Ideal aquifer
Ideal aquiclude
High
Permeability
Low
Low
Porosity
High

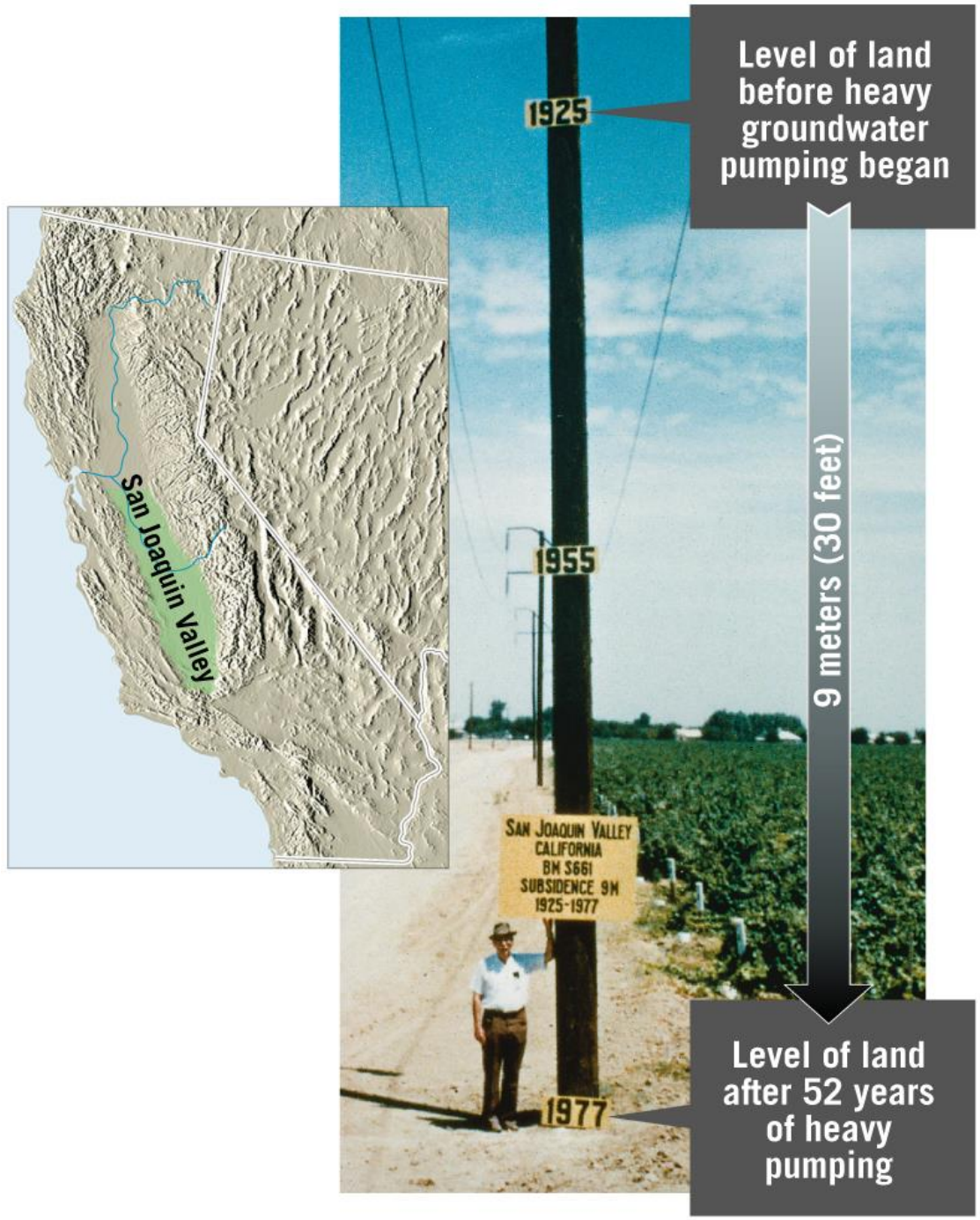
Tatio Geysers,
Antofagasta Province,
Chile

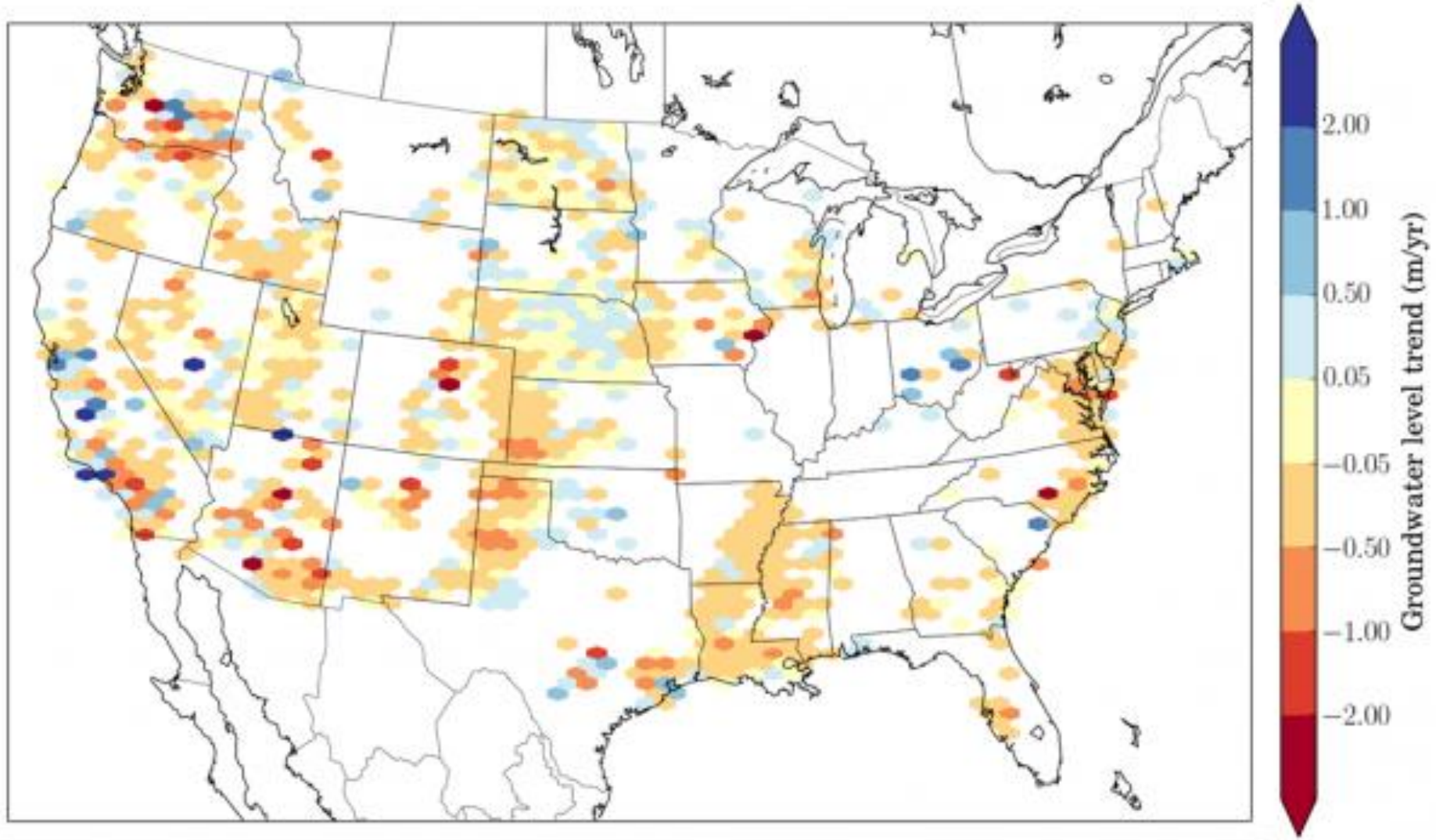
Tatio Geysers,
Antofagasta Province,
Chile

Lassen Volcanic National Park,
Mineral, California




Mining
Volcanism
Fluid extraction
Consolidation of alluvium soils
Subsidence
Stress from construction
Shrinking and swelling of clay soils
Karst dissolution
Crustal deformation



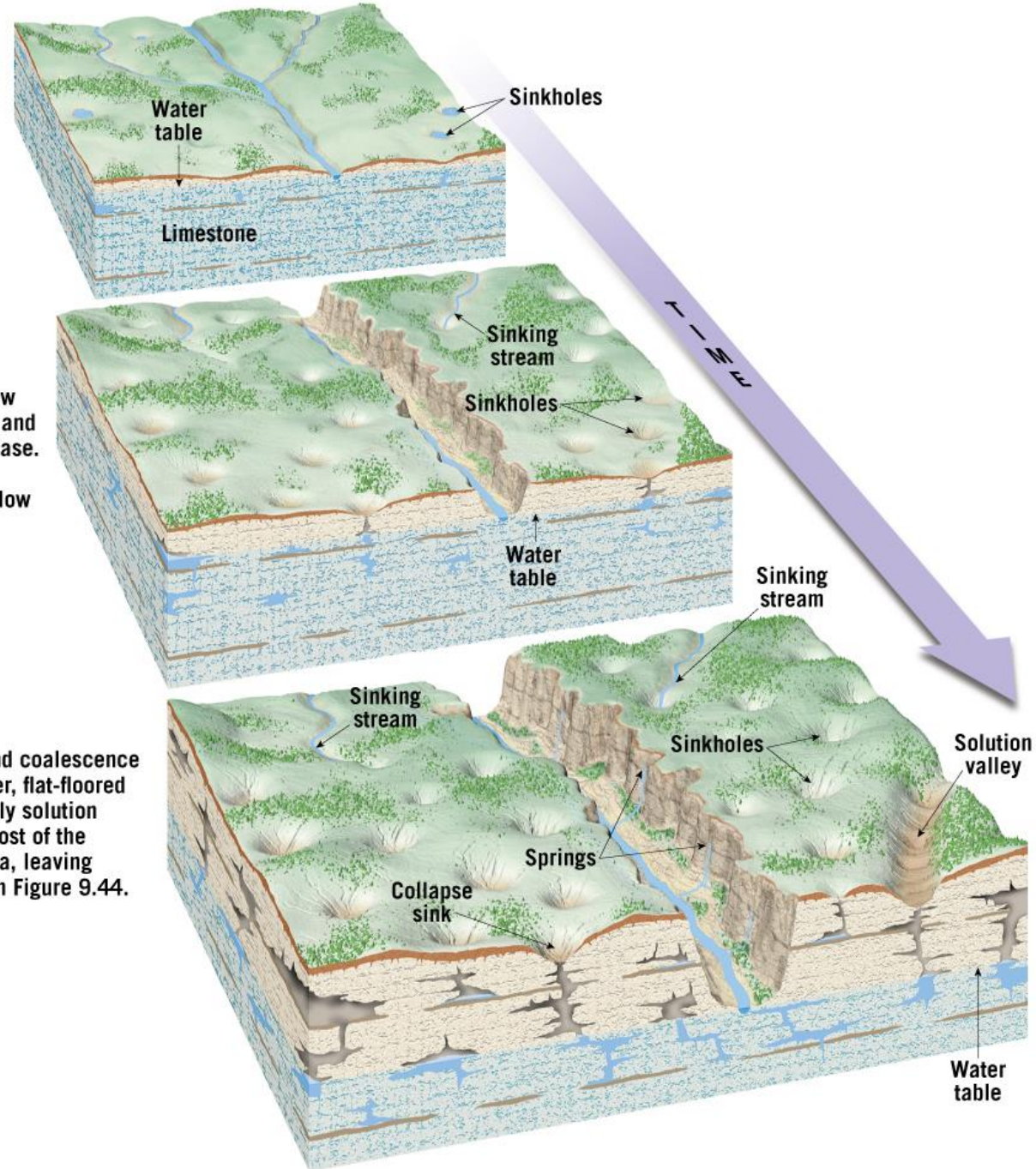


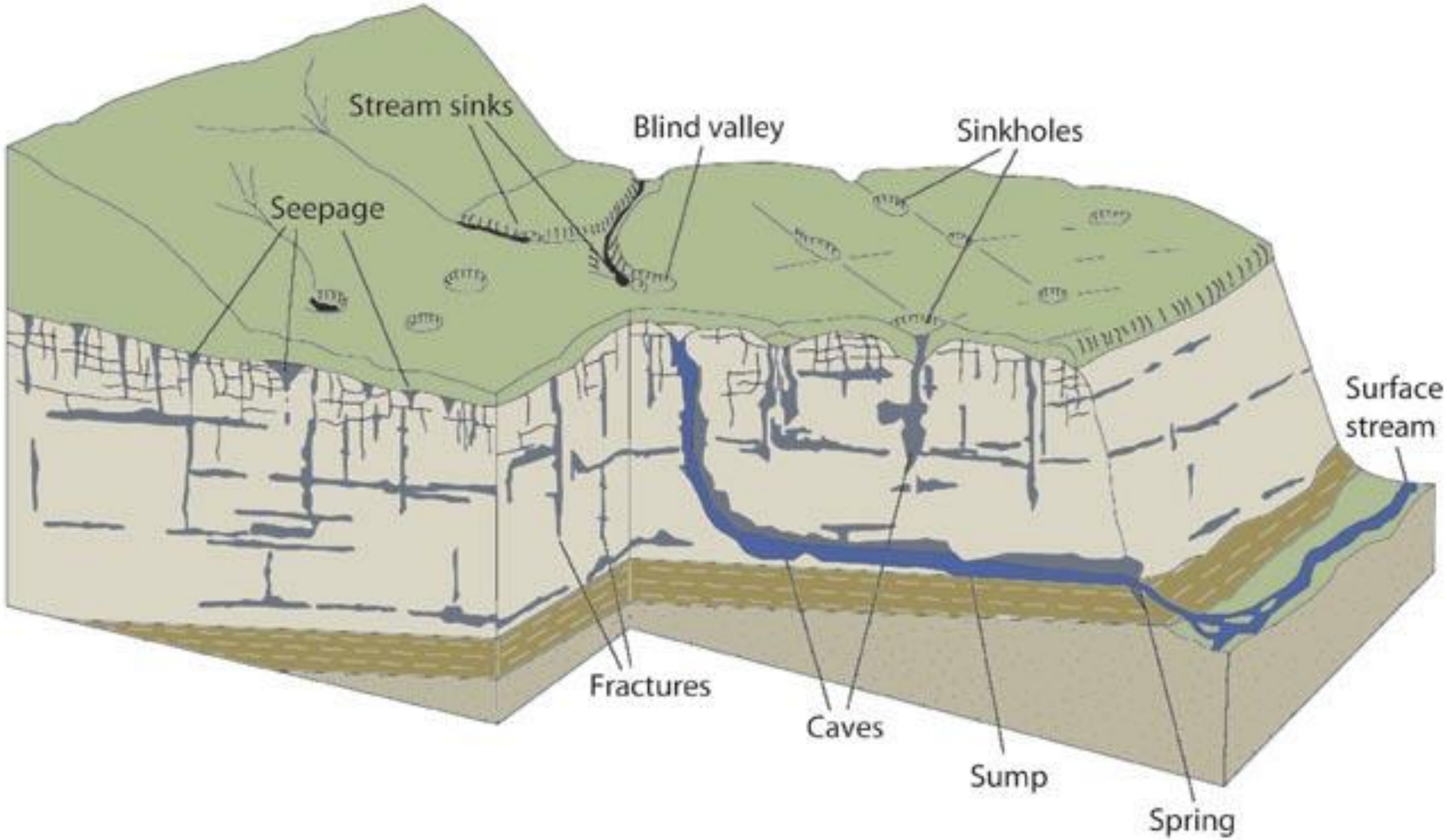
Trends in groundwater levels observed between 1949 and 2009. Negative (red/orange) indicates decline in groundwater level, while positive (blue) indicates a rise in groundwater level. Source: Columbia Water Center

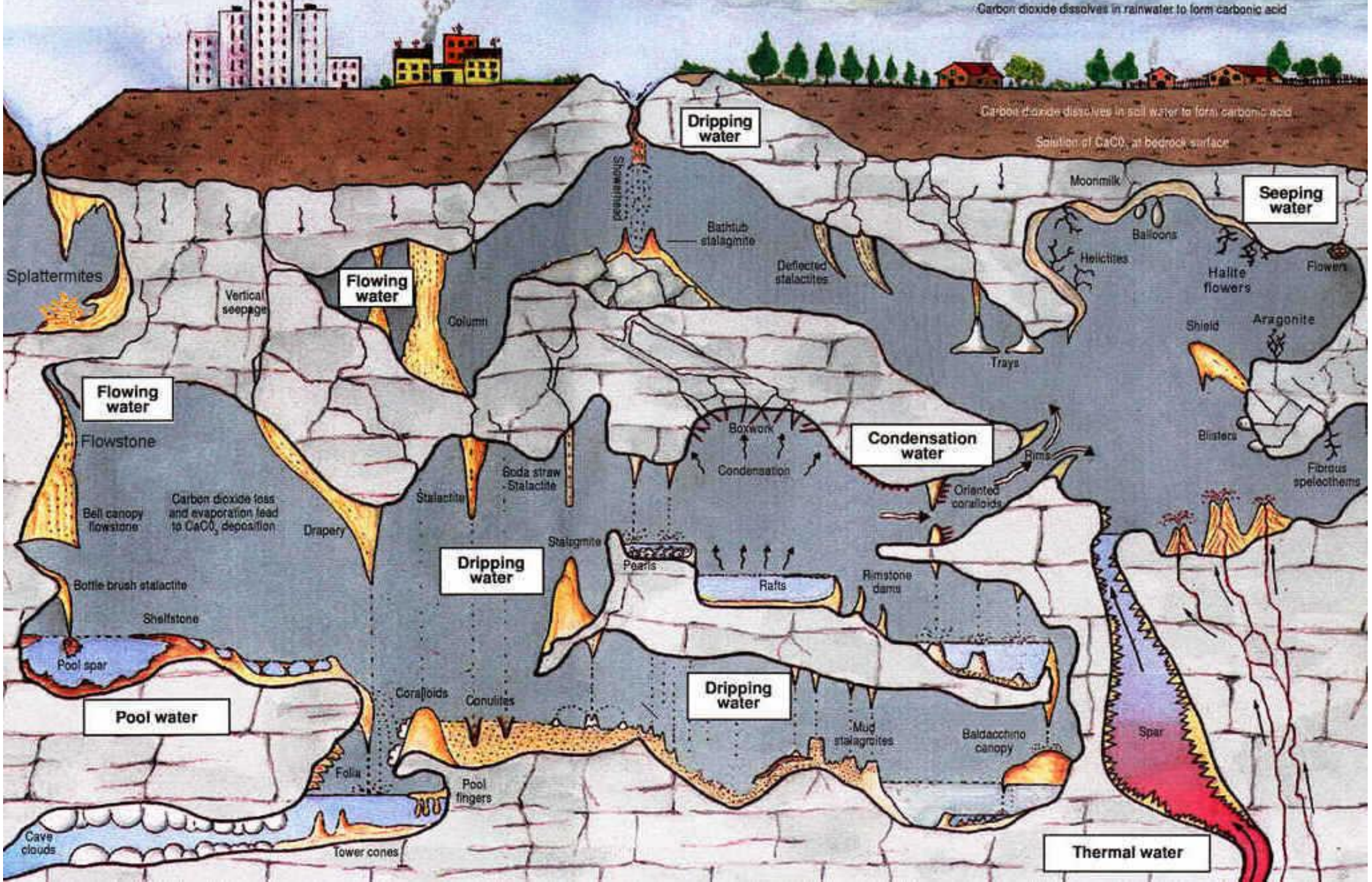
During early stages, groundwater percolates through limestone along joints and bedding planes. Solution activity creates and enlarges caverns at and below the water table.

With time, caverns grow larger and the number and size of sinkholes increase. Surface drainage is frequently funneled below ground.

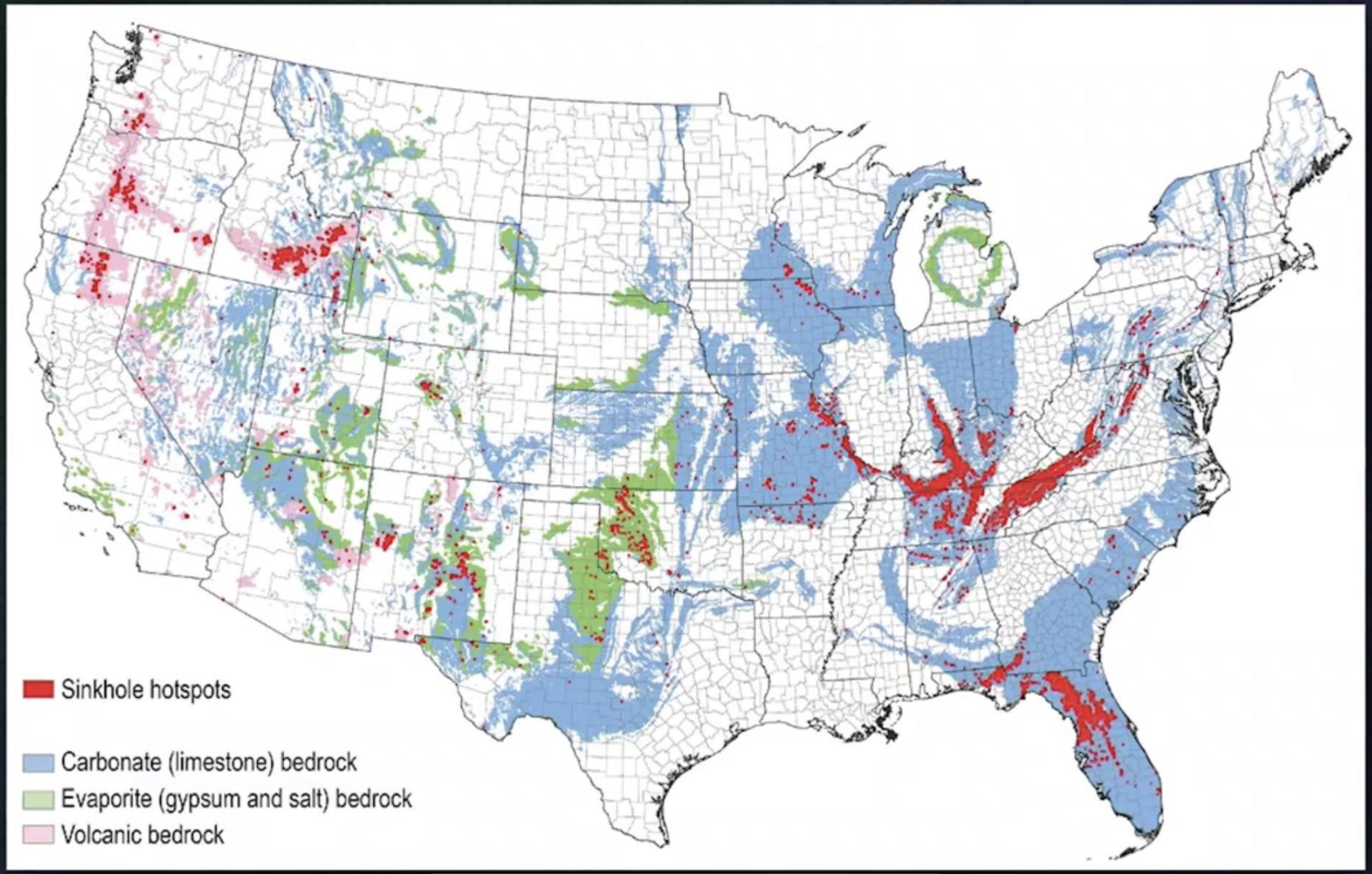
Collapse of caverns and coalescence of sinkholes form larger, flat-floored depressions. Eventually solution activity may remove most of the limestone from the area, leaving isolated remnants as in Figure 9.44.




Stream sinks
Blind valley
Sinkholes
Seepage
Surface stream
Fractures
Caves
Sump
Spring


Carbon dioxide dissolves in rainwater to form carbonic acid
Carbon dioxide dissolves in soil water to form carbonic acid
Solution of CaCO3 at bedrock surface
Dripping water
Seeping water
Flowing water
Flowing water
Condensation water
Dripping water
Dripping water
Pool water
Thermal water
Showerhead
Bathtub stalagmite
Deflected stalactites
Moonmilk
Balloons
Helictites
Halite flowers
Flowers
Shield
Aragonite
Trays
Splattermites
Vertical seepage
Column
Flowstone
Bell canopy flowstone
Carbon dioxide loss and evaporation lead to CaCO3 deposition
Drapery
Stalactite
Soda straw stalactite
Boxwork
Condensation
Rims
Oriented coralloids
Blisters
Fibrous speleothems
Stalagmite
Pearls
Rafts
Rimstone dams
Bottle brush stalactite
Shelfstone
Pool spar
Coralloids
Conulites
Mud stalagmites
Baldacchino canopy
Spar
Folia
Pool fingers
Cave clouds
Tower cones

Speleothems


Sinkhole hotspots
Carbonate (limestone) bedrock
Evaporite (gypsum and salt) bedrock
Volcanic bedrock

Vocabulary

Aquiclude	**Aquifer**	**Artesian Well**
Cavern	**Geyser**	**Groundwater**
Hot Springs	**Karst Topography**	**Permeability**
Porosity	**Sinkhole**	**Spring**
Stalactite	**Stalagmite**	**Water Table**
Zone of Aeration	**Zone of Saturation**	