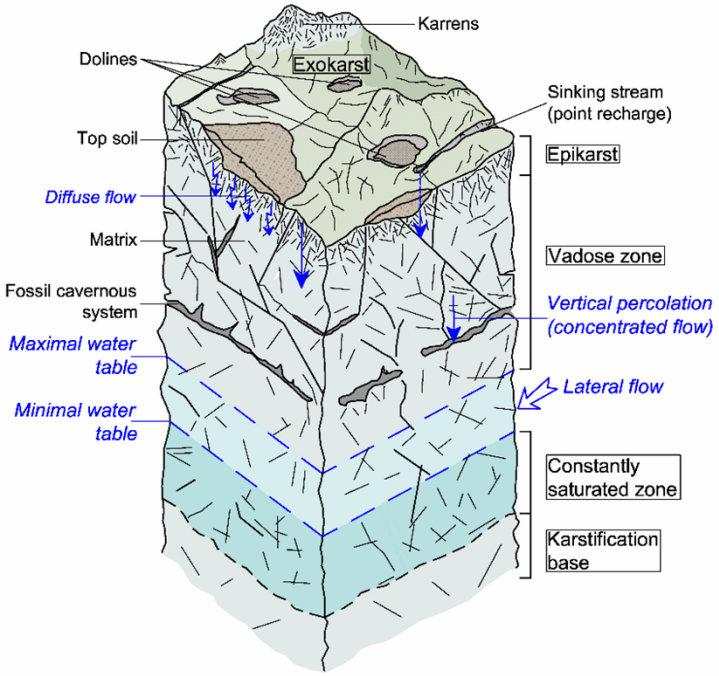
What is Karst?

- A landscape underlain by limestone and chemically similar rocks, where surface topography and subsurface is shaped by carbonation, a chemical weathering process
- Characterized by sinkholes, disappearing streams, subterranean drainage, and caves.
- Karst can also refer to the landforms that are formed through karstic processes

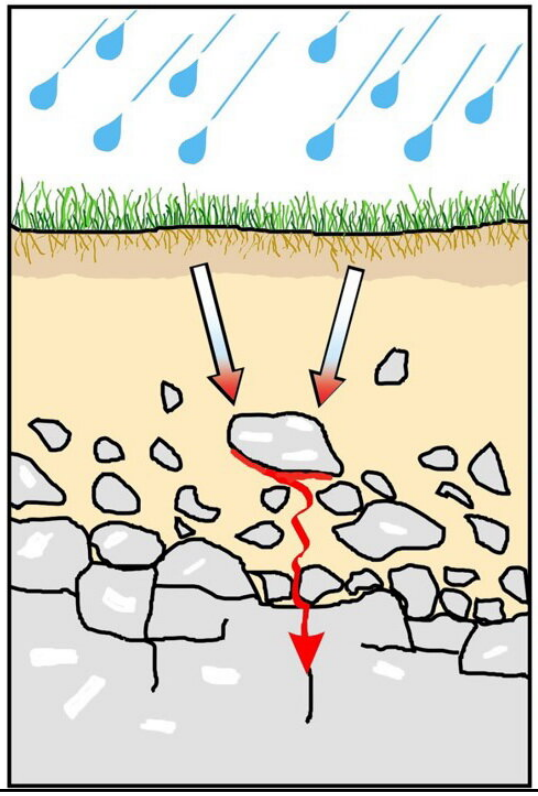


Karst can also form through acidic water that percolates up from underground sources rather than through surface waters

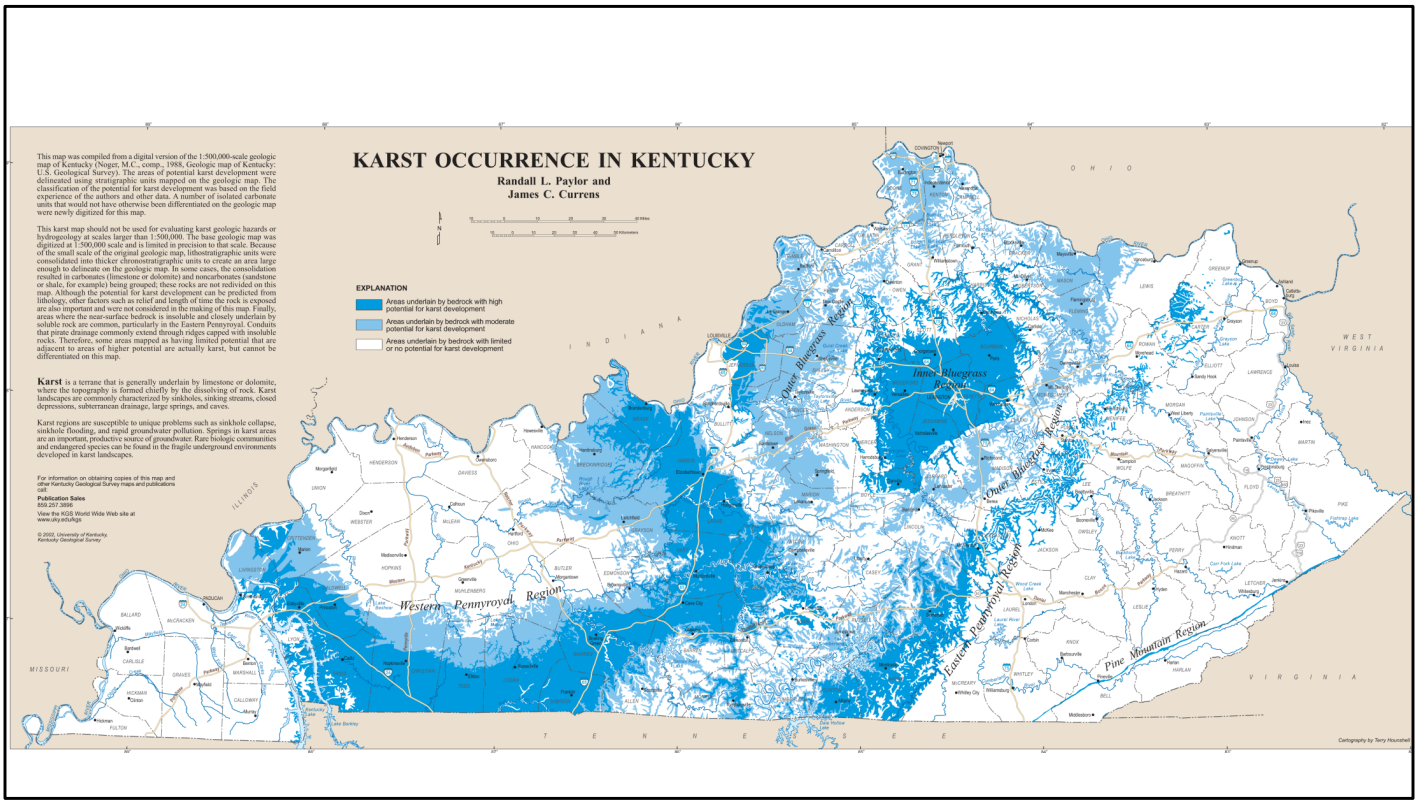
Epikarst refers to the near-surface layer of a karst landscape, typically characterized by enhanced dissolution and increased permeability due to the concentration of weathering processes. It acts as a transition zone between the surface and deeper karst systems.

Exokarst refers to the visible, surface features of a karst landscape formed by the dissolution of rock at or near the surface. It includes a wide range of landforms that are often dramatic and visually distinctive.

- Carbonation begins when carbon dioxide dissolves in water within surface soils to form carbonic acid
- When this slightly acidic water comes into contact with carbonate rocks, they are slowly dissolved and over time can weather large volumes of rock and create many different type of landforms.
- Karst landforms best develop where there are carbonate rocks, warm climates, and ample precipitation



Karst can also form through acidic water that percolates up from underground sources rather than through surface waters


KARST OCCURRENCE IN KENTUCKY
Randall L. Paylor and
James C. Currens
This map was compiled from a digital version of the 1:500,000-scale geologic map of Kentucky (Noger, M.C., comp., 1988, Geologic map of Kentucky: U.S. Geological Survey). The areas of potential karst development were delineated using stratigraphic units mapped on the geologic map. The classification of the potential for karst development was based on the field experience of the authors and other data. A number of isolated carbonate units that would not have otherwise been differentiated on the geologic map were newly digitized for this map.
This karst map should not be used for evaluating karst geologic hazards or hydrogeology at scales larger than 1:500,000. The base geologic map was digitized at 1:500,000 scale and is limited in precision to that scale. Because of the small scale of the original geologic map, lithostratigraphic units were consolidated into thicker chronostratigraphic units to create an area large enough to delineate on the geologic map. In some cases, the consolidation resulted in carbonates (limestone or dolomite) and noncarbonates (sandstone or shale, for example) being grouped; these rocks are not redivided on this map. Although the potential for karst development can be predicted from lithology, other factors such as relief and length of time the rock is exposed are also important and were not considered in the making of this map. Finally, areas where the near-surface bedrock is insoluble and closely underlain by soluble rock are common, particularly in the Eastern Pennyroyal. Conduits that pirate drainage commonly extend through ridges capped with insoluble rocks. Therefore, some areas mapped as having limited potential that are adjacent to areas of higher potential are actually karst, but cannot be differentiated on this map.
Karst is a terrane that is generally underlain by limestone or dolomite, where the topography is formed chiefly by the dissolving of rock. Karst landscapes are commonly characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, large springs, and caves.
Karst regions are susceptible to unique problems such as sinkhole collapse, sinkhole flooding, and rapid groundwater pollution. Springs in karst areas are an important, productive source of groundwater. Rare biologic communities and endangered species can be found in the fragile underground environments developed in karst landscapes.
For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call:
Publication Sales
859.257.3896
View the KGS World Wide Web site at
www.uky.edu/kgs
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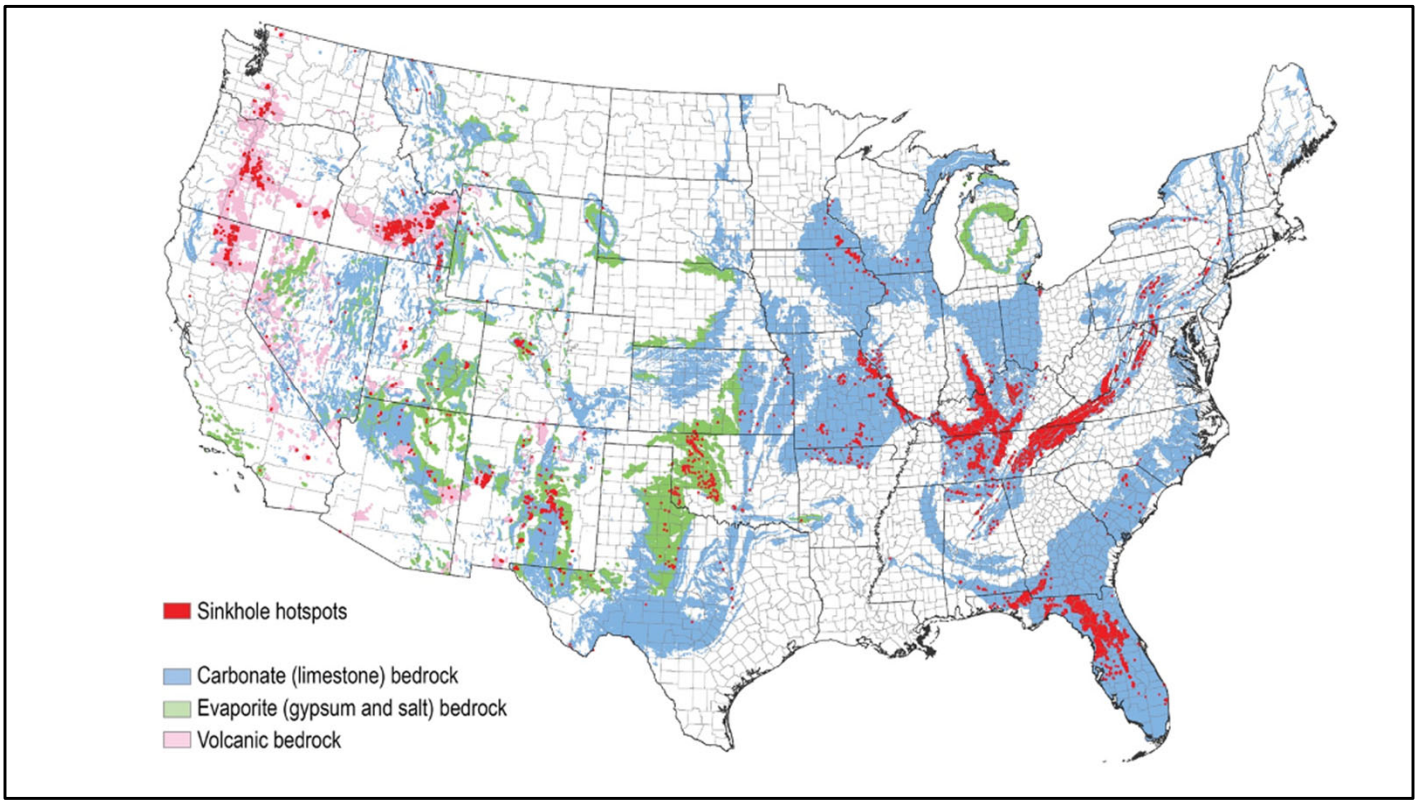
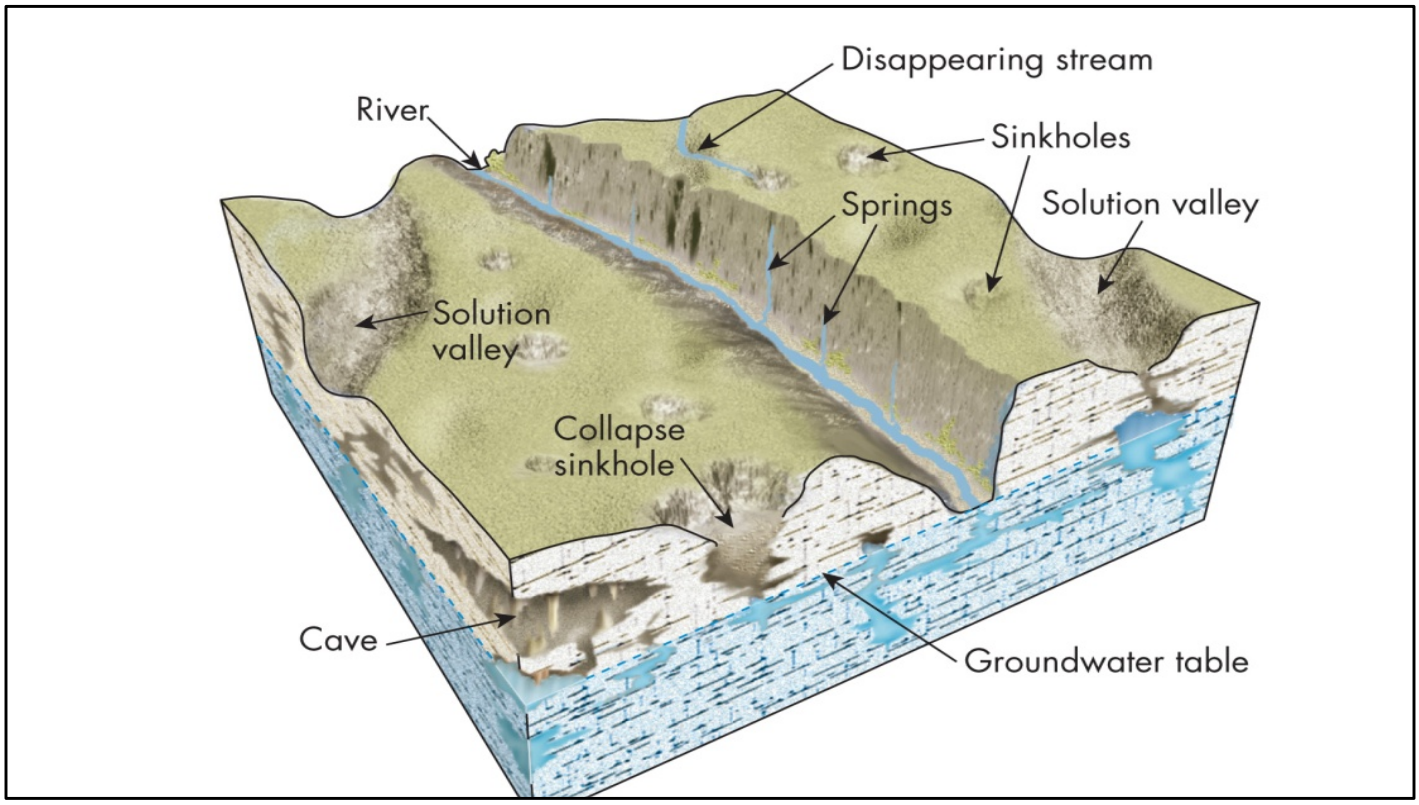
EXPLANATION
Areas underlain by bedrock with high potential for karst development
Areas underlain by bedrock with moderate potential for karst development
Areas underlain by bedrock with limited or no potential for karst development
Outer Bluegrass Region
Inner Bluegrass Region
Outer Blue Rock Region
Western Pennyroyal Region
Eastern Pennyroyal Region
Pine Mountain Region
Cartography by Terry Hounshell

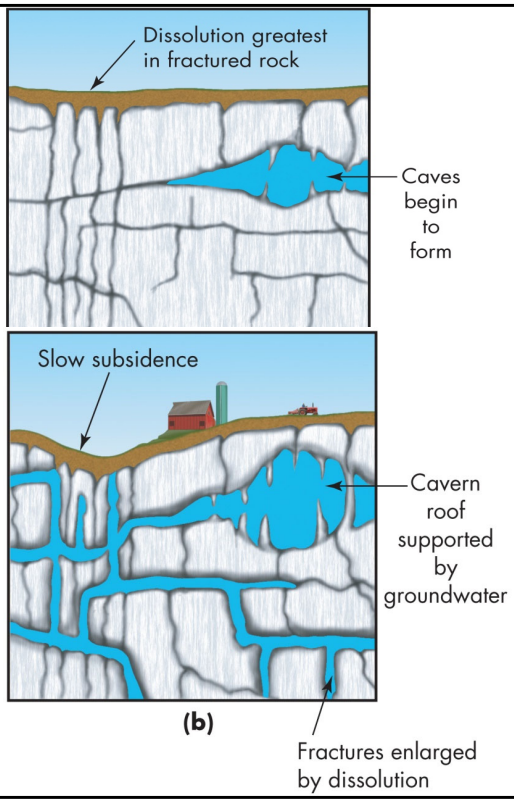


Karst terrains in the US


Disappearing stream
River
Sinkholes
Springs
Solution valley
Solution valley
Collapse sinkhole
Cave
Groundwater table

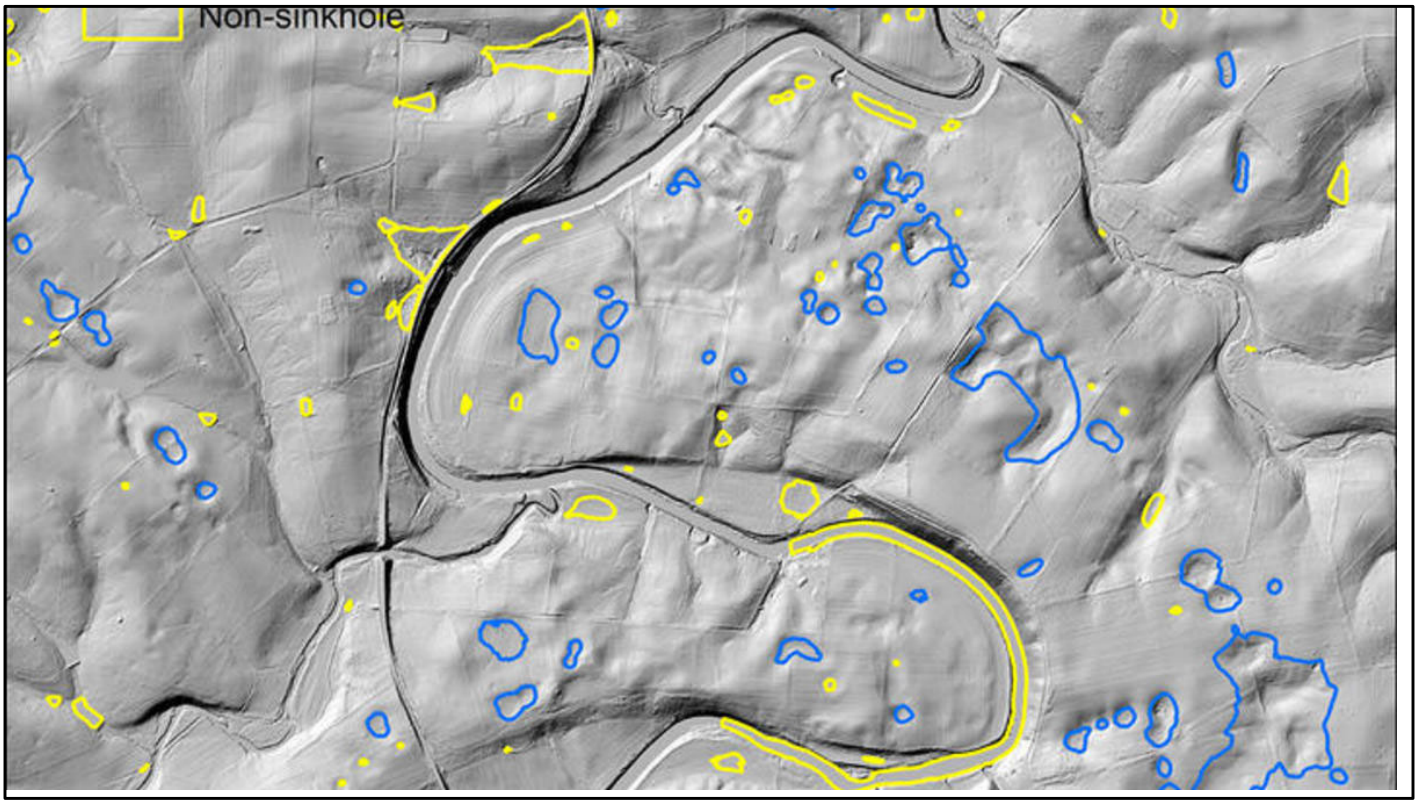
Sinkholes

- Various names depending upon language and culture, can also be known as dolines (parts of Europe or cenotes (Mexico).
- Formation: groundwater dissolves soluble rock, creating fractures and caves.
- Dissolving continues to form larger caves and fractures
- Different types of sinkholes and landforms due:
  - Extent of weathering and erosion of limestone
  - Amount of overlying soil
  - Surrounding rock types and orientation



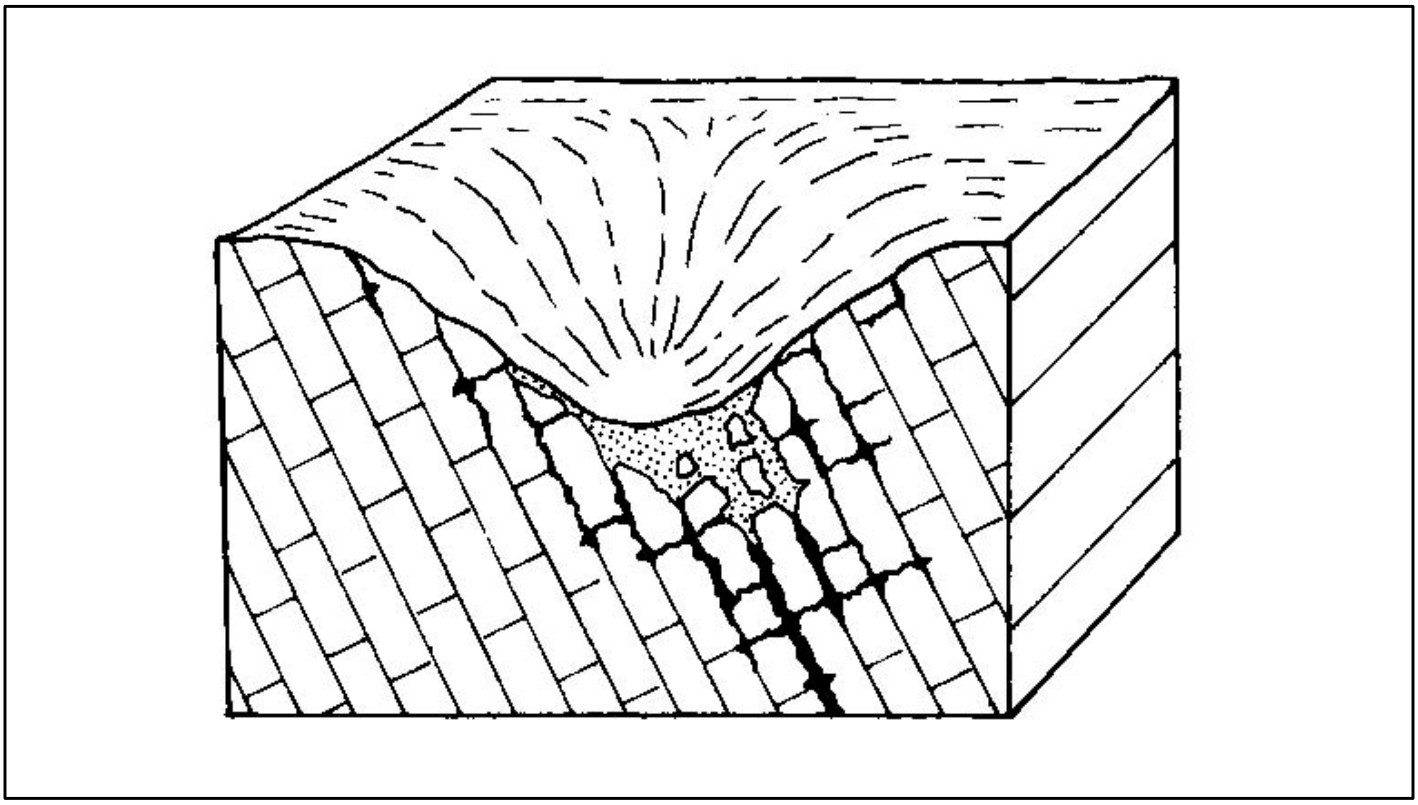
Cenotes (Yucatan state, Mexico)

Karst plain, Central Kentucky



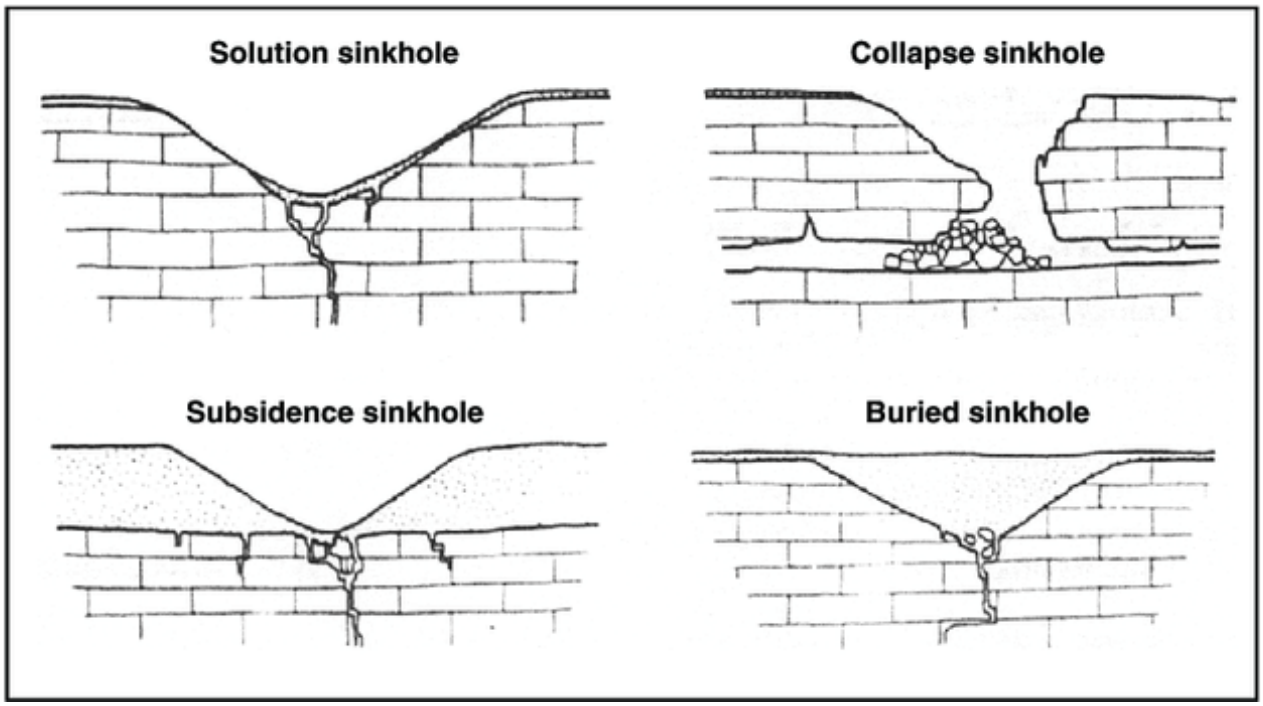
https://www.engr.uky.edu/news/2019/03/kgs-jacobs-collaborate-sinkhole-machine-learning-research

Sinkholes in blue. There are lots of sinkholes in Kentucky because it has all the ingredients necessary for a karst landscape to form.



Solution sinkhole

Note how the bedding and arrangement of the structure of the limestone enhances dissolution of limestone

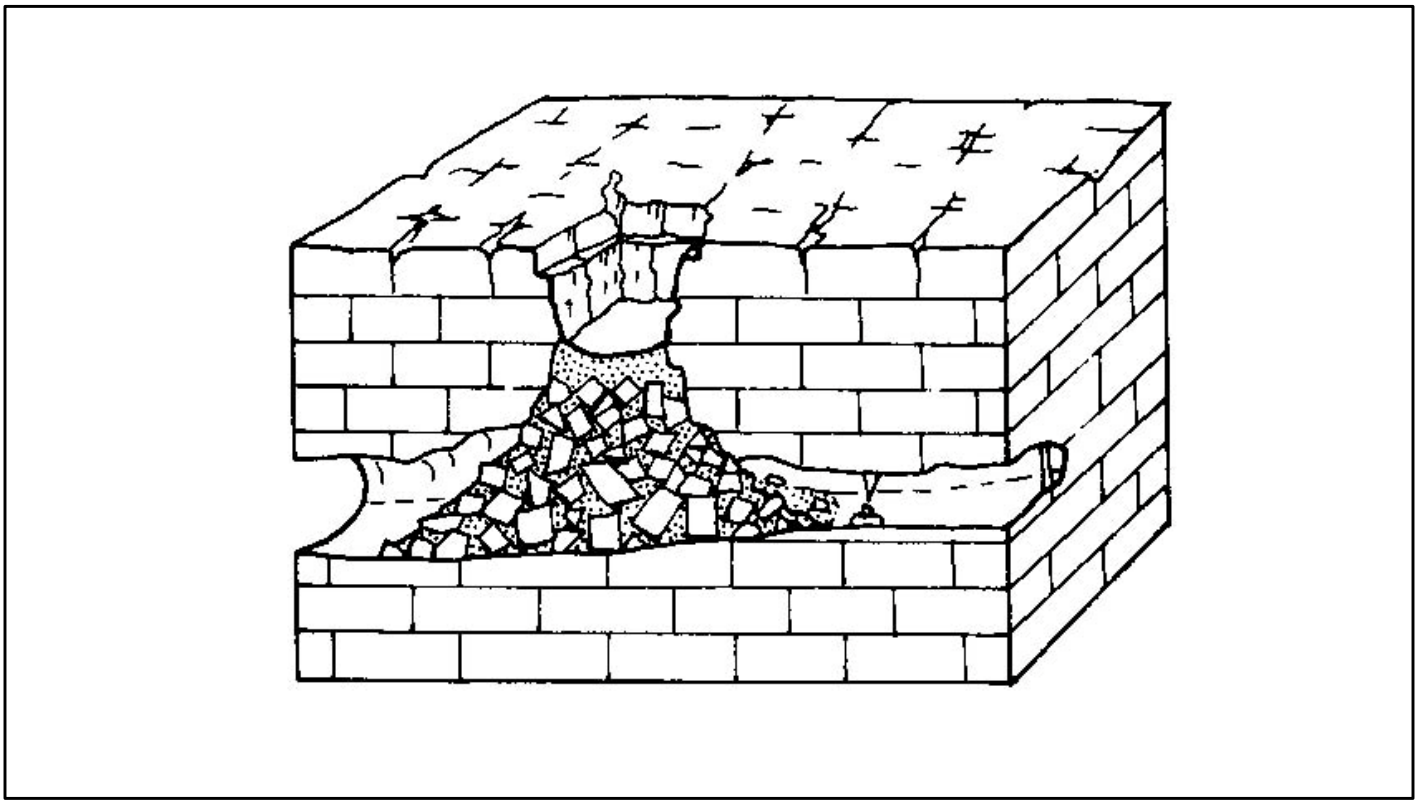

Solution sinkhole
Collapse sinkhole
Subsidence sinkhole
Buried sinkhole

Sink hole in Southern Basin from surface.

Located in the heart of campus, W.T. Young serves as the central library in the university library system. Stormwater from this approximately 20 acre site primarily discharges via the University storm sewer system and travels to a larger LFUCG culvert that discharges to Town Branch. In the event that flows exceed the capacity of the lines leading to the LFUCG culvert, this system has been designed with two large detention basins (North and South) with a sink hole located at the base of each basin. As flow begins to back up into the detention basins, it diverts to the sink holes as a secondary point of discharge. Most rainfall events will bypass the sink holes and discharge to Town Branch via the LFUCG system.

https://www.uky.edu/env/groundwater/class-v-injection-wells

An injection well is a well that is used to place water and fluids underground into porous geologic formations. Regulated by the Safe Drinking Water Act, these wells are subject to federal requirements in order to protect public health and prevent contamination of underground sources of drinking water. The EPA regulates injection wells. Injection wells are grouped into six categories or classes based on use. Class V wells are used for the injection of Non-Hazardous fluids into or above underground sources of drinking water. At the University, Class V wells are used to discharge stormwater from portions of campus into existing modified sinkholes.



Collapse sinkhole

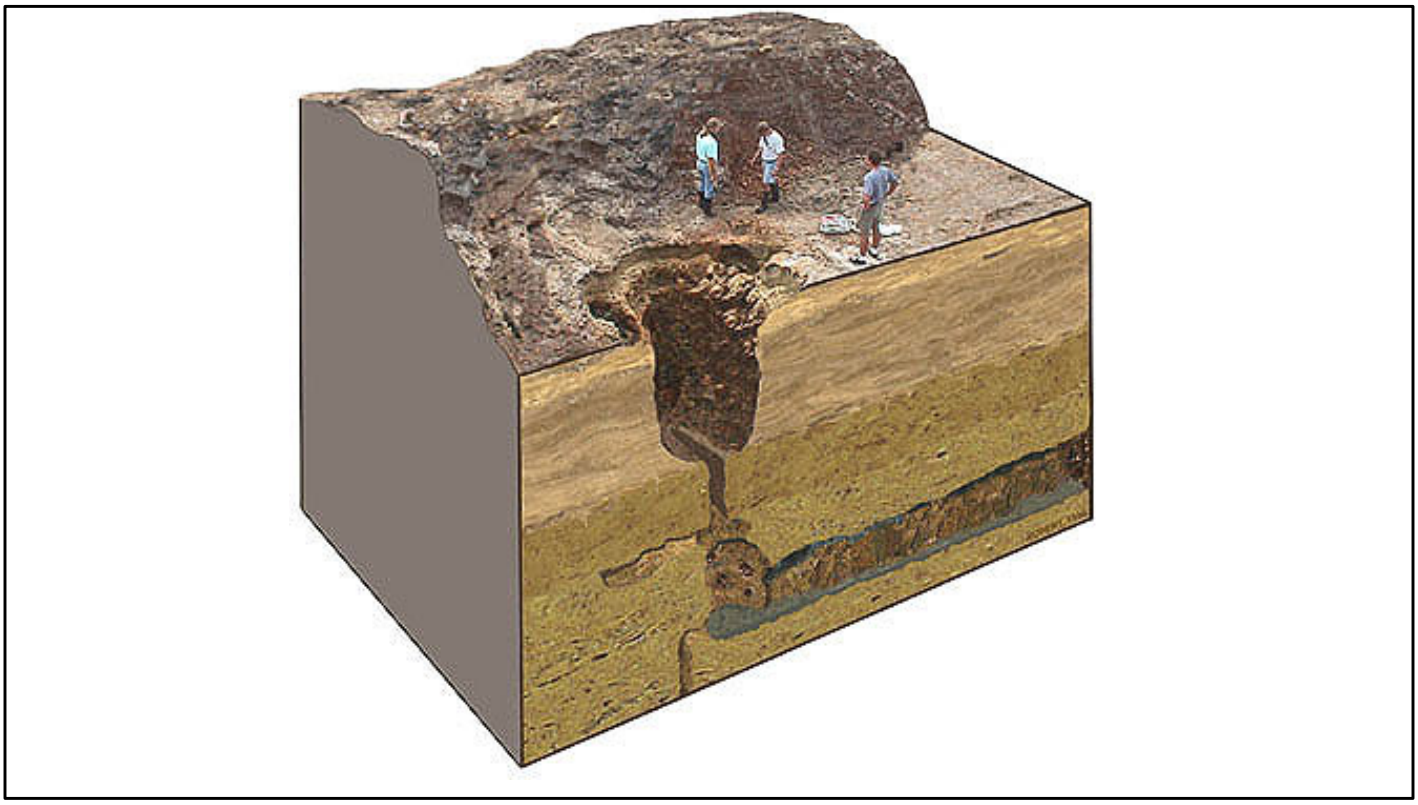
Collapse doline with water-table lake in Gambier Karst, South Australia

Western Kentucky University Department of Geography & Geology A sinkhole collapse in February 2002 undermined part of Dishman Lane in Bowling Green, creating an opening approximately 150 feet wide and 20 feet deep in the three-lane road. Repairs cost about $1 million, according to published reports. No one was injured, but several vehicles were trapped, with at least two falling into the opening.


2/12/2014 5:39:03 AM

Lake Jackson, near Tallahassee, Florida

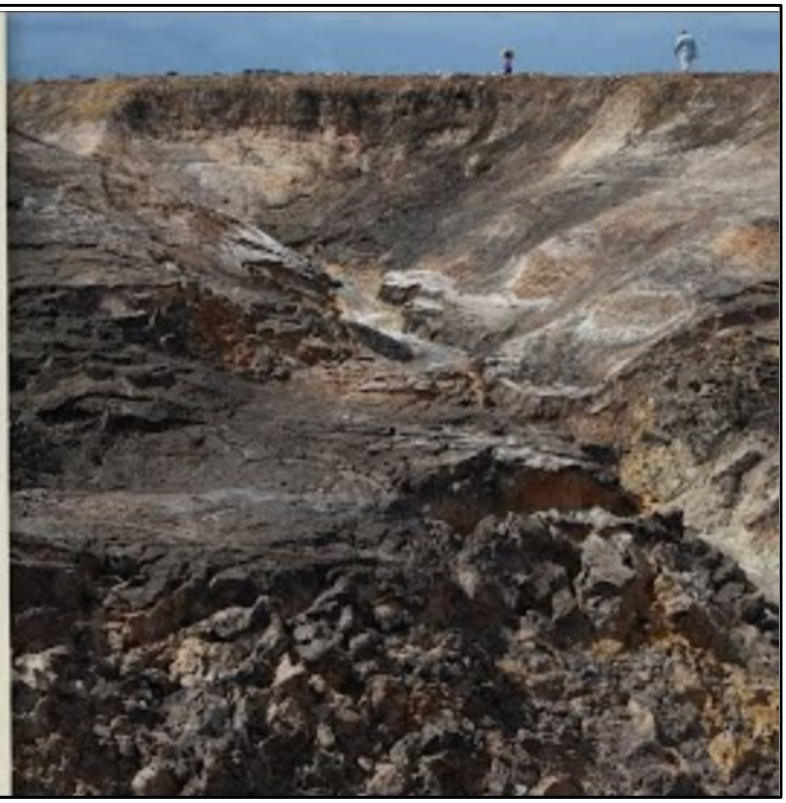
This is an example of a karstic lake



When Lake Jackson's sinks rupture and the lake water drains out, the process is referred to as a dry down. It has occurred many times during the last century.

wfsu
PUBLIC MEDIA

LAKE JACKSON
DRY DOWN
JUNE 2021
TALLAHASSEE,
FLORIDA



Karst plain, central KY

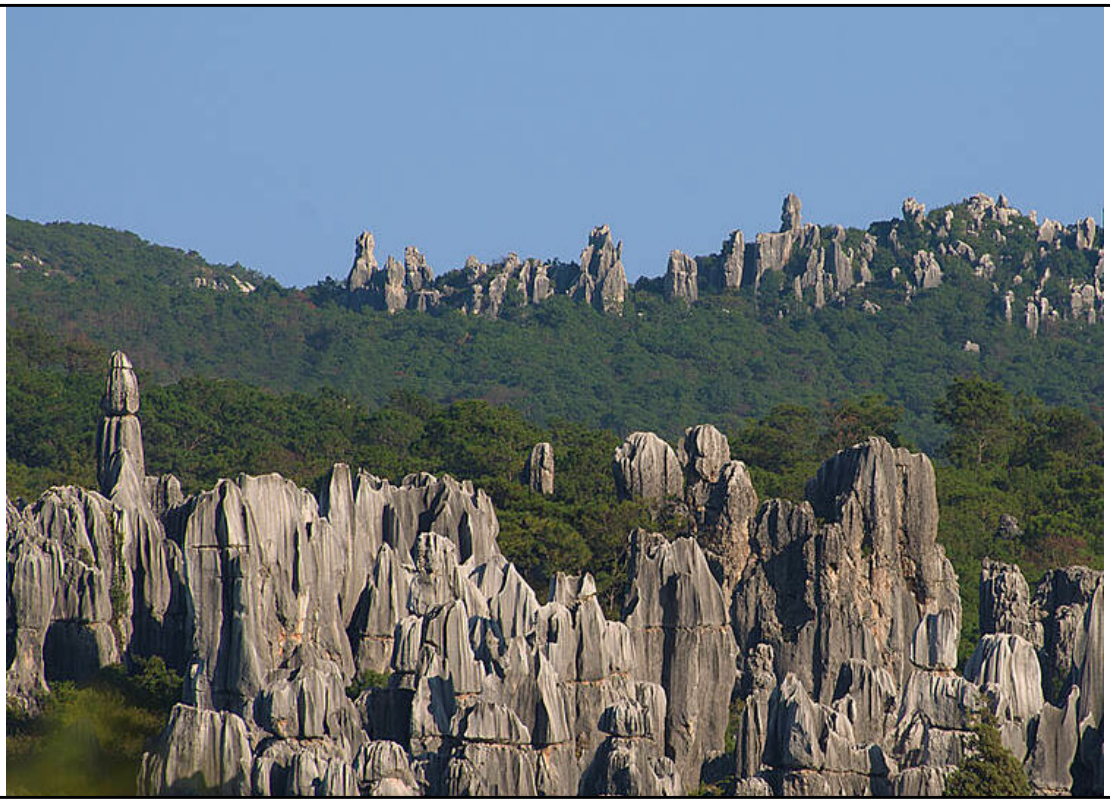
Uvalas and poljes

- Uvalas (top)
  - Compound sinkholes, coalescence of many smaller sinkholes
- Poljes (bottom)
  - Broad flat alluvial floor formed from coalescence of uvalas

Clints and grikes
Corrosive drainage along joints and cracks in the limestone can produce slabs called "clints" isolated by deep fissures called "grikes". (County Clare, northwest Ireland)

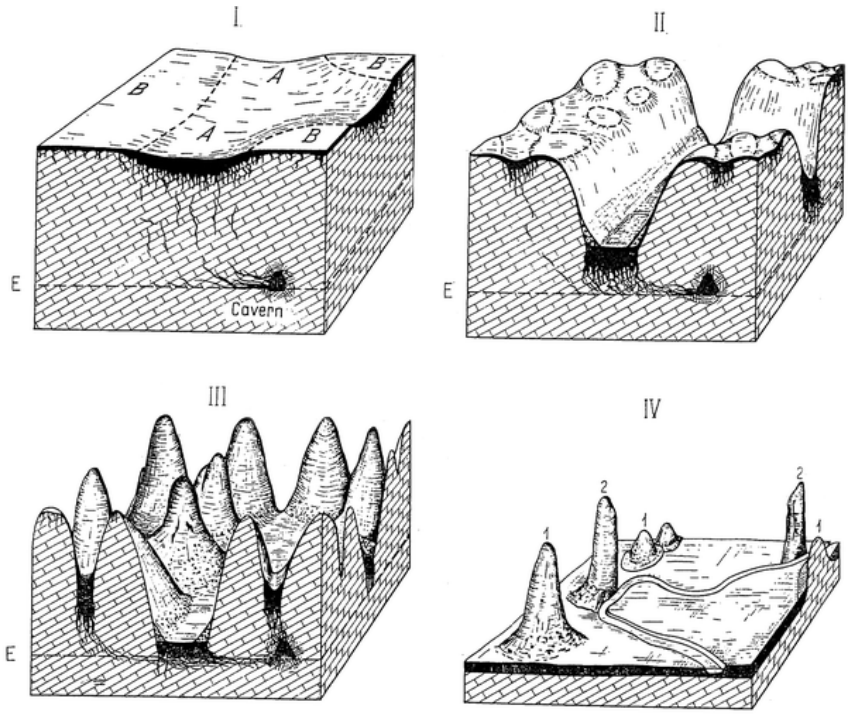
Karren landscape composed of clint and grike features in limestone (County Clare, northwestern Ireland, the Barrens).

Cockpit karst, Jamaica

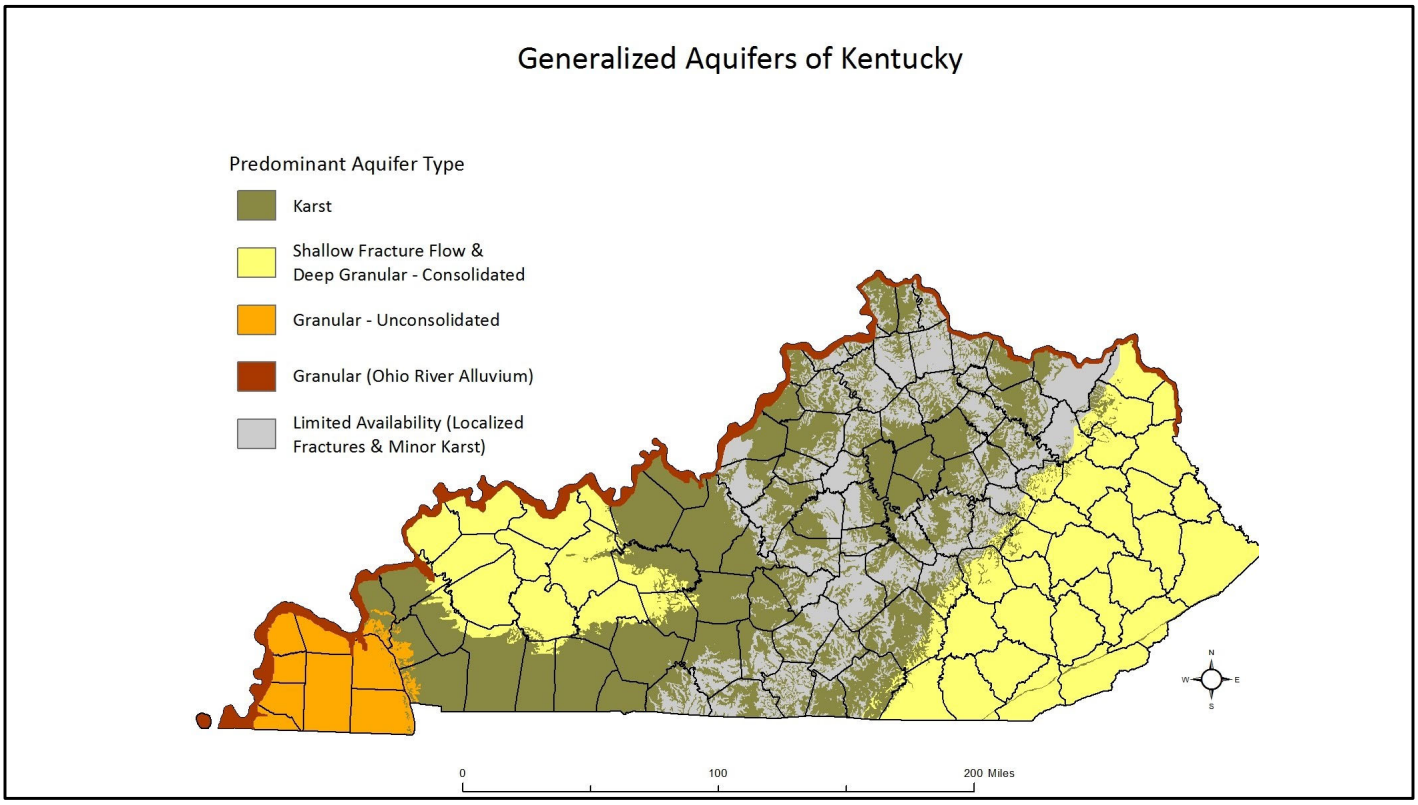


Tower karst, Guangxi province of southern China
https://whc.unesco.org/en/list/1248/

Tower karst, Madagascar


I
II
III
IV
A
B
E
Cavern
1
2

Mammoth Cave National Park

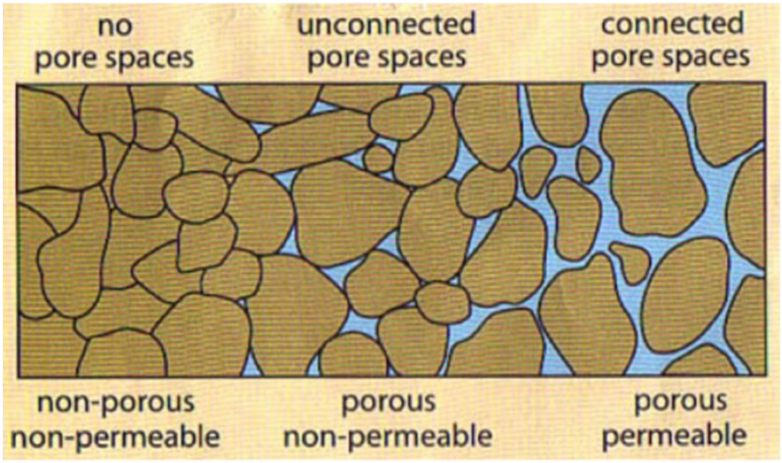


Karst aquifers are composed of limestone

https://www.uky.edu/KGS/geoky/index.htm

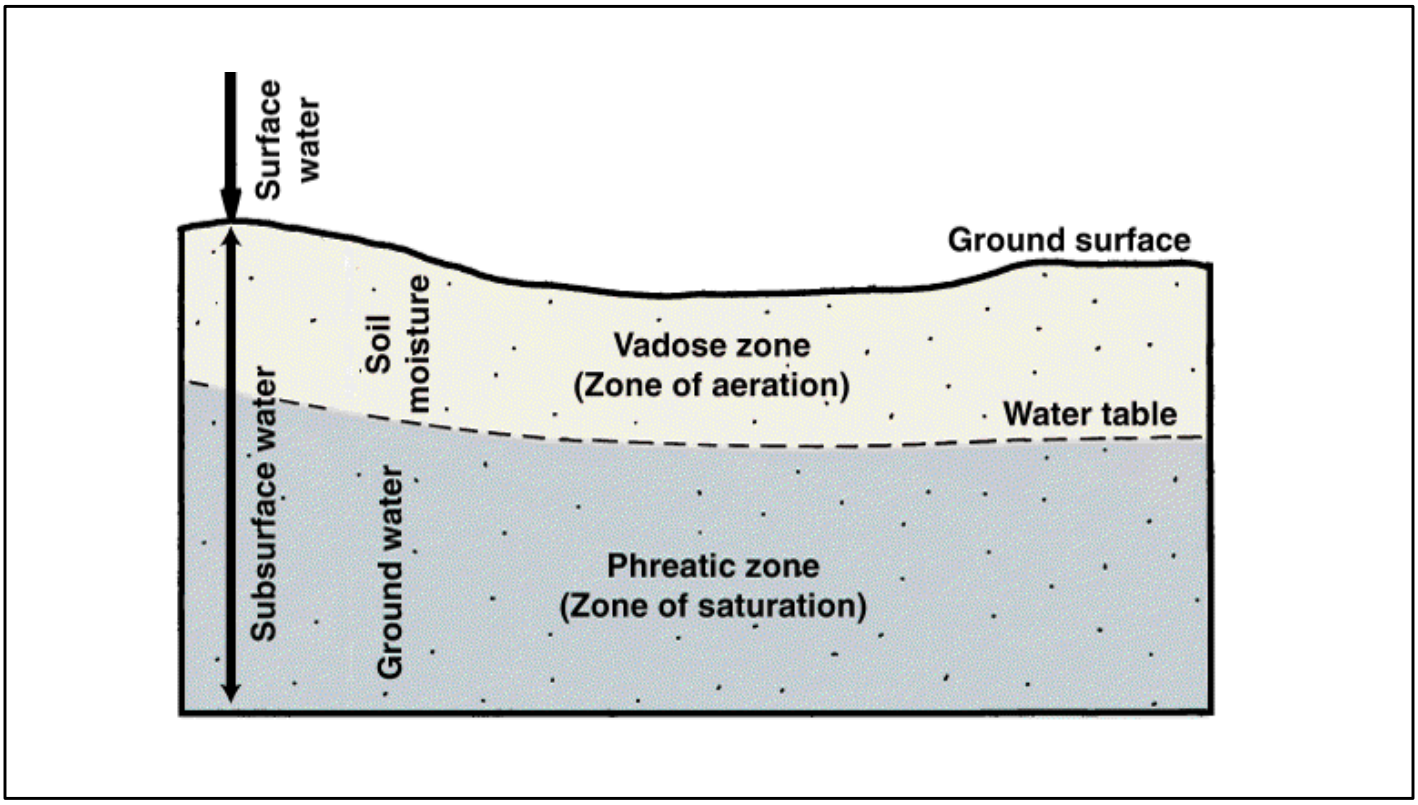
Aquifers

- Large body of porous, permeable rock or sediments capable of holding groundwater
- Porous – measure of the open space withing rock or sediments
- Permeable – measure of how much water can travel thru these spaces
- Karstic dissolution of carbonates creates porosity and permeability

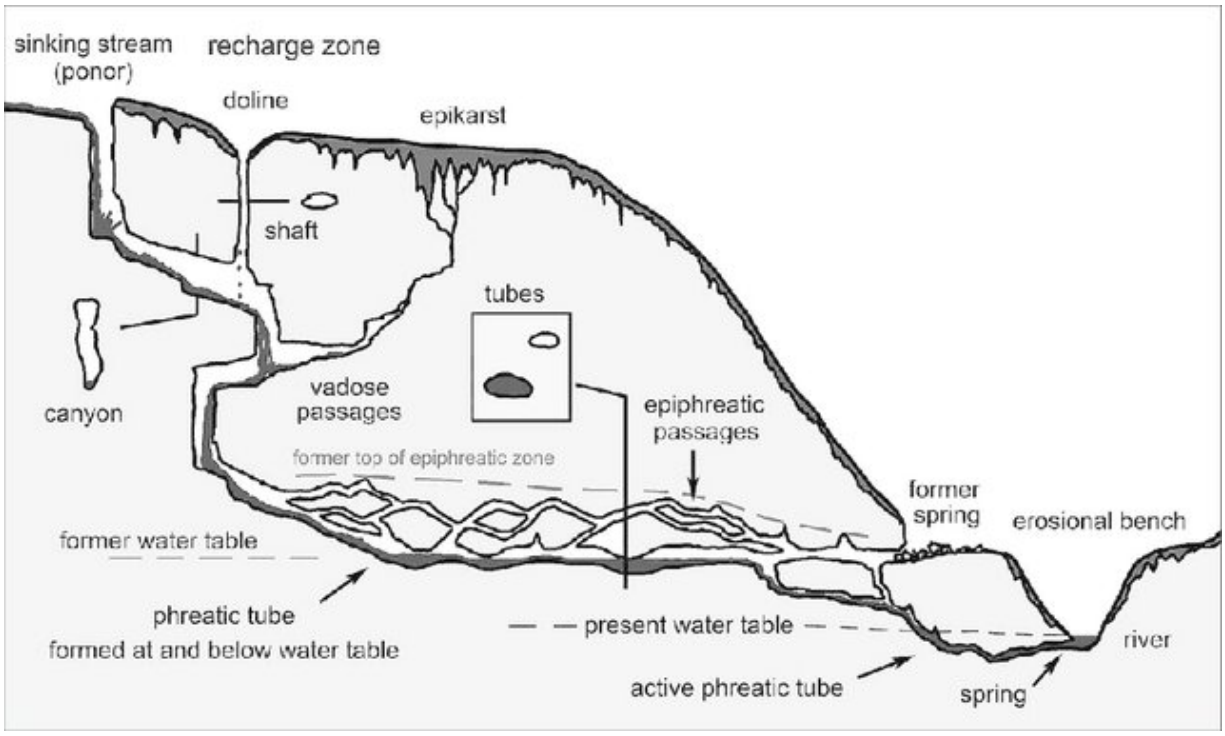


Porosity is a measure of how much of a rock is open space. This space can be between grains or within cracks or cavities of the rock.
Permeability is a measure of the ease with which a fluid (water in this case) can move through a porous rock.

Loosely cemented sand and gravel can also form aquifers



Surface and subsurface water



vadose passages – formed via surface water
epiphreatic passages – formed in phreatic zone but because of water table lowering are now air-filled
phreatic tube – contains flowing water

Water tables fluctuate through time, so it is possible to have a passage that has been wet and then dry and then wet again, depending upon the local geology and position of the cave relative to the water table

Types of cave passages

- Vadose passages form above the water table in the vadose zone, where water flows mainly vertically due to gravity, through cracks and fissures. Dominated by downward percolation of water.
- Epiphreatic passages form at or near the water table in the epiphreatic zone, where water flow shifts between the vadose and phreatic zones. These passages are periodically filled with water, often during floods or high-flow conditions, but not permanently submerged. May evolve into vadose passages if the water table drops over time.
- "Keyhole passages" form when a phreatic tube is later incised by vadose flow.
- Phreatic passages form entirely below the water table in the phreatic zone, where water flow is primarily horizontal and under pressure. Circular or elliptical cross-sections, often forming tunnels. Water dissolves the rock evenly in all directions, creating smooth passage walls.

In the epiphreatic zone, the typical shape of passages is most often a combination of an oval (phreatic) shape and a canyon (vadose)

Speleothems is the name given to stalactites and stalagmites. Speleothems form from the precipitation of minerals out of solution when caves are dry. They will not form underwater. This cave could have been never been underwater and formed from surface waters (a vadose passage). Or it could have been a phreatic cave, and when the water table fell, speleothems begin to develop when it was located in the vadose zone

Right, this passage formed as a phreatic cave and is now above the water table in the vadose zone.

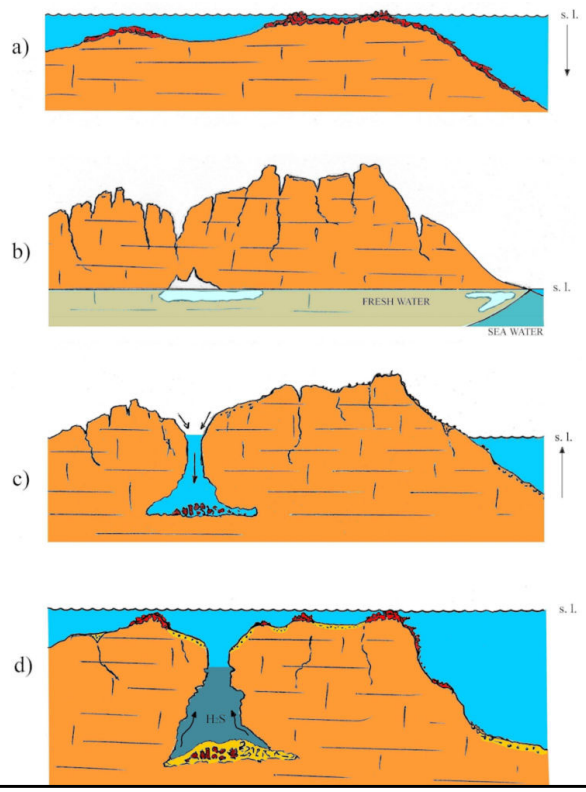
A phreatic passage forms below the water table. In the zone water will create rounded passages. These caves typically do not have speleothems because mineral formations develop only when air exposure and dripping water allow minerals to precipitate.

Vadose passage

This passage had to be exposed to air for a period of time for the speleothems to form. Then the water table rose and refilled the cave. Fluctuations in water table position give caves and their passages their defining shape and features.

43

Blue hole, Bahamas


a)
s. l.
b)
FRESH WATER
s. l.
SEA WATER
c)
s. l.
d)
s. l.
H.S


FREEFALL
A FREEDIVER'S JOURNEY
ART OF THE CENOTES
GARMIN
AQUA MARIS

https://www.ajc.com/news/photos-few-metro-atlanta-biggest-sinkholes/BQo0BCR60jFobPgCvJ7zyI/

Pseudokarst

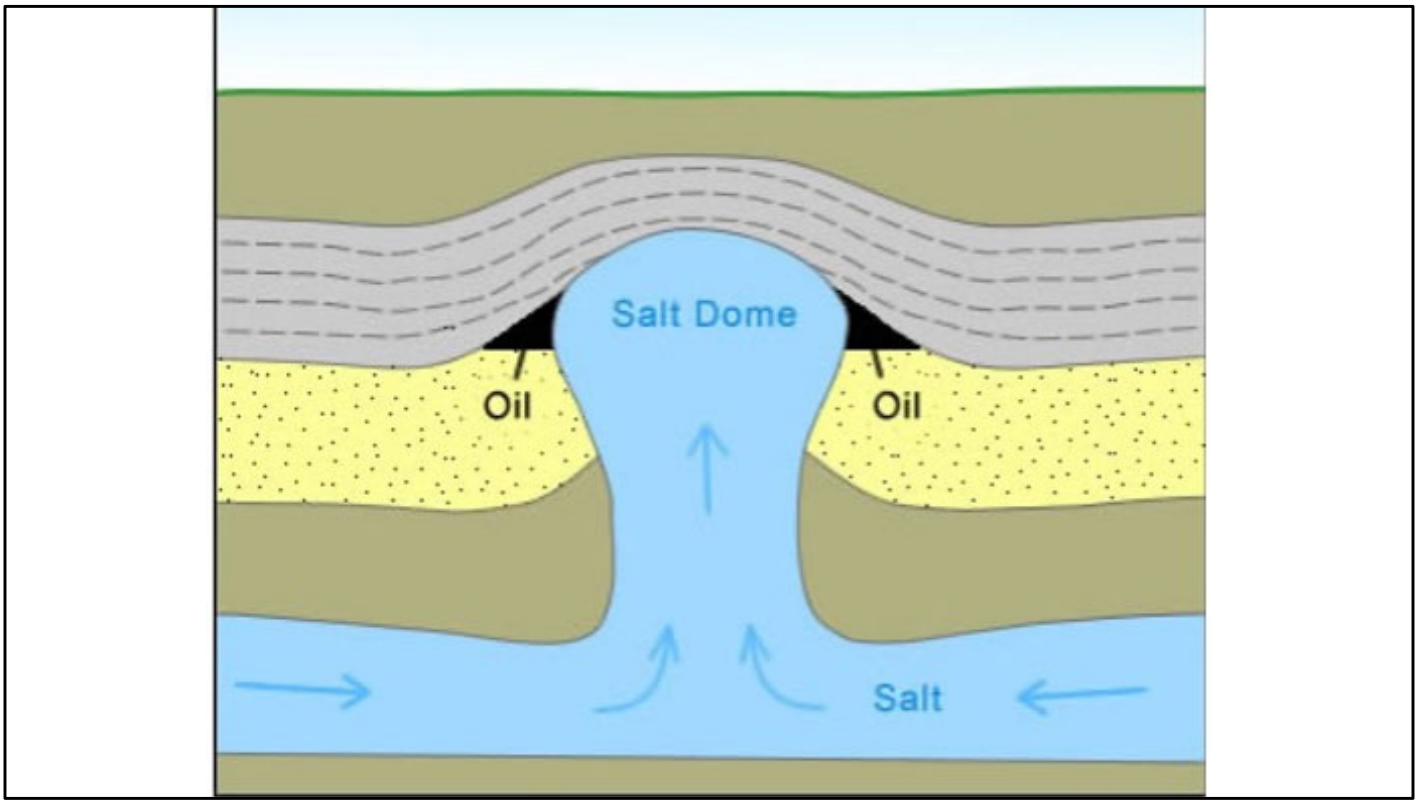
- Landforms that look like they were formed from karstic processes but aren't
  - Thermokarst can form when permafrost melts and create landforms and topography that resemble karstic sinkholes and lakes
  - Lava tubes can be mistaken for epiphreatic tubes
  - Evaporite rocks can weather in ways that leave behind landforms that resemble karstic landforms
  - Sinkholes and ground subsidence are not always associated with karst and karstic processes. Groundwater and oil extraction, as well as aging pipes and water infrastructure can also cause sinkholes
  - Springs can also form in different contexts and not just karstic processes associated with limestone

Huge sinkholes are now appearing in the wrong places

Originally published May 8, 2017 at 10:35 am | *Updated May 8, 2017 at 12:19 pm*

1 of 6 | FILE – In this Jan. 17, 2017, file photo, a 55,000 pound excavation truck is partially swallowed by a sinkhole in Oakwood, Ga. Oakwood Public Works department officials said the sinkhole appears to have been caused by an old storm drain that caved in. Sinkholes are not a new phenomenon in the United States, but a recent spate of huge, sudden-appearing caverns is prompting alarm. The usual cause: crumbling water, drain and sewer pipes, often neglected by cities with budget problems. (Hailey Van Parys /The Times via AP, File) **Less**

https://www.seattletimes.com/nation-world/huge-sinkholes-are-now-appearing-in-the-wrong-places/



Salt dome

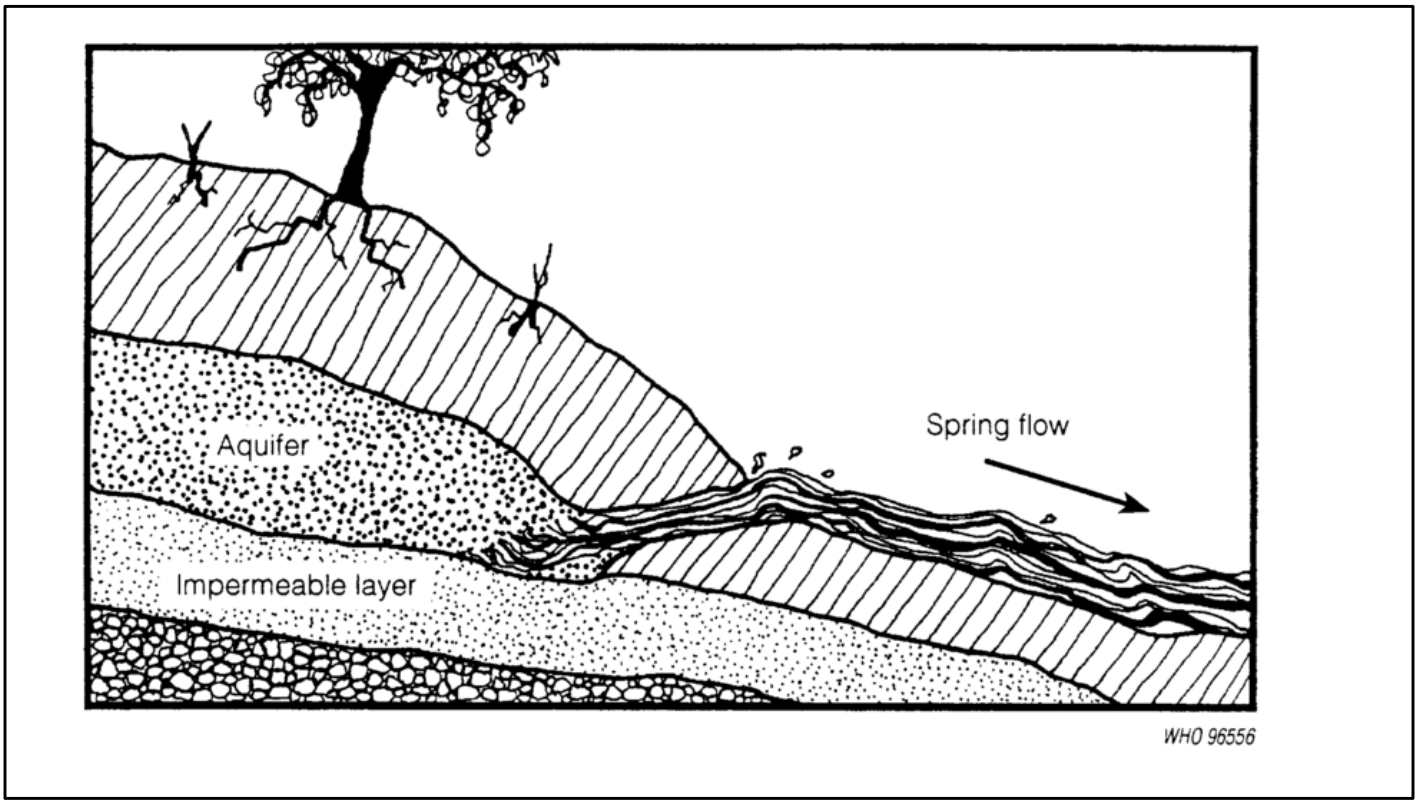
https://clui.org/projects/salt-domes-gulf-coast/salt-domes/avery-island-salt-dome

Avery Island Salt Dome

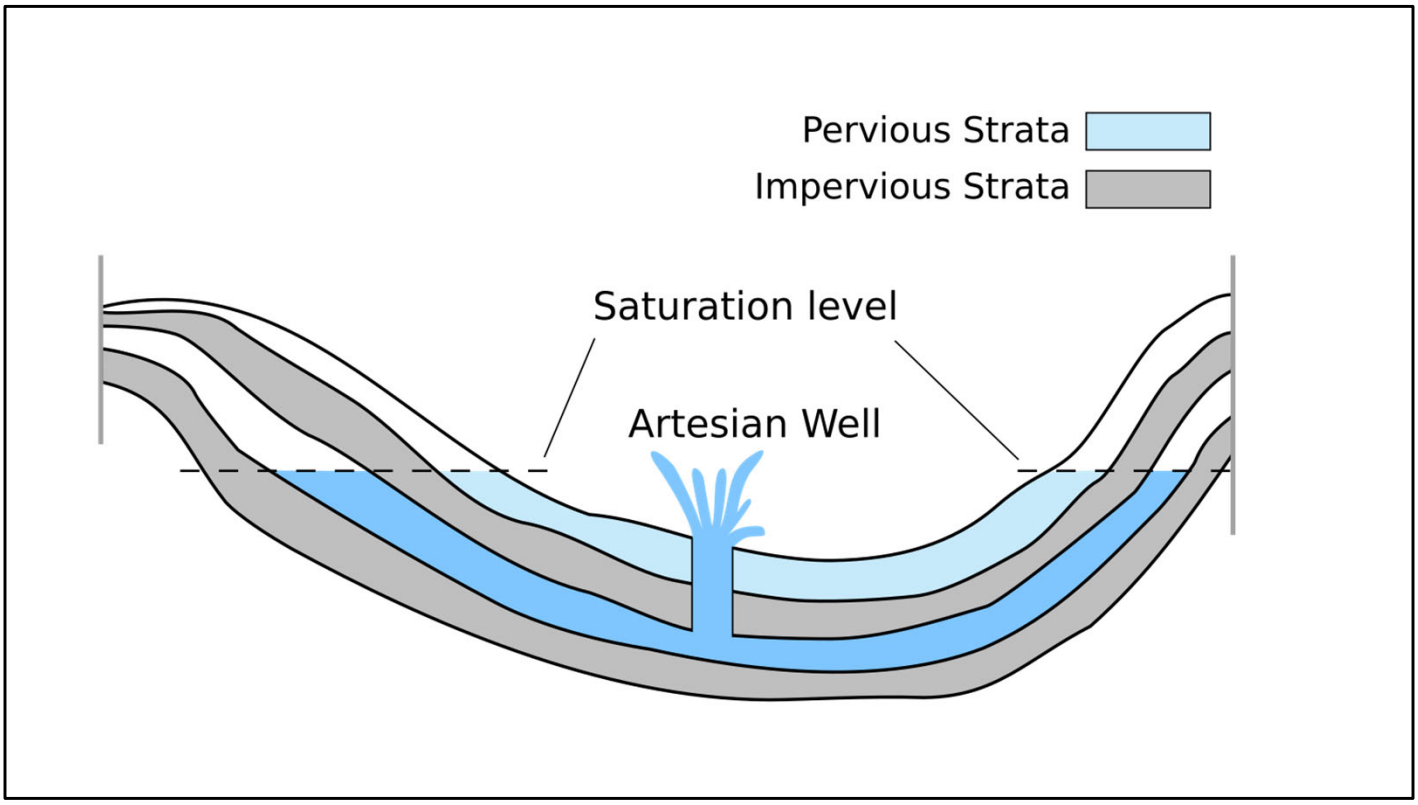
The Bayou Corne Sinkhole was created from a collapsed underground salt dome cavern operated by Texas Brine Company and owned by Occidental Petroleum. The sinkhole, located in northern Assumption Parish, Louisiana, was discovered on August 3, 2012, and 350 nearby residents were advised to evacuate.

Types of springs

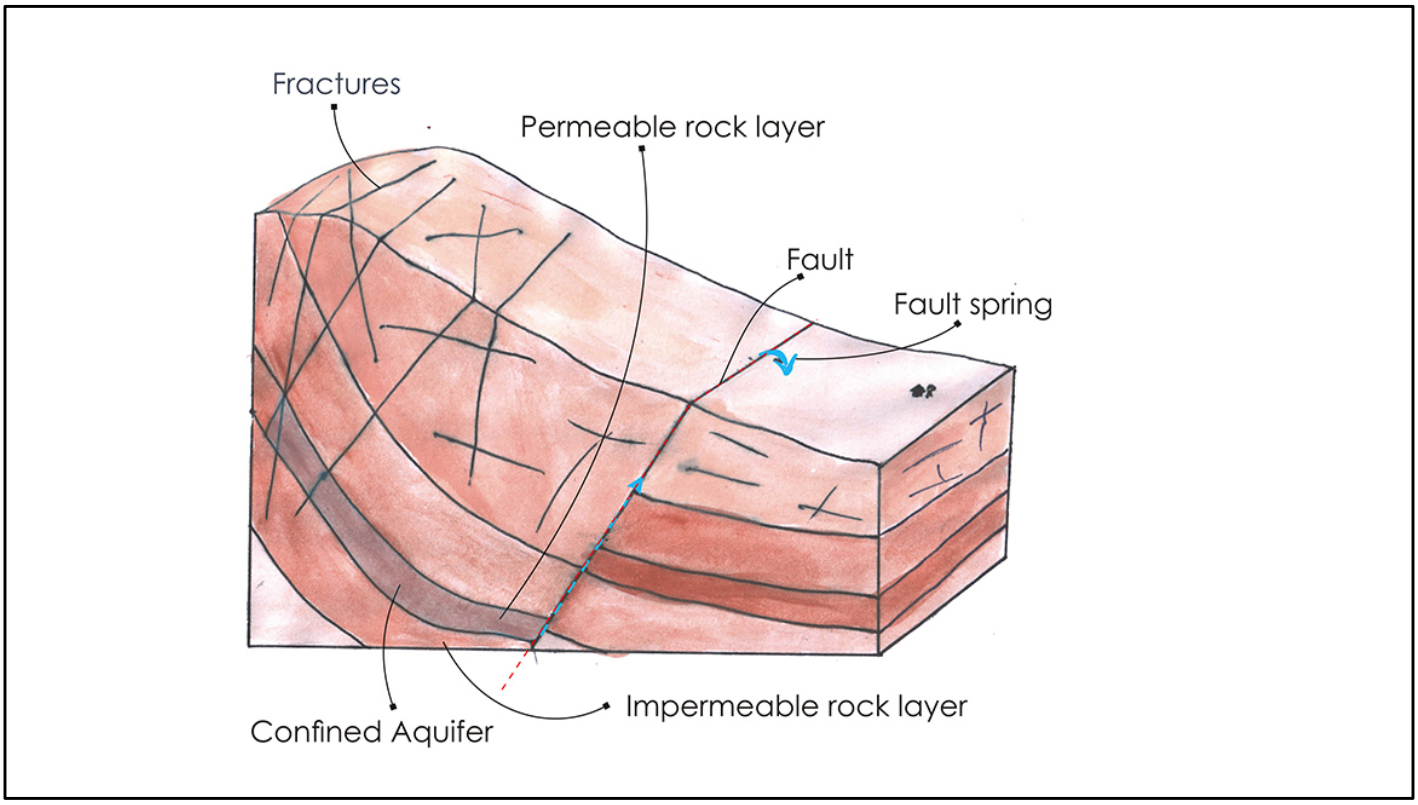
- **Karst spring** occur in karst landscapes where soluble rocks like limestone have been eroded to form underground channels and caves. Water flows through these channels and emerges as a spring, often with high flow rates, especially after rain.
- **Gravity springs** occur where groundwater flows naturally to the surface due to gravity, typically where the water table intersects the ground on slopes or valleys.
- **Artesian spring are f**ound in confined aquifers when groundwater is under pressure and flows to the surface through cracks or faults without the need for pumping
- **Fracture springs** are formed by water that flows through fractures, faults, or cracks in rock layers. They are common in bedrock formations where geological structures direct water to the surface.



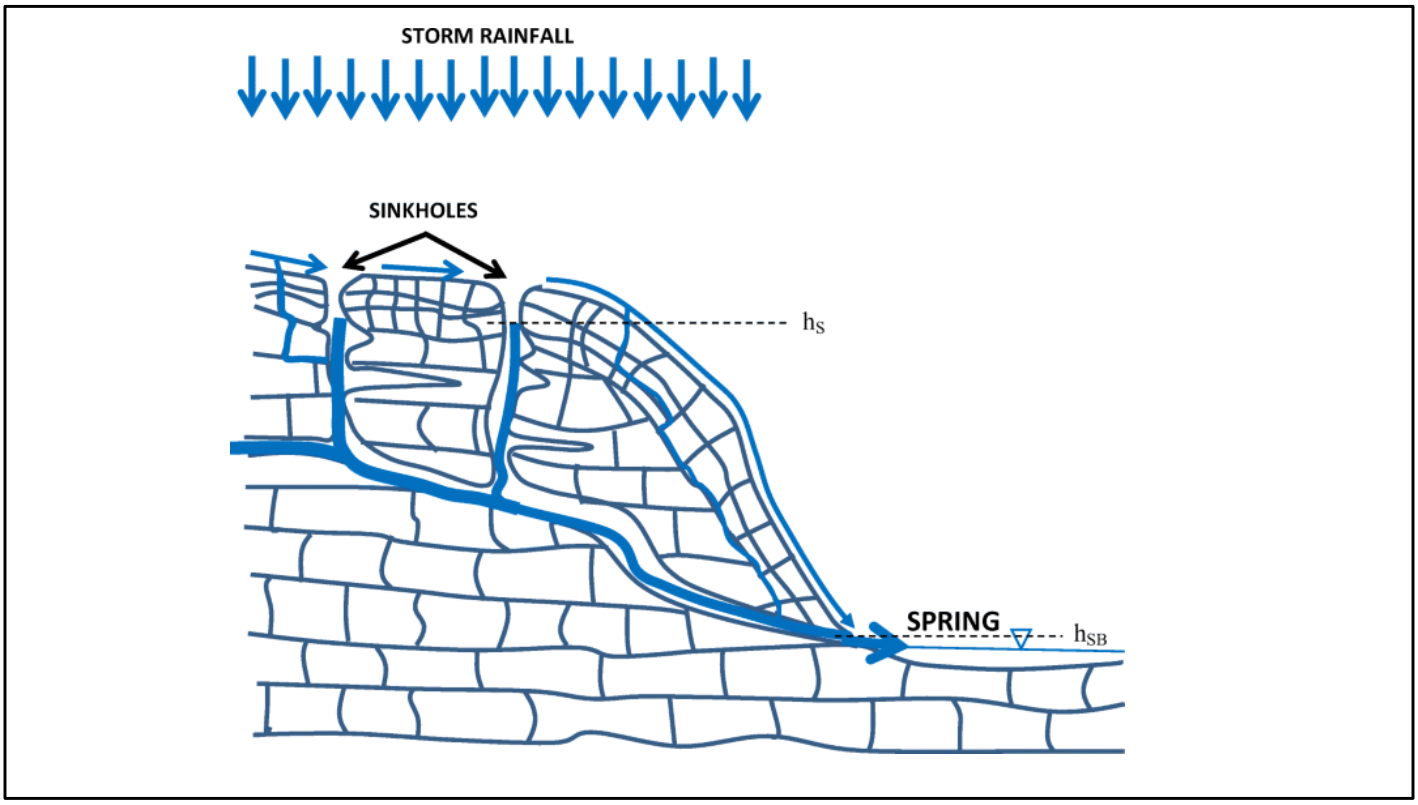
Gravity spring



Artesian well or spring if it is not drilled



Fracture and fault springs



Karst spring

Karst springs. Wakulla Springs Florida, Edward Ball State Park

Wakulla is one of the largest springs in the world

Boil Spring at McConnell Springs

Fluviokarst landscapes and landforms

- Shaped by both fluvial processes and karst processes.
  - Disappearing streams return to vadose passages
  - Blind valleys develop where a river abruptly disappears underground, usually into a sinkhole, rather than flowing to a visible downstream location.