Karst Topography & Soils

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Master Naturalist Training, Joplin, MO
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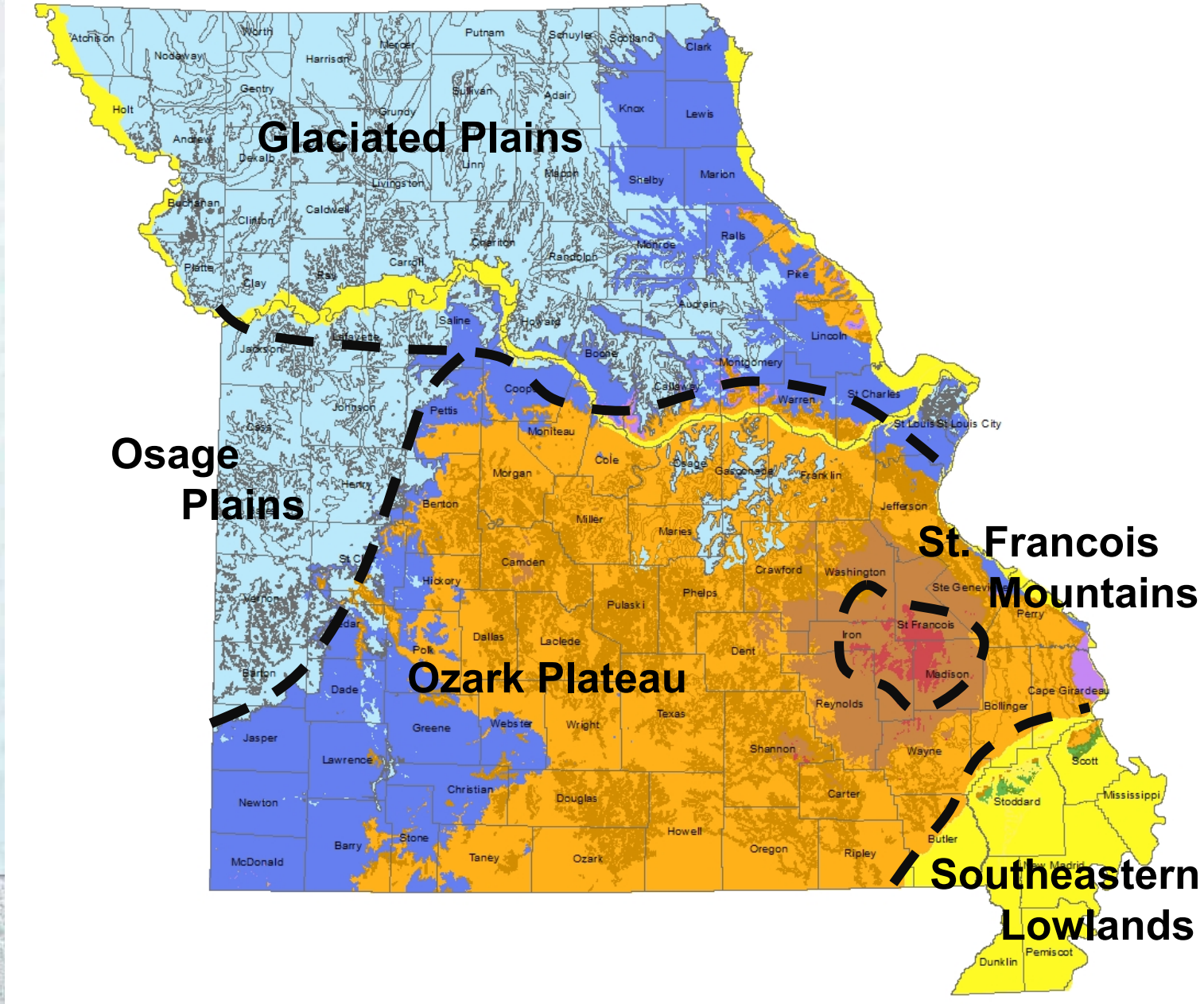
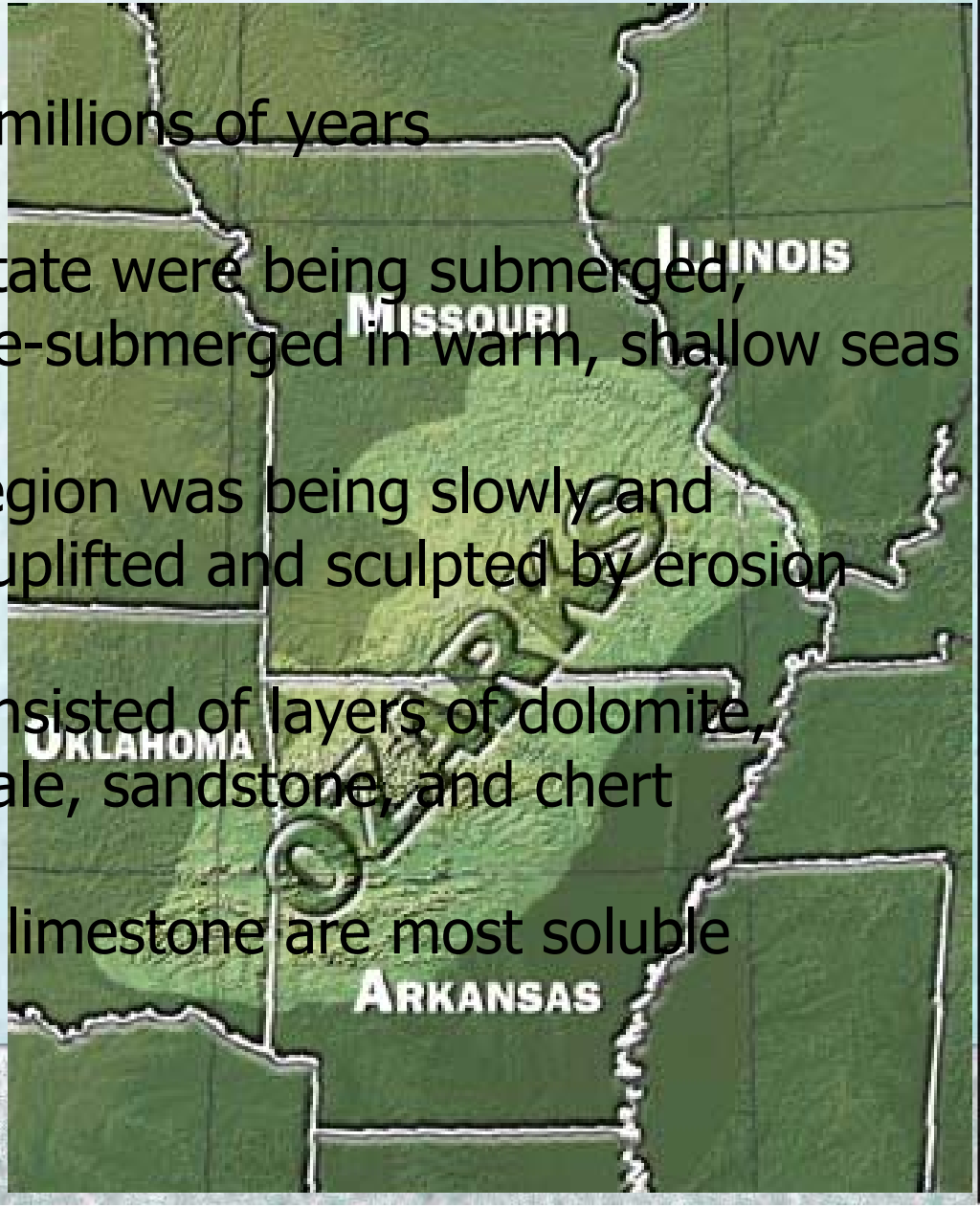
5 Major Geologic Regions In Missouri



How the Ozarks Was Formed

- Created over millions of years
- Parts of the state were being submerged, uplifted and re-submerged in warm, shallow seas
- The Ozarks region was being slowly and continuously uplifted and sculpted by erosion
- Sediments consisted of layers of dolomite, limestone, shale, sandstone, and chert
- Dolomite and limestone are most soluble



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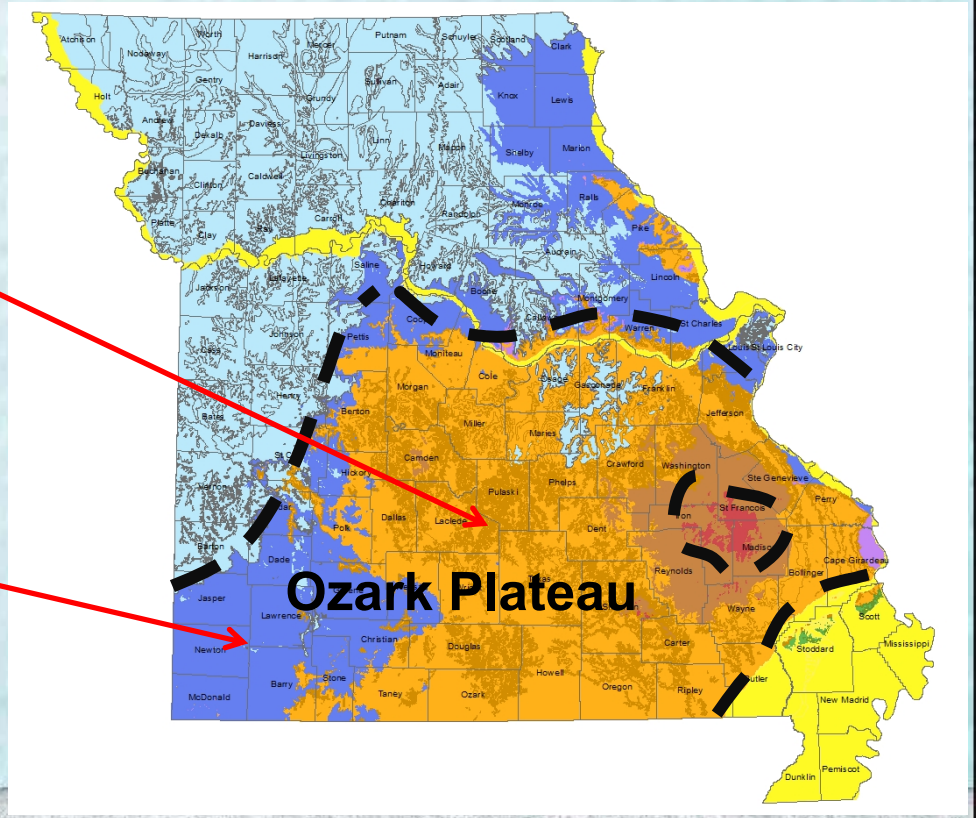
Typical Geology of the Ozark Plateau

- Includes the Salem Plateau & Springfield Plateau
- Underlain by highly permeable limestone and dolomite bedrock (karst)
- Large amounts of groundwater

Ordovician-age carbonates = 440-480 myo

Mississippian-age limestones = 320-360 myo



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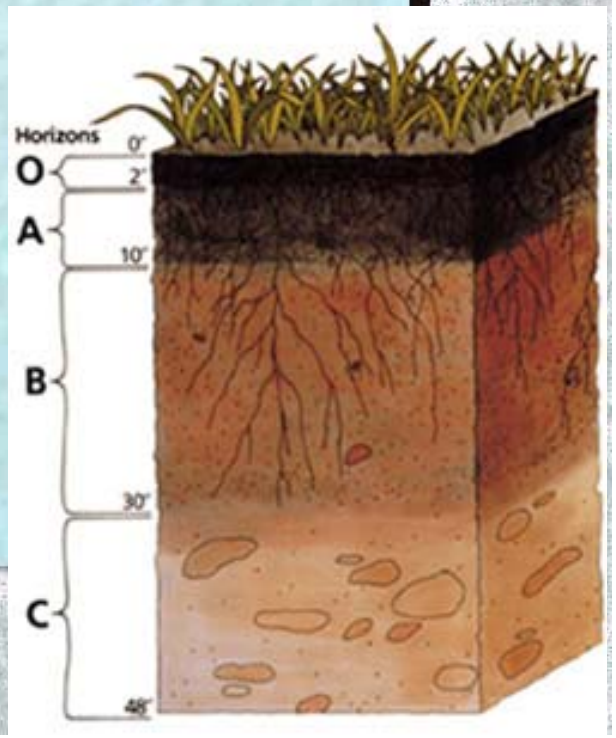
Typical Geology of the Ozark Plateau

- Soils are highly weathered; can be extremely gravelly
- Composed of highly-permeable cherty silty clay residuum
- Vary in depth from 0 feet to >50 feet and are poor quality
- High Iron (Fe) and Aluminum (Al) content
- Because the soils are highly permeable, there is a short retention time; therefore minimal natural filtration of pollutants



Why Do Soils Become Acidic Over Time?

- Parent material - sandstone or shale is more acidic than limestone
- Higher precipitation leaches more of alkaline elements like Ca & Mg, leaving acidic elements such as H, Mn and Al
- Decomposition of organic matter
- Nitrogen fertilization
- Crop grown
- Flooding
- Acid rain can also acidify the soil

What is Karst ?

- Created as groundwater dissolves soluble rock such as limestone or dolomite
- A landscape characterized by the presence of:
  - caves
  - springs
  - sinkholes
  - losing streams

Features of Karst – Limestone

A sedimentary rock composed of calcium carbonate; a rock of marine origin derived from the lime mud and ooze that accumulated on calm, shallow sea floors.

How Does Karst Form?

H_20 (rainwater) + CO_2 (carbon dioxide)

=

H_2CO_3

(weak carbonic acid)

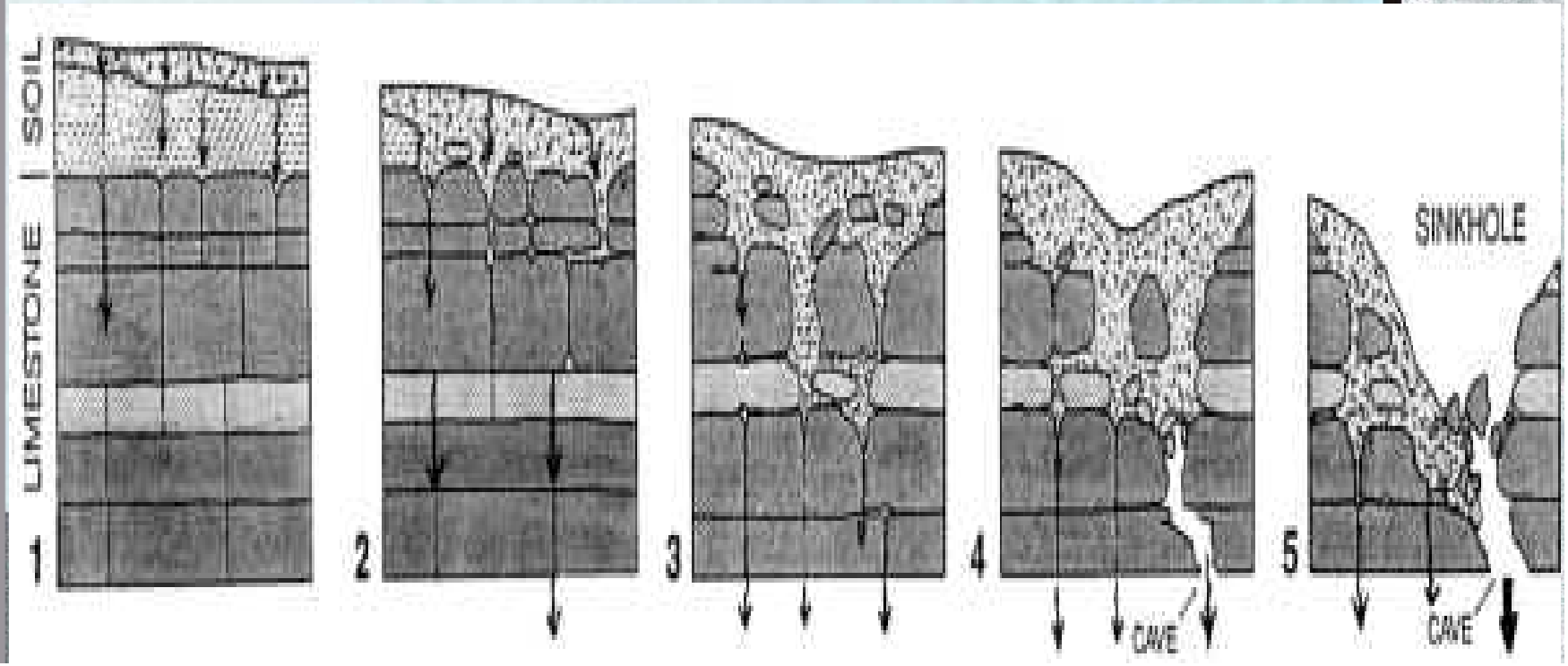
$CaCO_3$ (limestone) + H_2CO_3

=

Ca + CO_2 + H_2O (groundwater)

Basic Solution Weathering Process

- Small fractures in the bedrock allow water to migrate downward. Remember, during this process water is a weak carbonic acid.
- The fractures continue to grow and enlarge, ultimately resulting in the development of underground drainage systems.




Solution
Channel

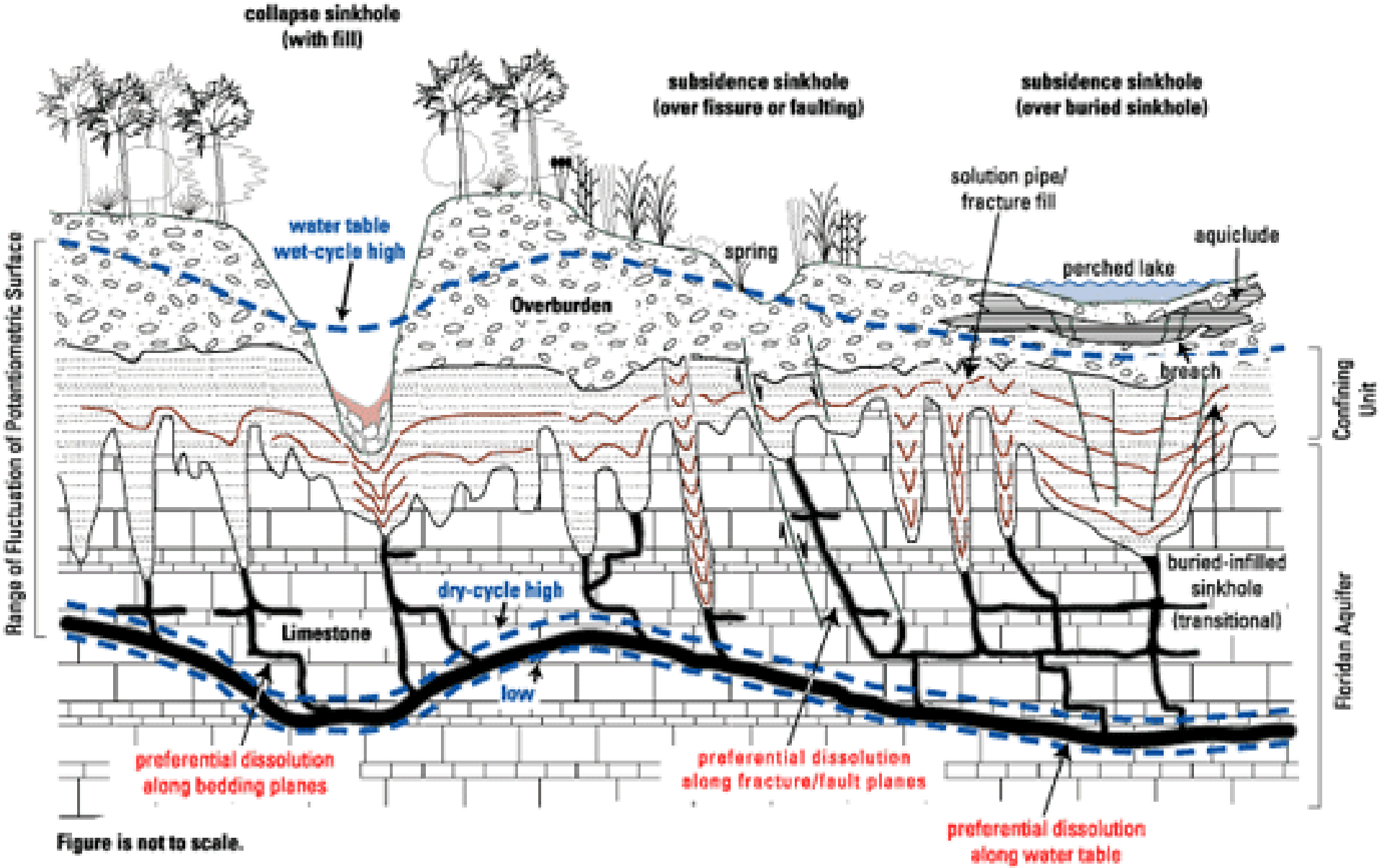
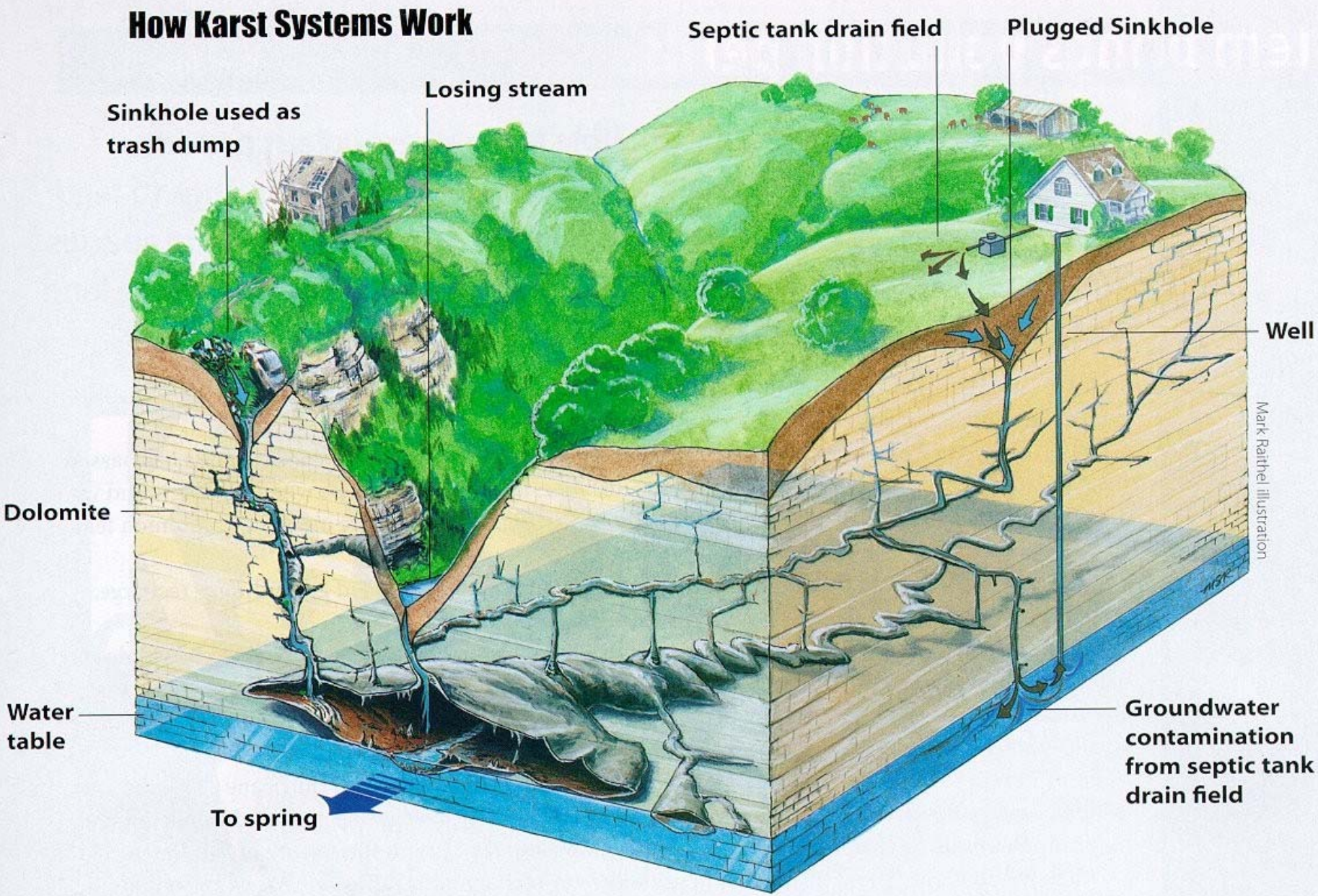


Figure is not to scale.


How Karst Systems Work
Septic tank drain field
Plugged Sinkhole
Losing stream
Sinkhole used as trash dump
Well
Dolomite
Water table
To spring
Groundwater contamination from septic tank drain field
Mark Raithel illustration

Karst Map of the U.S.

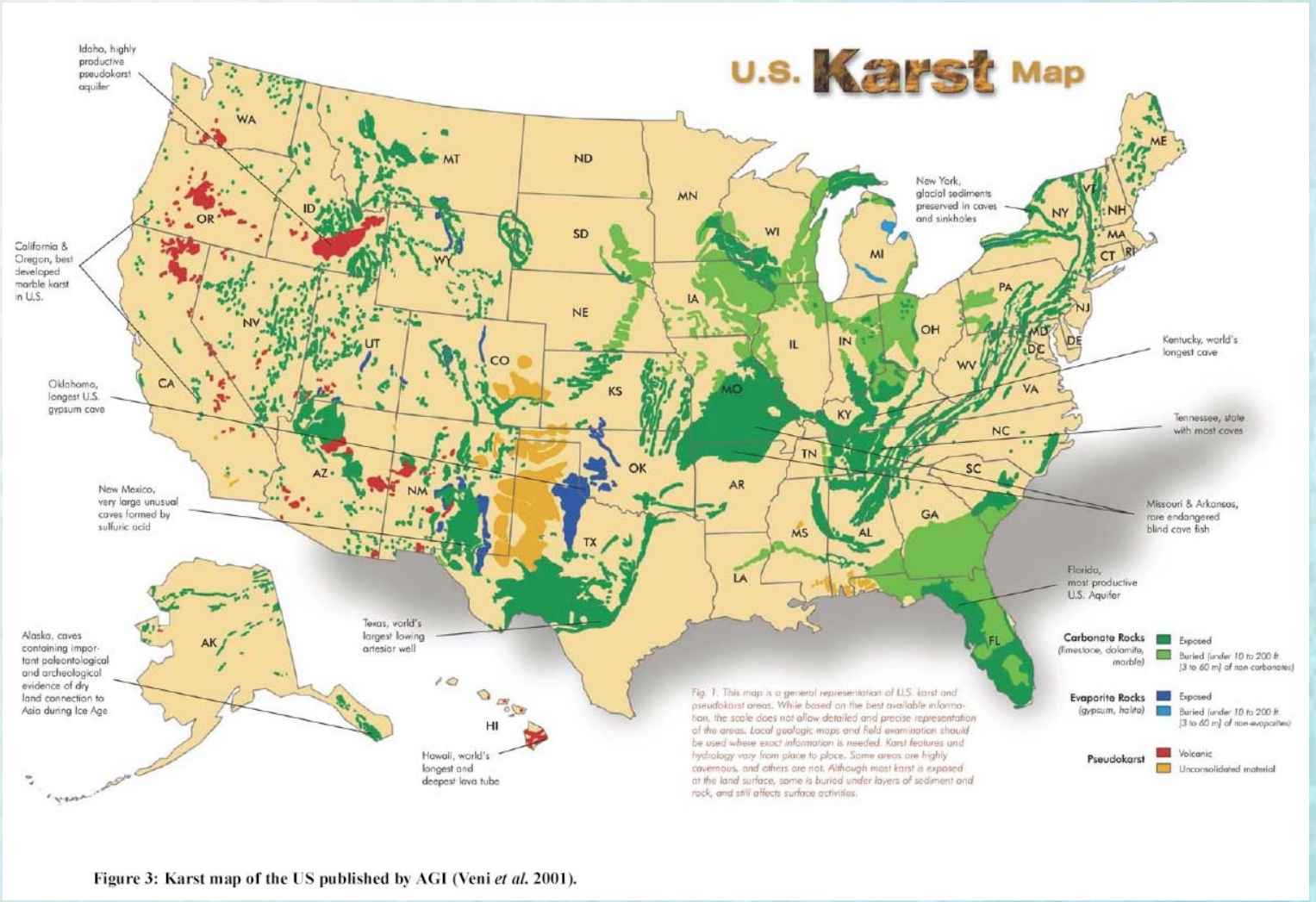


Figure 3: Karst map of the US published by AGI (Veni *et al.* 2001).

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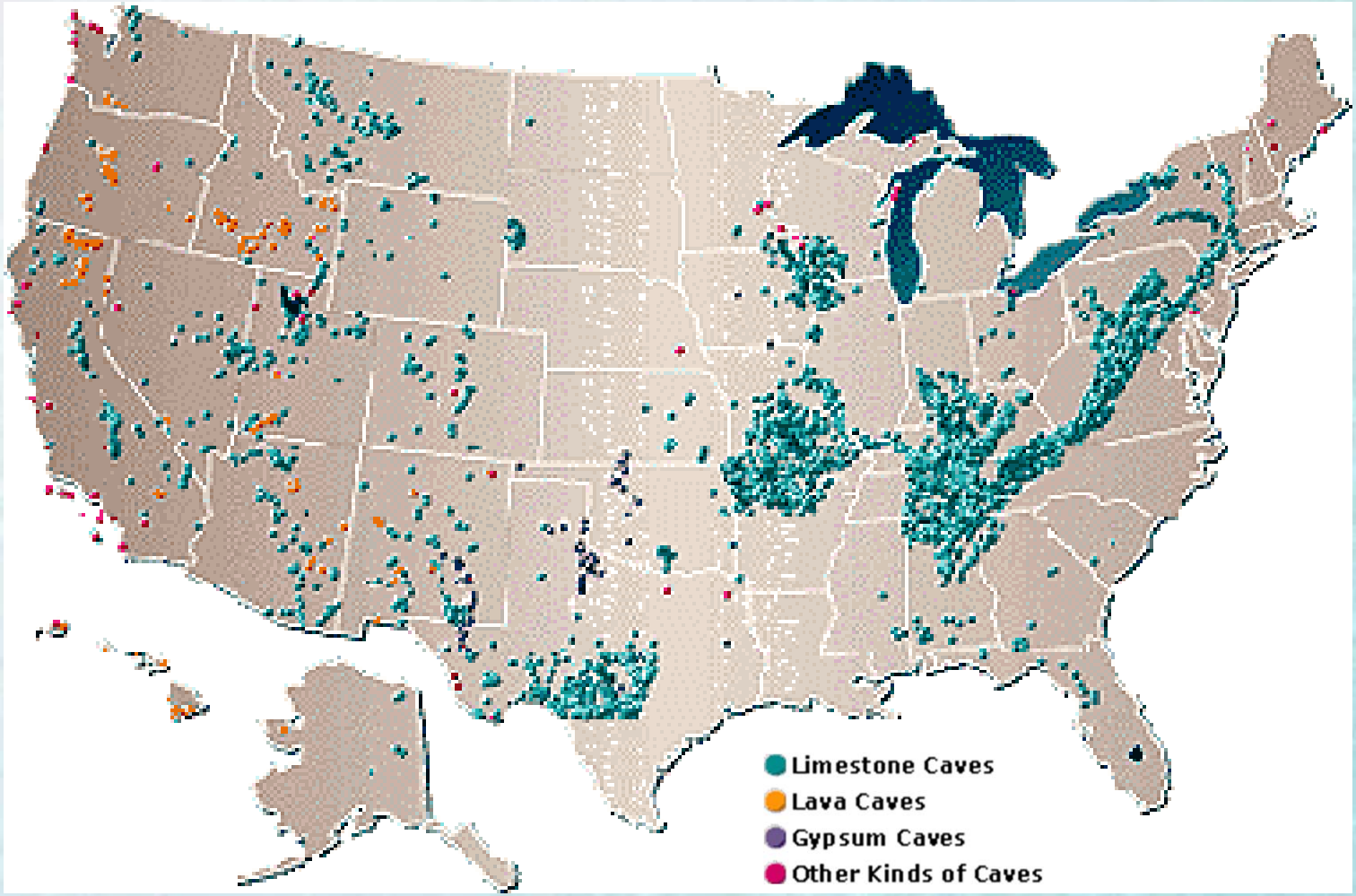
Features of Karst - Caves

A natural cavity beneath the earth's surface. Caves are formed when slightly acidic water combines with limestone or dolomitic rock, and dissolves the rock, creating a cavity.

Where are U.S. Caves ?



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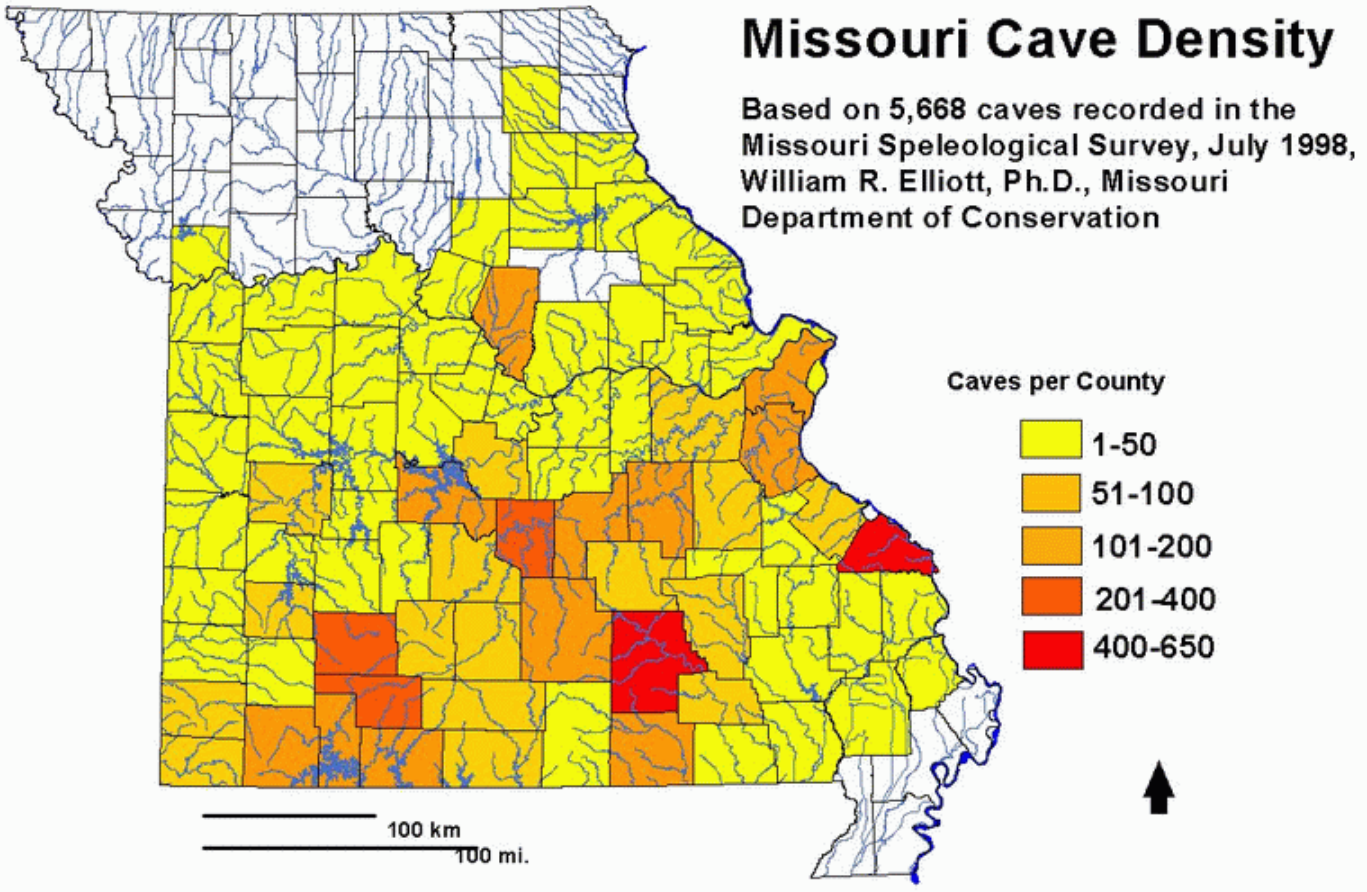
Where are Missouri Caves ?



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Missouri Caves

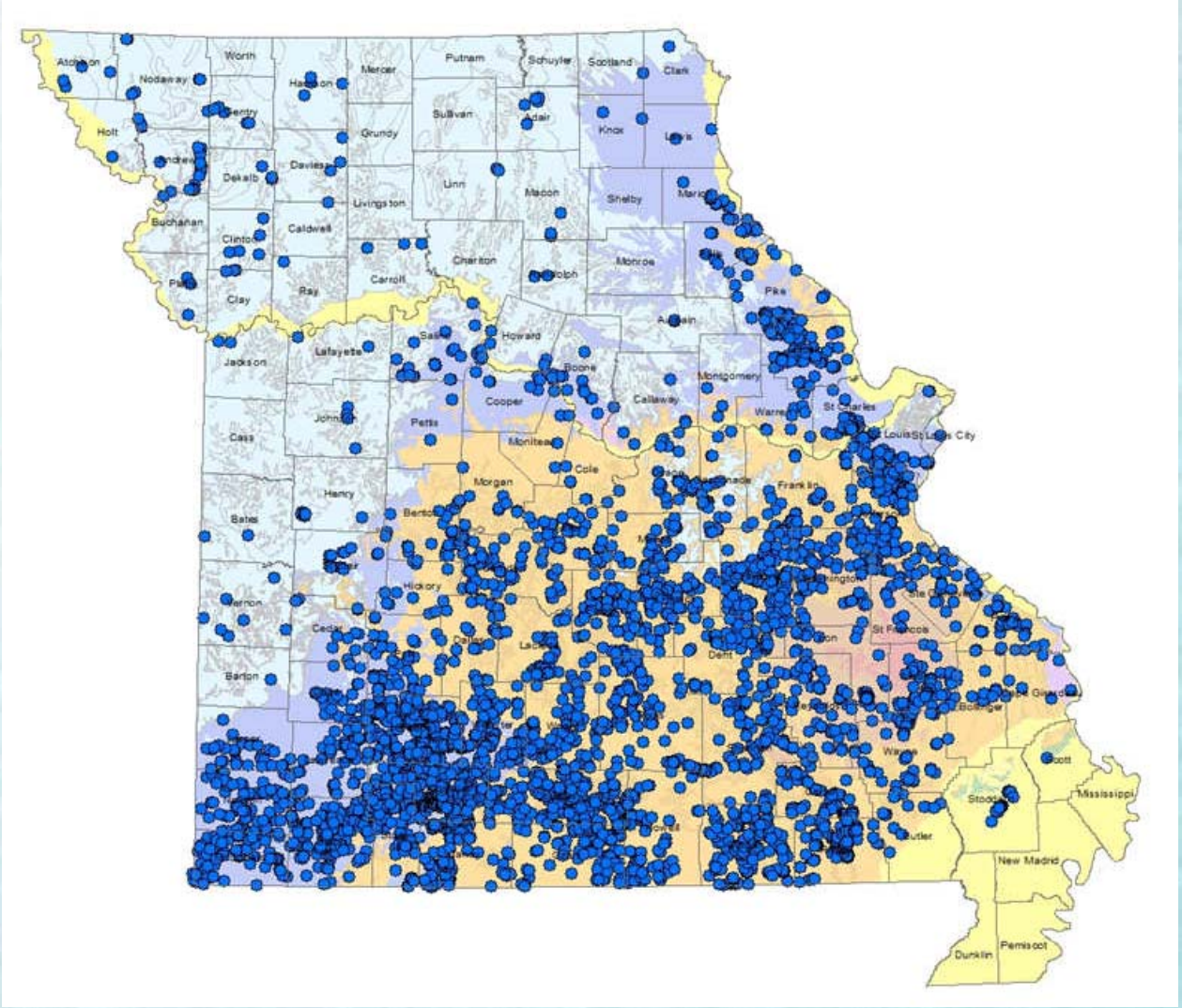
- 6,300+ caves recorded as of 2009
  - Perry 656
  - Shannon 535
  - Greene 360
  - Pulaski 350
  - Stone 283
  - Christian 220
  - Crawford 205
  - Texas 178

Photo credit: www.ozarkhighlandsgrotto.org

Features of Karst - Springs

A natural discharge of water from a rock or soil to the surface

Where are the Springs ?



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Large Springs of Missouri

Big Spring, Carter County, 289 MGD

Greer Spring, Oregon County, 222 MGD

Bennett Spring, Dallas County, 114 MGD

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Source: www.dnr.mo.gov/env/wrc/springsandcaves.htm

Features of Karst - Sinkholes

- Natural depression in the ground surface formed by the dissolution and collapse in soluble rock
- Ranging in diameter from a few feet to more than 3,000 feet

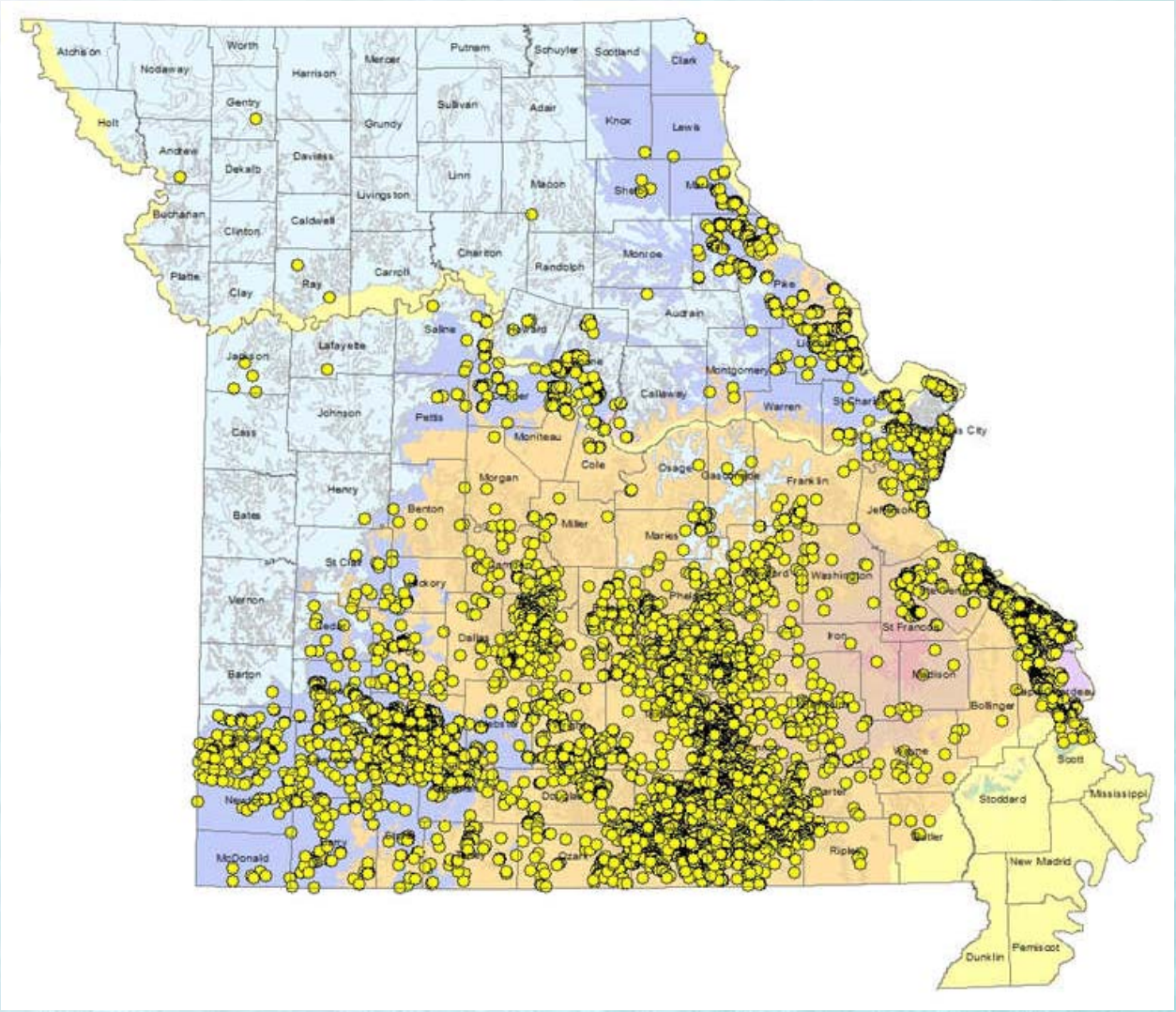
Sinkhole near Edgar Springs in Phelps County

Source: www.dnr.mo.gov/env/wrc/springsandcaves.htm

Features of Karst - Sinkholes

- Depths range from barely discernible to the eye and not represented on topographic maps to hundreds of feet deep
- Drainage is subterranean
- They are direct funnels to the underground

Where are the Sinkholes ?



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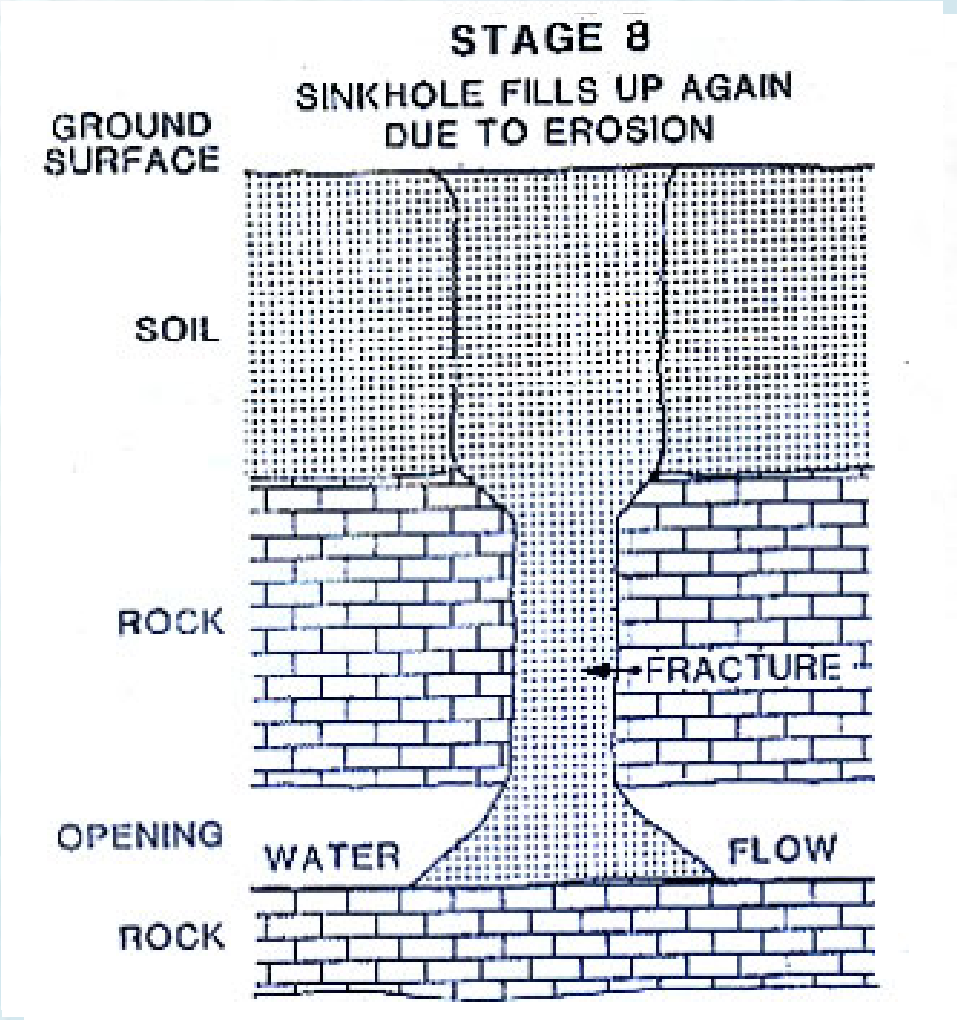
How Sinkholes Form



Source: dnr.mo.gov/geology/geosrv/envgeo/sinkholes.htm

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Sinkholes Take Many Shapes

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2004 Berg Sinkhole Collapse, Barry County
This sinkhole developed in one day!

Sinkholes are Funnels to Underground

Sinkhole in residential development on SE corner of
Kansas Expressway and Walnut Lawn, Springfield, MO

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Sinkholes are Funnels to Underground

Trash disposed in Laclede County sinkhole. Dye tracing shows this sinkhole provides recharge to Ha Ha Tonka Spring

Source: www.dnr.mo.gov/env/wrc/springsandcaves.htm

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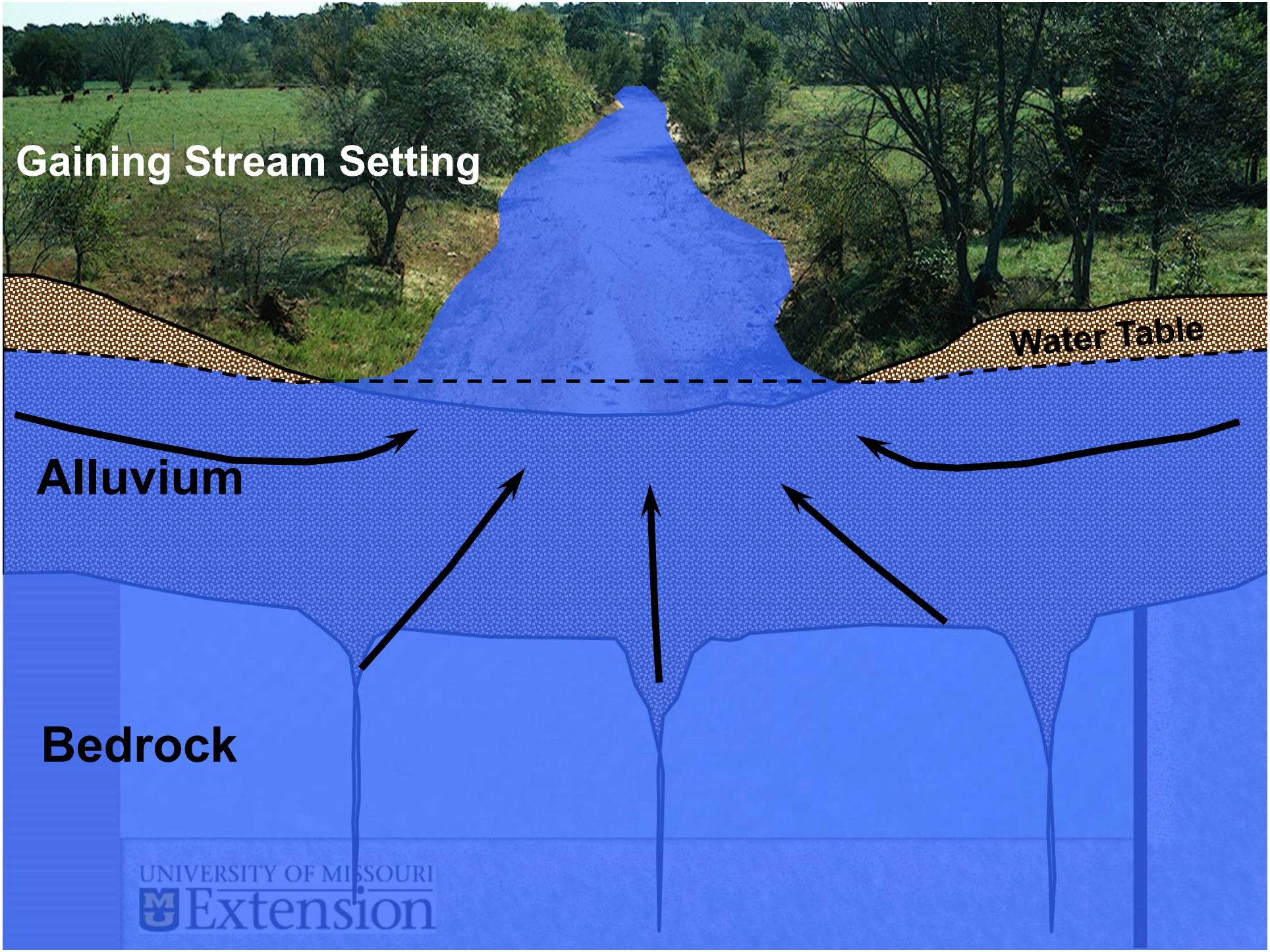
Features of Karst – Losing Streams

- A stream that loses a significant part of its normal runoff into bedrock openings beneath the streambed

Goodwin Hollow, Laclede Co.

On Missouri Highway 5 north of Lebanon, MO, this losing stream drains more than 72 square miles. Water lost underground provides recharge to Bennett, Sweet Blue and Ha Ha Tonka Springs.

Source: www.dnr.mo.gov/env/wrc/springsandcaves.htm


Gaining Stream Setting
Water Table
Alluvium
Bedrock
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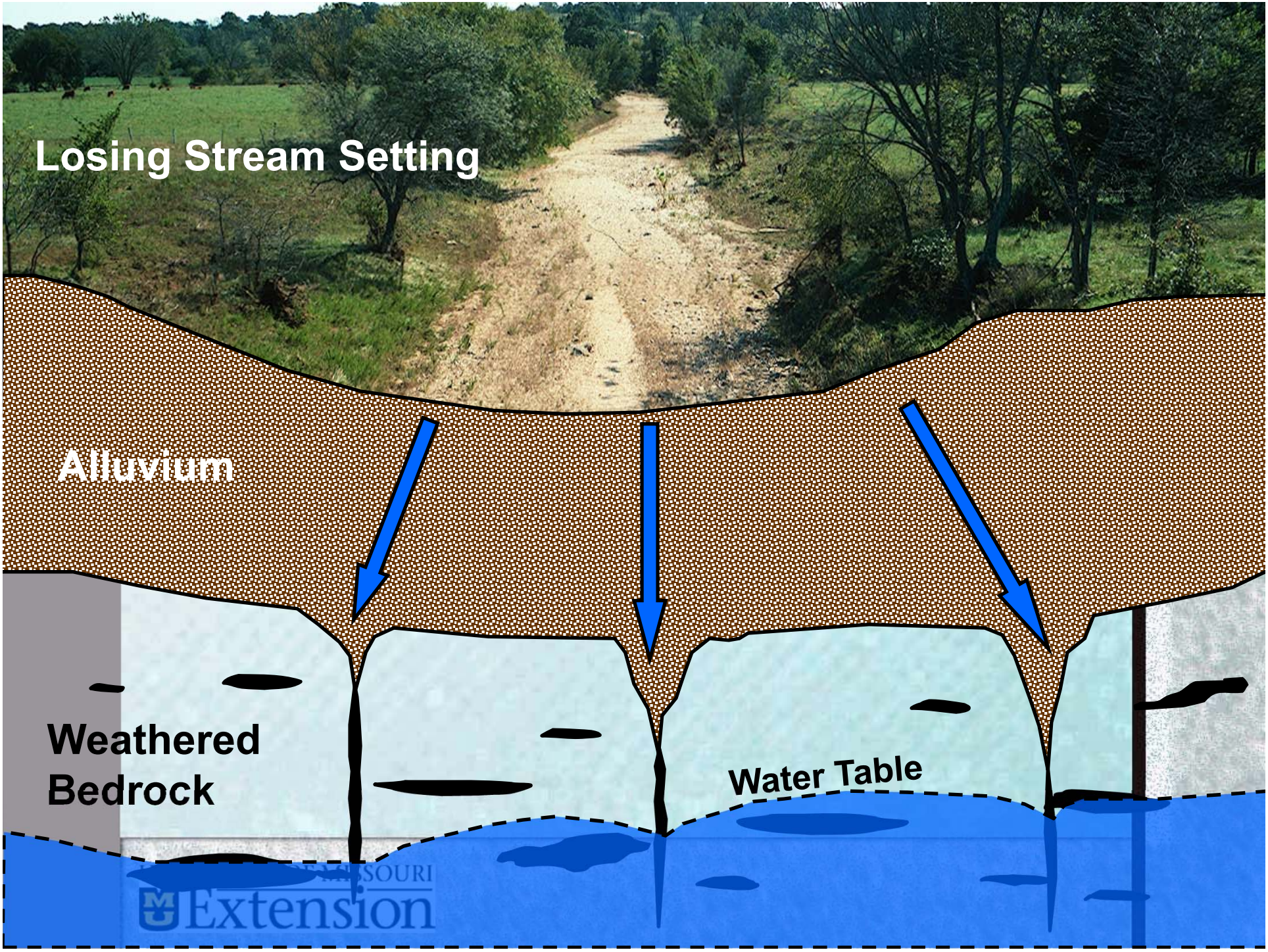
Losing Stream Setting
Alluvium
Weathered
Bedrock
Water Table
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Typical Losing Streams

North Cobb Creek, Laclede County

McDonald County

Taney County

Laclede County

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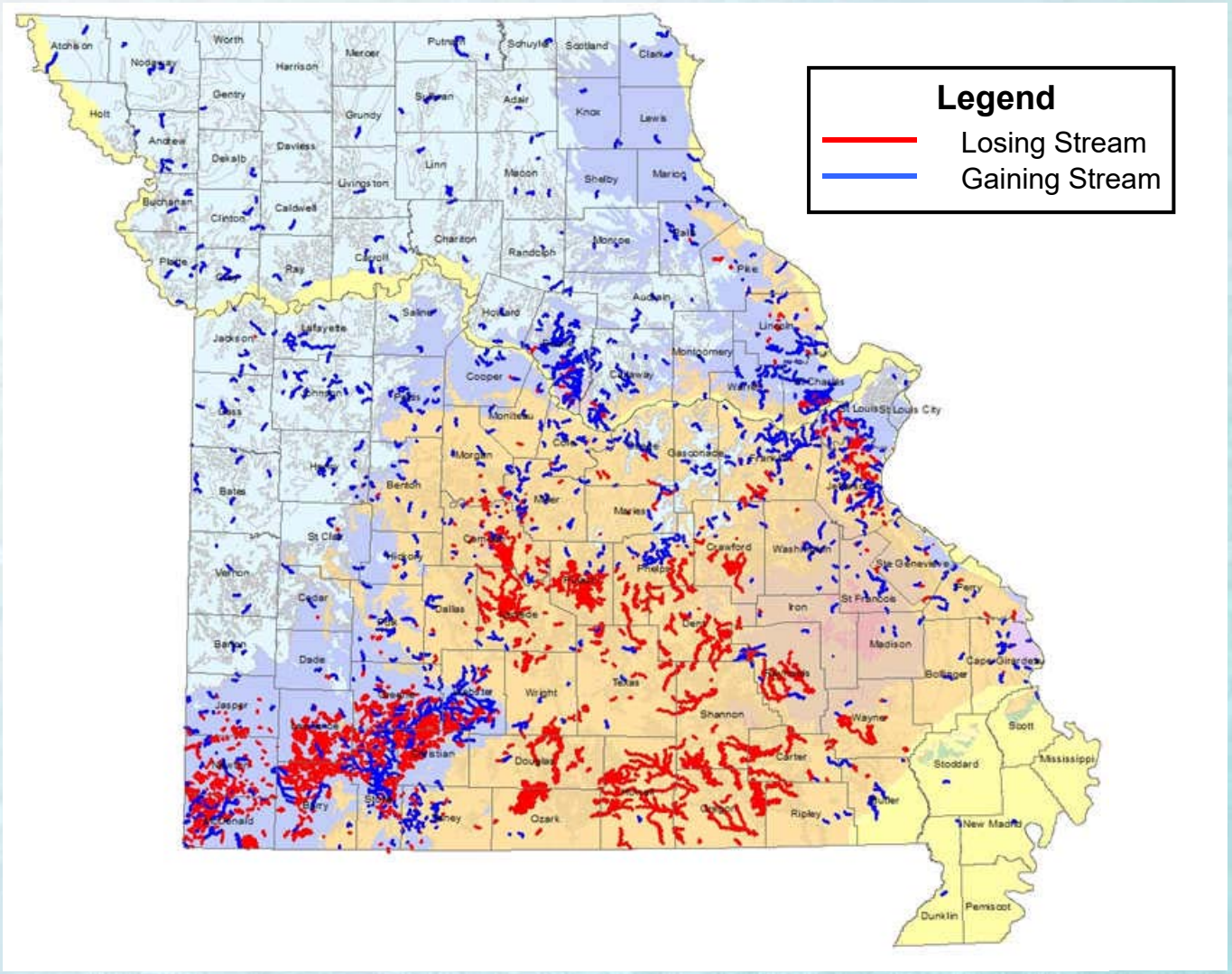
Schluersburg Karst Chasm

St. Charles County

July 2000
Completely filled
with coarse gravel

January 2000
237 feet long,
30 feet deep,
5 to 10 feet wide

Where are Losing & Gaining Streams?



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Tracking Groundwater Flow

Fluorescein dye

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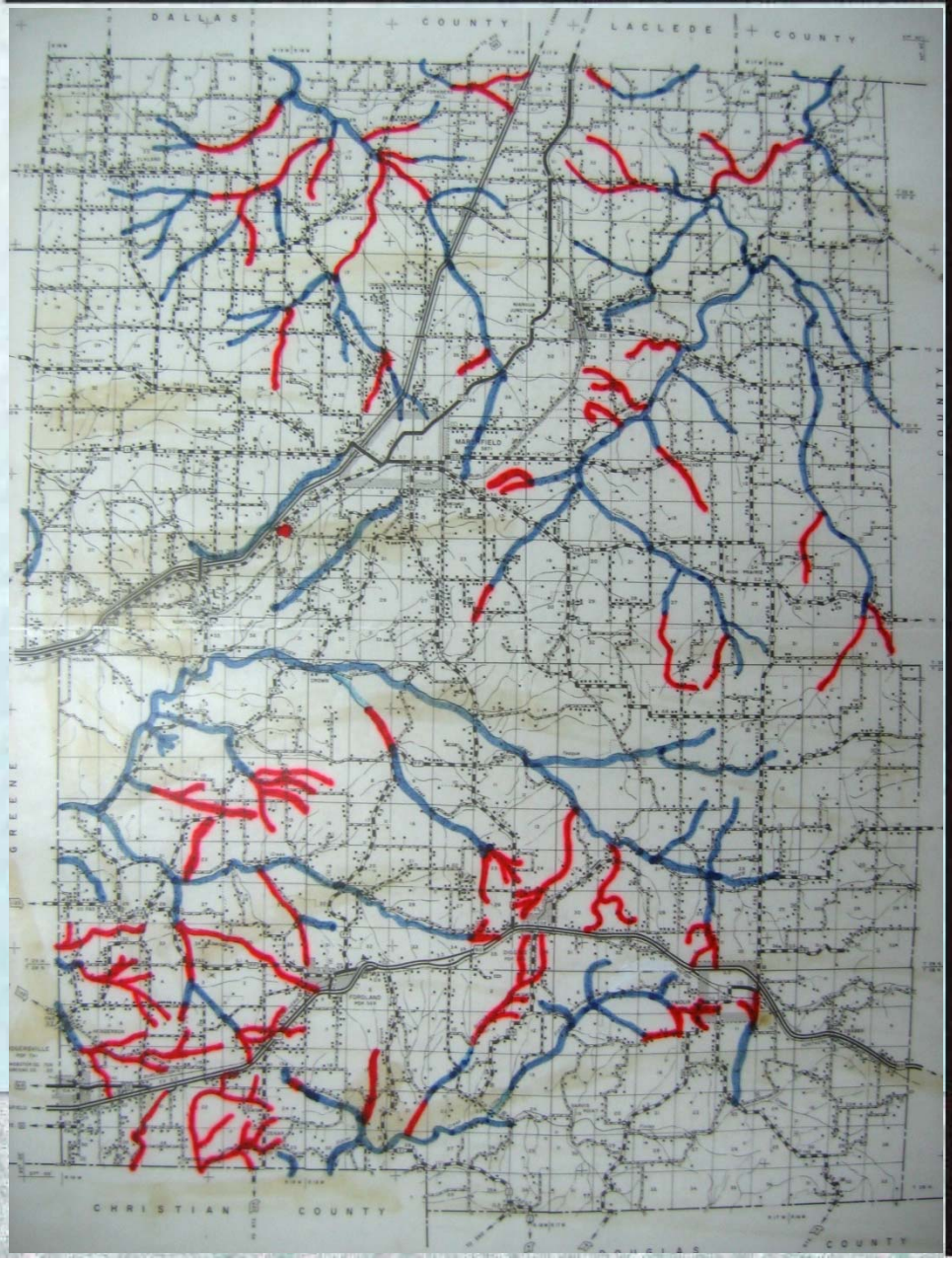
Tracking Groundwater Flow

Rhodamine dye

Losing Streams of Webster County

Gaining streams show in blue

Losing streams shown in red



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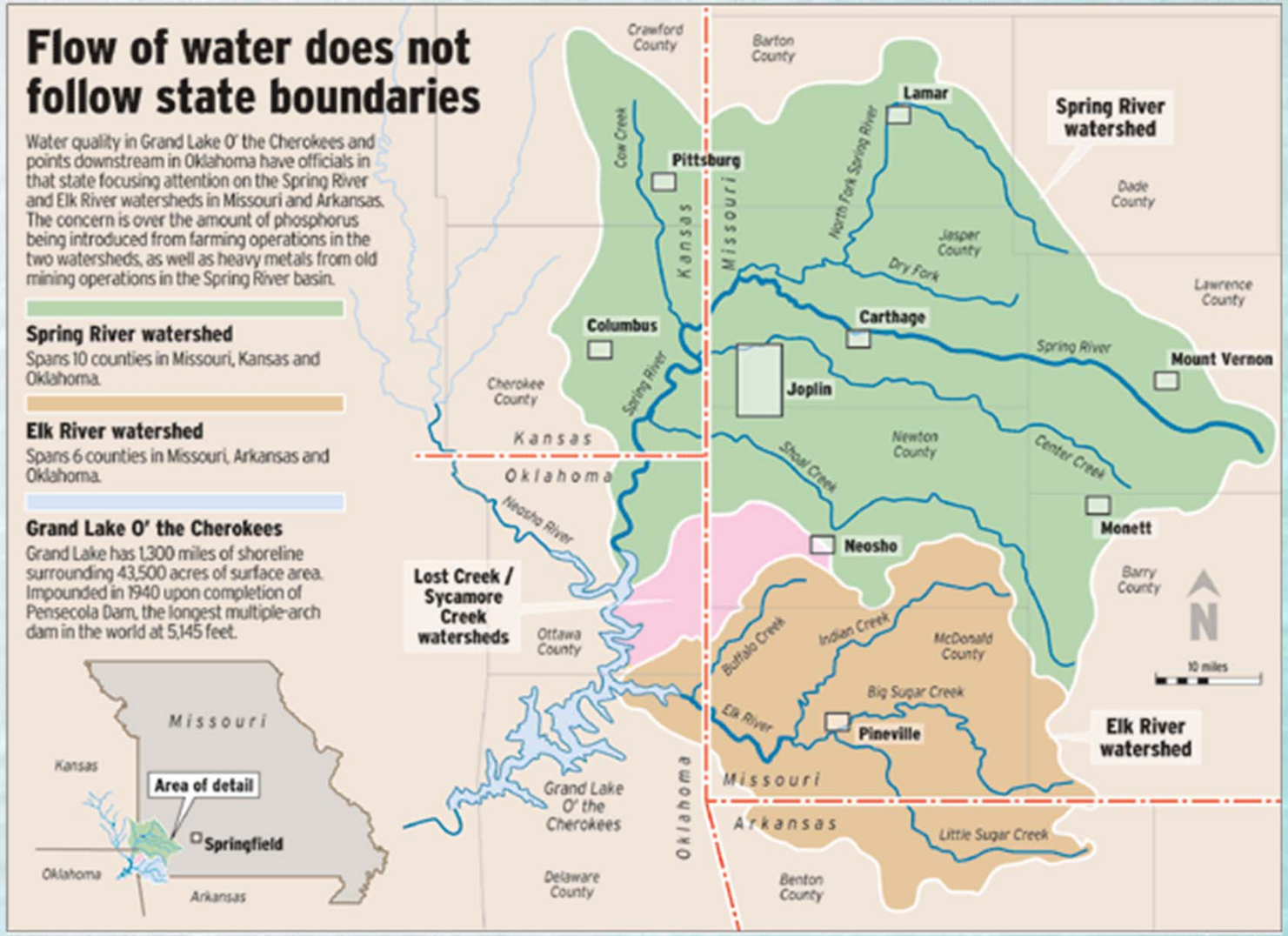

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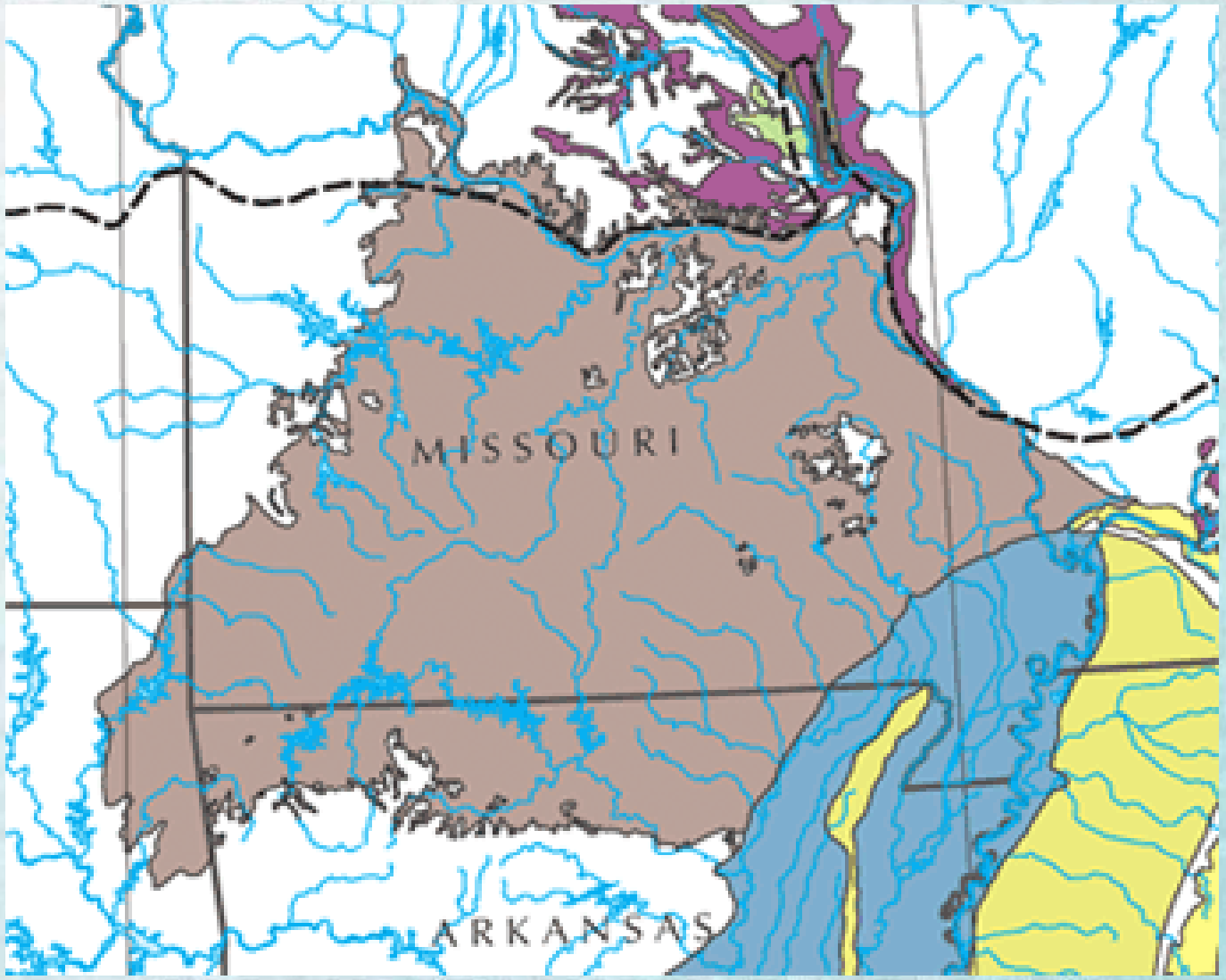
Ozarks Plateau Aquifer System



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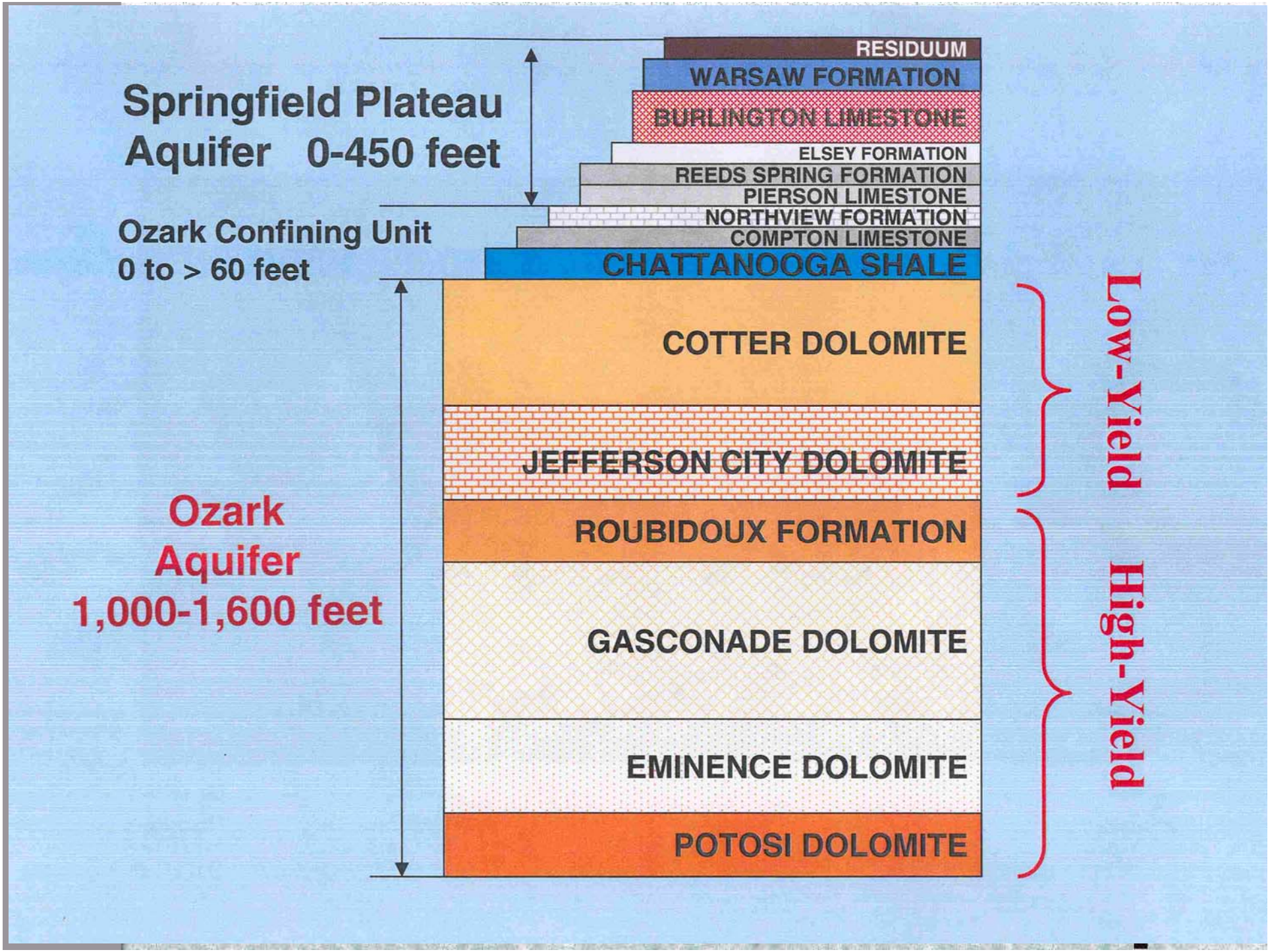
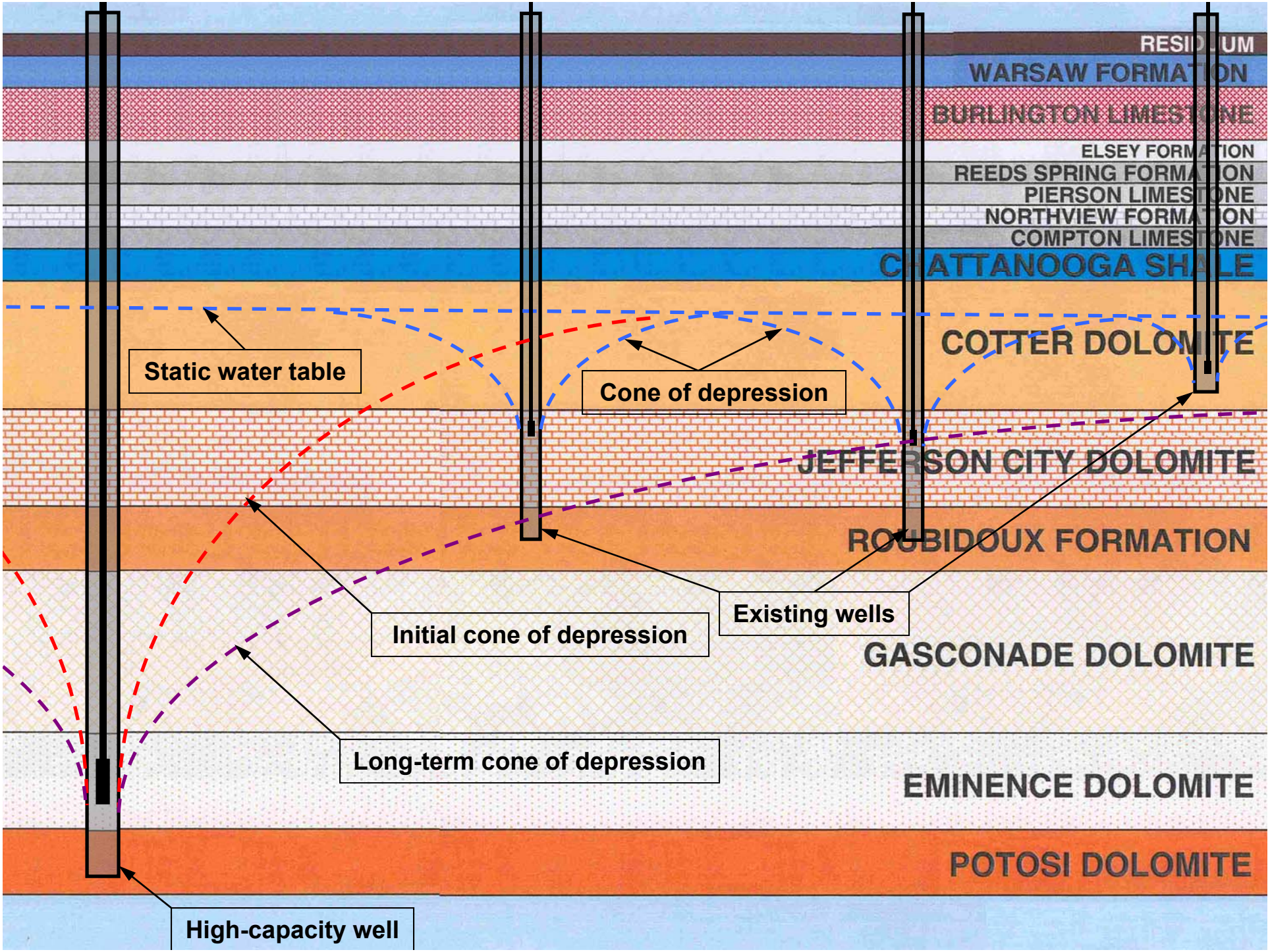

Springfield Plateau Aquifer 0-450 feet
Ozark Confining Unit
0 to > 60 feet
Ozark Aquifer
1,000-1,600 feet
RESIDUUM
WARSAW FORMATION
BURLINGTON LIMESTONE
ELSEY FORMATION
REEDS SPRING FORMATION
PIERSON LIMESTONE
NORTHVIEW FORMATION
COMPTON LIMESTONE
CHATTANOOGA SHALE
COTTER DOLOMITE
JEFFERSON CITY DOLOMITE
ROUBIDOUX FORMATION
GASCONADE DOLOMITE
EMINENCE DOLOMITE
POTOSI DOLOMITE
Low-Yield
High-Yield


RESIDUUM
WARSAW FORMATION
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REEDS SPRING FORMATION
PIERSON LIMESTONE
NORTHVIEW FORMATION
COMPTON LIMESTONE
CHATTANOOGA SHALE
COTTER DOLOMITE
JEFFERSON CITY DOLOMITE
ROUBIDOUX FORMATION
GASCONADE DOLOMITE
EMINENCE DOLOMITE
POTOSI DOLOMITE
Static water table
Cone of depression
Initial cone of depression
Existing wells
Long-term cone of depression
High-capacity well

Environmental Issues and Impacts

- Water quality degradation
  - Excessive nutrients may reach springs, streams and rivers through groundwater drainage.
  - Nutrients promote algae and aquatic plant growth which can impair water transparency and aquatic life.
  - Household chemicals, oils and cleaning products can also release toxins into the environment.

Algae Bloom on Lake

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Health/Social Issues and Impacts

- Contamination of drinking water by diseases and invasive parasites
  - Cholera
  - Typhoid
  - Salmonella
  - Shigella
  - Staphylococcus
  - Dysentery
  - Hepatitis A, B, C
  - Polio
  - Viral Gastroenteritis
  - Cryptosporidiosis
  - Giardiasis
  - Worms (flat, tape, round, hook)

Cases found in the Ozarks

Health/Social Issues and Impacts

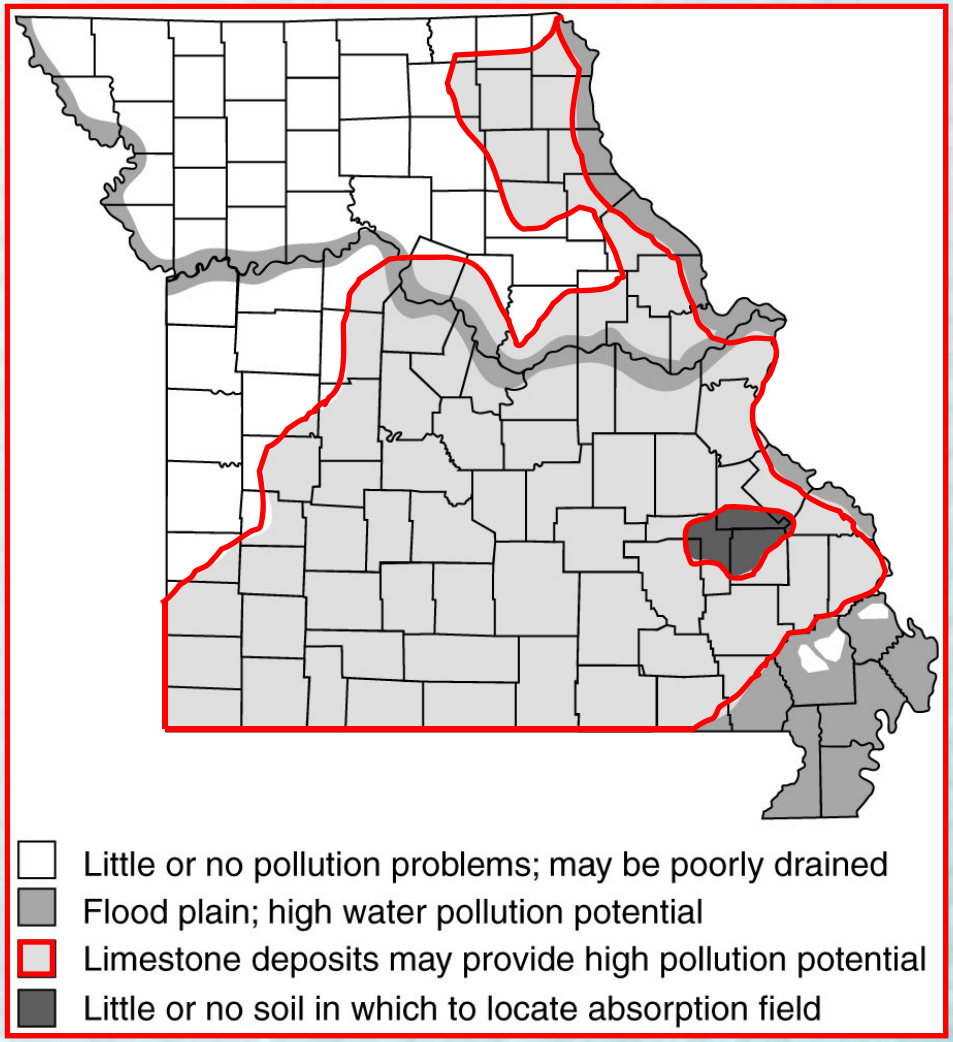
- Quality of life
  - Aesthetic (scenic environment)
  - Economic (tourism)
  - Recreation (fishing, boating, swimming)
  - Safety

Aerial photo of 1999 algae bloom in the James River arm of Table Rock Lake (Missouri DNR photo)

Environmental "Hot Spots"

- Failing septic systems
- Abandoned wells
- Livestock lagoons
- On-farm solid waste disposal
- On-farm fuel storage areas
- Hazardous materials disposal
- On-farm pesticide & fertilizer storage areas
- Former methamphetamine labs

Failing Septic Systems



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Septic System Soil Selection Matrix

Soil Dispersal System	Severe Soil Rating (See County Soil Survey Book for Soil Ratings)				
	Shallow to Bedrock	Rapidly Permeable	Slowly Permeable	Water Table	Steep Slope
Soil-Absorption (Gravity)	No	No	No	No	Yes
Shallow-Placed (Gravity)	Maybe	Maybe	No	Maybe	Maybe
Sand-Lined Trenches (Gravity)	No	Yes	No	No	Yes
Aerobic Lagoon	No	No	Yes	Maybe	No
Low-Pressure Pipe (LPP)	Maybe	Maybe	Maybe	Maybe	Yes
Drip Irrigation	Yes	Yes	Yes	Maybe	Yes
Mound	Maybe	Yes	No	Yes	No

= Soils not suitable for sewage system

= Soils possibly suitable for sewage system

= Soils acceptable for sewage system

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Abandoned Wells

- MoDNR estimates that Missouri has more than 150,000 abandoned wells (1 well per 80 acres)
- State law requires that abandoned wells be properly plugged. This can be done by the landowner or by a professional.
- Why plug an abandoned well?
  - Reduces health risk
  - Reduces liability
  - Reduces chance of environmental contamination to groundwater

Abandoned Wells

- Plugging is responsibility of landowner
- Plugged wells must be registered with MoDNR
- Typical cost = $300 to $1000
- See:
  - *Eliminating an Unnecessary Risk: Abandoned Wells & Cisterns* www.dnr.mo.gov/pubs/pub2281.pdf
  - *Casing Depth Request Form* www.dnr.mo.gov/forms/780-1426-f.pdf
  - *Abandonment Registration Record* www.dnr.mo.gov/forms/780-1603-f.pdf

Livestock Lagoons

- If not in use but was a permitted lagoon, owner must follow DNR regulations to properly close or abandon the lagoon.
- DNR land disturbance permit is required if 1+ acre(s) affected (Phase II Stormwater Rules).
- Lagoons can create environmental & liability problems, or can be a selling point if they can be rejuvenated as a pond or lake.
- See:
  - *Guide to Animal Feeding Operations* https://dnr.mo.gov/pubs/pub2351.htm

On-farm Solid Waste Disposal

Three main ways of trash disposal

1. Burning
2. Ditch or ravine
3. Have it hauled off by professional company

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On-farm Solid Waste Disposal

- If a burn area, what is effect on property value?
  - Household trash only
  - *Facts on Open Burning under Missouri Regulations* https://dnr.mo.gov/pubs/pub2047.htm
- If a ditch or ravine, what are cleanup procedures?
- If buried, dump must be listed with county recorder's office and becomes part of the property's legal description
  - *Report Illegal Dumping* www.dnr.mo.gov/env/swmp/dumping/enf_instruct.htm
  - *Management of Scrap Tires* https://dnr.mo.gov/env/swmp/tires/tirelist.htm
- Recommend to recycle, reuse or haul away

On-farm Fuel Storage Areas

- Fuel storage tanks and other areas must be reviewed to determine if they might create an environmental problem that will reduce the land value.

- See:
  - *Assessing Risk of Petroleum Product Storage* extension.missouri.edu/p/WQ654

Hazardous Materials Disposal

- Farm or household hazardous materials disposal areas may be a point of environmental concern that will affect property values.
- Paints, adhesives, cleaners, pesticides and many day-to-day materials are classified as hazardous materials and the area where they are disposed of must be treated accordingly.
- See:
  - *Assessing Risk from Hazardous Waste Management* extension.missouri.edu/p/WQ655
  - *Hazardous Waste in Missouri* https://dnr.mo.gov/env/hwp/

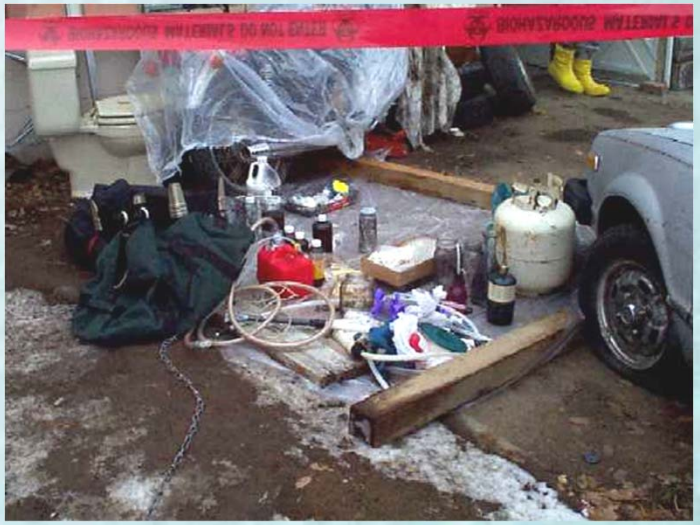
On-farm Pesticide & Fertilizer Storage and Handling Areas

- Review areas for human health & environmental concerns where pesticides and/or fertilizer were stored, mixed or disposed

- See:
  - *Assessing Risk from Fertilizer Storage and Handling*
    extension.missouri.edu/p/WQ653

Former Methamphetamine Labs

- Contact local law enforcement agency
- Ask for contractor name who removed materials
- Be sure buildings are aired out properly
- See:
  - *Methamphetamine Awareness*
    www.justice.gov/archive/olp/methawareness
    www.methproject.org
  - *Cleaning Up Former Methamphetamine Labs*
    health.mo.gov/atoz/pdf/MethLabCleanup Guidelines.pdf



For More Information

- DNR Division of Environmental Quality
  www.dnr.mo.gov/env
- Missouri Ozarks
  www.dnr.mo.gov/pubs/pub655.pdf
- What You Should Know Before You Build
  https://dnr.mo.gov/pubs/pub484.htm
- Water Protection Resources
  extension.missouri.edu/webster/water.aspx
- University of Missouri Guidesheets
  extension.missouri.edu/publications
- Ag Site Assessment Tool
  agsite.missouri.edu/

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Questions??

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Program Complaint Information
To file a program complaint you may contact any of the following:

University of Missouri

- MU Extension AA/EEO Office
  109 F. Whitten Hall, Columbia, MO 65211
- MU Human Resources Office
  130 Heinkel Bldg, Columbia, MO 65211

USDA

- Office of Civil Rights, Director
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-9410

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