Overview of Missouri Karst

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Karst is a geologic term from Europe, used to describe landscapes dissolved by groundwater with caves, springs, sinkholes, losing streams and other features. Karst usually is formed in limestone or dolomite, which are fairly hard, but soluble in weakly acidic groundwater. Some areas of Texas, Oklahoma, and New Mexico have **gypsum karst**. Another term, **pseudokarst**, is for cave areas not formed by dissolution, such as lava tubes, littoral (sea) caves, talus caves, and suffosion (dirt pipes).

There is an amazing variety of karst. About 25% of North America is karst. In the tropics you can find huge dolinas (dolines), deep sótanos (pits), big cuevas and grutas (caves) with gigantic speleothems (cave formations), and enormous nacimientos (springs, literally "birth places"). In Alaska you will find chilly caves in temperate rainforests, like the Tongass National Forest, with ice in the winter and only tiny speleothems. In between there are many types of karst, including a few caves dissolved by sulfuric acid.

Coming from Texas, I was accustomed to small sinkhole entrances, warm caves (65-70° F) and abundant cave life. Missouri karst is often marked by resurgences (springs) in river valleys, or old, abandoned outlets higher up the valley side. The Perryville Karst in Perry County, however, is a sinkhole plain with many sinks and karst windows. Missouri caves are colder (55-60° F) and have less abundant life, except in Gray Bat caves, where guano and stream habitat may support a hundred or more species.

The classical Ozarks karst has deep hollows, some of which are eroded remnants of caves. These were dissolved by the slow action of circulating groundwater, which is mildly acidic from dissolved carbon dioxide forming weak carbonic acid. In the caves and hollows you may find large blocks of "breakdown," which fell long ago. Abundant rainfall and geologic time have created over 6,000 caves in Missouri. A lot of the Ozark region is a plateau with deep hollows and sinuous ridges left by eons of dissolution and erosion. Our largest caves are growing now, down in Mother Nature's deep plumbing, like the natural conduits leading at least 39 miles to Big Spring, Carter County.

Karst Terminology:

Cave is an airfilled void, large enough to be explored by humans. The Missouri Speleological Survey has no strict definition, but some state cave surveys have minimal lengths or depths for a cave for database purposes.

Cave spring is a partially air-filled cave that has a spring running out. The Missouri Department of Conservation calls water-filled springs "springs," even if cave divers can explore them. Our larger springs are all karst springs, or resurgences.

Spring is a resurgence of groundwater. The term "effluent cave," used by some Missourians, has been replaced with "cave spring" or "resurgence," since effluent usually connotes a polluted stream.

Sinkhole or sink is a dissolved or collapsed portion of bedrock . Sinks may be a sheer pit into a cave, or a large, shallow depression. **Doline** is a very large sink.

Swallet or **swallow hole** is a term for an entrance that takes water.

Losing stream has cracks in its bed that allows water to flow into the groundwater. There are many losing streams in the Ozarks, floored with chert cobbles that dissolve very slowly.

Gaining stream has water upwelling from its bed. See examples below.

Natural bridge or tunnel is an arch that is a remnant of an eroded cave. A natural bridge is shorter than a tunnel, which may be air or water-filled.

Pit is a vertical entrance or cave. The public often says a cave is rather "deep," whereas a caver says it is rather "long" (in the horizontal plane). Deep means vertical depth to a caver, who may use rope to

explore a pit cave.

Rockshelter or shelter is usually an eroded cave in a bluff, often used as a campsite by native Americans. Some are eroded sandstone. Some dissolutional caves have very large entrances that were suitable as campsites. A rockshelter usually is a cavity that is wider than long.

Missouri and the Ozarks are a great "cave factory," as one geologist described it. We have abundant limestone and dolomite, fractures, rainfall (45" a year), and soils that provide carbon dioxide from bacteria. All this combines to dissolve out hundreds of miles of caves. Most of the caves you see are remnants of their former selves. The eventual fate of a cave is to weather away, but it may take hundreds of thousands to millions of years.

Water moves through the soil into the bedrock and enters **bedding planes** and **joints (fractures). Faults** are not usually directly involved in **speleogenesis**, the formation of caves, but joint sets and caves are often associated with them. **Sinkholes** may develop at fracture intersections or by collapse of caves below. These water collectors allow downward flow and gradual passage enlargement; some erosion is involved too. Most of the **dissolution** occurs below the water table. You would think it is all downhill from there, but some of our caves show evidence of water working under **hydraulic head**, or pressure, working its way up into high domes and dissolving them out. Generally the older caves are found up higher in the geologic section, or high on the valley side, because the water table gradually descended as the land and river valleys were cut down by erosion and solution, leaving the older conduits high and dry. But, as large, deep cave systems grow, this may lead to water being forced upwards at times, dissolving out upper cave passages.

Keep in mind that karst groundwater does not obey all the rules governing rivers. The watersheds between river basins are not necessarily boundaries for karst groundwater systems. **Dye-tracing** (water-tracing) studies have shown many instances where groundwater flows under surface divides. A good example is the Eleven Point River, much of which is shunted underground to emerge at Big Spring, which flows into the Current River. This is called **stream piracy** or **interbasin transfer**. In karst this is dynamic, and water may overflow into higher-level conduits during high water times, but stay more confined at low water. You can visualize this better with MDC's **3D Karst Groundwater Model**, which is a series of plastic jugs connected at two levels with plastic tubing.

Water emerges at springs and wells. Some are gravity springs and some are under pressure (**artesian**). Our larger springs ascend from horizontal conduits as much as 200 or 300 ft. down. Probably the great majority water in the Ozarks comes through karst.

After a cave drains and water drips and flows, **speleothems** or **cave deposits** or **dripstone** form. The term "cave formation" is commonly used, but it is not technically accurate. Some speleothems can form underwater (subaqueous), but most are formed in air (subaerial) of **calcite** or **aragonite** crystals, which are crystalline forms of **calcium carbonate** or **$CaCO_3$** (limestone). **Onyx** is an old term for calcite. Most of this deposition is caused by the outgassing of carbon dioxide from the water entering the air-filled cave, sort of like opening a bottle of soda. After the outgassing, the pH increases slightly, the water holds less mineral in solution and crystals form.

Soda straw stalactites form one drop at a time, crystals on the surface collecting in a ring when the drop breaks through. Some grow several feet long if left alone. Eventually most plug up and water flows over the outside, thickening the stalactite. **Draperies, curtains or bacon** form on sloping ceilings and walls where water trickles down the same narrow path, leaving traces of crystals. **Dogtooth spar** crystals may form on the edge of the draperies, projecting outward like teeth. Twisted **helictites** form on walls where water comes out under pressure through capillary spaces; the crystals form at the tip and stack up in odd directions as they form. **Stalagmites** form on the floor, and are broad because of the splashing and gravity flow. They may have **gours** or **rimstone pools** on the sides, and may grade into **flowstone**, which forms in layers on slopes. Caves have many other minerals and speleothems (see ***Cave Minerals of the World***).

Speleothems grow at different rates, depending on the chemistry, and you can't accurately judge their ages from their sizes. Some small, broken stalagmites from Crevice Cave, Perry County, were dated to

about 50,000 years old using radiometric methods. Small speleothems may be only a few decades or centuries old, and some dry ones might be thousands or hundreds of thousands of years old. Remember that if we break a speleothem, it may never grow back again because the conditions have changed since it formed, and the joint that carried the water may be filled with calcite and soil.

Missouri caves have long geologic histories, with repeated periods of sedimentation followed by erosion. You can see evidence of this in old red clays stuck to high ceilings, and hanging **flowstones**, **canopies** and **stalactiflats** that formed crusts on clay banks that are now gone. Round Spring Cave and others have many good examples of this.

The public is beginning to realize that karst is a subject of concern to all of us because of groundwater issues. Karst does not filter groundwater much, and water flowing for long distances underground receives no sunlight to drive off dissolved chemicals or to kill bacteria. So, pollution can travel long distances in karst.

Missouri Karst Examples:

Caves—Educational show caves may be closed in the winter for hibernating bats. **Fisher Cave,** Meramec State Park, near Sullivan; **Round Spring Cavern**, near Eminence; **Onondaga Cave** State Park, near Leasburg; **Fantastic Caverns**, near Springfield.

Gaining Streams—The Current and Eleven Point Rivers, and many other Ozark streams, have losing and gaining segments. The latter is where water wells up from cracks and springs in the river bed. Our springs and gaining streams provide much of the base flow of some of our fine rivers, and habitat for certain species of fish.

Karst Landscapes—Sinkhole Plain, Rock Bridge Memorial State Park, Boone County; Hahatonka State Park; Grand Gulf State Park. The Sunklands (MDC), Shannon County, is spectacular, but quite a hike.

Karst Windows—Devil's Well near Akers Ferry, Shannon County; Schnurbusch Karst Window, Perry County.

Losing Streams—Many Ozark creeks go underground and emerge farther downstream. Sinking Creek, Boone County; Sinkin Creek, Shannon County; and Hurricane Creek, Oregon County are dry most of the time. Segments of larger rivers may lose some of their flow to cracks in the streambed.

Natural Bridges and Tunnels—Hootentown Natural Arch, Stone County, is very large. Rockbridge Memorial State Park, Boone County, is nice, but the trail was re-routed around the bridge in 2006 after a significant rock fall. (Devil's Icebox Cave nearby is available for wild cave tours.)

Sinks—Grand Gulf State Park is a huge, collapsed sinkhole. Slaughter Sink and Conical Sink, Phelps County; sinkhole plains in Boone County, Perry County, and many places in the Ozarks.

Springs—We have some of the bigger karst springs in the USA, like Big Spring, Alley Spring, Round Spring, which are managed by the National Park Service, Ozark National Scenic Riverways. Greer Spring, U.S. Forest Service; Blue Spring, Shannon County, MDC; and Maramec Spring, near St. James, The James Foundation. A **"resurgence"** is type of spring, but it may not flow all the time. Ball Mill Resurgence is co-managed by L.A.D. Foundation and MDC in Perry County. It is a sinkhole which resurges after big rains. It is rumored to take water like a swallet sometimes, in which case it would be an **estavelle (es-**tah-vell**)**. It grinds stones like a "ball mill."

Cave books and publications are at libraries, but many more are available at **http://caves.org/service/bookstore/index.shtml and http://www.speleobooks.com**

Further Reading:

A Guide to Missouri's Cave Life. 2007 Ed. William R. Elliott. Missouri Department of Conservation. Caves and Karst. 2005. William R. Elliott and David C. Ashley. pp. 474-491 i*n* Nelson, Paul, *The*

Terrestrial Natural Communities of Missouri, 3rd Ed. Missouri Natural Areas Committee. 550 pp
Conserving Missouri's Caves and Karst. 2000-2007 reprints of the *Missouri Conservationist*, Missouri Department of Conservation. 38 pp. See articles Below Missouri karst by William R. Elliott, Karst Groundwater by Tom Aley.
Geologic Wonders and Curiosities of Missouri. 2nd Ed. 1990. Thomas R. Beveridge, revised by Jerry D. Vineyard. Missouri Dept. of Natural Resources, DGLS, Rolla, MO 65401.
Springs of Missouri. 2nd Ed., 1982. Gerald Feder and Jerry D. Vineyard. MDNR, DGLS, Rolla, MO 65401 [out of print].
Cave Minerals of the World, 2nd Ed. 1997. Carol Hill and Paolo Forti . National Speleological Society.

Suggested Web Sites on Caving & Cave Conservation:

Bill Elliott's Biospeleology website: http://www.utexas.edu/tmm/sponsored_sites/biospeleology/

On the home page see the link "Handouts for Cave Managers" and "Papers by Elliott," which are PDF files. Teachers and students may use any of this material in class. Also see the photos on Missouri Cave Life in other links. See the link for the 2007 NCKMS (National Cave & Karst Management Symposium), which MDC is co-hosting in St. Louis, Oct. 8-12, 2007. And see the many pages of photos of cave life, bibliographies, etc.

Missouri Department of Conservation's cave pages:
http://www.mdc.mo.gov/nathis/caves/
http://www.mdc.mo.gov/links/NaturalCommunities/Caves/
http://www.mdc.mo.gov/conmag/2000/03/ (the famous "cave issue" of *Missouri Conservationist)*
http://www.mdc.mo.gov/conmag/2000/10/3.htm (Cave Restoration article)

Others:

Acme Climbing (caving gear): http://www.acmeclimbing.com/
American Cave Conservation Association: http://www.cavern.org/
Bat Conservation International: http://www.batcon.org/
Bob & Bob (caving gear): http://www.4bobandbob.com/
Inner Mountain Outfitters (caving gear): http://www.caves.org/imo/
Karst Sports (caving gear): http://www.karstsports.com/
Missouri Caves Association: http://www.missouricaves.com/mo-map.htm
Missouri Springs: http://members.socket.net/~joschaper/jspring.html
National Caves Association: http://www.cavern.com/caves.htm
National Speleological Society (includes NSS Bookstore): http://www.caves.org/
NSS Conservation & Management Section: http://www.acave.us/ccms/
Ozark Caves: http://www.umsl.edu/~joellaws/ozark_caving/
Show Caves: http://cavern.com/
Speleobooks: http://www.speleobooks.com/

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