# Mammoth Cave

Official National Park Handbook

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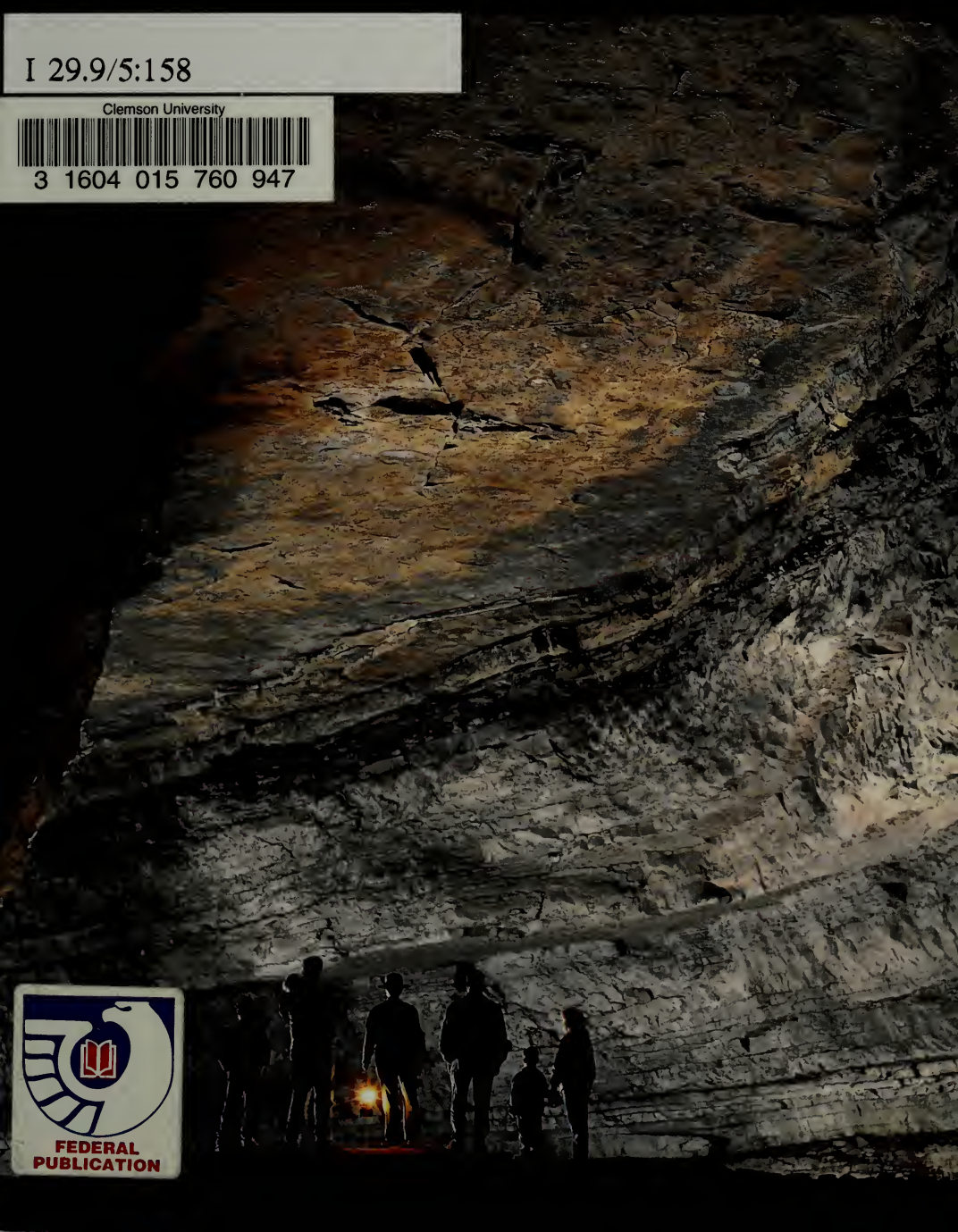

FEDERAL PUBLICATION

# Mammoth Cave

By David Rains Wallace

Mammoth Cave National Park
Kentucky

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Mammoth Cave National Park protects the world's longest cave system, a variety of woodland habitats, the scenic Green and Nolin river valleys, and outdoor recreation opportunities in an International Biosphere Reserve and World Heritage Site. Parts 1 and 2 of this handbook tell the story of curiosity about the cave, its geological dynamics, and why the park is a refuge for embattled species. Part 3 provides a travel guide and references for touring the park and its caves.

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# Part 1

# Welcome to Mammoth Cave

# Exploring the Interior of the American Interior

*Vertical shafts that dwarf the human figure show where water flowing through surface sinkholes dissolved the thickly bedded limestone rock to add this awe-inducing dimension to your experience in Mammoth Cave.*

Preceding pages: *Rose-pink sky reflects on Sloans Crossing Pond* (contents pages). *A salamander seems to drip with the moisture so crucial to its amphibious nature* (pages 4-5). *The profiles of big cave passages suggest the rush of the underground rivers that carved them. Here, below Booth's Amphitheatre, you can still see wooden saltpeter vats made in the early 1800s* (pages 6-7). *Two generations share a moment of the sense of wonder that is so much a part of experiencing the heritage preserved at Mammoth Cave National Park* (pages 8-9).

Covers: *The cave passage known as Audubon Avenue* (front) *shows why the cave was named Mammoth.*

*Wet Prong of Buffalo Creek* (back), *lies north of the Green River. Bursting with life, this scene shows why the creation of the national park would, over time, create a haven for biological diversity as well.*

I found a small cave in the woods once. I already had visited commercial caves and knew them as places with electric lights illuminating stalactites and stalagmites. That cave in the woods didn't look like anything I knew, however. It looked like an incredibly dark hole leading to a complete mystery, and after I'd crawled a little way inside, I crawled back out. That was wise—some of the people who disappear mysteriously may have wandered into such caves. Yet the cave's very scariness had seemed to offer something marvelous. Indeed, caves have been suggesting the marvelous to people at least since hunters began to make strikingly lifelike paintings of animals in them 40,000 years ago.

Life can seem to offer marvels and then not deliver them, but in some places the offer is more than fulfilled. Mammoth Cave is one of those places. When I first entered Mammoth, the realm that opens beyond its Historic Entrance far surpassed my imaginings of underground reality. Crawling into that little cave in the woods, I hadn't imagined the chill air current, a virtual wind, that blows from inside Mammoth. I hadn't imagined that a cave interior could be as wide and level as a subway tunnel, with passages always leading to more, up and down, doubling back, apparently endless.

I hadn't imagined walking through a cave for three hours, and after I'd walked through Mammoth that long during the Grand Avenue Tour, its apparent endlessness began to seem dreamlike. As Kentucky Avenue wound toward the reddish flowstone vaults of Frozen Niagara, I might have been walking under twilit canyon walls in Arizona, and I half expected to smell cottonwood trees, a notion enhanced by the cave's virtual odorlessness. This breakdown of normal waking perceptions was eerie, yet it was also oddly peaceful. It was as though in wandering through the bedrock for so long I somehow had sunk below the surface world's anxieties. In the scary darkness of

that long-ago cave in the woods, I had felt a little as if I had died and been buried. Deep down in Mammoth Cave, I felt unborn.

People seem to have sensed Mammoth's marvelous nature long before they realized just how big a cave underlies south central Kentucky's Mammoth Cave plateau. American Indians who inhabited the region thousands of years ago must have perceived great power in its windy "breathing" and domed chambers, because they explored for miles into the cave. The first European Americans who entered were awe-struck. (Legend says that a bear hunter named John Houchins discovered the Historic Entrance in the late 1790s.)

"There is a peculiar sensation experienced by visitors upon visiting the cave and its atmosphere for a few minutes; whether it has its origin mentally or physically or both, I am unable to determine," wrote chemist Ebenezer Merriam. "I have experienced this feeling in every visit...." Merriam knew the cave in 1814, and it still fascinated him when he wrote about it 30 years later. "Why should the majestic towering walls of this nether palace be decorated with brilliant mineral frostings, its countless millions of shining gems, sparkling with almost living light," he wondered, "and these subterranean surfaces be thus irradiated, far, far beyond the decoration of the most magnificent palace of any earthly potentate? Who can answer?"

Merriam's question was a good one, and his wonderment was linked to a larger fascination, one of civilization's greatest at that time. In 1800 south central Kentucky lay deep within a realm that tantalized the world much as the Amazon does now. The Mississippi Basin was largely unexplored, a wild lowland stretching from the Appalachians to the Great Plains. The few travelers who had seen it told of seemingly endless wonders—passenger pigeon flocks that darkened the sky for days, rivers full of giant fish and turtles, ancient tombs, and earthworks extending for miles through apparently virgin forest and savanna. Such tales made the Basin, then known as "the American Interior," a magnet for European writers and naturalists. It was one of Earth's "blank spots on the map," a place to seek not only new kinds of organisms, but new insights into life itself.

Mammoth Cave began to seem an ultimate mani-

festation of the interior's grandeur and mystery as its character emerged. By 1810 the *Richmond Enquirer* was calling it "the largest cave now known," because explorers had penetrated "six or seven miles from its only known entrance." Exploration accelerated when the War of 1812 quintupled the price of saltpeter, a gunpowder ingredient. Nitrate-rich cave soil could be processed to make saltpeter (potassium nitrate), so miners dug up cave floors, and wonders multiplied.

"In the excavations of the earth for the supply of the vats," Ebenezer Merriam wrote about the saltpeter works, "immense quantities of cane torches and old moccasins were found embedded in the dirt. There was also found embedded in the earth near the mouth of the cave, a human jaw bone of gigantic size. The inside of this bone would pass over the outside of that of an ordinary sized man." This jaw bone has disappeared, along with other giant bones Merriam mentioned, and may have been an exaggeration or legend. (He wrote that miners had re-buried the bones.) A complete body that he saw is a documented historical fact, however. "Beneath a wide flat stone," he wrote, "sat in solemn silence one of the human species, a female with her wardrobe and ornaments placed at her side. The body was in a state of perfect preservation, and sitting erect." Merriam described the female's deerskin, bark, feather, and bone wardrobe in detail and concluded: "The features of this ancient member of the human family much resembled those of a tall, handsome, American woman."

Actually, miners had found the ancient woman, known as "Fawn Hoof" for one of her ornaments, in nearby Short Cave in 1811, but the public quickly associated such a wonder with the "largest cave now known." This increased its fame as entrepreneurs publicized Fawn Hoof and other Short Cave "mummies." By 1815 promoters were claiming a 10-mile length for the cave, and had begun calling it Mammoth Cave, although the name's origin is obscure. ("Mammoth" mainly referred to giant fossil bones at that time.) Travelers sought out the area despite its remoteness. "Under miles of beech trees, every third one an unsung monarch—through orchestras of mocking birds and thrushes—over rocks, stumps and gullies, and through streams and quagmires—we made our way," wrote visitor Nathaniel P. Willis.

Yet the cave remained relatively little known until

*The long beak or "cranesbill" at the center of the flower gave the geranium its name:* geranium *means crane in Greek. The hairy stem of this wild geranium might grow to two feet tall—the better to attract insect pollinators? In the practice of traditional medicine many qualities have been attributed to the wild geranium.*

Next pages: *At Cedar Sink a great, thick, rock-layer roof of an underground passage caved in. Seeing its cavernous depression in broad daylight, you can imagine how water travels underground here and appreciate how mammoth Mammoth Cave really is.*

an entrepreneur named Franklin Gorin bought it to develop as a tourist attraction in 1838. This included the employment of his slaves as guides, which may now seem odd, but which furthered cave exploration because of one slave's remarkable abilities. Seventeen years old when he began guiding, Stephen Bishop taught himself to read and write, absorbed current cave geology from scientists, and spent his spare time exploring beyond easily accessible passages into the fearsome shafts and crawlways beyond. Bishop led the first parties to cross the Bottomless Pit, penetrate the cave's lower levels, and see the blind fish that swim in the River Styx and Echo River. A map he drew shows that he even reached a passage leading from a tributary of Echo River into the Flint Ridge caves across Houchins Valley, a passage possibly not found again until the 1930s.

A talent for displaying the cave to the antebellum era's mostly affluent tourists complemented Bishop's gift for exploring it. Famous for his "dexterity and bodily strength," he could "discourse upon the various formations" as fluently as leading geologist Benjamin Silliman. On a more pragmatic note, Bishop had a flair for the showmanship which could bring him tips, usually the slave guide's only payment. He and fellow guides Nicholas and Materson Bransford elaborated tours into performances that included acrobatics, fireworks, music, and theatrical tableaux. By 1850 the cave had a repertoire gaudy enough to draw an impressed if ambivalent response from naturalist-philosopher Ralph Waldo Emerson. The Sage of Concord enjoyed the cave's most famous tableau, involving an illusion of daybreak (complete with roosters crowing) in the "Star Chamber," a passage whose gypsum-dotted ceiling resembles a night sky. In his 1851 essay "Illusions" Emerson wrote that it was "the best thing which the cave had to offer." Yet Emerson also complained that he "did not like the cave so well for eking out its sublimities with this theatrical trick."

The pursuits of exploration and showmanship pervaded Mammoth Cave's history. Its strangeness—its unchanging temperature and absence of light, smells, and other features of surface life—encouraged both appreciation of its wonders and marketing of their novelty. This sometimes went beyond tourism. Because workers in the cave generally enjoyed good

health, a physician named John Croghan who bought it from Gorin in 1839 thought that it might cure tuberculosis. Croghan set up a sanatorium in the Main Cave passage in the winter of 1842-43. Unfortunately, the gloom and unvented smoke of cooking and heating fires proved decidedly unhealthy for the patients, and most soon died, followed in 1849 by their doctor, himself a "consumptive." Croghan's speleological sanatorium may seem reckless quackery now, yet it was a sincere attempt to extend the medical frontier in a place where miracle cures seemed possible.

Cave showmanship often predominated over exploration after the Civil War, when lean times came to south central Kentucky. Despite the biotic abundance of its wild forests and streams, the Mississippi Basin did not always fulfill settlers' dreams. In marginal areas such as the rocky Mammoth Cave plateau, a growing farm population faced an eroding natural resource base, and a high incidence of children's and young women's graves in 19th-century cemeteries attests to a hard life. Finding a commercially exploitable cave could mean the difference between security and poverty for hard-pressed families. Would-be entrepreneurs competed for control of caves with litigation, espionage, and promotional tricks.

Explorer and entrepreneur Floyd Collins's career epitomized Mammoth's post-Civil War period as Stephen Bishop's had the antebellum period. Born in 1887 on a small Flint Ridge farm, Collins literally lived and died for caves. He is said to have begun exploring small ones near his home at age six, and he grew up at an active time of cave exploration. In 1908 a German named Max Kaemper made an extensive instrument survey of Mammoth's known passages, which then extended 35 miles. Other explorers had discovered two caves on Flint Ridge around the turn of the century, and in 1915 a young civil engineer, Edmund Turner, was said to have found Great Onyx Cave there. (The property owner claimed the discovery for himself after Turner died, however.) Floyd Collins knew Turner, and the Onyx Cave discovery inspired him. He began spending most of his time exploring the holes that riddle the ridge. According to local lore, neighbors would see him suddenly climb out of limestone fissures in cornfields.

In 1917 after weeks of digging, Collins found a 65-

foot-high chamber so rich in gypsum formations that his family named it "Great Crystal Cave." They developed it, and Collins often guided tourists, sometimes growing so enthusiastic that he broke off gypsum "flowers" and handed them to surprised visitors. "He loved the cave," wrote historian Robert K. Murray, "It spoke to his soul and provided a contact with the mystery of the unknown that he evidently needed."

Yet Crystal Cave was too remote to attract profitable attendance, and Collins sought a better-located one. In 1925 he became convinced that Sand Cave, a small opening just off the main road, would lead to large passages. While he was exploring alone one January day, however, a watermelon-sized rock fell and caught his foot in a passage so tight he was unable to reach down and free himself. Neighbors, family, and professional rescuers also proved unable to extricate him.

As Collins remained trapped through the ensuing days, his predicament became a news sensation, attracting crowds and a carnival atmosphere. It drew almost as much attention as Charles Lindbergh's 1927 trans-Atlantic flight. (The then-unknown young pilot worked on the story as a news photo courier.) But Collins lacked Lindbergh's luck. Feverish activity in the cave caused a collapse that cut him off from rescuers, and he was dead by the time they dug a shaft to him, 17 days after his entrapment.

Collins didn't escape his bizarre celebrity even in death. In 1927 an entrepreneur bought Crystal Cave from Floyd's father, exhumed his body, and exhibited it in the cave for many years. Yet his fate did help resolve the conflict between exploration and showmanship that long had beset Mammoth Cave.

Many Kentuckians felt that "the world's longest cave" and its natural setting needed protection. They saw the Sand Cave "carnival" as symptomatic of that need. "Floyd Collins has brought Kentucky before the world," the Louisville *Courier-Journal* editorialized, "he will not have died in vain if you open the cave country, his country, to the people of the United States." This concern galvanized efforts to save the area.

In 1926 President Calvin Coolidge signed a bill authorizing a Mammoth Cave National Park, and private and state organizations in association with the National Park Service eventually assembled today's

Next pages: *Wet Prong of Buffalo Creek flows into the Green River from the north, above where the Nolin River joins the Green. Horse and hiking trails throughout the national park area north of the Green River make a variety of loop rides, walks, and hikes possible.*

*Mammoth Cave was among the first national parks to be authorized in the eastern United States. Advocates of saving the cave as a national park added the lands north of the Green River to make their proposal look big enough to be a national park. Countless beautiful scenes like this were the serendipitous upshot of their campaign. The Green River forms the base level of the Mammoth Cave system, all of which is south of the Green River.*

nearly 53,000-acre park. There was some local resentment as the Civilian Conservation Corps removed houses and reforested farms, but the park was necessary if the caves were to retain their grandeur. Some owners had been breaking off the flowstone and gypsum formations that take millennia to form and selling them as souvenirs. Forest and wildlife had been disappearing, and scientific study would show that septic tanks and other possible pollution sources could threaten water quality.

Underground exploration flourished after Mammoth Cave became part of the National Park System in 1936. Park cave guides Leo Hunt and Pete Hanson found their way to the passage beyond Echo River that Stephen Bishop had first mapped. Caving groups have continued to extend knowledge of the region's underground. In 1954 the National Speleological Society sponsored an expedition into Floyd Collins's Crystal Cave using base camps where members ate and slept underground for days. This produced some data, but the supply logistics proved so unwieldy that subsequent explorations reverted to using small survey teams. The Cave Research Foundation (CRF), formed locally in 1957, has been exploring in small groups ever since and finding ever more cave passages. "You know when you have climbed a mountain," CRF leaders Roger Brucker and Richard Watson have written, "but in a cave you can never be certain that the cave does not go on...."

In 1960 CRF explorers connected Crystal Cave to nearby Colossal and Salt caves, establishing the Flint Ridge network as the world's longest. Exploration culminated in 1972 with "the Everest of caving," as a team of five men and one woman followed the Flint Ridge network to and beyond the Mammoth-linked passage that Hunt and Hanson had explored in the 1930s. The first people ever to go underground on Flint Ridge and emerge from Mammoth Cave (via the elevator from the Snowball Room), the team extended the known length to more than 144 miles. They established beyond a reasonable doubt that this is the world's longest known cave.

"By God, there is absolutely no question we have done it!" reflected leader John Wilcox as he stood chest deep in the Echo River looking at a park handrail after 12 hours of wild cave. "Victory is a feeling of vastness in the skull." Since then, explorers

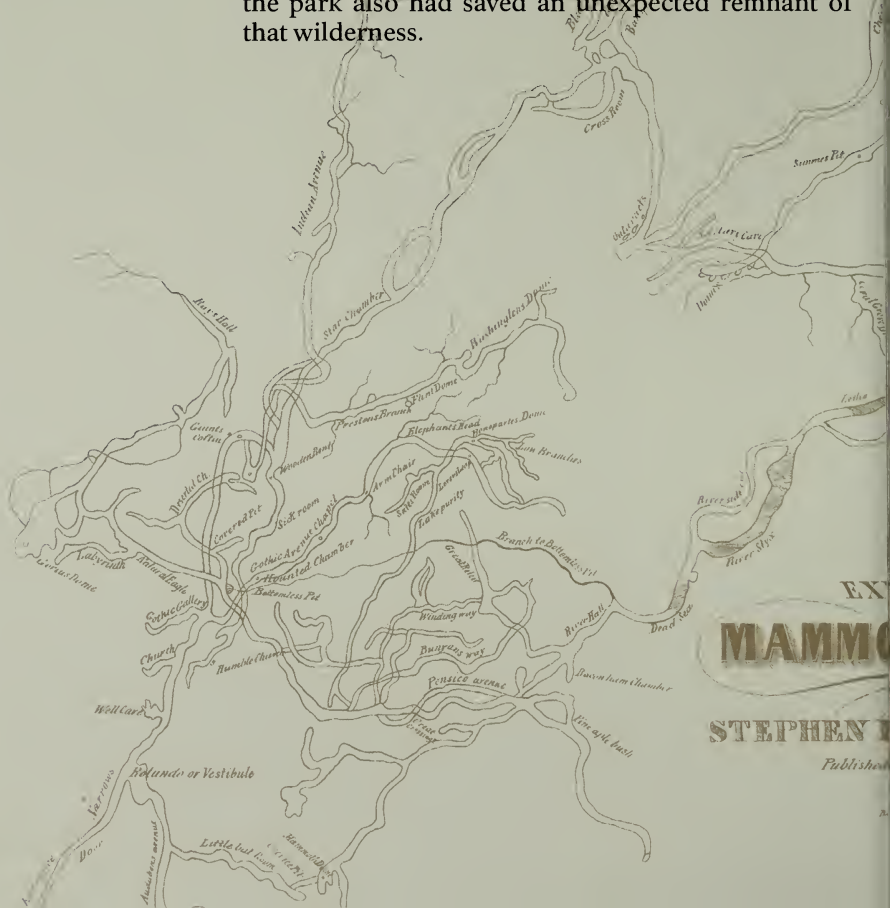
*From the Turnhole Bend Trail southwest of the park visitor center you can get a sense of the great vertical depth of the Mammoth Cave system. The Green River far below marks the base of the cave system, which is still forming today. Water that goes underground in sinkholes south of the park will eventually flow beneath your feet here, having dissolved and eroded cave passages on its way to the Green River.*

*Cave Research Foundation explorers first made the connection between Mammoth Cave and the Flint Ridge Cave systems in 1972. That link-up showed Mammoth Cave to be the world's most extensive cave system.*

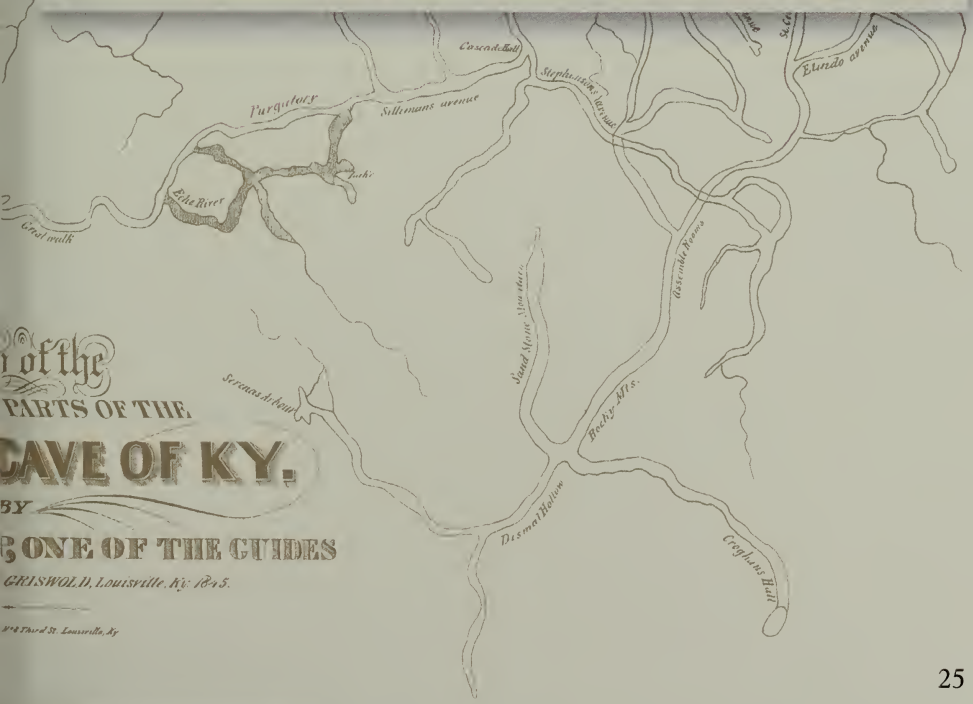
*Shown on the front porch of the Floyd Collins home are* (back row from left) *John Wilcox, Richard Zopf, Steve Wells, and Cleve Pinnix and* (front row from left) *Gary Eller and Pat Crowther. The map in the background was developed by the pioneering African American cave explorer and guide Stephen Bishop and published in 1843.*

have extended the known linked passages to more than 350 miles, including 70 miles in Roppel Cave to the east of Mammoth.

There may be a longer cave somewhere. Few have been explored as thoroughly as Mammoth. Yet length is not really the point. CRF's efforts are a modern manifestation of the sense of wonder that brought early naturalists to the American interior, and the 1972 "Everest" discovery was a watershed for Mammoth above ground as well as below. It came at a time when Americans increasingly felt a sense of loss at the fading of primeval splendors. As modern naturalists discovered that the park's caves are the world's longest and its cave fauna among the world's most diverse, they also realized that its 83 square miles of forest and 32 miles of river comprise one of the largest natural areas remaining in the Mississippi Basin. By protecting a cave whose apparent endlessness had epitomized a largely-vanished wilderness, the park also had saved an unexpected remnant of that wilderness.

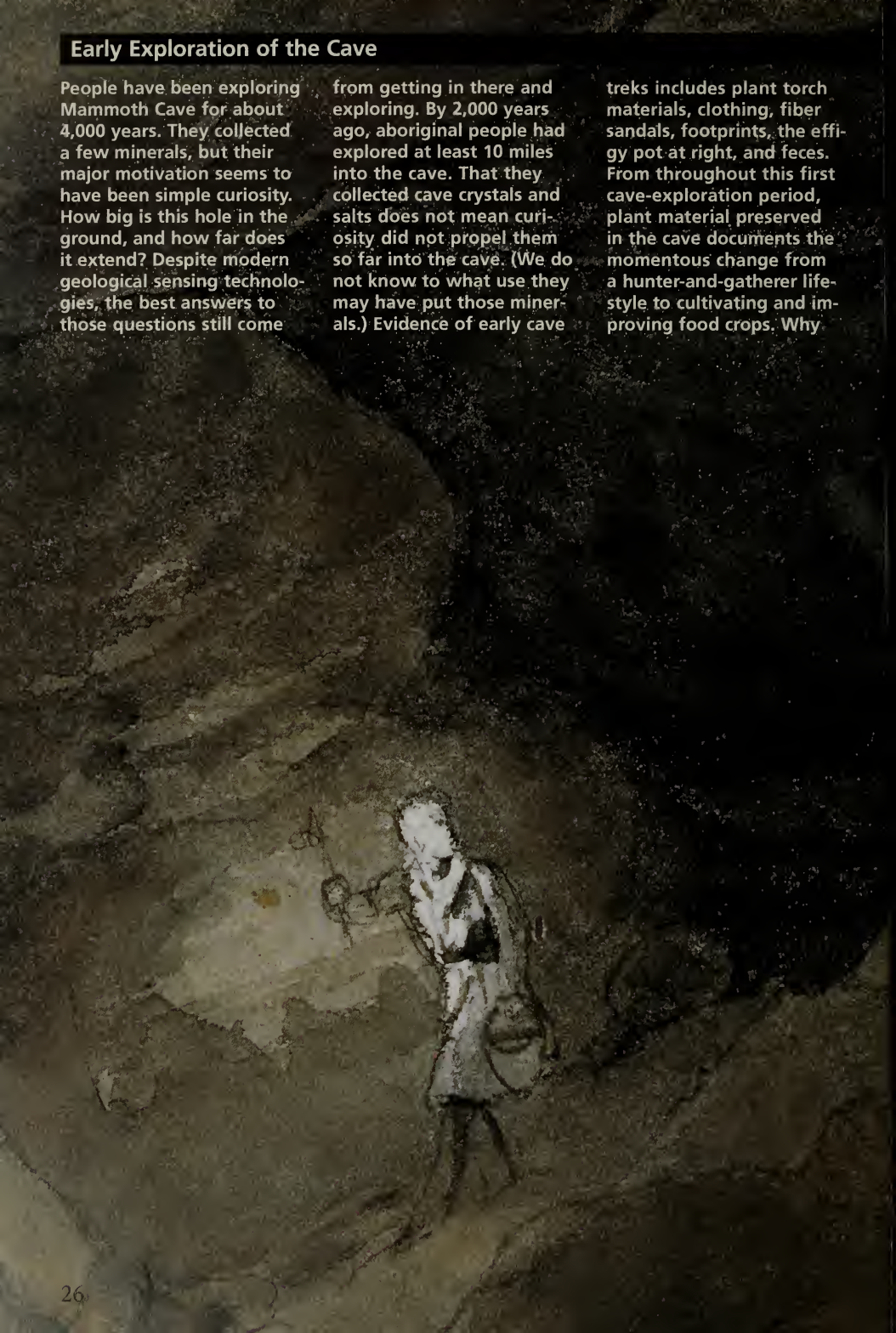


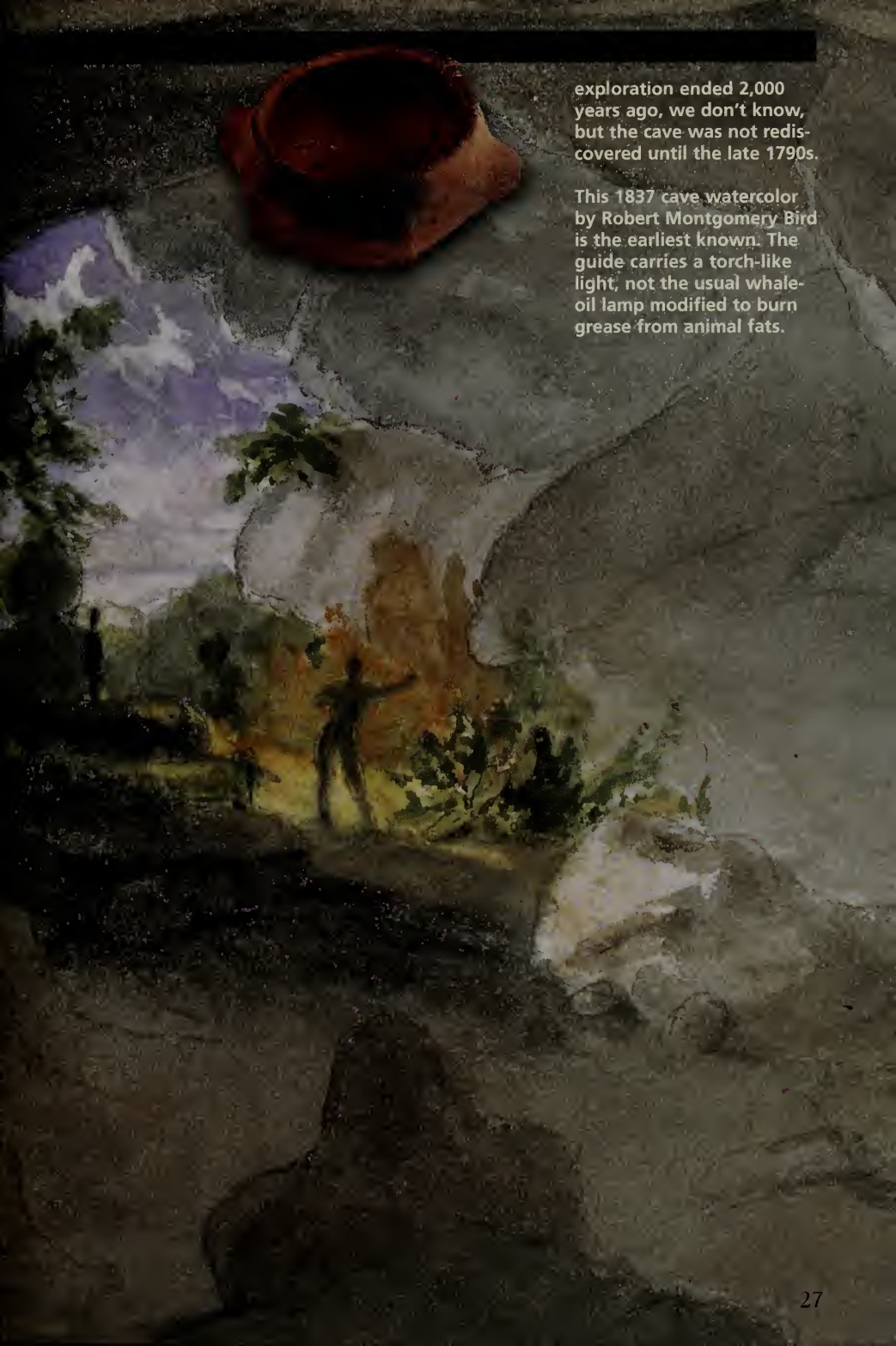

FLOYD COLLINS
HOME


Cascade Hall
Purgatory
Silliman's avenue
Stephanie's Retreat
Echo River
Grand walk
Sand Stone Steps
Broadway
Deserted Rooms
Serena's Retreat
Deserted Hollow
Creighan's Hall
Estudo avenue
PARTS OF THE
CAVE OF KY.
BY
ONE OF THE GUIDES
GRISWOLD, Louisville, Ky. 1845.

## Early Exploration of the Cave

People have been exploring Mammoth Cave for about 4,000 years. They collected a few minerals, but their major motivation seems to have been simple curiosity. How big is this hole in the ground, and how far does it extend? Despite modern geological sensing technologies, the best answers to those questions still come from getting in there and exploring. By 2,000 years ago, aboriginal people had explored at least 10 miles into the cave. That they collected cave crystals and salts does not mean curiosity did not propel them so far into the cave. (We do not know to what use they may have put those minerals.) Evidence of early cave treks includes plant torch materials, clothing, fiber sandals, footprints, the effigy pot at right, and feces. From throughout this first cave-exploration period, plant material preserved in the cave documents the momentous change from a hunter-and-gatherer lifestyle to cultivating and improving food crops. Why





exploration ended 2,000 years ago, we don't know, but the cave was not rediscovered until the late 1790s.

This 1837 cave watercolor by Robert Montgomery Bird is the earliest known. The guide carries a torch-like light, not the usual whale-oil lamp modified to burn grease from animal fats.

Rediscovered in 1798, Mammoth Cave was producing saltpeter before the War of 1812 with Britain. Calling it "cave nitrate," frontier people used saltpeter (potassium nitrate) for making gunpowder and for preserving meat. Valentine Simons owned the Mammoth and Dixon caves beneath his 200-acre claim in 1798. A later owner also produced saltpeter commercially, but production took off after Charles Wilkins and Fleming Gatewood purchased Mammoth Cave in 1810, using slaves to mine it. The War of 1812 saw saltpeter prices jump five-fold by 1813 but plummet with war's end in 1815. Publicity about the cave's role in the war effort and an increasing notoriety brought tourism to Mammoth Cave, at the western frontier then. The dried remains of a prehistoric miner in a nearby cave were hailed as a mummy." With Niagara Falls and a few other sites, Mammoth Cave became a part of America's version of Europe's Grand Tour even before the 1830s. Guided tours of the cave became increasingly sophisticated.

This 1837 watercolor by Robert Montgomery Bird shows the lodging that began as a log cabin serving the saltpeter mining activities. By sprawling additions, it became Mammoth Cave Hotel *(inset)*, serving tourists until it was destroyed by fire in 1916.

## The Cave Wars Era

Privately owned caves now considered part of the Mammoth Cave system competed for tourist dollars during the "Cave Wars" era. Roadside hawkers pitched other caves to passing coaches, attempting to lure the tourists away from Mammoth Cave. All the hoopla proved how popular cave tours were despite dirt roads alternately dusty-dry or quagmire-wet. Park City, on the road from Louisville to Nashville, grew up from Bell's Tavern, where travelers caught a local stage to Mammoth Cave. In 1886 the Mammoth Cave Railroad connected the cave with what is now Park City, using small engines like the one now displayed in the park—until automobile use *(inset photo)* shut the railroad down in 1929. A 1912 wedding *(large photo)* recalls Mammoth Cave's heyday as a top U.S. tourist attraction.

Stephen Bishop, a slave and guide, started exploring the cave in 1838. He was first to cross the Bottomless Pit and mapped many more miles

of the cave. Floyd Collins, trapped in Sand Cave in 1925, died before rescuers reached him. His story created a national spectacle. Today the Cave Research Foundation explores, surveys, and maps the cave and resurveys the work of earlier explorers.

## Establishing and Dedicating the Park—and the Work of the CCC

The eastern United States had no national parks when Congress, in 1926, authorized Mammoth Cave to be one. All national parks had been created from federal public lands; Congress had never appropriated funds to buy private land for parks. So, private citizens and the State of Kentucky contributed money to buy the land that would become Mammoth Cave National Park. The National Park Service was operating the park by 1941, but World War II put off its dedication until 1946. Secretary of the Interior Julius A. Krug accepted the cave from Kentucky Governor Simeon Willis for the Federal Government and National Park Service. Senator Alben W. Barkley *(inset photo)* was among those addressing the audience of 2,500. Creating the national park's infrastructure had fallen to four permanent camps of Civilian Conservation Corps (CCC) enrollees in that Depres-

sion-era public works program. For nine years this African-American CCC camp helped restore forests and build park roads, bridges, and buildings as well as cave walkways, lighting, rest facilities, and the boats and boat docks (no longer used) on the cave's underground river. For many African Americans this was

their first work for equal pay and in roughly comparable conditions with whites. World War II ended the CCC program. Many of the enrollees entered military service. We still benefit today from the dedicated work the CCC performed in the park.

## Mammoth Cave Timeline

**4,000 years ago**
Earliest evidence of ancient peoples exploring Mammoth Cave.

**2,000 years ago**
Last evidence for prehistoric use of the cave.

**Late 1700s and early 1800s**
Cave said to have been rediscovered by local settler John Houchins.

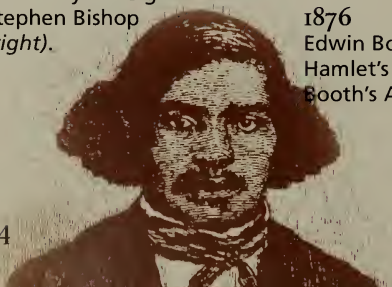
**1811**
Earthquake epicentered at New Madrid, Missouri, startles saltpeter miners in the cave but causes very little rockfall.

**1812-1815**
Saltpeter mining peaks during War of 1812—and ends when the war ends.

**1813**
The first preserved bodies discovered in cave region are popularly called "mummies."

**1816**
Mammoth Cave becomes a tourist attraction.

**1838**
First crossing of Bottomless Pit by slave guide Stephen Bishop *(right)*.



**1839**
Dr. John Croghan *(above)* buys Mammoth Cave and sets up world's first tuberculosis sanatorium in cave in 1842.

**1840-1841**
Stephen Bishop discovers underground river system, eyeless fish, Mammoth Dome, and Snowball Room.

**1849**
Dr. John Croghan dies, Mammoth Cave Estate formed from trust.

**1857**
Stephen Bishop dies.

**1866**
First photographs taken in Mammoth Cave.

**1875**
Child mummy discovered in Salts Cave.

**1876**
Edwin Booth delivers Hamlet's Soliloquy at Booth's Amphitheatre.

**1880**
Railroad begins serving Mammoth Cave *(below)*.

**1880**
James Gang robs Mammoth Cave stagecoaches.

**1893**
Cave exhibits shown at World's Columbian Exposition in Chicago.

**1906**
Steamboat service to Mammoth Cave *(above)*.

**1908-1909**
German engineer Max Kaemper and guide Ed Bishop map Mammoth Cave, discover new cave passages.

**1917**
First electric lights in cave.

**1921-22**
George Morrison opens New Entrance tours of Mammoth Cave.

**1923**
Frozen Niagara formation discovered.

**1924**
Mammoth Cave National Park Association formed to oversee Mammoth Cave estate.

**1925**
Floyd Collins *(above)* gets trapped in Sand Cave; dies after 17-day rescue attempt.

**1926**
Congress authorizes Mammoth Cave as a national park.

**1929**
Mammoth Cave railroad ends service.

**1931**
New Entrance and Frozen Niagara land sold to Kentucky National Park Commission.


**1933**
Civilian Conservation Corps camps *(logo above)* established; work begins on major infrastructure improvements for the new park in process.

**1935**
Prehistoric body known as "Lost John" discovered

**1941**
Mammoth Cave National Park established.

**1957**
Cave Research Foundation chartered.

**1972**
Connection of Mammoth Cave Ridge caves and Flint Ridge caves discovered *(above)*. This makes Mammoth Cave the world's longest known cave.

**1981**
Mammoth Cave National Park designated as World Heritage Site.

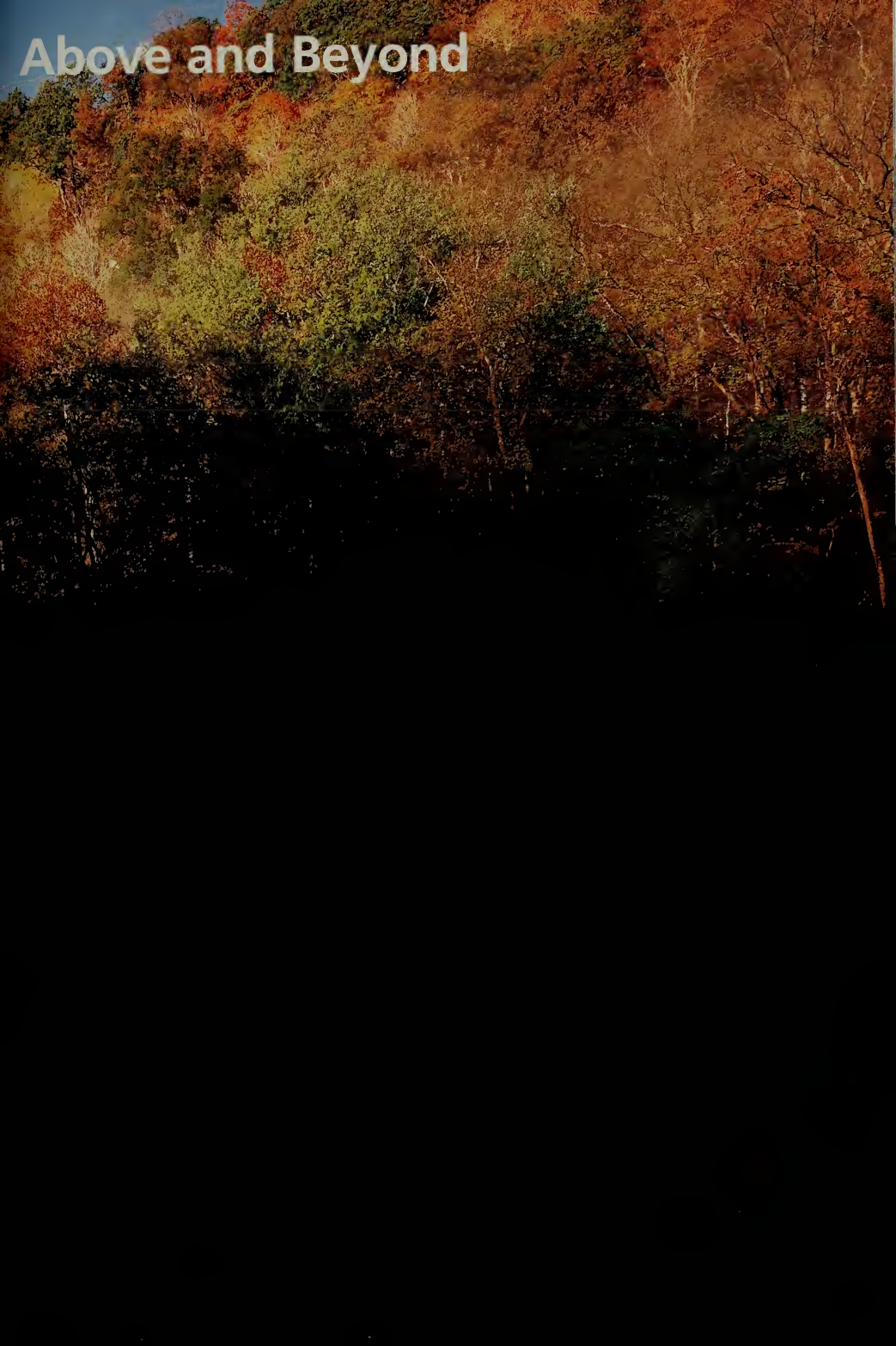
**1990**
Mammoth Cave National Park designated as International Biosphere Reserve.

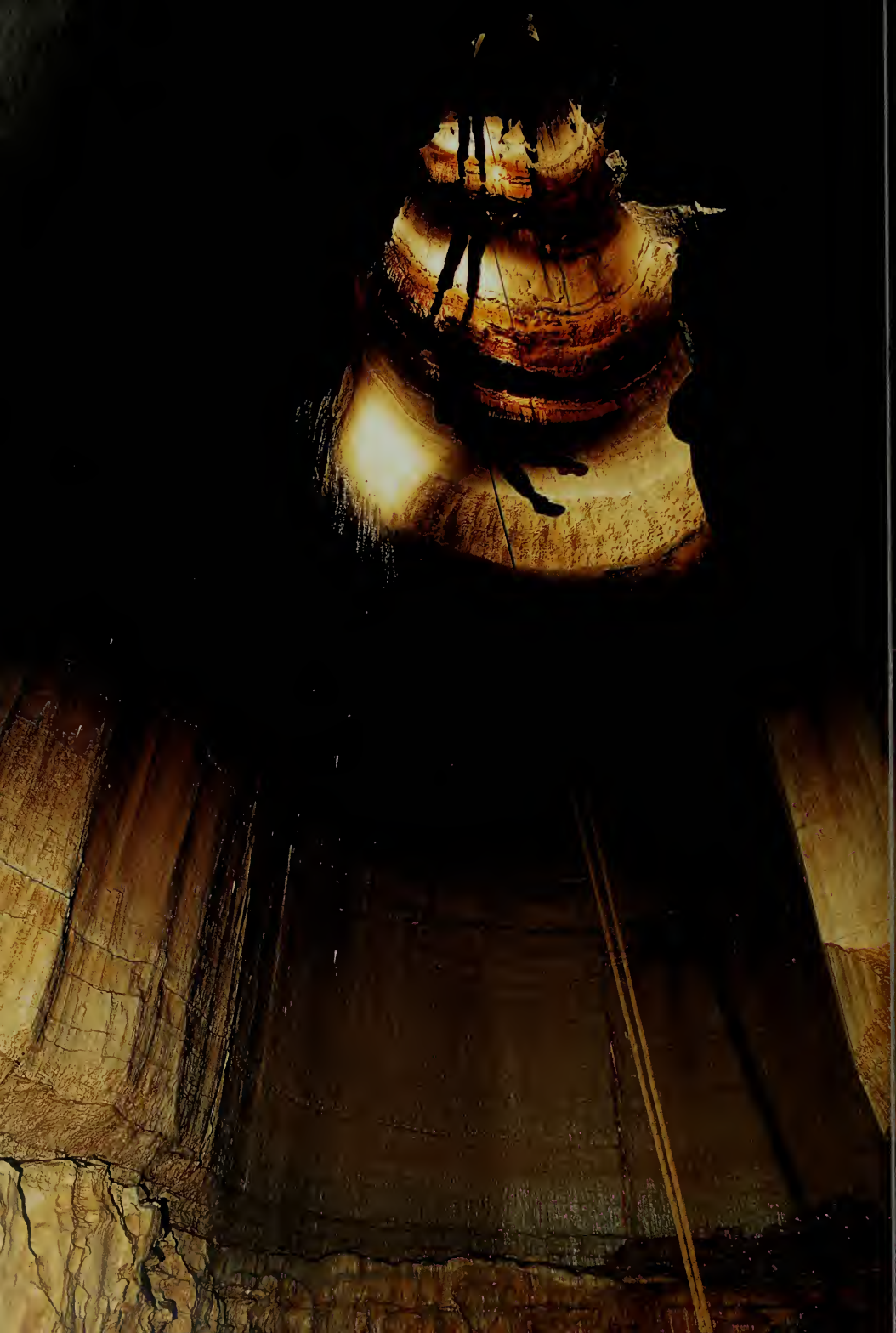
**1995**
National park joins Partners in Flight migratory bird conservation program.

**1998**
Archeologically intact major passage discovered in Mammoth Cave's historic section.

**1999**
Area citizens propose enlarging Biosphere Reserve to protect the region's karst ecosystem and other natural and cultural features.


Part 2


Above and Beyond



# Hide-and-Seek Rivers

*A caver rappeling a deep pit exemplifies how human curiosity about the cave goes on and on.*

Previous pages: *The Green River flows placidly beside forest canopies now given over to fall colors.*

Next pages: *Turf-smoothed dimples in cropland and circular stands of trees reveal the presence of sinkholes, important sources of water for the Mammoth Cave system downstream and underground. Atmospheric precipitation and surface runoff can enter the cave's water system through sinkholes, and so can spills of hazardous chemicals shipped by train or truck through the sinkhole plain.*

The greatest unknown facing Mammoth Cave's early explorers was its origin. Geology was just emerging as a science in 1800, and caves figured in a basic controversy. Some observers thought sudden, catastrophic events had formed caves. "The whole country is one bed of limestone," wrote one early traveler to south central Kentucky, "with as many caverns below as there are hills above, both seeming to have been formed at the same moment, and by the same cause, some primeval convulsion by which the rocky substratum was hollowed out, and the knobs heaped up." Other early geologists saw cave creation as a much slower process caused by water flowing underground through limestone bedrock.

Water seems a feeble force to have sculpted Mammoth's awesome passages, yet as geology developed through the early 19th century, the water explanation gained popularity. There was little evidence of past catastrophes, and a recent one, the big New Madrid, Missouri, earthquake in 1811, barely affected Mammoth Cave. The earthquake merely raised dust and knocked a few rocks from the cave ceiling. On the other hand, observers could watch water flowing through parts of the cave after every rainstorm.

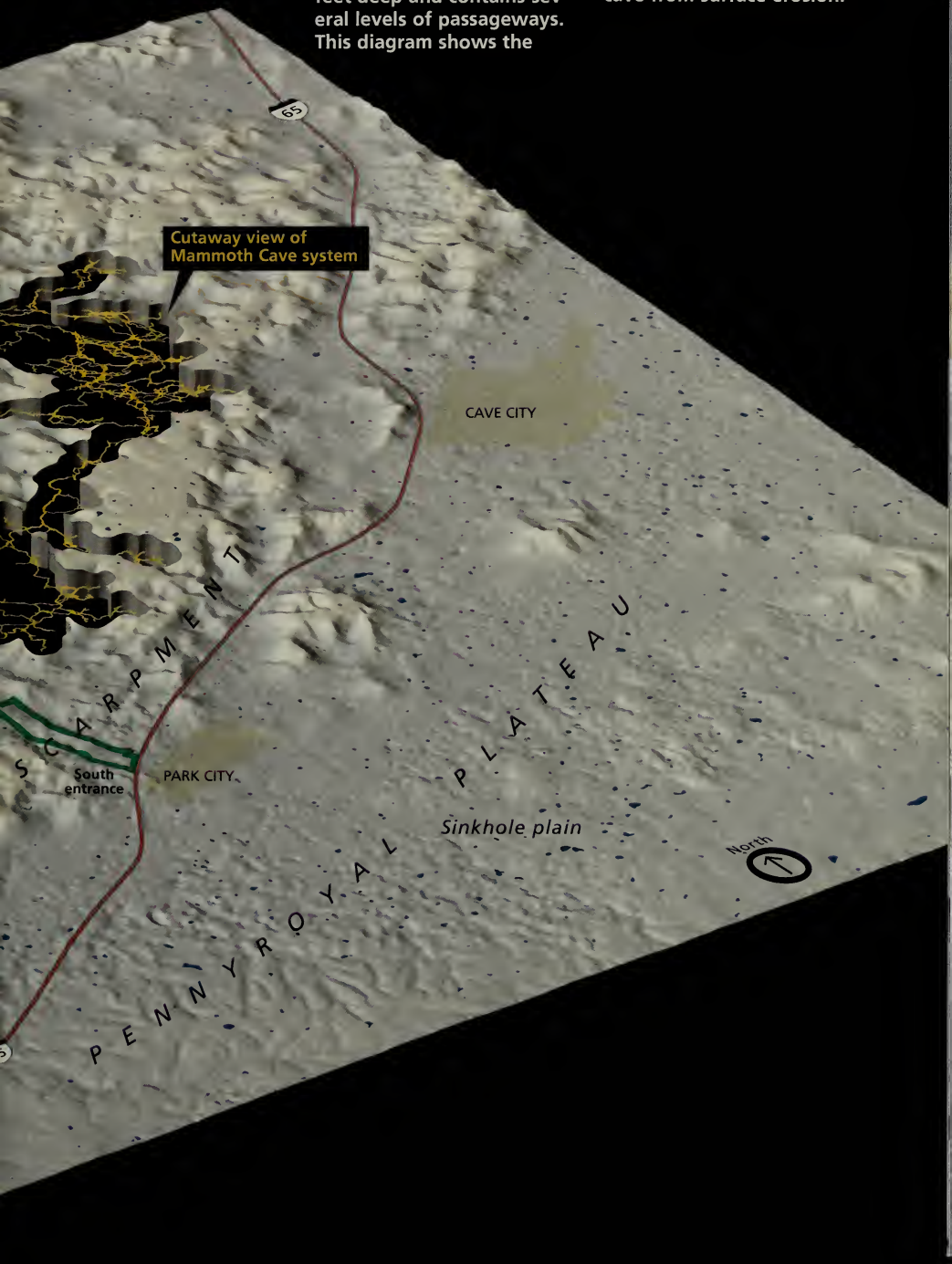
By the 1840s, Stephen Bishop was telling visitors that Mammoth had been "caverned out" by a stream. Emerson followed his lead, writing that "four combined engineers, water, limestone, gravitation, and time" had made the cave's "masterpieces." After an 1851 visit, Yale Geology Professor Benjamin Silliman confidently asserted that "water, and no other cause" was the cave's formative agent. By 1879, the public generally had accepted the idea that water slowly forms caves, and visitor Ralph Seymour could write that "the formation of Mammoth Cave must have occupied much more than a million years." (Volcanic action, surf, and wind also form caves, but such caves don't get as big as limestone ones.)

Geologists have had trouble understanding the

## The Cave Reflects the Region's Landscape

Formed by the solution of limestone bedrock, Mammoth Cave has developed in response to its regional landscape. The Green River, seen at upper left here, is the region's principal base-level stream. As it eroded through the sandstone-and-shale cap of the Mammoth Cave plateau, the region's ground water began to flow northwest from the sinkhole plain *(lower left)* to this lower water level. Springs appeared along the river, and caves began to form as the limestone was slowly dissolved by the slightly acidic rain water moving in the un-

derground streams. Each time the Green River cut its valley deeper, another, lower level of cave was formed. Today's Mammoth Cave system is some 400 feet deep and contains several levels of passageways. This diagram shows the cave as a stylized cutaway beneath the cap rock that continues to protect the cave from surface erosion.



*Limestone, sandstone, and conglomerate* (opposite) *are composed of progressively larger particles. In this area, some 300 million years ago, a river delta began to form. The mud and silt it deposited here formed fine-grained shale.*

*As uplift increased far to the north, the river steepened, flowed faster, and carried larger, sand-sized particles of quartz. These formed the Big Clifty sandstone layer that caps the bedrock limestone in which the cave system would form.*

*Later uplift to the north 200 million years ago enabled the river to carry larger mineral particles, rounded by tumbling action. These pebbles formed conglomerate when cemented together by lime or sand. Local names for conglomerate are puddingstone and bee rock.*

exact process and duration of Mammoth's formation, however, and no wonder. South central Kentucky is a complex, puzzling place, what has been called a "karst landscape" after a similar region in Slovenia. Visitors don't see any flowing water when they arrive in the area via I-65 on the rolling plain called the Pennyroyal Plateau. There are no permanent streams on the Pennyroyal Plateau south of the park because water sinks quickly into the highly soluble limestone. Streams entering from less soluble uplands south of the plateau disappear underground, and rain falling directly on the plateau vanishes into cracks and fissures in the limestone. Circular depressions dotting the plain show where the water has dissolved and enlarged such fractures in the bedrock, eventually forming funnel-shaped "sinkholes."

Flowing water remains hidden as visitors drive northward up the roads to the park among the cliffs, ridges, and valleys of the Mammoth Cave plateau. Streams that once cut the Houchins, Doyel, and Woolsey valleys into the Upland's sandstone sank out of sight after exposing the limestone beneath. When visitors finally do see flowing surface water in the park, however, they suddenly see a great deal. Just northeast of the park visitor center, the Green River cuts, like a serpentine moat, east-to-west through the Mammoth Cave plateau.

How did this hide-and-seek hydrology originate? It seems fairly clear that the flowing water that disappears under the Pennyroyal Plateau and then reappears in the Green River gets there through the underground rivers that Stephen Bishop first discovered in Mammoth Cave. Dye poured into sinkholes comes out in the river. Visitors can see some of the karst groundwater as it emerges from the cave at Echo River and River Styx springs, and they can see an exposed section of underground stream at Cedar Sink. Yet it's less clear just how all this happened.

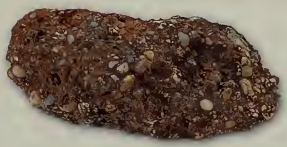
To the casual observer, it may seem to have come about at random, with underground streams dissolving their way here and there through the limestone. Explanations developed since the 1920s are more orderly. They are also more complicated.

Current accounts of Mammoth's formation go back not just a million years, but 350 million, to the Mississippian Period. North America was near the equator then, and a warm, shallow sea covered what

is now south central Kentucky. Mammoth Cave's limestone originated in that sea as calcium carbonate precipitated from the water. This substance accumulated on the bottom as ooze, eventually hardening into rock along with traces of the sea's prehistoric inhabitants—fossil of corals, flower-like crinoids, and clam-like brachiopods. Over millions of years, the sea grew shallower as a river flowing in from the north formed a delta, covering the older marine sediments with sand, mud, and gravel, which eventually hardened into sandstone, shale, and conglomerate. These rocks are easy to distinguish from the cave's gray, fine-grained limestone. The sandstone is light brown, relatively coarse-grained, and flecked with sparkling quartz. The shale is blackish and laminated, and the conglomerate consists of quartz pebbles cemented with lime or sand.

*Limestone*

*Sandstone*



*Conglomerate*

After the delta was deposited, a lot of things must have happened in what is now south central Kentucky. Dinosaurs would have appeared and disappeared, and early mammals would have replaced them. We can't be sure exactly what lived here then, however, because the rock strata that contained their fossil record had eroded away by about five million years ago. This erosion exposed the older Mississippian rock across a large area of the northeast Mississippi Basin. As this erosion proceeded, continental stresses caused the Basin to bulge, tilting the strata under south central Kentucky slightly downward to the northwest. These forces cracked the strata along lines of weakness. Water flowed into the cracks, and what we call Mammoth Cave slowly, slowly formed.

Cave formation begins as rainwater falls through the air and seeps through the soil. The water picks up carbon dioxide in the process, and becomes a weak solution of carbonic acid, about one-hundredth as corrosive as a carbonated soft drink. This weak acid dissolves limestone, but other rocks such as sandstone and shale are less soluble. The more erosion-resistant delta rock overlying the Mississippian marine limestone enabled a cave of such magnitude to form. If not for the Mammoth Cave plateau's sandstone and shale, water simply would have dissolved the limestone below it to the same level as the present Pennyroyal Plateau. Caves would have formed, as they have formed under the plateau, but they would have disappeared as erosion lowered the surface. The

## Longest Cave in the World…

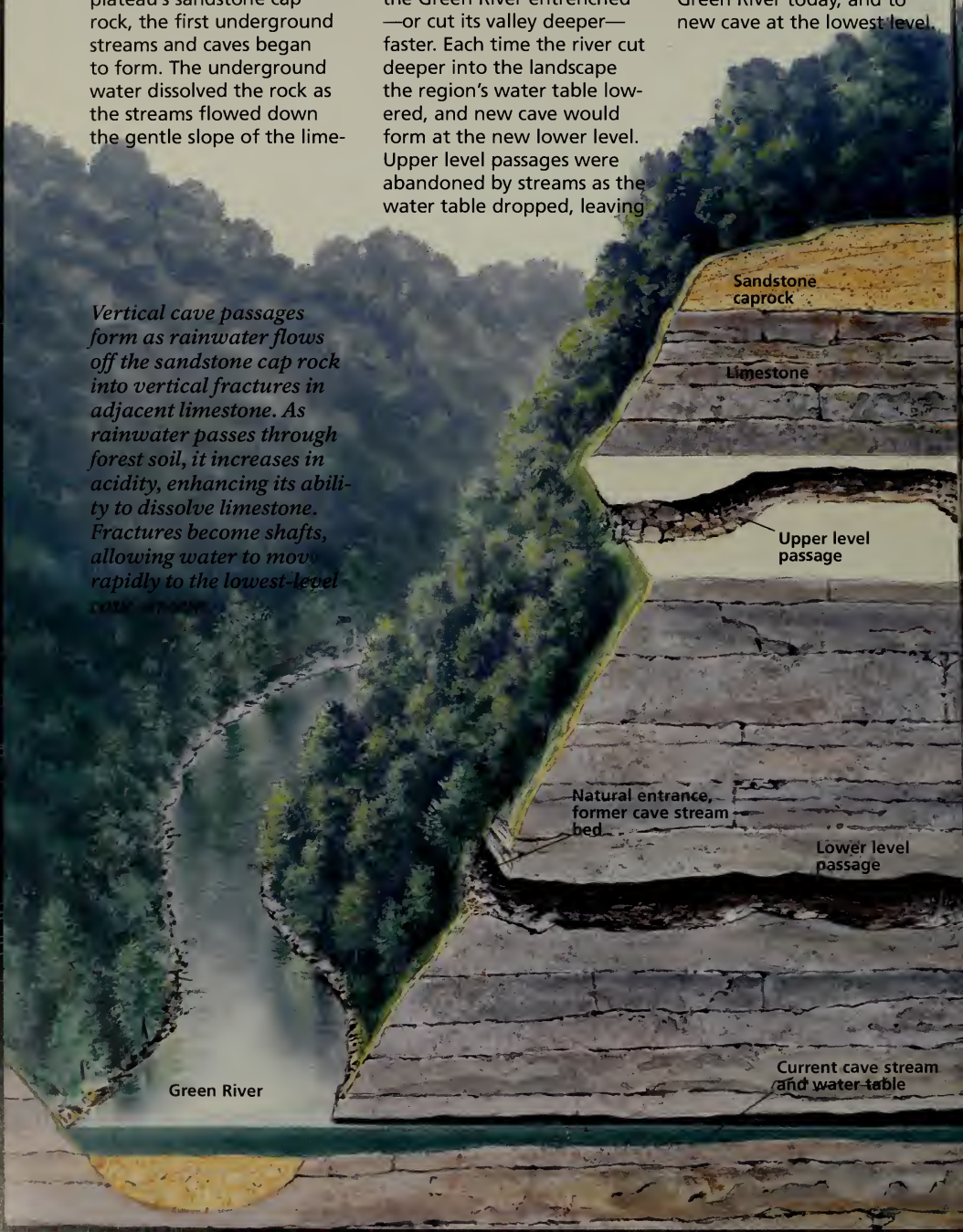
Mammoth Cave's 350 miles of passageways make it the world's longest cave. This does not mean you go in the cave and come out in, say, Chicago. The cave system is more like a spaghetti chart, as the illustration below suggests. There are several major layers and multiple connectors between the layers. Tours, shown as red lines here, explore only a small fraction of the cave system.

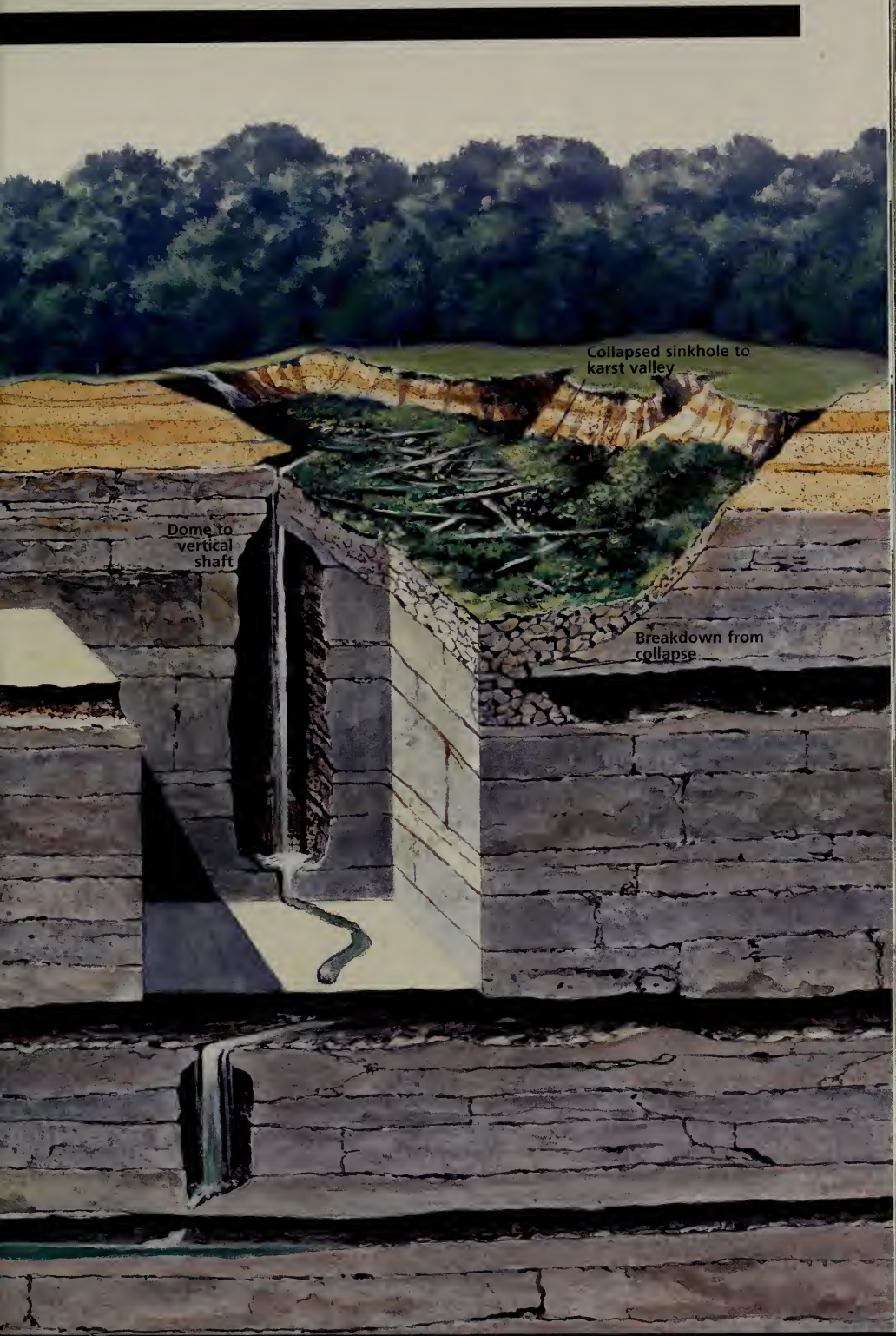

For 40 years the Cave Research Foundation (CRF) has been mapping the 350 miles of known passageways in Mammoth Cave. Sometimes walking, often crawling, survey crews set survey stations and then link them using compass, inclinometer, and tape measure. (The inclinometer measures vertical angles.) Today, computers run the trigonometry to plot the data points. This illustration is an actual 3D map of the entire Mammoth Cave system, created from CRF survey data.

## Hydrology and the Cave System's Formation

The Green River began cutting its deep valley through the Mammoth Cave plateau 30 million years ago. Once the river cut down past the plateau's sandstone cap rock, the first underground streams and caves began to form. The underground water dissolved the rock as the streams flowed down the gentle slope of the limestone beds to the Green River. In response to glacial action elsewhere in North America during the Pleistocene Epoch, or ice ages, the Green River entrenched —or cut its valley deeper— faster. Each time the river cut deeper into the landscape the region's water table lowered, and new cave would form at the new lower level. Upper level passages were abandoned by streams as the water table dropped, leaving behind dry cave passages. Some five different levels of cave passages have been identified in Mammoth Cave. Cave streams still flow to the Green River today, and to new cave at the lowest level.

*Vertical cave passages form as rainwater flows off the sandstone cap rock into vertical fractures in adjacent limestone. As rainwater passes through forest soil, it increases in acidity, enhancing its ability to dissolve limestone. Fractures become shafts, allowing water to mov rapidly to the lowest-level cave stream.*




Collapsed sinkhole to karst valley
Dome to vertical shaft
Breakdown from collapse

*A soft, white mineral that forms in very dry parts of the cave, gypsum takes several forms—and thousands of years to form snowball-sized deposits. The use of lanterns and torches in the past discolored gypsum formations.*

sandstone and shale protected the limestone of the older, upper cave levels from erosion.

Water has "caverned out" Mammoth in several ways. Surface water flowing down vertical cracks from sinkholes creates pit-like "shafts." Water following horizontal "bedding planes" between limestone strata carves out "canyons" and "tubes." Shafts and canyons form above the water table in the bedrock's "aerated zone," so gravity gives the water in them a force like that of waterfalls and creeks. Water behaves differently when it reaches the water table or "saturated zone." It dissolves tubes—level, elliptical passages following the bedding planes to the Green River.

Mammoth can seem a bewildering chaos of tubes. Geologists think the tubes formed at successively lower levels beneath the erosion-resistant sandstone as the Green River rapidly cut its valley deeper over the past two million years. The continental ice sheets probably caused this down-cutting as they advanced and retreated over the northern Mississippi Basin during this time, the Pleistocene Epoch. Glaciation buried what had been the northeast Mississippi Basin's major river, the Teays, under ice and debris, so the Ohio River became the region's major stream. Carrying the waters of the northern Appalachian Mountains, the Ohio cut its bed rapidly, and its tributaries such as the Green River did, too. As the Green lowered its bed, the water table would have dropped, too, and therefore the underground streams would have flowed at successively lower "base levels."

Geologists believe levels formed because the river was cutting into its bed at varying rates. The river might stay at a certain level for many thousands of years, then downcut its bed much faster for a time. It cut its bed more slowly during times of glacial retreat because the melting ice sheets were injecting vast amounts of sediment into the Ohio's watershed. Today the Green River's bed within the park is buried under some 30 feet of sediment left over from the Wisconsin glaciation, which ended 10,000 years ago.

These ideas may seem speculative, but there is a lot of concrete evidence for them underground. There are the more than 350 miles of cave passages, hard to account for in the absence of some very lengthy and complicated process. Four or five levels of passages are thought to lie above the water table under the

Mammoth Cave plateau south of the Green River. The oldest and highest level is a passage in Floyd Collins's Crystal Cave and is at least three million years old. The youngest and lowest level lies at the bottom of Mammoth Cave and is probably at least 100,000 years old.

Blocks of collapsed ceiling often obscure the passages, as do canyons that have dissected the floors of many tubes since the water table dropped below them. Yet the cave's ongoing formation becomes evident after rainstorms, when active shafts and canyons become cascades while upper passages stay as cosy as museum galleries. The cascades carry sand and gravel into the cave, and some upper-level passages are half-filled with such sediments. If enough rain falls, the Green River will flood and back up into the cave through the springs where the Echo River and other underground streams usually emerge, covering lower passages and leaving thick mud.

The exquisite mineral deposits on Mammoth's walls also support ideas of its antiquity. The caves' most extensive such deposits, gypsum crystals, are convincing evidence of its age. Because it is highly soluble, gypsum (calcium sulfate) crystallizes out of limestone only in the relatively dry caves. Gypsum also crystallizes very, very slowly, so the elegant structures that have grown from miles of Mammoth's passages—the "snowballs" of the dining room and the "flowers" and "gems" of Cleaveland's Cabinet—must have taken many millennia to develop.

Mammoth is relatively poor in the stalactites, stalagmites, flowstone, and other "travertine" structures that people usually associate with caves. Overlying sandstone strata prevents the gradual water flow that deposits them. Water rushes down Mammoth's shafts and canyons after a rain, but for the most part, it doesn't drip and trickle in a way that allows icicle-like stalactites to form. Still, the vast scale of the travertine deposits in places where conditions are right, such as at Frozen Niagara, supports the idea that Mammoth has been evolving for a long time.

The mineral deposits show, indeed, that Mammoth's main passages must have remained in an almost changeless state for an extraordinarily long time. Crystal Cave's upper passage presumably stayed the same for at least a million years before Floyd Collins found it. The upper passages under Mam-

*On some cave tours you can see fossil horn coral in the cave walls. These marine organisms arose some 570 million years ago in the great explosion of multicellular life that began with the Cambrian Period. Their presence shows that the cave limestone was laid down as seabed and that this happened more than 300 million years ago. At that time, what is now Kentucky was located 10 degrees south of the equator.*

*Limestone's main ingredient is the calcium carbonate that bonds its various grains together. It can be precipitated directly from seawater or indirectly—as shells, external skeletons, or other hard parts of living organisms.*

Next pages: *Audubon Avenue typifies the large passages in the upper level of Mammoth Cave. Its floor is breakdown boulders and sediment, which fill half the depth of this huge canyon.*

## Passageway Profiles and How They Form

Touring the cave makes it apparent that passages take different shapes, and these often show how they were formed. Small and sluggish streams can't form caves as fast as big and vigorous streams or waterfalls. Narrow canyons (A, *at right*) form as fast-moving water flows above water-table level. Tubular passages (B, *see photo*) form at or near the water table while flowing water fills them. A mushroom-like profile (C) results when faster, downcutting water turns the bottom of a tubular passage into a narrow canyon. A pit or shaft (D) forms as water sculpts a vertical crevice, perhaps below a sinkhole. At the cave's top levels, big passageways (E) like Broadway or Audubon Avenue *(see photo, pages 52-53)* took shape before the sinkhole plain south of today's park was well developed.

The surface streams captured underground then were fewer but bigger, and they carved out larger passageways. Profiles of these big passageways are often greatly modified by breakdown, rock fallen to the floor from walls or ceilings *(below, in Lee Cave in the park but not yet known to connect to Mammoth Cave)*. Passageways at lower levels of the Mammoth Cave system are not as big as Broadway or Audubon Avenue because less surface water enters the cave system now than in the distant past.

moth Cave Ridge must have remained unchanged for an equal amount of time.

Such stability seems fantastic today, when entire technologies appear and disappear in decades. Yet even technology can enter a twilight timelessness in Mammoth. Almost everywhere else, all vestiges of early 19th-century industry have whirled away in the currents of obsolescence and decay. In Mammoth, the wooden pipes and vats of the saltpeter industry remain where miners abandoned them soon after saltpeter's price dropped in 1815, following the end of the War of 1812. Dry rot has affected them, but they appear remarkably whole after the passage of almost two centuries. By contrast, large mine structures that once stood outside the Historic Entrance have vanished without a trace.

Of course, two centuries are a blink of geological time. Yet cane torches and plant-fiber sandals left two to four millennia ago by American Indian gypsum miners remain as recent-looking as the saltpeter vats. The fungi and bacteria that quickly reduce plant fiber to dust above ground don't thrive in the cave's dry inner passages, even though the cool dark seems ideal for mold. This might seem to go against common sense—decay is supposed to occur fastest underground—but the underground of a mere hole in the ground and the underground of Mammoth Cave are very different situations.

Opposite: *Wet-cave features formed by seeping water are not abundant in Mammoth Cave, but they are stunning where they do occur. These are in the Frozen Niagara area.*

# Refuge for Diversity

*If you see a tumbling stream on the surface of Mammoth Cave National Park, that means you must be north of the Green River. Indeed, this waterfall dances in the Wet Prong area.*

*The lands north of the Green River were included in the boundary authorized in 1926, to justify making the cave area a national park. National parks were all out West at that time, and most were big. The park's boosters thought that a plan to protect only the cave area south of the Green would fail to gain public support. In hindsight theirs was a marvelous move: the national park is now a haven for biological diversity and protects a great variety and abundance of life forms.*

Above: *Long feelers help cave crickets negotiate darkness, but these critters often venture out of caves at night to scavenge for food near the entrances.*

The stability of caves makes them virtual time capsules, not only of historic saltpeter vats and prehistoric cane torches but of geological time, too. A fossil coral found 300 feet down in the one-time bed of a Mississippian Period sea gives a much stronger sense of its almost unimaginable age than a similar fossil in a museum or even in a rock lying on the surface.

Of course, the coral inhabited that ancient sea more than 300 million years before Mammoth Cave began to form. Yet Mammoth is full of its own past too. The soil in its major passages is the sediment of million-year-old streams, and must contain an enormous amount of information about what the climate and ecology of both the cave and surface were like during the cave's formation. Extracting all this information will require research on a mammoth scale, but we have learned enough about south central Kentucky's landscapes—past and present, cave and surface—to get some vivid glimpses of Mammoth's 10 million years of existence.

The "human jaw bone of gigantic size" and other bones that Ebenezer Merriam saw or heard about in 1814 may have been a glimpse of Mammoth's living past. Although we probably never will be certain—because they have disappeared—those bones could well have belonged to a prehistoric animal. Ground sloths, huge herbivores that inhabited the Mississippi Basin until 10,000 years ago, had rounded jaws and peg-like teeth that could have been misinterpreted as a giant human's. Paleontologists found ground sloth bones in caves near Mammoth in the 1930s. Nearby caves also have yielded bones of mastodons, extinct relatives of the elephant.

In 1938 park guides Leo Hunt and Pete Hanson found a new passage in Mammoth that contained thousands of bones as well as spectacular travertine and gypsum deposits. When biologist Kenneth Dearolf studied the bones, he discovered that they belonged not only to animals that live in Kentucky

*At River Styx Spring an underground river that still works hard to form Mammoth Cave emerges. This cave river runs at about the same level as the Green River. When the Green rises high enough during floods, River Styx Spring reverses, and the nutrient-rich Green's water and sediments flow into the cave. This gives important seasonal boosts to the life-sustaining energy budget of the cave habitat. It can also raise water levels inside the cave by as much as 60 feet.*

*River Styx and Echo River springs can be reached by the network of trails that starts from the visitor center, picnic area, or campground.*

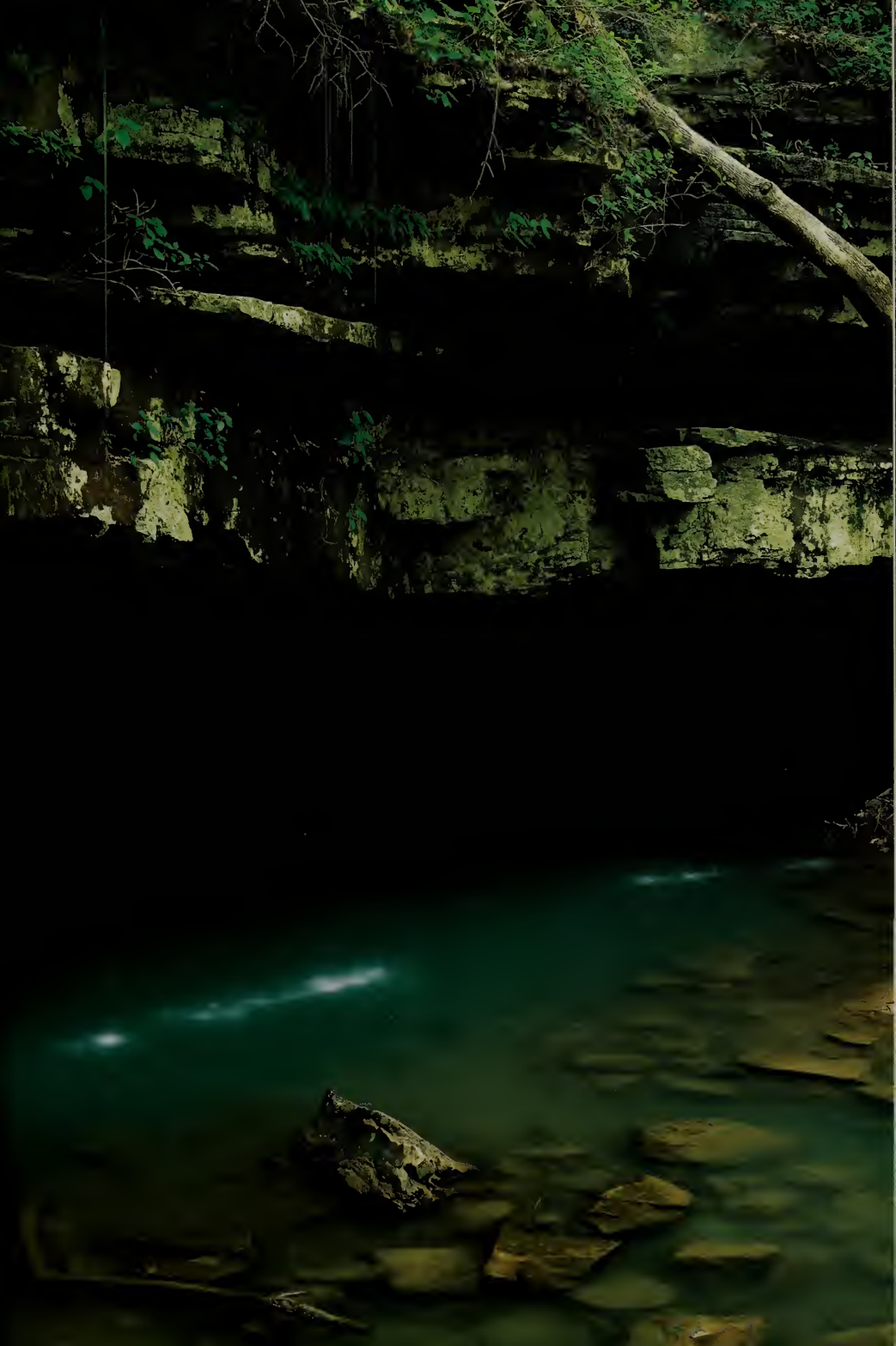
now—woodrats, raccoons, bobcats and a bear—but to a species that does not—the pine marten. This furbearer prefers conifer forest, so its bones may reflect a time when a more northerly forest type covered south central Kentucky. More recently, paleontological inventories in Mammoth's upper passages have yielded remains of further vanished animals—free-tailed bats and a vampire bat. These species now live mainly in Mexico and southward, so their bones hint at an interglacial time when Kentucky may have been much warmer, when jaguars may have roamed the Mammoth Cave plateau.

Mammoth's paleontology has been relatively little studied, and much remains to be learned about its past life and landscape. Yet its living inhabitants also provide information about the park's past. Some organisms may have moved into Mammoth Cave's impoverished but stable environment to escape changing surface conditions. They may therefore be relicts—fragments of the former surface community that have survived its changed environment.

The uncanny stability of caves is both a challenge and an opportunity for organisms. It is a challenge because of the very qualities that cause stability—darkness, coolness, and relative dryness. Most organisms cannot grow and reproduce without light, warmth, and water during at least part of their life cycles. The cave's scarcity of decay-causing bacteria and fungi is a measure of how deficient it is in those resources. Even the toughest organisms can't thrive cut off from sunlight or some other energy source. Green algae live inside Sahara desert rocks, but they can't live inside Mammoth—or couldn't until lighting was installed, and airborne spores grew into green stains on walls that bear light fixtures.

Caves aptly have been called "energy-starved" environments. Yet cave stability is an opportunity for organisms that somehow can meet the challenges of eternal darkness and relative coolness and dryness. Then caves can become a refuge from the energy-rich but volatile and competitive surface world.

The roughly 130 animal species known to inhabit Mammoth Cave use the subterranean environment in a variety of ways. Some enter caves only during part of their lives. Five bat species routinely take refuge from predators and weather in Mammoth, using its quiet passages for daytime sleeping, spring



reproduction, or winter hibernation. (Most will stay fairly near entrances, although the smallest species, the eastern pipistrel, may be found almost anywhere —I saw one sleeping on the Snowball Room ceiling.) Bats have surmounted the challenge of flying in darkness with the ingenious adaptation of echolocation. They guide themselves by hearing the echos of their own ultrasonic cries bouncing back from any obstacles. Mammoth Cave's bats cannot live only in caves, however, because the flying insects they eat are found outside.

Wood rats which often nest in cave passages, sometimes surprisingly deep, also depend on food from the surface. Such dependence on outside food is vital to Mammoth's ecosystem. By importing an energy source in the form of their feces and other organic materials, wood rats and bats link the surface's abundant food webs to the cave's impoverished ones. Fecal deposits support bacteria and fungi, which attract grazing organisms such as insects as well as creatures that prey on them, such as the long-tailed cave salamander.

Cave "crickets" (more closely related to katydids than to true crickets) are the most commonly seen such animals in Mammoth's passages. Their spookily long antennae are a typical adaptation to cave life, allowing them to pick up the slightest scent or vibration in the air. Their eyes are tiny, and probably do little more than distinguish between light and darkness. Food usually is so scarce in the cave, however, that crickets must come out at night to scavenge around cave entrances. This also makes them important as energy importers, and cricket fecal deposits near cave entrances support a community of organisms.

Many Mammoth Cave inhabitants can live only in caves. Blind cave beetles are the most commonly seen such animals in Mammoth. About a quarter-inch long and brownish in color, they live by digging up and eating the eggs cave crickets lay in passage soils. Most other cave-restricted species are rare, tiny, and/or secretive because of their energy-starved environment. Human visitors seldom see them. Quite a diversity of white, pinhead-sized things creeps about the cave, however. Primitive insects such as springtails and bristletails live in passages along with tiny flies, spiders, mites, pseudoscorpions, centipedes, and millipedes. Amphipods, isopods, cope-

*Below ground at Mammoth Cave National Park, biological diversity diminishes significantly. And why not? By photosynthesis, life on Earth thrives on sunlight, which barely reaches into caves. No* photo, *no* synthesis*—or precious little, which is why the influx of Green River floodwaters into cave habitat* (see the caption on page 60) *is so important.*

*People touring Mammoth Cave would no doubt give the most-often-seen-animal award to the cave cricket. Actually there are several species here, and cave crickets occur in basements and in suburban tunnels, sewers, and storm drains, too. Eyesight and long feelers help them find their way to cave entrances here—and outside to feed on green plants. In the cave, orb spiders and various salamanders prey on cave crickets.*

## Life in Total Darkness

Conspicuously absent, eyes that function would be of no use anyway to a fish that lives in total darkness deep in the lowest level of Mammoth Cave. Much of this eyeless cavefish's color is gone, as is that of the eyeless millipede and cave crayfish at right. Camouflage wins you nothing in the dark. Many cave dwellers have specifically adapted to their nutrition-poor environment. One strategy is to live longer. This gives you more opportunities to replace yourself reproductively. Endangered freshwater Kentucky cave shrimp, eyeless cavefish, and crayfish live longer than surface species. Lowering the metabolic rate is another strategy. An eyeless amphipod expends energy five or 10 times more slowly than surface amphipods. Rushing burns more fuel, so most cave critters move more slowly than their surface counterparts. Some egg-laying insects here lay

*The eyeless cavefish is also known locally as the blindfish. Most species of cavefish lack common names.*

fewer but larger eggs, giving their young a better chance to develop. Longer feelers tend to be the rule in the dark, too. Glacial advances during the ice age more than 10,000 years ago trapped many cave species here and set in motion their adaptations.

pods, and flatworms swim in pools and streams.

The most spectacular cave-restricted animals are eyeless white fish, crayfish, and shrimp that inhabit underground rivers. These relatively large creatures get around the energy-scarcity challenge by having slower metabolisms and longer life spans than their surface relatives do. They seldom eat, and they locate scarce food with powerful tactile organs. The two species of eyeless fish, called cavefish, that occur in south central Kentucky sense their surroundings with stitch-like structures on their skin. Oblivious to a flashlight, they will dart off nimbly at vibrations in the water.

Cavefish have a close relative that lives in surface waters of Atlantic coastal plain swamps from Virginia to Florida. That species, the swampfish, has eyes and is brown with black stripes, a "normal" little fish. Cavefish may have had a similar surface ancestor that inhabited the Mississippi Basin when conditions here were more like those of today's warmer and more swampy coastal plain. It may be that generations of that surface ancestor gradually moved underground to escape increasing ice age cold. Another related species which lives in cave springs from Kentucky to Missouri has small eyes and some pigmentation. Called the springfish, it implies an evolutionary transition between swampfish and cavefish.

One tiny cave-restricted cave animal is an even clearer vestige of a past world. It is the blind cave harvestman, distant relative of the common daddy-longlegs. National Speleological Society biologist Thomas C. Barr found three of these rare, predatory creatures under a piece of wood in a wet, seldom visited part of the cave in 1954. "About twenty species of the family to which it belongs linger on in temperate North America, living in caves or under rotting wood," Barr wrote, "but its close relatives (members of the same suborder) abound in the tropics."

Such creatures seem exotic, and they are fascinating, but there's a sense in which many of Mammoth's commonly seen surface organisms are also relicts. Some little tree and shrub species of the forest understory—abundant ones such as pawpaw and spicebush—are like the blind cave harvestman in that they belong to groups that live mainly in the tropics rather than in temperate latitudes. Such trees and shrubs may also may be vestiges of warmer times. Indeed,

the park's forest can seem like a Mexican rainforest in summer when colorful tanagers and warblers, themselves members of largely tropical bird families, have arrived from the south. Some year-round birds, such as the wild turkeys re-introduced into the park in the 1970s, also have tropical relatives.

On the other hand, hemlocks and yellow birches that grow on shady north slopes perhaps are relicts of the last glacial period, when a forest now typical of Minnesota covered south central Kentucky. Park forests may even seem to be in Minnesota during winter storms, when northern creatures such as snowy owls may appear south of the Ohio River.

Even the beeches, hickories, maples, oaks, and tulip poplars of the so-called "mixed mesophytic" temperate deciduous forest that is now dominant in the park are relicts of a sort. Fossil evidence shows that a deciduous forest of oak, magnolia, and other hardwood trees grew across what is now the Arctic of Greenland, Canada, and Siberia 80 million years ago. That forest migrated south as the climate began to cool about 50 million years ago. Kentucky's forest trees still have close relatives in Europe and Asia, as do smaller plants—wild hydrangea, anemone, and redbud. Many forest animals also have ancient affinities with Asian and European species, from deer and foxes to the ever-present jays, chickadees, and nuthatches. This temperate lowland forest is even more threatened in Europe and Asia than here in the Mississippi Basin, so Mammoth Cave National Park's woodlands are important in themselves.

Only very small parts of the park, such as the "Big Woods" at the northeast corner, contain old-growth forest. A century of clearing had removed most large trees by 1926, and the fallen trunks of chestnuts and the loss of American elms show that the park has lost major tree species to introduced disease. Some animals have disappeared as well. Visitors sometimes are disappointed that they don't see black bears. This species is inextricably linked with national parks in the public's mind, but Mammoth is isolated from the nearest bear population in the Cumberland Plateau.

Despite losses of species, the regrowth of scrubby second-growth woodland into the "miles of beech trees, every third one an unsung monarch"—which Nathaniel Willis described more than a century ago—is one of Mammoth's more hopeful spectacles. Park

*Preserving Mammoth Cave within a national park had the unforeseen additional benefit of creating a surface refuge or sanctuary for plant and animal species that today are threatened or endangered regionally or nationally.*

*Many of the most endangered classes of organisms nationwide are freshwater species, such as mussels* (above). *Within the national park, the Green River, protected on both sides for a significant stretch, is now home to two thirds of the more than 70 species of mussels known throughout the river's total length. Keeping regional waters clean to benefit Mammoth Cave's ecosystem also benefits all life in the Green River, into which cave rivers, streams, and springs flow.*

*Because creating the national park also meant there would be no more farming, logging, mining, or urbanization, the landscape began to restore itself, in the late 1920s, from human activities and toward a more natural state. Today the park is among Kentucky's significant protectors of the variety and diversity of life, from eyeless cavefish, to mussels and birds.*

## 1930

*This aerial photograph of the area's vegetation in 1930 shows how much of what is now Mammoth Cave National Park was then used for agriculture.*

1990

*A 1990 photograph shows how the area recovered to forest as a national park. A hundred years from now, more and more people may see park woodlands as sacred groves.*

*Small forest delights include these trilliums* (above), *which may reward woods walkers.*

Opposite: *Relatively open forests dominated by cedars often grow on sloping areas underlain by limestone. Such forests are some of the least disturbed, historically, of all plant communities in the park. Their sparse soils did not support agriculture, and the cedars saw only limited but important use by humans as fence posts. These forests hold so little surface moisture available to plants that they are called dry, or xeric, communities.*

Next pages: *Against a mossy backdrop, roots of a birch tree reach groundward in a seasonally moist park area north of the Green River.*

visitors someday will have an opportunity, now virtually unavailable, to walk for a day through Mississippi Basin old-growth forest and savanna.

The national park also protects remnants of the Mississippi Basin's most threatened major ecosystem. Tallgrass prairie covered the Pennyroyal Plateau in historic times, and bison and elk grazed it. "Formerly, these Barrens were destitute of timber but were covered with grass and with flowers that grew spontaneous and with great luxuriance," Ebenezer Merriam wrote. He described great lightning fires that burned across the plateau every year. Botanists think such prairies, similar to but isolated from the Midwest's much larger ones, were relicts of an arid period when grasslands extended east of the Mississippi as far as central Kentucky. Fire and the relative scarcity of surface water in the karst terrain perpetuated a six-foot-tall mixture of native grasses such as big bluestem, and forbs such as blazing star, butterflyweed, and purple coneflower. Farming extirpated the tallgrass prairie from the plateau, as it did from most of North America, but patches of its colorful plants still live in the park's open spaces and roadsides.

Among the national park's most ancient organisms are the more than 80 fish species, 50 freshwater mussel species, and other aquatic creatures that inhabit the streams within its boundary. As a lowland of extraordinary age—like the Amazon Basin—the Mississippi Basin has accumulated a great diversity of wonderfully primitive life forms. Turtles, for example, have existed in much their present form for 225 million years, so seeing the softshell and map turtles that sun themselves on river snags is like seeing the world before the dinosaurs.

Freshwater mussels have inhabited rivers at least as long as turtles have. The Mississippi Basin has the greatest diversity of these mollusks in the world. They are not often seen alive, but their attractively shaped and colored shells are common on gravel bars. The shells' delicately tinted mother-of-pearl is blue, purple, or pink as well as white, according to the species. It supported a profitable button industry before plastics, water pollution, and habitat alteration from dams. Freshwater mussels live by seining detritus from the water with a so-called "mantle" that is colored bright orange or scarlet in some species. They pull themselves about stream bottoms with a muscu-

## Some Glimpses of Life on the Surface

Worldwide the biggest threat to birdlife is destruction of habitat. This applies to many other animals and to plants, too. Natural habitats disappear as humans use more and more land for housing, industry, agriculture, forestry, and mining.

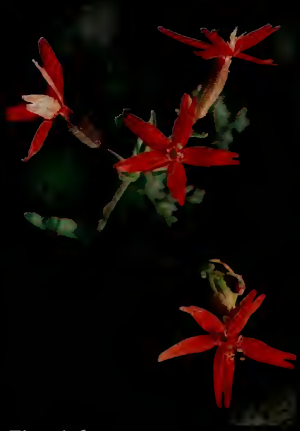
Mammoth Cave National Park is particularly important as bird habitat because its forests are expanding, not shrinking. In so many areas once-expansive forests are now gone or are carved up into such small strips and blocks that certain forest-nesting birds no longer raise young there. This is the problem known as forest fragmentation.

Mature and old forests are important to cavity-nesting birds that rely on holes in—often—dead trees for nest sites. Woodpeckers depend on such forests, too. These same forests support fewer white-tailed deer, however, because they contain fewer saplings and the shrubbery that deer like to browse.

The park also preserves important wetland areas now drained over so much of the nation.

*Downy woodpecker*

*Yellowthroat warbler*



*Firepink*

*Virginia white-tailed deer*

*Eastern tailed blue butterfly*

*Cardinal flower*

*Crested dwarf iris*

*Bullfrog*

*Southern flying squirrel*

*Wild turkey*

*Barred owl*

*Eastern mud turtle*

lar "foot," as clams do. The various species' common names—elk's toe, cob shell, snuffbox, mucket—evoke 19th-century frontier times, when those expressive names were coined.

The upshot of this long evolutionary past is that a biodiversity of global significance survives in this park's cave and surface habitats. I got a sense of this one hot afternoon as I walked along the Green River's north bank. I heard squawks and wingbeats as I approached a rocky ledge, and realized I'd disturbed a wild turkey flock that perhaps had been enjoying the cool breeze from some limestone fissure. I certainly enjoyed it as I stood under the ledge. It evoked the cool wind of the Historic Entrance, and I imagined that bats and wood rats might be sleeping through the day inside the hidden fissure.

Big white oaks and sycamores soared overhead, and tall canes and yellow-flowered wingstems covered the bank. Robins and wood thrushes skulked in the shrubs, and swallowtail and tortoiseshell butterflies fluttered over the river mud. Looking around, I realized I probably was seeing very much what Ralph Waldo Emerson would have seen in the summer of 1850. Riding a steamboat up the Green from the Ohio, Emerson found the river "fringed with primitive forest on both sides," and described how "wild turkeys flew before us from tree to tree."

After I'd been standing under the ledge awhile, one of the turkeys sneaked back to see if I was still intruding. Finding that I was, it launched peevishly into the air and flapped away to the river's other bank. Then the scene relapsed to an early September torpor that might have been in any summer of the past thousand years. The Green flowed quietly toward the Ohio, disturbed only by the occasional flight of a wood duck or kingfisher, the jump of a fish, or the wake of a swimming deer.

*This dragonfly is in no danger from the gray tree frog* (left), *because the frog commonly is active only at night. Its scientific name,* Hyla versicolor, *suggests why a frog called gray looks green. Its varied coloration is good camouflage in trees. Its European cousin can rapidly go from a bright green to gray.*

*With damselflies, dragonflies make up an insect order that includes some 4,900 species worldwide. Dragonflies are highly predatory. The large and mobile head holds large compound eyes and biting mouthparts. And if you see a dragonfly flying backwards, don't doubt yourself. They can and do. They also turn on a very tight radius—within the length of their own bodies.*

# Possibilities of Stability

*One of the most important roles of national parks in American life is to represent the interests of the future to those now living. In creating national parks and other protected natural and cultural areas, Congress has declared that preserving our heritage is crucial not only for generations now living but also for future ones. This is a very fair and equitable policy because the number of future citizens always outnumbers those now living—or so we hope!*

*Today the national park contains three churches—Mammoth Cave Baptist Church is at left—and more than 70 cemeteries. Family members and genealogists make use of the cemetery listings that the National Park Service keeps. The grave of Floyd Collins, who died in 1925 while he was trapped in Sand Cave, is in this cemetery.*

Mammoth Cave has preserved particularly vivid glimpses of local American Indian culture from between about 4,000 to 2,000 years ago. Archeologists have learned intimate details of the ancient peoples' lives from traces they left on the cave floor as they explored its passages and camped in its entrances. Cane torches, footprints, and other evidence show that they penetrated at least two-and-a-half miles from the Historic Entrance to collect gypsum, selenite, and other minerals from the walls.

When park guides found a prehistoric accident victim in 1935, scientists even were able to study the well-preserved body—including skin, hair, and internal organs—of a man who had entered the cave over two millennia ago. (Unfortunately, "Fawn Hoof" and other "mummies" discovered in the 19th century had been lost or destroyed by the 1900s.) The middle-aged, 5-foot-3-inch tall man apparently had been in good health—except for a few intestinal parasites—when a limestone slab shifted and trapped him as he gathered gypsum crystals in a dry passage. He had lain undisturbed, wearing a mussel shell necklace and what may have been a garment of woven bark, ever since.

These ancient people left feces as well as shells and bones in the cave, so archeologists have a good idea of their diet. They ate mostly nuts, seeds, and other plant foods supplemented with game, fish, and mollusks. Interestingly, plant remains show that American Indians then were in the process of developing agriculture. They ate domesticated plants such as sunflower and lamb's quarter. The increasing size of these domesticated seeds in successively younger cave deposits suggests that the prehistoric farmers were selectively improving their plant stock. The appearance of squash gourds in later deposits further suggests that the local people were assimilating plant cultivars and probably other traits from cultures to the south.

*Now recovering to forests, the park may look as though no one ever lived here, but people have lived here 8,000 years or more. A woven fiber sandal* (above) *is a far more recent clue to prehistoric park residents. People of Scotch-Irish, Pennsylvania German, and French Huguenot heritage moved into the area around 1800. Many people worked small farms here into the 1930s, when those were bought to create the park.*

Opposite: *A solitary caver beneath Mammoth Dome's shaft suggests flowing water's immense power to sculpt this limestone. Water flows vertically like this to join, deep down, a horizontal river.*

Next Pages: *Children enjoy a special tour—and no doubt enjoy wearing headlamps, too!*

Other evidence shows that the people who frequented Mammoth Cave made pottery and twined soft basswood, pawpaw, and other plant fibers to make footwear, clothing, and other artifacts. Yet much remains mysterious about them. Their language is unknown, as is how they relate to the sophisticated moundbuilder cultures that developed in the Mississippi Basin beginning about 3,000 years ago. We also are largely ignorant of their relationship to Mammoth Cave. We don't know why they started visiting the cave 4,000 years ago and then apparently stopped completely after 2,000 years. Their reasons for collecting cave minerals also remain mysterious, because there is no evidence of what they did with them. They may have used them for rituals or decorations, or as medicines or food seasonings, but gypsum and related minerals deteriorate quickly outside the cave. The vast moundbuilder sites of the Mississippi and Ohio river valleys, which contain ancient trade goods from as far away as the Rocky Mountains, have yielded no traces of these Mammoth Cave minerals.

The mystery of these ancient people's relationship to Mammoth Cave raises a related contemporary question. What does Mammoth Cave mean to us, who visit it today? The cave supports a profitable tourist industry attracting worldwide visitation, and it has great cultural value, educating visitors on geology and ecology. It offers fascinating challenges to explorers and scientists. The United Nations recognized these values in 1981 when it listed Mammoth Cave National Park as a World Heritage Site, classifying it with the Egyptian pyramids and the Grand Canyon as a "wonder of the world" precious to all humanity. Yet in a civilization of ever-accelerating cultural and technological change, can a place where change hardly exists have a significance beyond vacations, school field trips, and Ph.D. theses?

Unexpected answers can arise to such a question. The idea that a billion dollar industry called "DNA fingerprinting" would arise from a species of bacterium discovered in a Yellowstone National Park hot spring would have seemed fanciful two decades ago. That is what happened, however. Study of the bacterium yielded an enzyme which allows the fingerprinting process to occur at a commercially viable rate. Study of complex natural systems such as hot

springs or caves often leads to significant discoveries. In fact, there is no way of predicting just what information a natural system may generate. The 1954 National Speleological Society Expedition collected hundreds of vials of earth from Crystal Cave's floor in the hope that they would yield new antibiotic-producing mold species. As it happened, they did not. This perhaps isn't surprising, because energy-starved caves turn out to be hard places for molds to live. An attempt to start a Mammoth Cave mushroom farm failed in the 1880s. Biologist Thomas Barr has written that "there probably are no species of plants indigenous to caves; the kinds of plants that do develop there germinate from spores brought in by air currents and various animals, including man."

Yet the blind alleys of some scientific studies do not foreclose other possibilities. The first thing explorers learn is that the potential for cave passages to ramify into more cave passages is great, and the only way to find where they go is to try them all. Certainly, the fact that cave organisms have adapted to survive on scarce energy resources suggests that they might have things to teach a civilization dependent on abundant but nonrenewable energy resources.

One thing is predictable: the quality of information generated by a system like Mammoth Cave will depend on the system's integrity. For example, scientists today can't learn much from the mummy called Fawn Hoof because her once well-preserved body has been reduced to a skeleton stored in the Smithsonian Institution. Future scientists wouldn't learn much from a cave system if it were to become a mere vestige of its former complexity.

Civilization already has simplified the Mammoth Cave system in some ways. When the national park's Historic Entrance Ecological Restoration Project invited bat expert Merlin Tuttle to visit Mammoth in 1996, he estimated from ancient stains on upper level Historic Route passages that it once had sheltered nine to 13 million bats. That would have made it one of the greatest hibernating colonies in the world. Early cave visitors described large bat populations in the Audubon Avenue area, where Tuttle thought as many as five million bats may have lived. Ebenezer Merriam saw them hanging "in clusters like bees in a swarming" in 1814, and as late as 1851, Benjamin Silliman described "countless groups of them on the

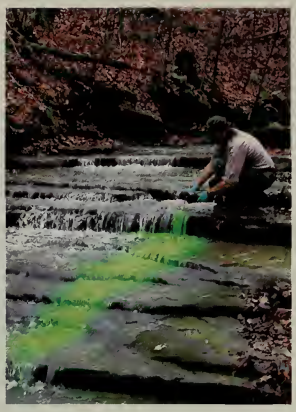
ceilings...within a mile or two of the mouth of the cave.... And it is safe to number them in millions."

Probably only a few thousand bats now frequent the cave, however. Human activity has reduced their numbers through both direct disturbance and environmental changes. Although the interior cave maintains a stable temperature, the temperature of outer passages used by most bats shifts seasonally as air flows outward in summer and inward in winter. Hibernating bats can survive only within a narrow temperature range, and human manipulation of the Historic Entrance during the past two centuries apparently made the climate and airflow in the passages inhospitable to the bats.

The difference between an ecosystem with millions of bats importing energy and one with less than a thousand must be considerable indeed. The study of wall stains, bat bones, and other traces of the past can help scientists and park managers learn how the cave once functioned. Yet the best way to learn how the cave system works is to restore bat colonies and other natural features, and that will not prove easy. A 1990 attempt to help restore them by replacing a masonry gate with an open-grid gate had the unexpected effect of changing the cave climate even more from its prehistoric state. The new gate allowed cold air to move farther inside during winter. This influx of cold air caused some deterioration of the cave's geological and cultural features.

Human activity can impoverish the cave system by adding things as well as subtracting them. This is perhaps the greatest future threat to the biota. Most of the water in cave rivers originates outside the park boundary—from the Pennyroyal Plateau and farther south—and the limestone bedrock doesn't filter this water. Sewage, toxic wastes, and other pollutants can quickly enter the park through underground drainage. Such substances can move through almost a mile of karst terrain in a single night, and their movements are essentially impossible to control once they have entered the ground.

Pollution of cave waters has contributed to the federally endangered status of the cave shrimp, *Palaeomonias ganteri*, which lives nowhere else outside the Mammoth Cave area. Pollution of the Green River with topsoil from farm operations as well as sewage and other substances has contributed to the endan-



*Dye-tracing studies have led to better preparedness for the protection of the cave's ecosystem should a spill of hazardous materials happen. Both roads and railroad lines cross the land surfaces that collect the precipitation that recharges the cave's streams and rivers.*

*Dye placed into the ground via sinkholes far south of the cave itself reveals how—and how fast—water moves into and through the cave's mostly underground water system.*

## Bats and the Ecological Restoration of the Cave

Until recently it was assumed that Mammoth Cave had never been important habitat for large numbers of bats. Not so. By 1810 and as late as 1851, cave visitors wrote of bats as thick as clusters of bees, like clouds, and "safe to number in millions." There may have been 10 to 30 million bats, but they left before the national park came to be, and people forgot. Mammoth Cave may even have hosted one of the world's greatest bat hibernating colonies—apparently abandoned because, over some 200 years, human activities have changed the air flow through the Historic Entrance. Hibernating bats can survive only within a narrow temperature range. When it changed they left. Millions of bats living in Mammoth Cave would have greatly boosted potential food-energy in the cave that came from outside sources. The park staff is working to get bats back by restoring the Historic Entrance ecologically, with its gate baffled to mimic natural air flow

*Gray bat*

*Amazing echolocation ability makes it possible for bats to use dark caves for shelter, hibernation, and to rear their young. Highly directional hearing lets bats "picture" their dark environment and what moves through it.*

and restore natural temperatures and humidity near the opening. The inset photo shows another park cave gate and the horizontal grill that allows bats to fly through easily. Today park caves harbor endangered Indiana and gray bats, the eastern pipistrel, and big and little brown bats.

*Big brown bat*

## Things To See and Do Above Ground in the Park

You don't need to remain in the dark to have fun here at Mammoth Cave National Park. Preserving the cave in a national park has created, over time, a large protected natural area that offers lots to do above ground, too.

Because the cave is so popular, you may be surprised to hear a ranger talk about a "surface hike" or "surface activity." That means something to do above ground! North of the Green River there are 60 miles of hiking and walking trails. South of the river there are 10 miles of trails. The river itself can often offer good canoeing and kayaking.

Birding is a popular pursuit. The park's large areas of uninterrupted woodlands are important nesting habitat for migratory songbirds. Rivers and wetlands add to the mix of birding habitats and of the species you may list. See Part 3 of this handbook for information about ranger-led programs and other "surface activities" in the park.

*Canoeing the river*

*Sharing a story*

*Learning to appreciate nature*

*Bicycling*

*Afield with a naturalist*

gered status of six freshwater mussel species in the national park. A single accidental spill of some highly toxic material from a truck on I-65 could have a disastrous effect on Mammoth Cave National Park's aquatic ecosystems, both above and below ground—and toxic spills occur in the area almost every year. Air pollution also may be simplifying the park ecosystem by removing species, which diminishes the park and its ecosystem. High ozone levels may impact sensitive plants. Acid rain and other acidic deposition may threaten amphibian breeding waters, although there is no data on this yet.

The National Park Service has acted in recent decades to reduce or reverse the impoverishment of Mammoth Cave's natural system. It has now stopped some traditional visitor activities. Lighted rags are no longer flung into dark corners in the cave to illuminate them dramatically. The Echo River boat trips were disturbing the aquatic ecosystem, and they have been discontinued. Some caves have been gated to curtail disturbance of bats and other creatures, and public entrances are being redesigned to make them more wildlife friendly. Park managers have gated the upper approach to the Historic Entrance and reconfigured lights to reduce the disturbance of bats. They have rerouted some tours.

Such management actions may be showing benefits for cave biodiversity. At the Historic Entrance in mid-1998, mist netting (catching bats in soft nets strung across flight paths, then releasing them after identification) turned up more individuals than at nearby Dixon Cave, which is closed to visitors. Bat numbers have increased in other caves as human measures improved conditions for them. If Mammoth Cave's bat population does grow, its growth will have national significance. Two of its species—the Indiana and gray bats—are federally endangered.

"Mammoth Cave National Park has the opportunity to conduct the grandest experiment ever," Merlin Tuttle has said, "to work with something we have extirpated...and bring it back!" Some people might not welcome increasing bat numbers, yet these are far more appealing animals than once thought. Traditional photos of grimacing, fanged bat faces often resulted from rough handling of the bats. Tuttle's more recent portraits of happy bats instead show strange but rather winsome little beings. The restoration of

Mammoth's bat colonies would have a generally welcome effect on insect populations, as well. Individual bats may consume half their body weight of insects in a single night, eating an insect every few seconds.

However, bats suffer from more than disturbance and change within their caves. Widespread pesticide use probably has helped decimate them—by reducing their food supply and poisoning many individuals. Pesticides also are among the many substances that flush quickly into underground streams in karst landscapes. Faced with such threats, which reflect the cave's own complexity, the park's managers increasingly have had to look beyond the park's boundary to address its mandate of protecting both the park's and Mammoth Cave's natural systems.

Fortunately, the local concern for Mammoth Cave that led to the park's creation continues to be keen, and the National Park Service has been able to work very innovatively with regional government agencies.

The area's Barren River Area Development District (BRADD) coordinates concerns for sustainable economic development in 10 south central Kentucky counties. In the late 1980s, BRADD applied to the United Nations Educational, Scientific, and Cultural Organization's Man and the Biosphere Program to have Mammoth Cave designated as an International Biosphere Reserve. The designation has three overall goals: to conserve the area's globally significant natural resources, to encourage sustainable use of resources, and to educate local communities on natural systems. Two other national parks in the southeastern United States, the Everglades in Florida and Great Smoky Mountains in North Carolina and Tennessee, are in biosphere reserves. This designation involves no change in administrative control, which stays entirely in the hands of local entities.

Established in 1990, the Mammoth Cave Area Biosphere Reserve contains three zones: a "protected natural area" is the national park itself, a "zone of cooperative use" encompasses the critical watershed areas just north and south of the park, and an "interactive zone" includes areas of concern west and east of the park.

Through cooperation involving the National Park Service and many other local, state, and federal groups and agencies, the Biosphere Reserve has been able to accomplish a number of things which will

*Fall colors come to rest on one of the park's wetland surfaces. A yearly ritual for many folks throughout this region is to come to the park to see its autumn foliage displays, particularly as the maple leaves break out in bright scarlet and yellow.*

serve to maintain the cave system's integrity. For example, it has helped local farmers to reduce water pollution through improved practices such as using manure-retention structures and no-till cropping. It has also produced a groundwater hazard map of the hydrology beneath transportation corridors that will help emergency workers respond quickly to accidental spills on railroads and highways.

The Biosphere Reserve has been so beneficial, in fact, that some local government entities originally outside it have now asked to be included. BRADD has successfully applied to have the Biosphere Reserve expanded.

Many problems remain. Air pollution sometimes hides the Pennyroyal Plateau from park ridgetops, and the possibility of a disastrous toxic spill hangs like the sword of Damocles over aquatic fauna. New problems doubtless will emerge as economic growth continues. Yet 1850 cave tourist Ralph Waldo Emerson, a major articulator of American civilization's values, probably would have seen hope in what is being done to perpetuate Mammoth's "sublimities."

In his essay "Illusions," Emerson used the cave as a metaphor for the way we "create" the world through interpretation of our sense impressions.

"Our conversation with Nature is not just what it seems," he wrote. "The senses interfere everywhere and mix their own structure with all they report of." Emerson saw an encounter with the cave's underground strangeness as a way of cleansing the perceptions and seeing life in a new way. "The mysteries and scenery of the cave had the same dignity that belongs to all natural objects," he wrote, "and which shames the fine things to which we foppishly compare them."

Today's cave tours in the national park—like my first long cave walk during the Grand Avenue tour—provide thousands of visitors with such an experience. Taking the Wild Cave Tour a few days later made me see life in an even newer way. After six hours of crawling and slithering through what Emerson called "black miles," I felt reborn.

It's not even necessary to enter the caves to get a sense of sublimity. Their dark and enigmatic natural entrances evoke it vividly as they seem to breathe into the forest. Sand Cave just off the East Entrance Road is an example. Despite Floyd Collins's efforts, the small cave has yet to be connected with the big one.

When Roger Brucker surveyed Sand Cave in 1977, he found no great chamber such as Floyd had sought. What Brucker found instead was the irony that what he called a "bypass" led from the upper cave down to where Collins was trapped—suggesting that he might have been saved. "If the last parties of rescuers...had squeezed through the nine-inch crack," Brucker observed, "they would still have been able to feed Floyd, keep him warm, and work to release him. Instead, they had abandoned the scene because of fright and exhaustion."

Sand Cave seems symbolic both of natural mystery and of the frailty of human hopes as we impoverish our environment while trying to master it. The cave can seem haunted, especially at dusk, when water drips furtively from the entrance rim, and cave crickets creep under the ledges. Although Collins's body now rests in a local cemetery, explorers deep in the cave sometimes think they hear a voice calling: "Wait! Wait for me!"

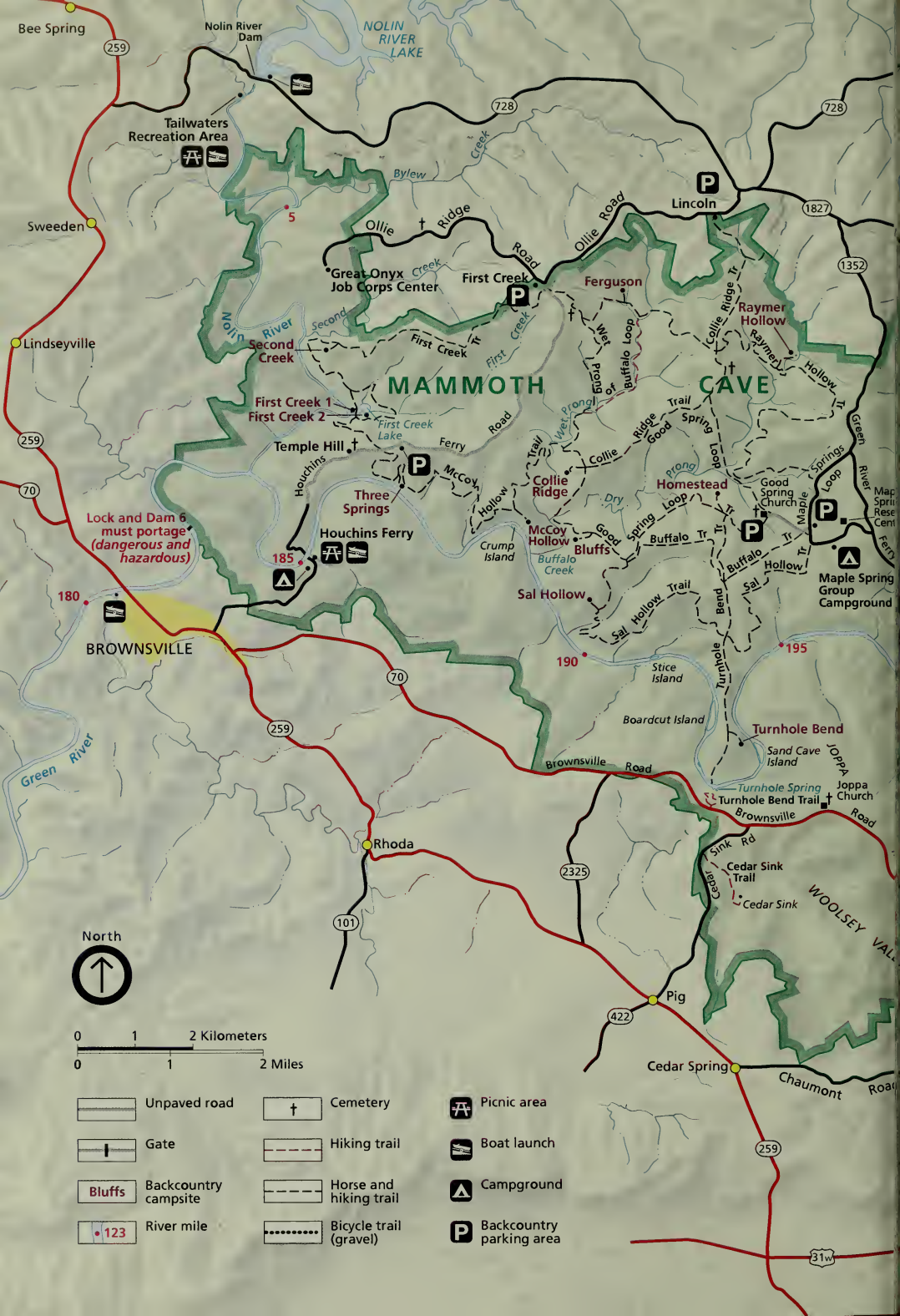
Yet Sand Cave is beautiful, surprisingly beautiful compared to the bleak expanse of trampled mud in 1925 photos of the Collins tragedy. There's no sign of that "carnival" now. Arrow-straight tulip trees shade the entrance, and wild hydrangeas, pawpaws, and redbuds cover the ground. Even the collapsed rescue shaft is now green with fern and liverwort. Sand Cave might be part of the "miles of beech trees" that Nathaniel Willis described a century and a half ago. In the morning light, it seems to promise unknown splendors such as those that beckoned to Ebenezer Merriam nearly 200 years ago. Some of the splendors are gone, but it still is not an empty promise. Much has been restored in the park, and much remains to be explored. We still know relatively little about this "American Interior."

*Its pointed hood curls over the deep pulpit inside which Jack stands in a Jack-in-the-pulpit. Indians processed the plant's bulb-like corm to make a flour. The corm also explains its other common name, Indian turnip. However, you are better off letting wild turkeys eat what they like of the Jack-in-the-pulpit, its clustering red berries found in fall. Much of the plant contains the chemical calcium oxalate, which will make your throat burn intensely. The corms were used to prepare an insecticide. Just enjoy looking at this remarkable tall plant of moist woodlands. It can grow to three feet tall.*

**Next pages:** *Outside the Historic Entrance a ranger preps her tour group before taking them on the Historic Tour.*

# Part 3

# Guide and Adviser


Bee Spring
259
Nolin River Dam
NOLIN RIVER LAKE
728
Tailwaters Recreation Area
Creek
Bylew
Sweeden
5
Ollie
Ridge
Road
Ollie Road
Lincoln
1827
1352
Great Onyx Job Corps Center
First Creek
Ferguson
Raymer Hollow
Collie Ridge Tr
Raymer
Hollow Tr
Green River
Nolin River
Second Creek
First Creek
Lindseyville
MAMMOTH CAVE
First Creek 1
First Creek 2
First Creek Lake
Ferry Road
Temple Hill
Houchins
McCoy
Three Springs
Houchins Ferry
Lock and Dam 6
must portage
(dangerous and
hazardous)
185
180
BROWNSVILLE
70
Wet Prong
Dry Prong
Collie Ridge
Homestead
Good Spring Church
Maple Loop
Springs Loop
Maple Spring Group Campground
McCoy Hollow
Bluffs
Buffalo Tr
Buffalo Hollow
Buffalo Creek
Crump Island
Sal Hollow
Sal Hollow Trail
Bend
190
195
Stice Island
Boardcut Island
Turnhole Bend
Sand Cave Island
JOPPA
Turnhole Spring
Turnhole Bend Trail
Joppa Church
Brownsville Road
Green River
Rhoda
2325
Sink Rd
Cedar Sink Trail
Cedar Sink
WOOLSEY VAL
101
North
0 1 2 Kilometers
0 1 2 Miles
422
Pig
Cedar Spring
Chaumont
Roa
31W
Unpaved road
Gate
Bluffs
Backcountry campsite
123
River mile
Cemetery
Hiking trail
Horse and hiking trail
Bicycle trail (gravel)
Picnic area
Boat launch
Campground
Backcountry parking area


NATIONAL PARK
Visitor Center
Park Headquarters
Mammoth Cave Campground
Ranger Station
Elevator
Violet City Entrance
New Entrance
Frozen Niagara Entrance
Dennison Ferry Day Use Area
(no ferry, no water)
Sand Cave Trail
(wheelchair accessible)
Official vehicles only
Official vehicles only
Sloans Crossing Pond
Sloans Crossing Pond Walk
(wheelchair accessible)
Floating Mill Island
Great Onyx Cave
Three Sisters Island
White Oak
Crystal Cave
Mammoth Cave Baptist Church
Lucky Island
Big Woods
Cub Run
Green River
Ugly Creek
Dennison Ferry Road
White Oak Trail
Flint Ridge Road
Eaton Valley
Houchins Valley
Hamilton Valley Road
Park Ridge Road
R Hunter Rd
Green River Ferry Rd
Mammoth Cave Pkwy
Doyel Cave
Cave City Road
Ridge Valley
Sand Cave
Cedar Hill Church Rd
Park City Road
Northtown
Exit 58
To Horse Cave
Exit 53
CAVE CITY
Exit 48
PARK CITY
To Bowling Green
To Glasgow
1827
88
210
205
200
474
65
70
255
31W
90

## Finding Information—At a Glance

### Phone Numbers and Websites

*Emergencies* 911

*General Park Information* 270-758-2180
Internet www.nps.gov/maca
Email maca_park_information@nps.gov

***Reservations for Mammoth Cave Tours, Campgrounds, and Picnic Shelters***
Contact the National Park Reservation Service. Call hours: 9 a.m. to 9 p.m., daily (Central Time Zone)

| | | |
|---|---|---|
| **Toll free** | cave tours | 800-967-2283 |
| | campgrounds | 800-365-2267 |
| **Fax** | | 301-722-1174 |
| **TDD** | | 888-530-9796 |
| **International** | | 301-722-1257 |
| **Internet** | | http://reservations.nps.gov |

*In the Park—Lodging and Activities*
Lodging reservations, general information, and kennel 270-758-2225
Internet www.mammothcavehotel.com

Boat tours (seasonal) 270-758-2243
Ferry hotline (recording) 270-758-2166
Guided horse rides 270-286-8167

*Outside the Park—Lodging and Activities*
Cave City Convention Center
Toll free 800-346-8908
Internet www.cavecity.com

Edmonson County Tourist Commission
Toll free 800-624-8687
Internet www.cavesandlakes.com

Hart County Visitor Information
Toll free 800-762-2869
Internet www.hartcountyky.org

## Getting to and Around the Park

### Travel Basics

***Vehicles*** From Louisville, Kentucky, the most direct route is I-65 south to Exit 53 at Cave City. Go west on Ky 70 and follow the signs to the park visitor center. *Note:* Mammoth Cave National Park is in the Central Time Zone, one hour behind Louisville, which is in the Eastern Time Zone.

From Nashville, Tennessee, the most direct route is I-65 north to Exit 48 at Park City, Kentucky. Go north on Park City Road and follow the signs to the park visitor center. Nashville and the park are in the Central Time Zone.

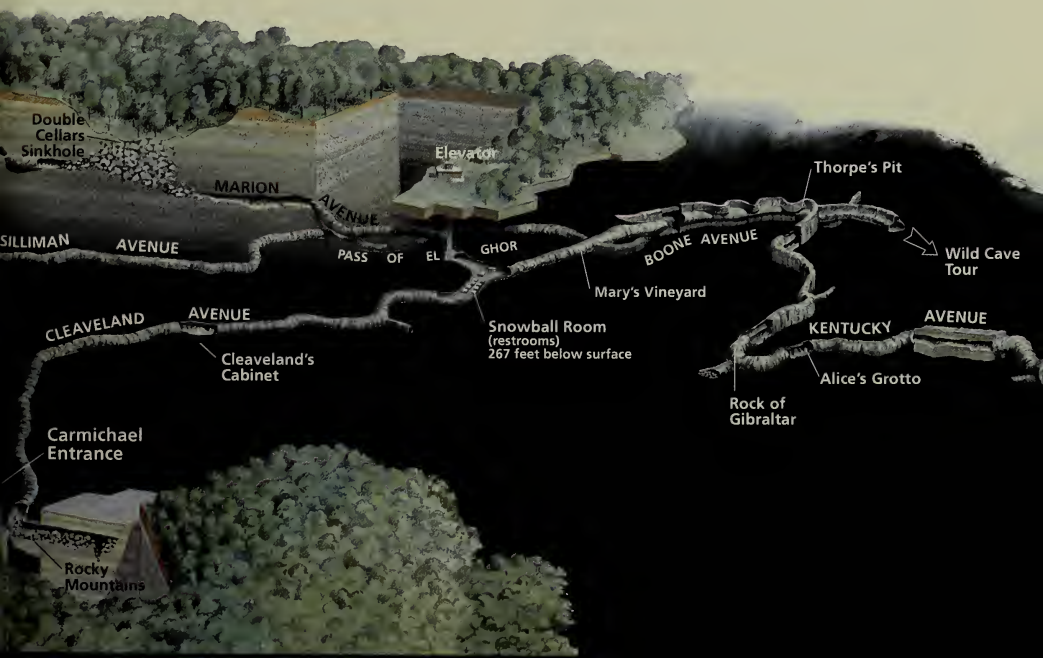
***Airlines and Rental Cars*** Major airlines serve Louisville and Nashville, where you can rent vehicles. From each city it is about 1½ hours driving time to the park.

***Public Transportation*** Buses serve Cave City and Park City, Kentucky. There is no public bus service to the park.

***Getting Around the Park*** You may travel by vehicle to many places in the park, including trailheads and a variety of scenic spots. In the backcountry you may hike, ride horses, and, in limited areas, ride a mountain bike. You may canoe for miles on the meandering Green and Nolin rivers.

***Oversized Vehicles—Ferries*** Buses, RVs, and oversized vehicles will not fit on the ferries. Trailers are prohibited on ferries when the water is low.

***Accessibility in the Park*** The visitor center, restrooms, campstore, and many facilities are accessible for visitors with disabilities. Mammoth Cave Hotel has accessible rooms. Mammoth Cave Campground has accessible sites. The park offers some surface trails with benches and wheelchair turnouts. Some of the ranger-led activities around the visitor center are accessible. Ask for details.



## A Sampling of Cave Tours

***Plan Ahead!*** The park offers a variety of cave tours—but tour offerings vary by season. Contact the park or check our website to find out what tours will be available during your visit. There is a fee for all cave tours, and tours sell out quickly. To get the tour you want, make advance reservations. Here are highlights of some of the tours:

***Travertine Tour*** (easy) Ride a bus to the Frozen Niagara entrance and see some of the cave's finest geologic artistry, including stalactites, stalagmites, pits, and domes. Designed for those with infants and toddlers or those who have difficulty walking.

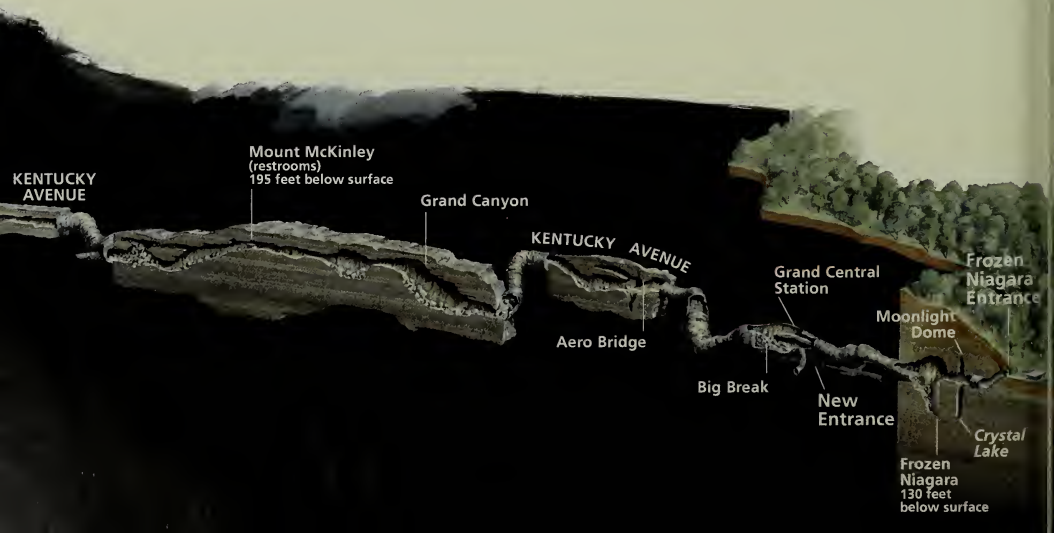
***Discovery Tour*** (moderate) Visit one of the cave's largest rooms. Learn about cave geology and saltpeter mining. See American Indian artifacts. To get the full picture hike the River Styx Spring or the Green River Bluffs trails (surface) along with this tour.

***Great Onyx Lantern Tour*** (moderately strenuous) Join a ranger to see Flint Ridge and Great Onyx Cave. Climb and descend 20 stairs and several hills. Hand-held Coleman lanterns light the beautiful stalactites, stalagmites, helictites, and soda straws.

***Trog Tour*** (moderately strenuous) Children (ages 8-12) discover connections between the sunlit world and the underground world on this environmentally focused activity. Be prepared for crawling. Helmets and lights provided. Long pants and sturdy shoes required.

***Historic Tour*** (strenuous) Learn about the human history that made Mammoth Cave famous. See mining operations and evidence of early explorers. Descend and climb a 60-step stairway and climb more than 130 steps on a steel tower. If you fear heights or close places or cannot climb steps, do not take this tour.

***Wild Cave Tour*** (extremely strenuous) You must be 16 or older and have a chest size no larger than 42 inches—anyone larger will not fit through the tight spaces. Crawl, climb, and squeeze through small passages. Helmets and lights provided. Lace-up boots with deeply treaded soles required. Bring lunch and water.



## Settling in for Your Visit

***In the Park—Lodging, Food, and Services*** Mammoth Cave Hotel is a short walk from the Historic Entrance of Mammoth Cave. It has hotel and meeting rooms, restaurants, gift shops, and a campstore with self-serve gas. The hotel has a kennel where you can leave your pet (a fee is charged) while you tour the park. The hotel is open year-round.

Woodland Cottages, located a short distance from the hotel, offer no-frills lodging typical of the early days of the park. These cottages are open from mid-May through September.

Historic Hotel Cottages are in a secluded grove of trees. They are fully furnished and just a short walk from the hotel's restaurant and other facilities. These cottages are open from mid-March through October.

Sunset Lodge is in a picturesque setting at the forest's edge. It is near Heritage Trail (wheelchair accessible), which leads to Sunset Point.

For information and reservations contact Mammoth Cave Hotel *(see page 100)*.

***Camping*** The park has three campgrounds that offer the convenience of camping near your vehicle. One accommodates groups and horses. All have tables, grills, toilets, and water. There are no hookups.

Mammoth Cave Campground, 0.25 mile from the visitor center, has more than 100 sites. A nearby campstore and service center, open spring to fall, has hot showers and a laundry (additional fee). Bulletin boards list programs and schedules in the park. Reservations are recommended. The campground is closed December through February.

Houchins Ferry Campground is 15 miles from the visitor center, on the south bank of the Green River. This small campground is not suitable for large trailers or RVs. Sites are on a first-come, first-served basis. It is open year-round.

Maple Springs Group Campground is six miles from the visitor center and three miles north of the Green River Ferry. Note: the most direct route from the visitor center requires taking the *Green River Ferry*. High or low water in the river may impede crossing. There are sites for groups with horses and sites for groups without horses. Campground reservations are required. It is closed December through February.

***Backcountry and Riverside Camping*** Scenic backcountry campsites offer solitude and the chance to appreciate the park's diverse landscape. Overnight camping is allowed at designated sites, on river banks, and on islands by permit only. Get your permit in person at the visitor center.

***Outside the Park—Lodging, Camping, and Services*** Motels, camping, restaurants, groceries, gas stations, and other services are available in Cave City, Park City, and Brownsville. For information on facilities and services outside the park contact the Cave City Convention Center, Edmonson County Tourist Commission, and Hart County Visitor Information *(see page 100)*.

## Surface Highlights—Visitor Center, North Side, South Side, and More

***Visitor Center*** This is the best place to begin your visit to the park. Here you will find information about the park and its programs, a ticket office, and a bookstore. Staff can answer questions and help you plan your visit. The visitor center is open daily, except December 25.

***Mammoth Cave Guide*** The free park newspaper, *Mammoth Cave Guide*, describes cave tours, gives tips on visiting the North and South sides of the park, offers ideas for river recreation, and lists hiking trails and distances. The *Guide* also includes information on special events, accessibility, and regulations and safety.

Ranger-led programs, such as campfire talks and interpretive walks, are scheduled regularly in summer and periodically during the rest of the year. Programs explore the park's natural and cultural stories. Topics and schedules are posted on bulletin boards. They are also available at the visitor center on video monitors and in printed flyers.

***Exploring the North Side*** Hike along more than 60 miles of trails, and you may not see another living soul. Seek solitude in the deep valleys and rugged hills, camp by a river or lake, and explore bluffs and ridgetops. Ride horses along these backcountry trails. Drive the scenic routes of Houchins Ferry Road and Ugly Creek Road.

***Hiking and Walking*** The park offers many trails, from wheelchair-accessible to strenuous. Before you start out, pick up the official park brochure at the visitor center. This brochure contains maps and important information. Park staff at the visitor center can help you plan your hiking trip.

***Horseback Riding*** Most trails north of the Green River are open for horseback riding; check with the park for trail restrictions. You may bring your own horse or go on guided rides provided by a concessioner. A trail map is available in the free park newspaper, *Mammoth Cave Guide*. Other maps and guides sold at the visitor center show trails in greater detail. If you meet hikers on a trail, slow your horse to a walk; hikers must remain quiet. Contact the park or ask at the visitor center about horse use.

***Exploring the South Side*** A quick drive and an easy walk will take you to some of the park's most beautiful scenery. Take a picnic, stroll the circle of Sloans Crossing Pond Walk (it is wheelchair-accessible), and listen for bullfrogs and red-winged blackbirds among the cattails. Descend into Cedar Sink, a colossal sinkhole, to look through a window into the way water travels beneath the ground, then go to Turnhole Bend Trail and find out where and how that same water joins the Green River.

***Discover the Park's Biodiversity*** Mammoth Cave National Park's nearly 53,000 acres help protect Kentucky's biodiversity. Animals abound: white-tailed deer and fox, raccoons and mice, frogs and salamanders. Warblers, woodpeckers, and thousands of birds feed or nest here. Cool ravines, wetlands, and prairies protect plant life. Scientists have discovered nearly 900 species of flowering plants growing on the surface and 200 species of animals living in the cave. Have you ever seen a wild turkey? These beautiful birds, reintroduced in 1983, have made a remarkable comeback. Keep a watchful eye for them as you explore the trails, scenic roads, and backcountry.

## Enjoying the Green and Nolin rivers

***Rivers of Life*** The Green River that meanders through the park for more than 25 miles supports a diversity of animals, including more than 80 species of fish and more than 50 species of freshwater mussels. The Nolin River, while in the park for only six miles, is home to abundant aquatic life too, including bass, bluegill, and catfish.

Two species of eyeless cavefish, not found in the Green or Nolin rivers, are adapted to life in the complete darkness of underground streams. One species of springfish spends its life in the twilight world of springs formed when underground cave streams emerge to join the Green River. *(See* Life in Total Darkness, *page 64).*

***Canoeing*** The world seems different from a canoe. Dramatic bluffs and majestic trees tower as you paddle along the Green or Nolin rivers. Wildlife abounds. A beaver slips into the water, a frog plops off its lily pad, and chipmunks scurry along the bank—all startled by your unexpected appearance.

The Green and Nolin rivers offer canoeing adventures for novice paddlers and for those seeking more intense trips. The Green River, dotted with sandbars and island gravel bars, averages 200 feet wide and 10 feet deep. At normal water levels, the Green runs at about five miles per hour. The Nolin River is narrower than the Green and averages a depth of about 10 feet; its current is slower. River levels and currents fluctuate throughout the year; use caution when paddling.

You can rent canoes from outfitters outside the park. Ask at the visitor center about river distances, the best places to launch your craft, and riverside camping. If you camp overnight you will need a backcountry permit; get the permit and a copy of the backcountry regulations at the visitor center.

***Fishing*** Muskie, bass, white perch, and catfish, and nearly 100 other species await anglers in the Green and Nolin rivers. Fishing is good year-round, but you will have the best luck in spring and summer. You do not need a Kentucky fishing license as long as you fish within the park. All other Kentucky fishing regulations apply. Ask for a list of fishing regulations at the visitor center.

***Boat Tours*** Tours aboard the *Miss Green River II* are provided by a private concessioner in the park. Take a leisurely one-hour ride on the Green River and see dramatic bluffs, springs, and wildlife. Tours are offered seasonally. For boat tour tickets and more information, visit or call the visitor center *(see page 100).*

***Swimming*** While it is tempting to take a dip in the rivers, especially on a hot summer day, swimming is not recommended. Mud banks, gravel bars, and submerged rocks and branches can be dangerous. There are no lifeguarded areas.

## Safety Tips and Regulations

Check the park newspaper, *Mammoth Cave Guide,* for information about safety and regulations in the park. Remember, your safety is your responsibility—think about safety and learn how to protect yourself.

**In case of an emergency contact a ranger or call 911.**

***Pets*** Pets are restricted in the park. A kennel is available through Mammoth Cave Hotel (a fee is charged). Don't be tempted to leave your pet in your vehicle. In summer, temperatures inside a closed vehicle can quickly reach 120°F, and a pet can die of heat exhaustion.

Service animals, such as seeing-eyes dogs, are allowed in the cave. Ask for details.

***Be Car Savvy*** Sadly, not all visitors are as honest as you, and items have been stolen from vehicles. Always lock your vehicle. When parking at the visitor center, remote trailheads, or in other areas, take your valuables with you or stow them out of sight. When possible park in an open, well-lit area.

***What to Know about Water*** Swimming in the Green and Nolin rivers is not recommended; there are no lifeguards. Do not drink water from the rivers, ponds, lakes, or springs without first treating the water. Water that is safe to drink (potable) is available at the visitor center and at campgrounds.

***Animals that Bite*** Be alert for chiggers and ticks. From early spring until mid-autumn you can find chiggers and ticks in campgrounds, wooded areas, and lawns. Chiggers are irritating but are not known to transmit diseases. Ticks can pose health hazards, such as Lyme disease and Rocky Mountain spotted fever. Follow these precautions to avoid bites: Wear a safe insect repellent. Stay on designated trails and avoid taking shortcuts across bushy or grassy areas. Be sure to check your body often and remove chiggers and ticks. Ask a companion to check areas that you cannot see.

The park has two species of poisonous snakes, the timber rattlesnake and northern copperhead. Be watchful in rocky areas, and don't put your hands or feet into places that you cannot see. If you see a snake don't hurt it—report it to a ranger.

***Plants*** Poison ivy grows throughout the park. The plant's sap contains urushiol (a poisonous oil) in its berries, leaves, roots, and stems; the oil is active year-round. Poison ivy grows as a vine and as a shrub. Watch for its ropelike vine and clusters of three leaves. Stay on trails and wear protective clothing.

***Keep Wildlife Wild!*** Please do not feed animals in the park. Human food is not part of their natural diet. Animals can die if they become dependent on unhealthful handouts.

All animals in the park are wild. No matter how harmless the animals seem (oh, those cute squirrels, deer, and raccoons), they can be dangerous. Do not approach them.

Do not kill any living thing, even animals that you may be afraid of or find unpleasant, such as snakes, salamanders, and insects. The park is their home and refuge. Animals here are part of Mammoth Cave's living system.

## Safety Tips and Regulations

***Selecting the Right Tour for You*** Cave tours can be strenuous and may require stooping and walking over uneven terrain. All tours require walking up and down stairs. Some tours are not recommended for visitors who fear heights or close places and cannot climb steps. Do not let friends or family members talk you into joining a cave tour if you feel uncomfortable about doing so.

To select the right tour for you, learn all you can ahead of time. The park offers a variety of cave tours, but some are offered only seasonally. Contact the park, study our website, read the park newspaper, *Mammoth Cave Guide*, and ask questions.

***What to Wear*** Year-round the temperature in the cave averages about 54°F, but the temperature can fluctuate as much as six degrees in some passageways. In winter, temperatures at the entrances may be freezing. In most areas of the cave you will be comfortable if you wear long pants and take along a sweater or jacket.

Hard-packed dirt trails can be rough, and they may be wet and slippery. You will encounter stairs and some steep inclines on many cave tours. Wear sturdy footwear with non-skid soles.

***What Should I Do on My Tour?*** You must stay with your tour and stay on the defined tour trails. Don't lag behind—the lights at tour stops are turned off after each group leaves. Use handrails where available.

***Touring the Cave with Children*** Keep your children close to you—losing a child in the cave even for a moment can be frightening. Children under age 16 must be accompanied by an adult. Infant backpacks are allowed, but restrictions apply from tour to tour. Some passages are too narrow or low for backpack carriers, and small heads can be injured. Strollers are not allowed on cave tours because they are impractical on stairs and uneven trails; carry your children. Note: The Travertine Tour is designed for visitors with infants or toddlers. Ask for details.

***What Can I Take on a Tour?*** Cameras are allowed but don't use a camera on the stairs or when you are walking. Tripods are prohibited because they can be hazardous to other visitors and may damage cave formations. Photography and videorecording may be restricted under certain conditions.

Food and drink are permitted in the cave; use the trash cans provided or take your trash with you. Flashlights are welcome, but they may not be used during tour stops. Be aware of other visitors. Don't shine the light in their eyes in the dimly lit cave.

***Protecting the Cave for Future Visitors*** Writing on cave walls or collecting cave rocks as souvenirs obviously damages the cave. Natural oils in hands (not so obvious) will also damage the cave; do not touch the walls or any cave features. To protect air quality, smoking is not allowed. Please help us safeguard Mammoth Cave for future generations by treating it with care and respect.

Eastern National, a non-profit cooperating association of the National Park Service, sells books, maps, videotapes, art prints, notecards, and other items about Mammoth Cave National Park and the region. Proceeds of sales help support the interpretive, historical, scientific, and educational programs of the park.

***For a free list of sales items contact:***
Eastern National
Mammoth Cave National Park
P.O. Box 33
Mammoth Cave, KY 42259
www.eparks.com

***Here is a sampling of the sales items:***

Borden, James D. and Roger W. Brucker. *Beyond Mammoth Cave: A Tale of Obsession in the World's Longest Cave*, 2000.

Brucker, Roger W. and Richard A.Watson. *The Longest Cave*, 1987.

Bullit, Alexander Clark. *Rambles in the Mammoth Cave in 1884*, reprint 2000.

Casteret, Norbert. *Ten Years Under the Earth*, 1998.

Halliday, William, R. *Floyd Collins of Sand Cave—A Photographic Memorial*, 1998.

Hovey, H. C. *One Hundred Miles in Mammoth Cave in 1880*, reprint 2000.

Lyons, Joy Medley. *Mammoth Cave—The Story Behind the Scenery*, 1992.

*Mammoth Cave National Park.* Finley-Holiday. National Park and Monument Series. Video or DVD, 2001.

Meloy, Harold. *Mummies of Mammoth Cave*, 1998.

McClurg, David R. *Adventure of Caving*, 1998.

Murray, Robert K. and Roger W. Brucker. *Trapped! The Story of Floyd Collins*, 1983.

National Geographic Maps. *Trails Illustrated Mammoth Cave National Park: Kentucky USA*, 2000.

Olson, Colleen and Charles Hanion. *Scary Stories of Mammoth Cave*, 2002.

Palmer, Arthur N. *A Geological Guide to Mammoth Cave National Park*, 1979.

Seymour, Randy. *Wildflowers of Mammoth Cave National Park*, 1997.

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Sides, Stanley D. *A Guide to the Surface Trails of Mammoth Cave National Park*, 1991.

Tuttle, Merlin D. *America's Neighborhood Bats*, 2000.

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***Picture Sources***

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The mission of the Department of the Interior is to protect and provide access to our nation's natural and cultural heritage and to honor our trust responsibilities to tribes. The National Park Service preserves this heritage unimpaired in the National Park System for the enjoyment, education, and inspiration of this and future generations. The National Park Service cooperates with partners to extend the benefits of conservation and outdoor recreation throughout this country and the world.

Mammoth Cave National Park is one of more than 380 parks in the National Park System, which contains more than 3,600 caves, found in 77 of the parks. To learn more about national parks and National Park Service programs in America's communities visit www.nps.gov.

*Inside covers: An early lithograph of The Dead Sea in Mammoth Cave.*

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U.S. Department of the Interior

Mammoth Cave National Park
Kentucky

*Mammoth Cave's cavernous passages make you feel truly small and utterly important all at once. Who knew that saving the cave as a national park would also create a refuge for plants and wildlife? Award-winning writer David Rains Wallace tells these intriguing stories richly illustrated by colorful photos, maps, and stunning geological artwork.*