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# Mapping of Mammoth Cave: How Cartography Fueled Discoveries, with Emphasis on Max Kaemper's 1908 Map

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## Abstract

Maps came first at Mammoth Cave, Kentucky. Then came explorers who used the maps to make discoveries as they gained a more comprehensive understanding of the longest cave in the world. The saga of mapping at Mammoth Cave parallels the mapping of North America from the 1600s onward. The first map was an "Eye-Draught Map of Mammoth Cave", penned from memory in 1811, not a survey, to acquaint merchants with the location of saltpeter dirt. In 1835 the managers of Mammoth Cave hired a surveyor, Edmond Lee, to survey and map and profile the main cave passages. Stephen Bishop, a slave guide at Mammoth Cave (1838 – 1857) drew a comprehensive map in 1842, partly based on the Lee survey. Bishop's map is a schematic diagram showing many named passages and their relationship to each other. Max Kaemper, a German civil engineer, was hired by the cave manager to make an instrumental survey of the cave in 1908 and to draft a map showing five levels of the cave in distinctive colors. The Walker survey in 1936 served to establish an accurate baseline through the cave and tied entrances to each other. Ray Nelson drafted an unpublished map of the Walker survey, New Discovery survey, and more in 1956. Cave Research Foundation cartographers began mapping passages in the Flint Ridge Cave System in 1954 resulting in one of the first cave maps plotted on a topographic map. The Flint Ridge Folio, 1964, brought Flint Ridge mapping up to Kaemper's graphic standard with the improvement of the superimposition of the surface topography. Since the 1972 connection between Flint Ridge and Mammoth Cave Ridge, Mammoth Cave has blossomed into a cave with a comprehensive high-accuracy set of cave maps showing 365 miles of connected cave. The Kaemper map lay fallow in Park Service files for many years until it was rediscovered by James F. Quinlan in 1963. Diana Daunt retraced the original Kaemper map for publication by the Cave Research Foundation. The utility of the Kaemper map is its use by generations of explorers to find their way around in Mammoth Cave and to ultimately resurvey and remap all the features Kaemper recorded, and more.

## Introduction

Explorers have been making maps of Mammoth Cave since before the war of 1812. The fascinating history of this cartographic activity has been partially described by Meloy<sup>1</sup>. To keep cave mapping in perspective, it parallels the early exploration of the United States. Explorers ventured into far away places and brought back tales of wonder, wealth, and possibilities. Second-wave explorers made maps, so their audience could visualize and understand better the relationship of lands, rivers, mountains, and culture including trails. Each round of maps inspired new explorers to go forth, and cartographers followed in their wake. When President Thomas Jefferson commissioned the Lewis & Clark Expedition to explore lands west of the Mississippi River in

1804, they plotted a map of their two years of discoveries and prepared an extensive report.

Some Mammoth Cave maps influenced generations of explorers while other maps hardly saw the light of day. Arguably, the most influential maps were those that showed the cave in relation to topography. Karst is an erosional landscape of sinkholes, sinking springs, and caves. When the cave map and its overlying surface topography are shown together, features such as vertical shafts are shown to be located at the heads of reentrants, and truncated passages and terminal breakdowns are shown to occur under the walls of valleys. Insights from these map understandings led explorers to find over 300 miles of passageway that were unknown prior to 1954.

In his book, *Mapping and Imagination in the Great Basin: A Cartographic History*,<sup>2</sup> Richard V. Francaviglia concludes (p.196): “Like exploration itself, then, mapping is never the innocent process it first seems, for it demands even more knowledge, first of surfaces and then of more hidden places. Nor are maps produced in the process neutral or innocent, for they work hand in hand with exploration to first intrigue, then inform, and ultimately seduce.” Mammoth Cave’s maps certainly reinforce Dr. Francaviglia’s observation.

Three important conclusions need to be kept in mind as we think about the maps of Mammoth Cave: 1. Many of the maps were deliberately kept secret and thus for explorers in general did not exist until published. The Kaemper map is one of these hidden maps. 2. Unless the topography is shown superimposed on the cave map, the viewer cannot know the relationship of the cave to the surface above it. Few Mammoth Cave maps include topography, and 3. Unless map viewers engage in active exploring or touring of the cave, map viewing is mainly an aesthetic experience.

### Maps of Mammoth Cave<sup>3</sup>

	Map Name	Date	Remarks
1	Eye-Draught*	1811	Three versions of a sketch map showing saltpeter areas
2	Bogert	1813	Working sketch map for saltpeter miners, Several made.
3	Egnew	1815	Copy of Bogert map.
4	Nahum Ward	1817	Sketch map after saltpeter mining ended. Several made.
5	Lee*	1835	First instrumental survey, plan and profile.
6	Bishop*	1842	Based on Lee map. Sketched. Widely published.
7	Blackall	1871	Supressed until 1899, showed scale and north arrow.
8	Klett	1881	Hovey used this map to correct the Bishop map. Published.
9	Hovey	1882	Based on Lee and Bishop. Widely published.
10	Call	1897	Based on Hovey plus Cleaveland Avenue survey.
11	Hovey & Call	1897-9	Minor variation of Call. Showed scale and north. Widely published.
12	Vaughn & Marshall	1899	Accurate Colossal Cave map. Connected to MC 1972.
13	Kaemper*	1908	First accurate survey of cave. Topo overlay? Secret until 1963.
14	Hovey	1909	Based on Call and 8 other maps. Published.
15	Parrish	1922	George Morrison survey, showed scale, north, property lines.
16	Loebeck	1928	Diagram published widely.
17	Nelson*	1956	1935 Walker survey, New Discovery. Secret.
18	CRF FR Folio*	1964	Flint Ridge Cave System, connected to MC 1972. Published.
19	CRF map card*	1977-85	Map card with topo. Several editions published. Shows Roppel Cave.
20	CRF Poster	1981	Multi-color shows levels. 250 miles.
21	CRF*	2007	Multi-sheet map based on 50 years of CRF surveys.

Figure 1. 21 maps of Mammoth Cave (After Meloy<sup>2</sup>.) \*Maps discussed in this paper.

Cave maps are foundational to every kind of scientific and historic study of Mammoth Cave. Cave maps are the basis for management and interpretive decisions, and engineering decisions such as lighting and entrance development.

I was taken to Mammoth Cave in 1937 at age eight. My mother and I took the All-Day tour from Historic Entrance to Frozen Niagara Entrance. As we rode the bus back to the hotel I realized that the cave ran beneath the surface we

were riding over and I wondered where were the underground features relative to the surface? Many years later, in 1954, I decided to make a topographic map of Flint Ridge and plot Floyd Collins’ Crystal Cave on top of it as we surveyed during the NSS 1954 C-3 Expedition.<sup>4</sup> In 1970 and 1977 I plotted the cave on the topographic map and published it as the CRF Map Card of Mammoth Cave, which is still on sale in the Visitor Center.

I will comment on the Kaemper map of Mammoth Cave in the context of a continuous output of cartography that brought understanding of this vast cave to successively higher levels of accuracy and knowledge.

**Some Maps of Mammoth Cave**

**Eye-Draught Map, 1811**

The first map of record is the “Eye-Draught Map of Mammoth Cave”, Figure 2. The map is a sketch, not a survey, prepared to show eastern saltpeter merchants the extent of peter dirt

deposits in Mammoth Cave. Three variation copies were made. Gunpowder, an essential commodity on the frontier, was also needed for the War of 1812. Caves in Kentucky like Mammoth Cave and Great Saltpeter Cave were important sources for saltpeter that the duPont Company in Philadelphia made into gunpowder. The sketch clearly shows the cave entrance, the Narrows, Main Cave, and several branching avenues.

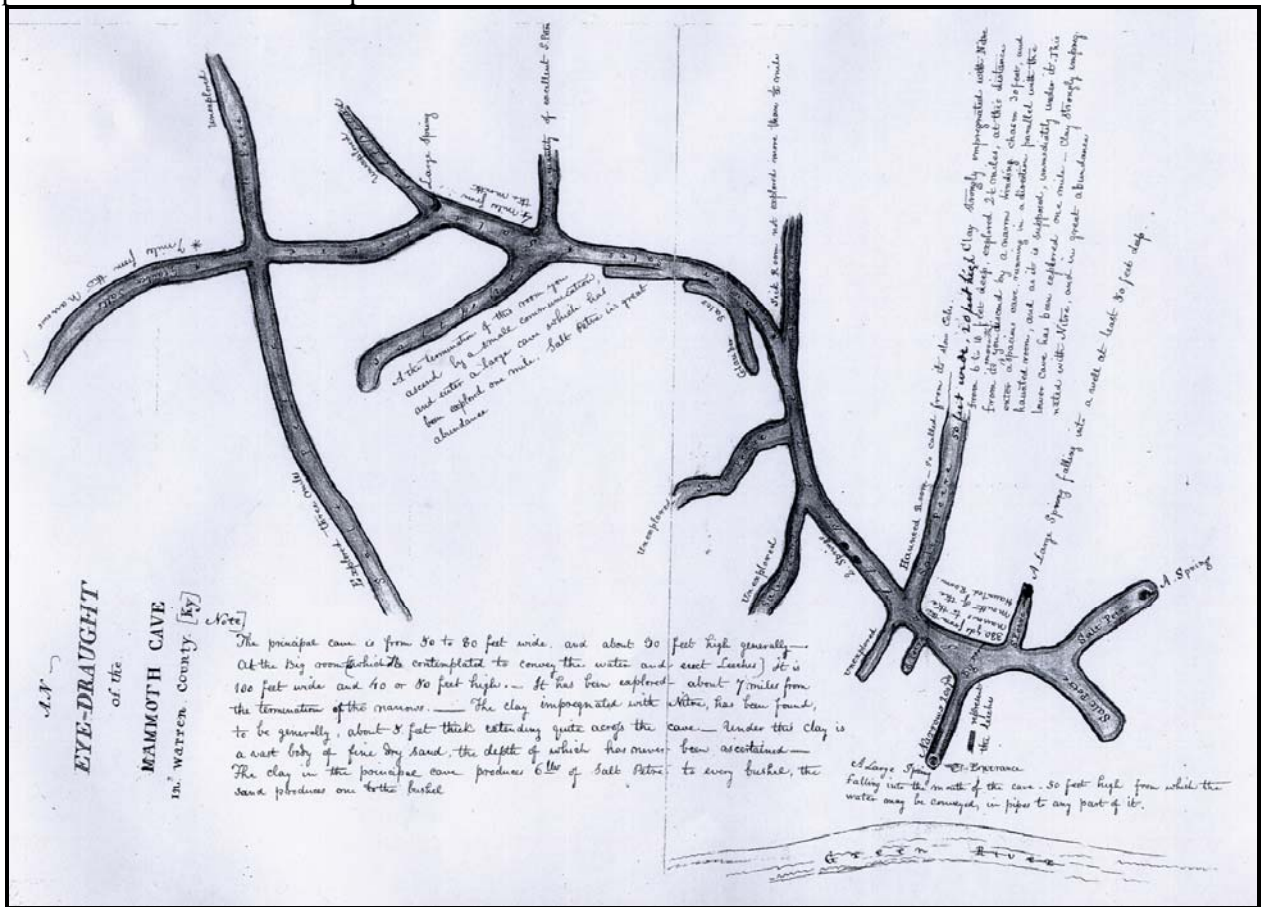


Figure 2. Eye-Draught map of Mammoth Cave, one of three variants.

**Edmond Lee Map, 1835**

After the 1812 war between British and American forces ended in a draw, Mammoth Cave’s saltpeter mining dwindled and ended, overcome by technology. People would pay money to be taken into Mammoth Cave and the tourist industry began with a modest log hotel and a small guide force. In 1834 the manager hired a professional surveyor, Edmund F. Lee, to

make a comprehensive map of the known main portions of Mammoth Cave. He spent several months in 1834 and 1835 running a compass and level line down the main passages. His map shows the Main Cave, or Broadway, from entrance to a breakdown beyond Chief City. If the lower levels of Mammoth Cave were known at all at that time, the way there consists only of

a “Snake Hole” in what we know as the Wooden Bowl Room.

Lee’s map was probably a sales tool when Hyman Gratz sold Mammoth Cave to Glasgow, KY attorney Franklin Gorin in 1838 for \$5,000.

The Lee map is a beautiful example of early cave cartography and deserves study by everyone interested in the history of Mammoth Cave.

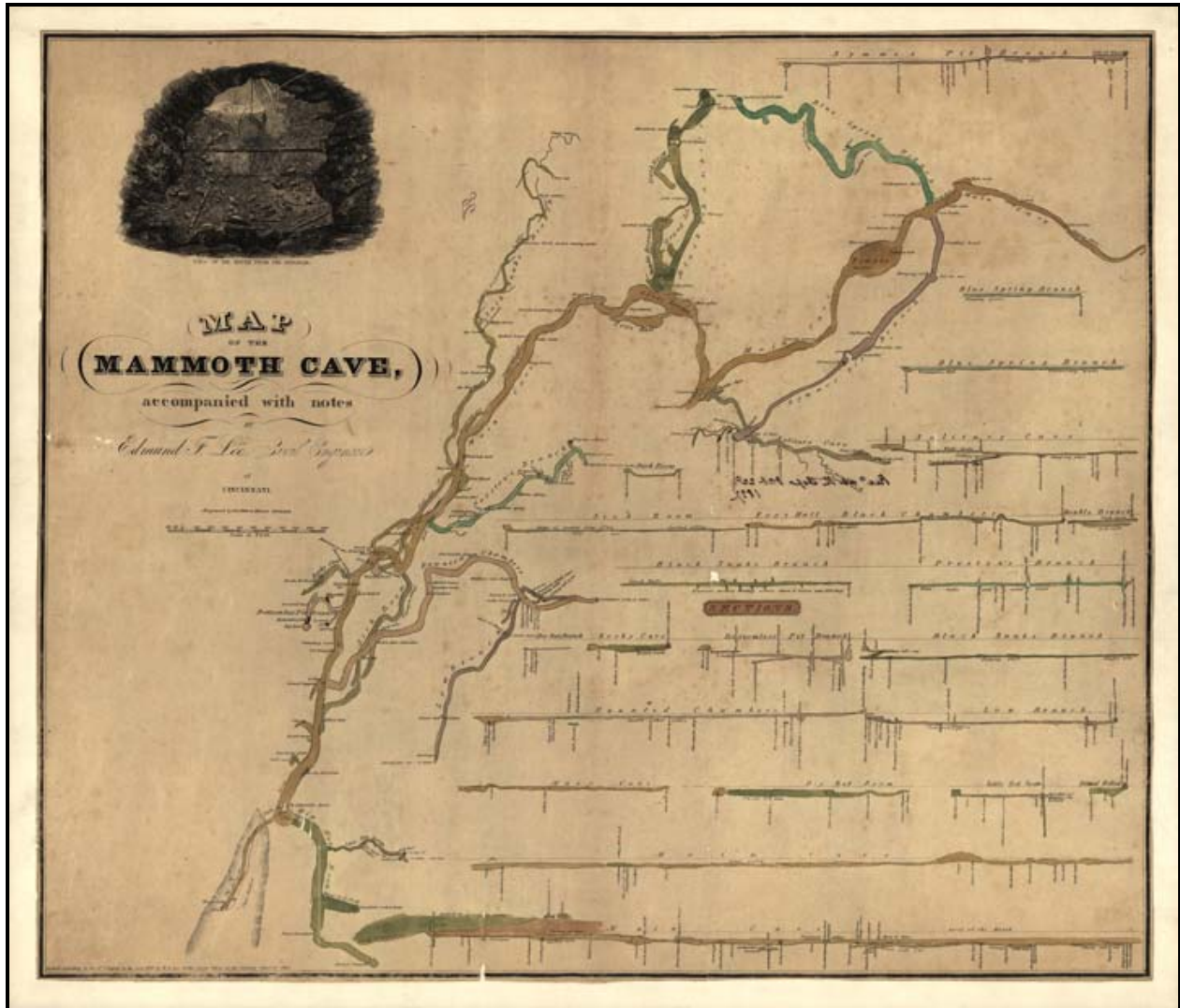


Figure 3. Lee Map of Mammoth Cave.

### ***Stephen Bishop Map, 1842***

Franklin Gorin, a lawyer and land sales agent for the Croghan family in Louisville, moved to Mammoth Cave with his seventeen year-old slave, Stephen Bishop, in 1838. His purchase was more an opportunity than a valuable asset because the log hotel was a dump by the standards of the day. He began a program of improvement of the buildings and set Stephen

to learning to take tours into the cave, taught by some guides that had come with the property. Stephen, curious by nature, began to look beyond the large passageways and soon discovered Gorin’s Dome, reached through the Snake Hole. Gorin sold the cave in 1839 to John Croghan, M.D. from Louisville, and Stephen Bishop was sold as part of the cave package.



Stephen's explorations carried him onward to Echo River, Cleaveland Avenue, and Mammoth Dome. In 1842 he convinced his owner, John Croghan, to publish a map showing the passages, and Stephen was taken to the Croghan family home, Locust Grove, in Louisville. There he spent several weeks drawing a map of Mammoth Cave. He consulted the Lee map.

Bishop's map resembled a bowl of spaghetti dumped on the floor. The map went through several printings, once as a tip-in to Alexander Bullitt's *Rambles in Mammoth Cave* (1845). The Bishop sketch map served as the basis for several subsequent maps.

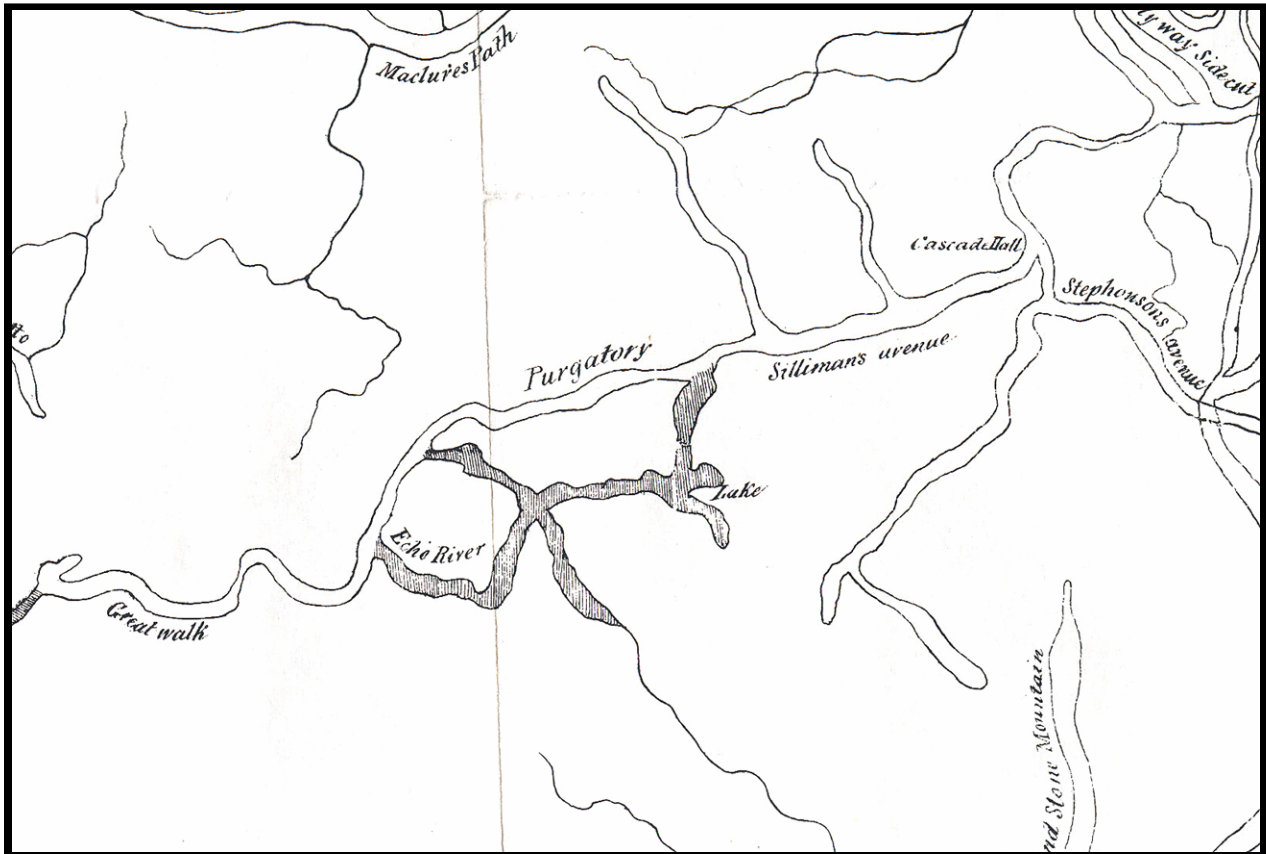


Figure 4. Detail of Bishop Map showing Hansons Lost River connection.

As an interesting sidelight, Bishop's map shows the passage off Echo River through which the 1972 connection with Flint Ridge was made. That passage is not shown on the Kaemper map because the pool of the Brownsville Dam on Green River probably drowned the entrance to that passage before Kaemper surveyed the lowest level.

***Kaemper Map, 1908***

Albert Janin, Trustee of Mammoth Cave for the Croghan estate, in 1908 hired a 23-year old German surveyor, Max Kaemper. Henry C. Ganter, the cave manager assigned guide Ed

Bishop to show him all the cave and help him survey it. The pair spent eight months surveying and plotting notes. The resulting map was drafted in five colors, each showing its respective level of the cave. It may be the first map to depict cave levels with distinctive color. Names of many places and passages were shown in a table. Kaemper mapped about 35 miles.

The map shows no scale or North orientation, but registration marks appear to correlate with similar marks on a topographic map. Kaemper's map was proof that some of Mammoth Cave extended off owned property,

and hence the map was suppressed. It showed that Boone Avenue and Mary's Vineyard lay off the Mammoth Cave property, a secret that George D. Morrison learned later from his

friend, ex-manager H. C. Ganter. Morrison used this information to hunt for the right location for his New Entrance to Mammoth Cave.

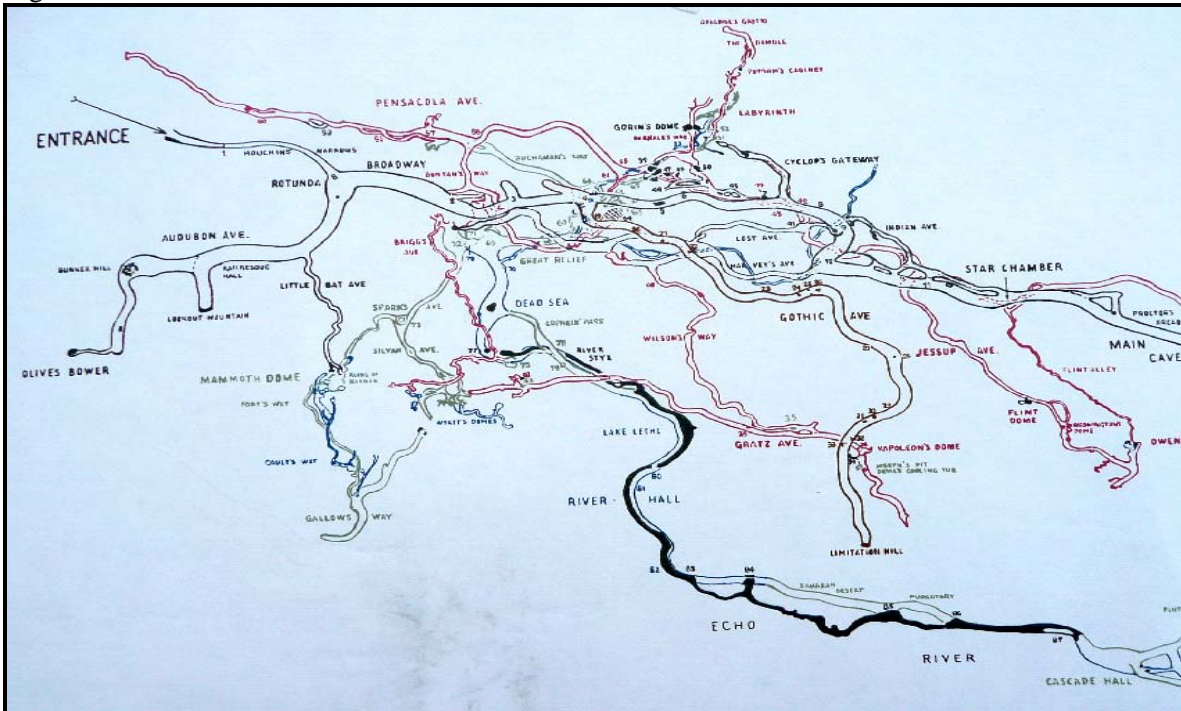


Figure 5. Kaemper map showing the Acute Angle.

When the Kaemper map surfaced after the National Park Service obtained the cave, his map was filed away. In 1963 Park Geologist James F. Quinlan rediscovered the Kaemper map. Since it was in fragile condition, Pat Quinlan traced the Kaemper map. Roger Brucker traced the Quinlan copy. And Diana Daunt made a more careful tracing of the original which was published by CRF. Daunt also drafted a map of the Historic Tour from CRF surveys and other sources during that time. The Kaemper map was extensive and guided CRF survey teams in their systematic effort to resurvey Mammoth Cave to higher standards of accuracy and greater detail. Today the Kaemper map is used by Wild Cave Tour guides to show their curious patrons the route they took during their strenuous trip.

#### **Walker Survey, 1936**

In 1935 the U.S. Government sent surveyors to map a 21-mile length of passages. This highly accurate bench-marked survey provided entrance control, and a subsequent base line for

later CRF (Cave Research Foundation) surveys of Mammoth Cave. Ray L. Nelson compiled the Walker survey, the New Discovery survey, and three additional miles into a 28-mile Nelson map in 1956. Between the Kaemper map and Nelson map, Quinlan tallied a total of 46 miles of surveyed and mapped passages.<sup>3</sup>

#### **Flint Ridge Folio, 1964**

In 1954 the National Speleological Society mounted the C-3 expedition into Floyd Collins' Crystal Cave on Flint Ridge, adjacent to Mammoth Cave Ridge<sup>4</sup>. Surveys made by NSS cavers were combined with an instrumental survey of the upper levels of the cave which were plotted on a topographic map. That map was redrafted as an isometric drawing and published in *The Caves Beyond*<sup>6</sup>. As exploration continued, Flint Ridge Reconnaissance maps were plotted of new surveys on a series of overlapping 8-1/2" x 11" sheets of cave and topography at a scale of 1" = 100'. The pace of discoveries and cave surveying outgrew these

small maps, and the CRF mappers began to plot their surveys on quadrangles that encompassed 30-seconds of latitude and longitude on the topographic map.

Ten years later, in 1964, CRF published the Flint Ridge Folio, first edition, by Roger W. Brucker and Denver P. Burns, Figure 1., showing the Flint Ridge Cave System consisting of several connected caves: Crystal Cave, Unknown Cave, Colossal Cave, and Salts Cave. The discovery of a natural connection between the Flint Ridge Cave System and Mammoth Cave in 1972 resulted in a cave 144.4 miles in length – Mammoth Cave became the longest cave<sup>5</sup>.

#### ***Cave Research Foundation Map, 1977***

Large-scale maps of the growing Mammoth Cave were unwieldy, so in 1977 CRF published the first of several “map cards” to display the total surveyed Mammoth Cave system on a single sheet of heavy paper. The latest version

published in 1985 shows the connection with Roppel Cave<sup>6</sup>. Both *The Longest Cave* and *Beyond Mammoth Cave* contained maps drafted by Patricia Crowther and Pat Kambesis respectively. Passages were superimposed on topography. The CRF map card takes its place with the reprint of the Bishop map, the traced Kaemper map, and a colorful poster map by CRF available for sale in the Mammoth Cave Visitor Center. The poster map shows cave levels in distinctive colors and also shows topography.

#### ***Cave Research Foundation Map, 2007***

At the CRF 50th Anniversary celebration on October 19, 2007, the entire set of Mammoth Cave maps which have been computerized was printed out at a scale of 1” = 50’. The overlapping sheets show 365 miles of cave passage, and they literally filled the floor of a school gymnasium. Guests could remove their shoes and walk upon the map.

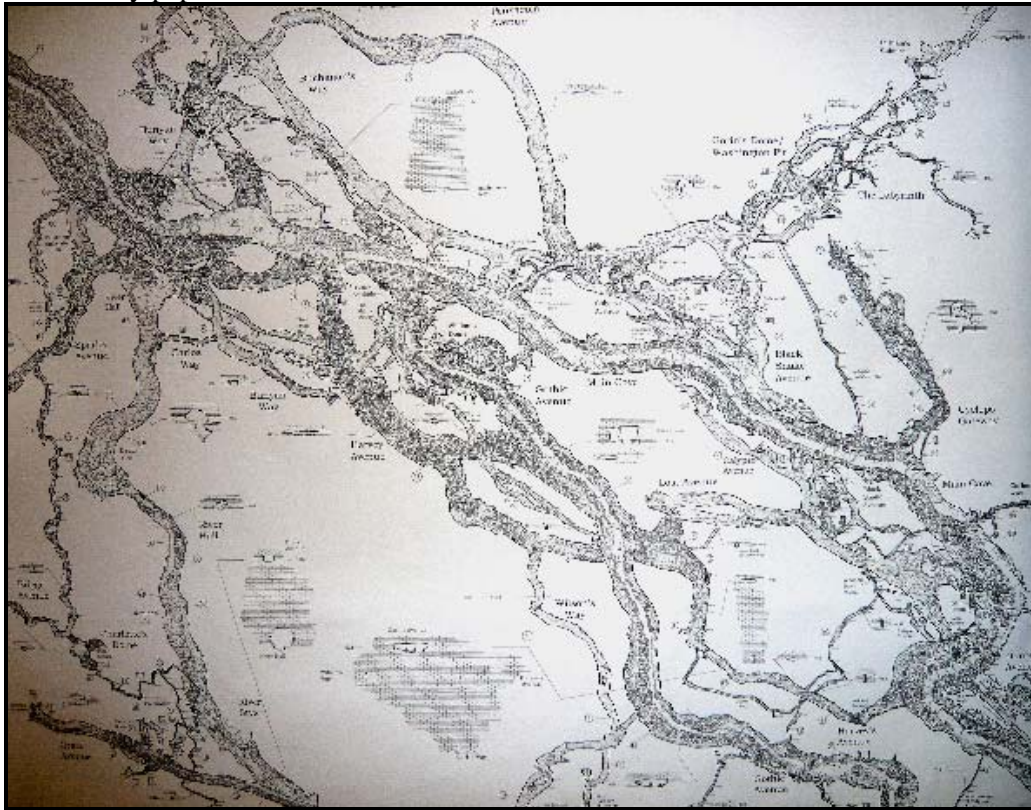


Figure 6. A portion of the CRF 2007 map of Main Cave.



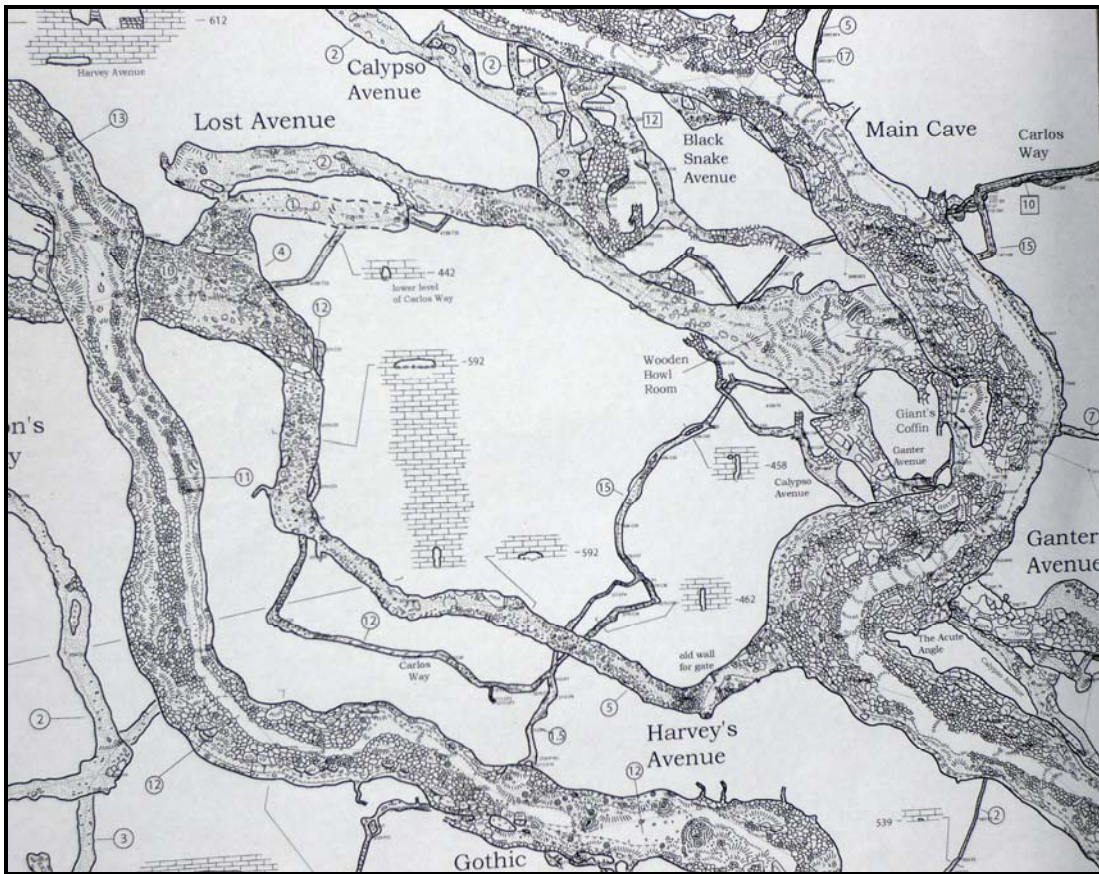


Figure 7. Detail of the CRF 2007 Main Cave map showing the Acute Angle.

### Mapping Today

CRF cartography at Mammoth Cave requires a large volunteer staff of cave surveyors, data entry persons, data checkers, cartographers, and survey control integrators. Digitized topography is available for the computer plotter to superimpose on the cave passage maps. A variety of second order level nets and GSP downloads have been used for survey control over entrance locations, and to adjust surveys for magnetic North declination changes through the years. Survey loop closures are continually improved by resurvey for increased accuracy.

Individual CRF cartographers have been assigned to draft individual sheets, Figure 6. Their job is to identify areas where passages have not been surveyed and target those for priority investigation. They prepare the finished plan views and cross-sections to CRF cartographic standards so the maps exhibit uniformity of style and can be added to as new

discoveries are made. When will this cartographic work be finished? Nobody can say and predictions that Mammoth Cave will eventually reach 500 miles or 1000 miles in length suggest the answer to the question is: "Not in our lifetime."

### Conclusions

It can be argued that Mammoth Cave maps triggered exploration through time, but it is certain that the maps launched the major CRF discoveries since 1954. Cave explorers believe they see a pattern in the mapped passages. With sufficient surveying, the map helps build awareness of where cave passages may be "missing" or undiscovered. Explorers then go to the blank areas of the map, and use their knowledge of truncated passages and terminal breakdowns to find the most likely leads. The deepest passages pass beneath valleys and they are reached through vertical shaft drains. Discoveries cascade so rapidly that the only way explorers can comprehend them is to follow a

systematic surveying and mapping regimen. “No exploration without survey” became a CRF doctrine, and the required narrative exploration trip reports followed.

Mammoth Cave mapping is a dynamic process partly fueled by discoveries and partly by improvements in cave cartography. For this reason the map of Mammoth Cave may never be “finished.”

The Cave Research Foundation pioneered many of these exploration/cartography techniques, which are now widely employed by cave explorers everywhere – especially cavers working on large cave systems that require years of effort. Max Kaemper’s contribution was not only a beautiful and accurate map, but it inspired the Cave Research Foundation to take mapping to the next levels – survey and map every part of the cave, no matter how wet or small. This systematic, foot-by-foot descriptive effort continually leads to new and significant discoveries.

## Notes

1. Francaviglia, Richard V., *Mapping and Imagination in the Great Basin: A Cartographic History*, Univ. of Nevada Press, Reno, NV, 2005, 231 pp.
2. Meloy, Harold, *Early Maps of Mammoth Cave*, *J. of Spelean History*, vol 1 no 3 (#3) 1968, p 47-57.
3. Meloy, Harold, *Historic Maps of Mammoth Cave*. Unpublished manuscript, MCNP library, 19 pp, 1976. On page 15 is a description of the Nelson map of 1956.
4. Lawrence, Joe, Jr. and Roger W. Brucker, *The Caves Beyond; the Story of the Floyd Collins’ Crystal Cave Expedition*. Cave Books, Dayton, Ohio, 283 pp, reprinted 2007.
5. Brucker, Roger W. and Richard A. Watson, *The Longest Cave*, Southern Illinois University Press, Carbondale, IL, 316 pp, reprinted 1987.
6. Borden, James D. and Roger W. Brucker, *Beyond Mammoth Cave; a Tale of Obsession in the*

*World’s Longest Cave*, Southern Illinois University Press, Carbondale, IL, 353 pp, 2000.

7. *ibid.* Lawrence, Jr., Joe, pp 56-7.