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THE SALTPETER WORKS AT MAMMOTH CAVE AND THE NEW MADRID EARTHQUAKE

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The New Madrid earthquakes of 1811-1812 rank among the worst natural disasters ever to strike the North American continent. Owing to the sparsely settled condition of the interior at that time, the loss in human life was low, but the severity of the tremors caused property damage and interrupted navigation along the Ohio and Mississippi rivers for months. Much has been written on this event, one of the greatest quakes of historic times, yet little has been known of its effects on commercial industries outside the major area of destruction. One industry that suffered disruption was the underground mining of saltpeter from Mammoth Cave, Kentucky.

Saltpeter production was an important early industry in Kentucky from the pioneer era through the War of 1812. Refined saltpeter is the chief constituent of gunpowder and so was in great demand. During this period, saltpeter was made from calcium nitrate which is found in the soil and rock of certain limestone cave passages. The soil and rock fragments were excavated and placed in large rectangular or V-shaped wooden hoppers; water was poured through to dissolve the nitrate minerals. The liquid leachate (known as "beer" or as "mother liquor") was collected and piped to evaporation furnaces

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on the surface outside the cave. Here the solution was concentrated by boiling and then percolated through a vat of wood ashes (potash). Calcium is replaced by potassium from the wood ashes to form potassium nitrate, or saltpeter, in the only chemical conversion process required in the production sequence. The saltpeter solution was again concentrated and impurities removed in the evaporation furnaces. Additional cycles further increased the purity of the saltpeter; similar techniques were used in whiskey distillation to increase alcohol concentration. Cooling the remaining liquid promoted the growth of saltpeter crystals. These were collected, dried, and placed in bags or barrels for shipment to market.

Mammoth Cave in present-day Edmonson County was mined extensively for saltpeter prior to 1814 and was one of its major producers in the state. This production reached its peak during the War of 1812 when as many as seventy workmen mined in Mammoth Cave.[1] These saltpeter miners, primarily slave workers, brought the excavated soils to two processing sites in the cave. The First Hoppers were located in the Rotunda and the Second Hoppers were located in Booth's Amphitheatre (figure 1); these place names were given much later. In addition to the hoppers, each processing center contained a tall wooden tower with a hand-operated pump that supplied sufficient gravitational pressure to pipe the liquid concentrate from the hoppers out to the cave entrance (figures 2 and 3). The passageways of the Rotunda and Booth's Amphitheatre today contain numerous V-vat remnants adjacent to each rectangular hopper complex. The rectangular hoppers are located on a well developed apron of lixiviated (leached) saltpeter soils. Once leaching was complete, the chemically exhausted soils were discarded and spread outward from the rectangular hoppers. The gradual build-up of lixiviated soil formed a saltpeter apron. When the apron be-

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1 Ebenezer Meriam, "Mammoth Cave," *New York Municipal Gazette*, 21 February 1844, 1 (no. 17), 319.

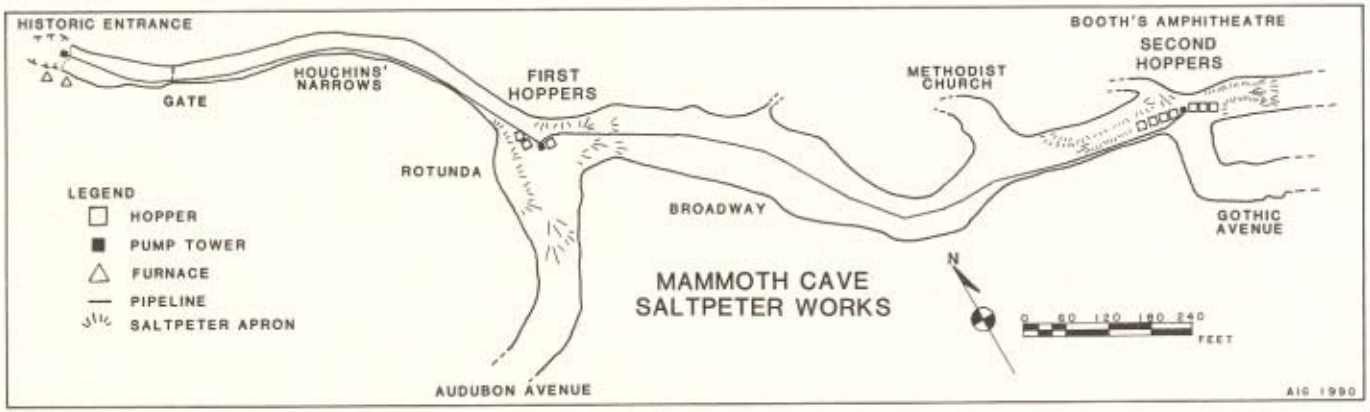

Figure 1 — Sketch map of Mammoth Cave showing saltpeter processing centers, pipeline, and pump towers (adapted from Mullins, 1986). Field evidence for the pipeline is fragmentary.
Angelo I. George

came unmanageable, the hoppers were disassembled and rebuilt at a higher elevation. The V-vats are located on an even higher soil apron, suggesting that they were worked in tandem with the large rectangular hoppers or afterward.[2]

The two pump towers in the cave were of modular design and could be taken down and reassembled by following a system of numbers engraved on their principal supports.[3] The large rectangular hoppers were constructed in such a way that they too could have been taken apart and reassembled. This was necessary to keep pace with a growing apron of lixiviated soil.

Daniel Drake's map of Mammoth Cave shows that the Second Hoppers were the first rectangular hoppers built in the cave.[4] The map indicates that four rectangular hoppers and a pump tower were located in Booth's Amphitheatre; there was also a pump tower in the Rotunda and one at the entrance to the cave (figure 1). A pipeline connected all three pump stations. John Hay Farnham reported a visit to Mammoth Cave three months after the discovery of the mummified body of an Indian in nearby Short Cave, placing him at the saltpeter operation in early December 1811.[5] He observed that "The earth is dug up

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2 Angelo I. George, "Rotunda V-vat Complex, Mammoth Cave, Kentucky," *Cave Research Foundation 1988 Annual Report* (1989): 75.

3 Carol Hill and Duane DePaepe, "Saltpeter Mining in Kentucky Caves," *Register of the Kentucky Historical Society* 77 (1979): 255. Manufacturers of industrial machinery still use this method of numbered notches on each part.

4 Daniel Drake, *Map of a Salt Petre Cave in Green River Kentucky*, Daniel Drake Papers, vol. 2, Ohio, Draper Manuscripts, microfilm 2080; Angelo I. George, "V-vats and Rectangular Hoppers in Mammoth Cave," *Cave Research Foundation 1988 Annual Report* (1989): 74. The Second Hoppers have this name because they constitute the second processing station in the cave from the entrance.

5 John Hay Farnham, "Extract of a Letter from John H. Farnham, Esq., a Member of the American Antiquarian Society, Describing Mammoth Cave, in Kentucky," *Archaeologia Americana, Transactions and Collections of the American Antiquarian Society* 1 (1820): 357. Farnham is the only visitor during actual mining to describe clearly the rectangular hoppers in operation. The entrance pump tower either was not built at this time or the pumps were frozen during the winter. Knowing when the first two mummies were found in Short Cave has helped to determine the approximate time of Farnham's visit to Mammoth Cave. About August 1811 the mummified body of an Indian child was found in Short Cave. The dating of Farnham's visit is based upon his mention of the Fawn Hoof

and deposited in square pits, called hods." At that time, the liquid leachate was piped to the entrance and then carried in buckets from there to the nearby evaporation furnaces. By the time Ebenezer Meriam was supplying potash to the Mammoth Cave operation in 1813-1814, his notes record that a functional pump was situated in the cave entrance. The saltpeter hoppers then in use were V-vats, similar to ash hoppers.[6] By the beginning of 1814, Mammoth Cave had been exhausted of its saltpeter reserve.[7] By dumping leached soils wastefully on the rising aprons, instead of replacing them in the mined passages, this naturally renewable resource was depleted despite earlier studies showing the feasibility of recycling.[8]

Knowledge of the changeover from rectangular hoppers to V-shaped hoppers makes possible a significant reinterpretation of the saltpeter mining history at Mammoth Cave. During the War of 1812, Charles Wilkins of Lexington was part owner-operator of the Mammoth Cave saltpeter operation; he had contracted the entire production to the Du Pont Powder Works in Wilmington, Delaware, the largest manufacturer of gunpowder in the nation. In a 20 December 1812 letter from Archibald McCall, the Du Pont purchasing agent in Philadelphia, to Eleuthère Irénée Du Pont, there is a cryptic reference that has long puzzled researchers. McCall refers to a letter he had recently received from Wilkins who reported that, "Having been obliged to repair their works they had made very little Salt Petre this season."[9] Burton Faust conjectured that this alluded

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Indian mummy discovery (presumably in September 1811), the use of rectangular hoppers, and the lack of any mention of earthquakes. Reference to the 1811-1812 earthquakes is prominent in early antebellum guidebooks.

6 George, "Rotunda V-vat Complex," 75. Meriam does not describe the presence and operation of rectangular hoppers. His silence suggests that the large box-shaped vats were not used in 1813-1814.

7 Angelo I. George, "Pre-1815 Demise of the Domestic Saltpeter Industry, Kentucky," *Journal of Spelean History* 22 (April- June, 1988): 15-20.

8 Anonymous, "Caverns in Virginia, Kentucky, and Tennessee, which Afford an Inexhaustible Supply of Salt-Petre," *Medical Repository* Hex. 2, 14 (1805): 86.

9 Archibald McCall to E. I. Du Pont, 30 December 1812. Longwood Mss.,

to the expansion and repair of the saltpeter works under the new ownership of Wilkins and Hyman Gratz.[10] Marsha Mullins thought that the repairs could have been connected with "additional construction, modification, or simple repairs. . . . We can not tell whether the repairs discussed late in 1812 substantially modified the system, or were routine maintenance."[11] Duane DePaepe held that the letter is "our best evidence as to when the Mammoth Cave saltpetre works we see today were constructed."[12] Interpretation of the McCall letter suggests a year-long difficulty in the Mammoth Cave mining and refining operations caused by the damage inflicted by the earthquakes of 1811-1812.

The New Madrid earthquake was felt over 965,250 square miles in the midwest and in the eastern part of the United States from 16 December 1811 to 5 March 1812; it was coupled with hundreds of smaller aftershocks lasting another year.[13] Four major shocks occurred on the following dates: 16 December 1811, at 2 A.M. and 8 A.M.; 23 January 1812, at 6:30 A.M. and a strong aftershock at 7:15 A.M.; and on 7 February 1812, at 3:15 A.M. The earthquake on 7 February 1812 was the worst and is often referred to as the "hard" shock. Otto W. Nuttli estimated the Richter magnitude at 8.6, 8.4, and 8.7 respectively for the above dates.[14] By comparison, the 1906 San Francisco earthquake was measured at 8.3 on this scale.

Group 5, Series A., Hagley Museum and Library, Wilmington, Delaware (hereafter HML).

10 Burton Faust, "Saltpetre Mining in Mammoth Cave, Ky.," *The Filson Club History Quarterly* 41 (1967): 328.

11 Marsha Mullins, "Mammoth Cave Saltpetre Works," Historic American Engineering Record, National Park Service, 1986, typewritten. Copies in Superintendent's Office, Mammoth Cave National Park and Library of Congress.

12 Duane DePaepe, *Gunpowder from Mammoth Cave* (Hays, Kansas, 1985), 13.

13 James Lal Penick, Jr., *The New Madrid Earthquakes* (Columbia, Missouri, 1981), 147; Henry McMurtrie, *Sketches of Louisville* (Louisville, Kentucky, 1819), 233-55; Roger T. Saucier, "Evidence for Episodic Sand Blow Activity During the 1811-1812 New Madrid (Missouri) Earthquake Series," *Geology*, 17 (no. 2, 1989): 103-106.

14 Penick, *The New Madrid Earthquakes*, 8, 141. The Richter magnitude

There have been no published direct references to damage to the saltpeter works in Mammoth Cave. Existing reports were made long after the event or were transmitted through second and third-hand accounts. There have, however, been a number of published accounts of earthquake effects within the cave, notably those of Nahum Ward, Robert Montgomery Bird, Ebenezer Meriam, and Adam D. Binkerd.[15] The Ward and Meriam accounts are second-hand renditions. John Hay Farnham described the Mammoth Cave operation in the few weeks immediately before the first earthquake.[16] Harold Meloy, Duane DePaepe, and Marsha Mullins provide modern interpretations of the earthquakes' effects on Mammoth Cave.[17]

The first published account of the New Madrid earthquake and its effects in the cave was written by Nahum Ward in 1816. His guide recited the story at the Second Hoppers (Booth's Amphitheatre, figure 3). Ward says:

> The walls of the Cavern are perpendicular in every passage that I traversed; the arches are regular in every part, and have bid defiance even to earthquakes. One of my guides informed me, he was at the Second Hoppers, in 1812, with several workmen, when those heavy shocks came on, which were so severely felt in this country. He said about five minutes before the shock, a heavy rumbling noise was heard coming out of the Cave like a mighty wind; that when that ceased, the rocks cracked, and all appeared to be going in a moment

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is based on a numerical scale of earthquake energy at its source as determined from seismograph records. From historic accounts of earthquakes predating such instruments, estimates of magnitude can sometimes be made.

15 Nahum Ward, "Wonders of Nature," *Kentucky Gazette*, 9 September 1816, p. 2; Robert Montgomery Bird, "The Mammoth Cave of Kentucky," *American Monthly Magazine* (1837): 417-38, 525-46; Meriam, "Mammoth Cave," 317-34; *New York Municipal Gazette*, 9 March 1844, p. 328; A. D. Binkerd, *The Mammoth Cave and Its Denizens* (Cincinnati, Ohio, 1869); Edmund F. Lee, *Notes on the Mammoth Cave* (Cincinnati, Ohio, 1835), 10, reprinted in *Journal of Spelean History* 2 (Spring, 1969): 29. Lee restricted his comments to earthquake-induced rockfalls into Green River.

16 Farnham, "Letter," 355-61.

17 Harold Meloy, "The Gatewoods at Mammoth Cave," *Journal of Spelean History* 2 (Fall, 1969): 51-62; Duane DePaepe, "Mammoth Cave and the New Madrid Earthquakes of 1811-1812," *Cave Research Foundation Annual Report* (1980): 33; Mullins, "Mammoth Cave Saltpetre Works," 12-13.

> to final destruction. However, no one was injured, although large rocks fell in some parts of the Cave.[18]

Ebenezer Meriam supplied potash to the Mammoth Cave saltpeter operation during 1813 and 1814. His job required him to be at the cave on a periodic basis, though he was not present during the earthquakes. In his *New York Municipal Gazette* (1844) he gives this description of activities:

> In 1810 [1811] and 1811 [1812], the earthquakes which were so severe at New Madrid, upon the Mississippi, were felt in the Cave. The Miners were at work at the Cave during one of these shocks, and they were greatly alarmed, and it was sometime before they could be persuaded to return.[19]

Adam D. Binkerd in his 1869 traveler's chronicle of Mammoth Cave gave a third-hand description of the earthquake and resulting pandemonium:

> Mr. J[oseph A.] Gatewood, a native of the county, and an employe[e] in the saltpetre mines, frequently stated during his lifetime, within hearing of Mr. A. L. Mallory, my informant, that he was in the cave with a number of other workmen, during the occurrence of the eathquake that formed the lake in the lowland known as the "Kentucky Purchase," in the southwestern part of the State, bordering on the Ohio. The tremulous motion of the earth filled the miners with alarm, and they fled in the wildest confusion toward the entrance, which they did not reach till long after the danger was past, when they stepped forth with thankful hearts from what they feared might prove their supulcher [*sic*]. Fortunately no one was hurt, nor were the mining operations interfered with. Since the cave has proved a safe retreat during a violent earthquake, it is hardly probable that it could be unsafe at other times.[20]

This word-of-mouth statement was published fifty-eight years after the fact. The story has been greatly altered; certain significant facts have been omitted. In fact, saltpeter mining operations *were* interrupted by the earthquakes. Binkerd did not have access to primary documentation and could not give an accurate account of those tumultuous events.

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18 Ward, "Wonders of Nature," 2. The guide mentioned was not Archibald Miller but one of two slaves assigned to escort Ward through the cave.

19 Meriam, "Mammoth Cave," 324.

20 Binkerd, *Mammoth Cave and Its Denizens*, 17. His informant was A. L. Mallory of Cave City, Kentucky.

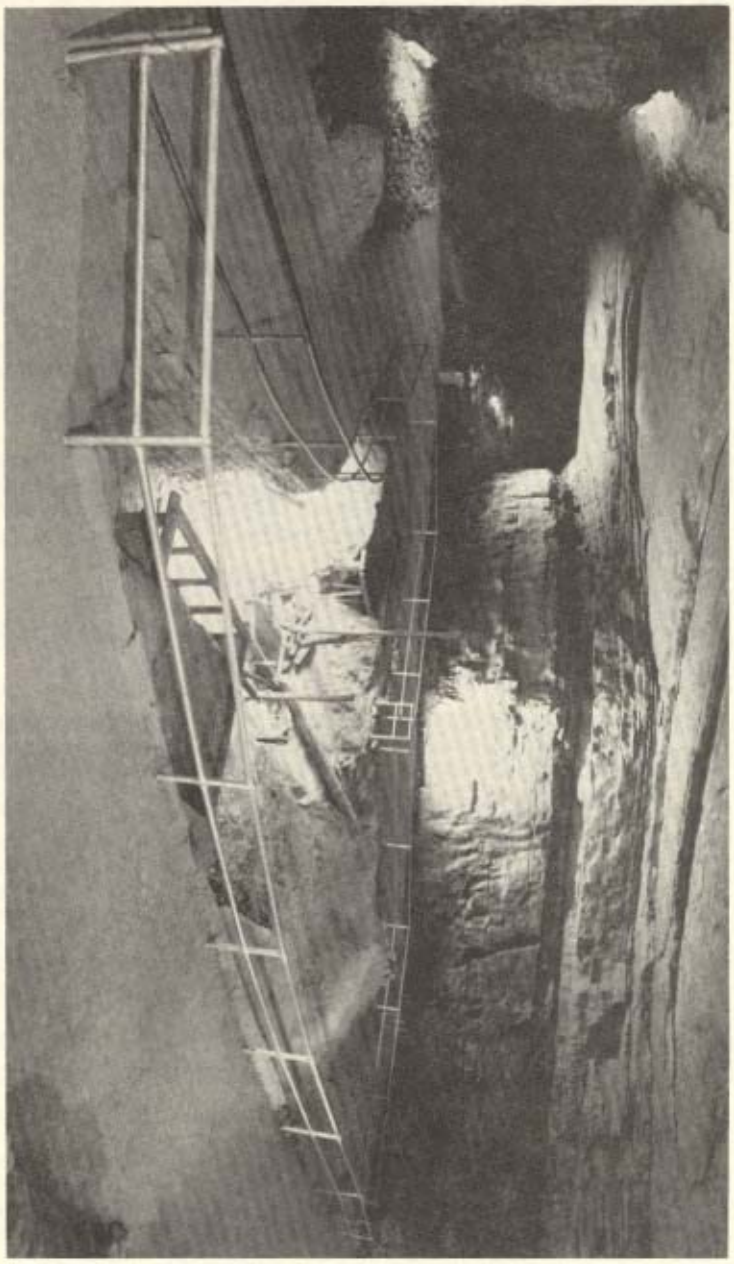

Figure 2 — The First Hoppers in the Rotunda consist of three rectangular saltpeter vats. In the center are the remains of a small pump tower, sump tank, and pump column. At the base of the aluminum fence on the right side is a long leg belonging to a taller pump tower. Photograph by Diana Emerson George

One of the best travel accounts of Mammoth Cave was written by Kentucky author Robert Montgomery Bird, who reported in 1837 that:

> The earthquakes that have left their visible devastations in every part of the cave, must, however, have been a thousand times more violent than those of modern days. Many shocks — the concussions that succeeded the great New Madrid earthquake of 1811 — were experienced by the nitre-diggers while at work in the cave; but though sorely frightened on each occasion, they never saw a single rock shaken from the roof or walls.[21]

Edmund F. Lee, a civil engineer from Cincinnati, produced the first transit survey and guidebook of Mammoth Cave in 1835. His comments on the earthquake were restricted to the effects at nearby Green River:

> Large rocks sometimes become detached from the cliffs and tumble into the river with a tremendous noise, crashing every thing before them. During the earthquake of 1811 so many fell, as materially to impede the navigation of the river.[22]

An unpublished letter from Archibald McCall to Eleuthère Irénée Du Pont on 10 March 1812 describes physical and historic events in the cave on the day of the first earthquake:

> I have likewise a letter from Mr. Wilkins in which he informs me that but little business has been done at his Cave during the Winter. The Earthquake on the 16th Dec'r had thrown down several of the hoppers & sunk the pump three feet. That the frequent repetions [*sic*] of alarms had so frightened the hands, it was with difficulty they could, after some time, be got to work. The Manager has refused to go into the Cave ever since. On the whole he had only received 15,000 lbs. w'ch had been forwarded to the Ohio & will be shipped about this time for Pittsburg. They are now under way again & expect to make 3000 lbs. pr week which shall be sent on as fast as it is made.... There is but [little] Salt Petre at Market in Lexington. The [earthquake] has had the effect of stopping the workmen all thro' the [cou]ntry.[23]

This recently discovered letter at last resolves the question

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21 Bird, "The Mammoth Cave of Kentucky," 544. Bird is under the mistaken impression that most of the breakdown in the cave was produced by earthquakes. Nahum Ward is the only one to say that rocks actually fell in some parts of the cave during the earthquake ("Wonders of Nature," p. 2).

22 Lee, *Notes on the Mammoth Cave*, 10.

23 Archibald McCall to E. I. Du Pont, 10 March 1812 (HML).

of why the Mammoth Cave works required the repairs indicated in the McCall letter of 20 December 1812, though it raises the question of why a year was required to effect them.

From these sources and others, the picture of mining activity at Mammoth Cave during and following the earthquakes can be reconstructed. Several saltpeter miners, along with Joseph A. Gatewood (brother of Fleming Gatewood, part-owner of Mammoth Cave) and possibly Archibald Miller (manager of the saltpeter works), were working in the cave at the Second Hoppers when the earthquake struck at 2:00 A.M. Everyone was frightened by the tremors and ran out of the cave. Aftershocks, some almost as strong as the initial quake, occurred daily.[24] Another strong quake occurred on 23 January, followed by the hard shock on 7 February. Only after much encouragement during the next three months did the workers re-enter the cave after each of the quakes. Those hardy souls who did return faced not only the daily aftershocks but also the additional major quakes that soon followed which were enough to quail the stoutest heart. Archibald Miller, manager of the works, refused to enter the cave after the initial earthquake. It was not until early March 1812 that saltpeter production again approached normal levels. Disruption of saltpeter mining was not limited to Mammoth Cave but affected *all* mining sites in Kentucky as the miners viewed their underground occupations with new trepidation.

Reported earthquake damage in and near Mammoth Cave consisted of some rockfalls within the cave coupled with surface rockfalls into Green River that created navigational hazards.[25] At least two of the rectangular saltpeter hoppers in the cave were "thrown down" and one of the pump towers sank three feet into the ground. A modern survey indicates that the tower

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24 Daniel Drake, *Natural and Statistical View, or Pictures of Cincinnati* (Cincinnati, Ohio, 1815), 233-42; McMurtrie, *Sketches of Louisville*, 233-55.

25 Duane DePaepe, "Mammoth Cave and the New Madrid Earthquakes," 33. DePaepe was not able to discover the reported earthquake-induced rockfalls in the cave.

may have actually sunk as much as four feet (figure 2).[26] The sinking of the tower made the leachate gravity-flow pipeline inoperable. It seems likely that there must have been some damage to the pipeline itself as well as to the dry-stack stone walls built from Houchins Narrows to the Methodist Church.

The report that workers were in the cave at 2:00 A.M. suggests that the operation at Mammoth Cave was around the clock.[27] During the period when work was disrupted by frequent earthquakes, a span of nearly three months, the total saltpeter production at the cave amounted to approximately 15,000 pounds. The cave seems to have been capable of producing 3,000 pounds a week under normal conditions; the earthquake damage and worker strikes apparently reduced production by fifty percent or more. Two additional McCall letters, written on 29 May 1812 and 27 April 1813, imply that saltpeter production never regained pre-quake levels.[28]

Antebellum guidebooks and contemporary interpretations indicate that the saltpeter miners at Mammoth Cave were very superstitious.[29] Many of the superstitions involved an Indian mummy found in nearby Short Cave in September 1811. Probably late in September the mummy that became known as Fawn Hoof was taken from Short Cave and placed in the Rotunda of Mammoth Cave (figure 1). Its presence frightened the workmen. They staged a strike and refused to go back to work.[30] The mummy was moved to the Haunted Chambers (present-day

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26 Mullins, "Mammoth Cave Saltpetre Works," 17.

27 This is consistent with maintaining around-the-clock fires in the surface boiling (evaporation) furnaces, a condition also practical with large salt-brine or pig-iron furnace operations. Too much heat and fuel loss would occur if the fires were allowed to go out.

28 Archibald McCall to E. I. Du Pont, 29 May 1812 and 27 April 1813 (HML).

29 Farnham, "Letter," 360-61; Bird, "The Mammoth Cave of Kentucky," 529-30; Horace Martin, *Pictorial Guide to the Mammoth Cave of Kentucky* (New York, 1851), 21; Harold Meloy, *Mummies of Mammoth Cave* (Shelbyville, Indiana, 1971), 24-25; Angelo I. George, *Mummies of Short Cave Kentucky and the Great Catacomb Mystery* (Louisville, 1985), 47-48.

30 Meloy, *Mummies of Mammoth Cave*, 24-25.

Gothic Avenue), and with this concession the uneasy miners returned to work.[31]

The naturalist John Hay Farnham wrote, "[T]he superstitions of some people in the vicinity of the Cave, though perfectly independent of classical or fabulous history, induces them to believe this Cave to be the passage to hell itself."[32] The story of the lost miner in the Haunted Chambers well illustrates this belief.[33]

The Great Comet of 1811 had made its appearance in September, and it was visible until the following 16 January.[34] Its presence inspired doomsday seers with visions of a bleak future and the end of the world.[35] The superstitious miners, and perhaps also their supervisors, were already on edge from Fawn Hoof in the cave of hell and by the Great Comet in the sky above when the New Madrid earthquake first struck in the small hours of morning. Their greatly strained composure was shattered completely. Far away from the New Madrid area of destruction, there was great alarm in Louisville. Over the next few years, the great revivalist movement gained many new members called "earthquake Christians."[36] John Latrobe sums up the sentiment of the times as "those days of horror."[37]

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31 Ibid.

32 Farnham, "Letter," 360-61.

33 Bird, "The Mammoth Cave of Kentucky," 529-30. Gothic Avenue used to be called The Haunted Chambers. The passage received its name during the days of saltpeter mining and commemorates the exploits of a lost miner. An inexperienced miner was introduced to the lower reaches of this passage. While there, his co-workers in the upper level forgot about him and left the cave for the evening. Meanwhile, the miner completed his task and was making his way to the upper cave when he realized that he was lost. This produced panic, and in this excited state his light was extinguished. In total darkness, his imagination started to play tricks; according to Bird, he believed that "he was in hell itself, the prey of devils, who would presently be let loose upon him." He even thought his rescuers were these very devils!

34 Penick, *The New Madrid Earthquakes*, 118.

35 Carl Sagan and Ann Druyan, *Comet* (New York: Random House, 1985), 372; Penick, *The New Madrid Earthquakes*, 119-20.

36 Wayne Vitanen, "The Winter the Mississippi Ran Backwards," 66.

37 Carl R. Bogardus, *The First Steamboat on the Western Waters* (Austin, Indiana, 1961), 20. John H. B. Latrobe quotes from a letter by Mrs. Roosevelt, wife of Nicholas Roosevelt, builder of the steamboat *New Orleans*.

Figure 3 — The Second Hoppers in Booth's Amphitheatre contain seven rectangular hoppers. The sump tank for the pump tower is located at the 2:00 o'clock position out from the base of the stair casing. Legs for the pump tower are used for a fence railing seen in the far right of the photograph. Photograph by Diana Emerson George.

One possible reason the story of the earthquake effects in Mammoth Cave has not been told may be connected with manager Archibald Miller. He is believed to have been at the cave since 1808.[38] When the saltpeter production ceased in 1814, shortly before the end of the War of 1812, he remained to conduct public tours through the cave. Early guide patter stems in part from Archibald Miller's experiences and remembrances. As he had refused to enter the cave for some time after the earthquakes, he may have concealed his earlier fears by downplaying earthquake stories to the public.

Over a twenty-year period (1836-1856), many of the saltpeter artifacts were destroyed by the cave guides.[39] The public was entertained with bonfires built to illuminate the vast size of the Rotunda; V-vats and other wooden structures were consumed as firewood. Wood from the pump tower, reconstructed after having been sunk by the earthquake, may also have been used for fires or for construction elsewhere in the cave; today only remnants of it are left.[40]

The knowledge that the saltpeter of Mammoth Cave was nearly exhausted by the wasteful practice of dumping in spoil aprons may have caused the managers to limit repairs of the more complex rectangular hoppers and return to V-vat construction.[41] Added structural support to some of the hoppers suggests that the rectangular hoppers may have been repaired at least after the initial earthquake of 16 December. Mounting frustration after further shocks and resultant damage appar-

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38 Meloy, "Gatewoods at Mammoth Cave," 54; William Newnham Blane, *An Excursion Through the United States and Canada During the Years 1822-23* (London, 1824), 276-77. It is generally believed that Miller was the manager (or agent) of the saltpeter works during the ownership of Fleming Gatewood and Charles Wilkins; he certainly was manager during that of Hyman Gratz and Charles Wilkins.

39 George, "Rotunda V-vat Complex," 75.

40 Angelo I. George, "Tandem Pump Tower in the Rotunda, Mammoth Cave, Kentucky," *Cave Research Foundation 1989 Annual Report* (1990): in press.

41 George, "Pre-1815 Demise of the Domestic Saltpeter Industry, Kentucky," 17.

ently led to abandonment of the rectangular hoppers in favor of the more easily constructed, if less efficient, V-vats. The "marvelous machine," so well described by DePaepe, had evidently failed to function.[42] In order to salvage their operation, the cave owners built a series of V-vats in Booth's Amphitheatre and in the Rotunda.

After the earthquakes, Charles Wilkins and Fleming Gatewood were not able to meet their obligations to the Du Pont Powder Works even with the purchase of bulk saltpeter from competitors. Attempts to bring Mammoth Cave back into full-scale production had not been successful by late May 1812. On 29 May McCall wrote to Eleuthère Irénée Du Pont that:

> It is to be presumed from this, tho he [General John Wilkins] does not say so, that the Salt Petre is not from the Cave of Mr. Wilkins. You will therefore please decide & let me know as early as possible whether you are willing to take it or not. With regard to the quality it is to be presumed it is no better than the common Salt Petre of Kentucky.[43]

John Wilkins, residing in Pittsburgh, had for some years received and forwarded to Philadelphia saltpeter produced and processed by his brother.

Faced with these difficulties, efforts were soon underway to sell Mammoth Cave. Legal formalities were concluded on 25 August 1812; Hyman Gratz of Philadelphia bought out Fleming Gatewood and other prior landowners.[44] For Gatewood, this was only a formality because he had not been associated with Mammoth Cave since 18 April 1812. Gatewood purchased a nearby saltpeter cave.[45]

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42 DePaepe, "Gunpowder from Mammoth Cave," 13.

43 Archibald McCall to E. I. Du Pont, 29 May 1812 (HML). John Wilkins is the brother of Charles Wilkins.

44 Samuel W. Thomas, Eugene H. Conner, and Harold Meloy, "A History of Mammoth Cave, Emphasizing Tourist Development and Medical Experimentation Under Dr. John Croghan," *Register of the Kentucky Historical Society* 68 (1970): 324-25.

45 Archibald McCall to E. I. Du Pont, 11 June 1812 (HML). Fleming Gatewood in V. T. Rousseau, "Pages from the Past: Boom Times Be-Dazzle Barren County Pioneers," *Glasgow's Daily Newspaper*, 20 February 1939. Saltpeter manufactured at Gatewood's cave was sold to Wilkins.

Charles Wilkins retained his own interest in Mammoth Cave for a time, but no documentation has yet been discovered to suggest what improvements may have been made by the new partnership of Wilkins and Gratz. The infusion of new money from the wealthy Gratz (who probably had no direct hand in the operation) should have alleviated any problem. Even so, production remained depressed to the end of the year. On 30 December 1812 in the letter previously cited, McCall reported to Du Pont that needed repairs to the Mammoth Cave works had greatly reduced saltpeter production for the season. Charles Wilkins had expressed the hope that his brother John Wilkins would "supply the balance that was due, from the purchases they had made from other caves."[46]

From necessity, Du Pont rejected all saltpeter that had not been made at Mammoth Cave because the quality of the proposed substitute was thought to be inferior. John Wilkins then sold the rejected saltpeter to other powder-makers. Continued efforts to bring the cave back into large-scale production were thwarted; McCall reported to Du Pont of a personal visit by John Wilkins:

> [He] advises me that during the last winter, the pipes in the cave for the conveyance of water burst, & that the quantity of Salt Petre made was not more than sufficient to defray the expenses of the works.[47]

These two letters prove the continuation of problems in the production of saltpeter at Mammoth Cave, which were begun by the earthquakes of 1811-1812. Key managerial issues were unfilled contract quotas, disrupted mining schedules, constant repairs, new construction, and a quality-control problem. John Wilkins thought that it would be August 1813 before shipments from Mammoth Cave would again arrive at Du Pont's business.[48] The business relationship between the Gratz-Wilkins partnership and the Du Pont Powder Works continued to deteriorate. In late 1813, Wilkins disassociated himself from the saltpeter

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46 Archibald McCall to E. I. Du Pont, 30 December 1812 (HML).
47 Ibid., 27 April 1813.
48 Ibid.

operation, writing McCall that he no longer had "control over the Salt petre made at the cave."[49] The saltpeter operation was probably shut down before the end of the year; purchases contracted by Du Pont were suspended before 29 January 1814.[50] In 1815 the war ended and saltpeter prices plummeted so that a return to production no longer had any economic viability.[51]

The New Madrid earthquakes of 1811-1812 caused major damage to the saltpeter works inside Mammoth Cave although the structural integrity of the cave itself was little affected. Fear, superstition, and strikes by the miners occurred after each major tremor and were reinforced by the nearly continuous aftershocks. Several of the saltpeter hoppers were rendered inoperable and the pump tower in the Rotunda sank four feet. This damage presented a major problem to the operation because saltpeter liquor could no longer be drained from the cave by gravity. The series of earthquakes temporarily affected the mining, refining, shipping, and commerce of saltpeter throughout the region.

Rebuilding the saltpeter factory took over a year. With apparently repeated damage to the rectangular hoppers, V-vats were subsequently used extensively due to the greater ease of construction. Following the general failure of the operation, all of the V-vats, and presumably much of the other idle wooden equipment, were cannibalized for firewood by the commercial cave guides from 1836 to 1856.

The correspondence among Charles Wilkins, General John Wilkins, Archibald McCall, and Eleuthère Irénée Du Pont provided new insight into the day-to-day operations of one of the most famous saltpeter mines in Kentucky — Mammoth Cave.

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49 Charles Wilkins to Archibald McCall, 5 January 1814 (HML). It is not clear if Wilkins relinquished his interest or if Gratz shut Wilkins out of the Mammoth Cave operation.

50 Mullins, "Mammoth Cave Saltpetre Works," 12.

51 George, "Pre-1815 Demise of the Domestic Saltpeter Industry, Kentucky," 17-18.