SALTPETER MANUFACTURING AND MARKETING AND ITS RELATION TO THE GUNPOWDER INDUSTRY IN KENTUCKY DURING THE NINETEENTH CENTURY

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ABSTRACT

This article provides a detailed examination of the saltpeter industry in Kentucky during the nineteenth century. Special attention is focused on the early 1800s, and the importance of Kentucky saltpeter in the War of 1812, when Kentucky was one of the most important producers nationally. Production processes, location of saltpeter mining sites, marketing practices and factors, and key players in the Kentucky trade are discussed.

INTRODUCTION

In the world of the nineteenth century, gunpowder was very likely of greater political impact in the destiny of nations, pound for pound, than virtually any other article of trade. The nineteenth century was an era when American ordnance was called upon many times; sometimes in the acquisition of territory under the self-righteous spirit of Manifest Destiny, sometimes in defense of the nation against foreign powers, and on that one terrible occasion when families divided against themselves. Correspondingly saltpeter[1], a naturally-occurring mineral that was the primary ingredient used to make gunpowder, was a vital item of commerce during the early history of Kentucky and the nation.

Naturally occurring nitrate minerals historically used in manufacture of explosives include calcium nitrate and potassium nitrate. Only pure potassium nitrate, saltpeter, was suitable for making black powder used in small arms. In a multistep process, three-quarters saltpeter by weight was combined with lesser amounts of sulfur and charcoal at European gunpowder mills to produce gunpowder. Prior to the War of 1812, the American colonies and later American nation had little developed industry. The colonies had been forced to rely on British manufactured goods. High-grade British gunpowder was generallly far superior to that produced by the few primitive powder mills in the colonies.[2]

This trade monopoly also extended to semi-raw materials such as refined saltpeter. In the Bengal region of British India, potassium nitrate deposits were found in surface soils in high concentration. This gave Britain virtual control of the world's most extensive and easily obtainable supply of saltpeter. Other major deposits in Imperial China were not so readily available to the world market. As Indian saltpeter was critical war material, trade was restricted to only those countries with which Britain was on a friendly footing. Nations excluded from this trade, such as arch-rival France (and frequently the United States), were forced to develop other sources.

Historically saltpeter was obtained from the barnyard. Manure heaps were overturned, the floors of barns, henhouses and cellars dug up, and privies excavated. Such places proved to have small but recoverable amounts of saltpeter. Occasionally nitrates were recovered from dry European caves. Vigorous attempts had been made in Europe to develop artificial production methods aimed at recreating conditions under which saltpeter forms. All together, such sources supplied only the barest needs of a nation.[3]

There were three periods in American history during which domestic saltpeter production was of critical importance. Peak saltpeter production in the United States occurred roughly from 1775-1783, 1808-1814, and 1861-1865, a total of only 20 years from the American Revolution to the almost universal adoption of smokeless powder circa 1900.[4] The American colonists had little incentive to develop domestic saltpeter supplies prior to the American Revolution. Saltpeter production by the traditional "barnyard/cellar" methods was slow and yielded little. During the Revolution, various Committees of Safety attempted to organize saltpeter production based on traditional sources found in cellar and barnyard. Actual production was relatively low; fortunately adequate supplies were smuggled into the country beginning in 1776 from France, Spain, and the West Indies. Not until after active hostilities had ceased did it become well-known that saltpeter was plentiful in the dry caves of Virginia's frontier.[5]

Among the early settlers in Kentucky were men experienced in processing saltpeter earth and manufacturing gunpowder. Having knowledge of the saltpeter caves of what are now the limestone regions of western Virginia and West Virginia, they searched for similar sources in the Kentucky karstlands.[6] Kentucky proved to have a greater abundance of such sites than any other region and became the most important supplier of saltpeter for the needs of the country.

Whenever relations between Great Britain and the United States were tense or in a state of war, the supply of Indian saltpeter as well as high-quality European gunpowder was cut off or greatly restricted. When relations were amicable, gunpowder and saltpeter flowed freely through American ports at low cost. So low was the cost, in fact, that domestic saltpeter was not worth mining. American saltpeter, made in the heart of the nation, was considerably more expensive than that shipped across the world from India.[7] The American, and thereby Kentucky, saltpeter industry was highly sporadic, being stimulated only at those infrequent times when commerce was hindered between the United States and the rest of the world.

Beginning with the du Pont's[8] Eleutherian Mills in Delaware in 1802, several large mills with capacity to manufacture large quantities of saltpeter into gunpowder became established in the east during the first decade of the nineteenth century. This created a large national demand for a reliable saltpeter source. American trade had become very important to both France and Great Britain in the late eighteenth century. With the rise of Napoleon in France, international tensions greatly increased. The period 1808-1814 was characterized by disrupted shipping in the Atlantic. As war material, saltpeter was subject to the most stringent restrictions. Both France and Great Britain, embroiled in war since 1803, passed orders forbidding American trade in ports controlled by their opponents. The American responses, the 1807 Embargo Act (repealed 1809), the more limited 1809 Non-Intercourse Act, and the 1810 Macon Bill, further hampered American trade with Europe.[9]

Britain was then undergoing a serious economic depression and, under pressure from merchants and workers, Parliament on June 16, 1812 revoked the Orders in Council that had circumscribed American shipping. Unaware of Parliament's action, the U.S. Congress declared war on Great Britain on June 18, 1812. One practical effect of the war and its prologue was to stimulate domestic saltpeter production to unprecedented heights. The British blockade and the earlier trade restrictions from both sides had cut off the flow of cheap saltpeter imported from British India.

During the boom period of the War of 1812, saltpeter entrepreneurs multiplied across Kentucky, either as mining operations large and small in the countryside or as broker/wholesalers in trade centers. A central market for trade in Kentucky saltpeter was established in Lexington, where brokers and speculators gathered during times of high demand. The region of the Inner Bluegrass correspondingly developed a dependent industry of gunpowder manufacture that took advantage of proximity to the mining area (O'Dell 1989). Other powder mills were scattered through the mining belt but generally were more transient than those closer to the trade center. Following the 1812 boom period, domestic saltpeter was far more expensive than saltpeter imported from India and in Kentucky local industries of nitrate mining and gunpowder production collapsed permanently.

The Mexican War (1846-1848) did little to stimulate domestic saltpeter production in the United States. Although the war with Mexico was, like earlier conflicts with Britain, across international boundaries, Mexico was unable to interfere with American shipping. As there was no disruption of the international saltpeter trade and the war was of short duration, domestic saltpeter production was neither economical nor necessary.

The third major period of domestic production occurred during the Civil War. The Confederate States in 1861 found themselves in a similar position to that of the entire nation in 1812. The largely agricultural southern states, unlike the industrialized north, had few powder mills. The Confederacy had little power to interfere with Northern shipping, but was itself blockaded by federal warships. The Confederate states were desperately short of gunpowder, with little prospect of obtaining either gunpowder or its makings from abroad. In extremity, the Confederate government turned to the numerous caves of the South, many of which had been mined half a century before. The southern Congress quickly passed bills to encourage manufacture of saltpeter and small arms, and to organize a corps of officers to "work nitre caves and establish nitre beds"(CSA Journal 1904:82, 85, 133, 139, 145).

Of those states containing saltpeter caves, Kentucky and Missouri were border states not completely dedicated to the southern cause. Individual sentiments were widely divided in Kentucky, but the state remained politically aligned with the Union. In practical terms, it became an occupied territory under Federal control. The North, with access to international trade denied to the Confederacy, did not need Kentucky saltpeter. As a consequence, little mining occurred in the state during the period. It may be suspected that a few small clandestine operations occurred in Kentucky near the southern border, although proven examples are yet lacking.

Strong Unionist sentiments in mountainous western Virginia led that region, with numerous saltpeter caves, to separate from the Confederacy in 1863. The South was left with cavernous Tennessee and the remaining portion of Virginia, and a scattering of saltpeter caves in northern Alabama and Georgia, as sources of domestic saltpeter. Although blockade runners ultimately funneled large amounts of war materials to the Confederacy, a tremendous effort was made to develop domestic supplies in the South.

In national and local history, domestic saltpeter production, while significant in impact, occupied a relatively small time frame. Active exploitation of saltpeter resources took place only during the war periods and immediately before, when tensions were peaking and speculators anticipated sudden demand. In Kentucky, production of commercial quantities for export occurred only during the seven year period 1808-1814.

Successful operation of powder mills in the United States was linked to the availability and cost of saltpeter. The large powder mills of the Northeast, dominated by the du Pont company in Wilmington, were in the most advantageous position, able to utilize either foreign saltpeter brought

to adjacent ports or to use domestic manufacture -- whichever was most plentiful at the least price. Powder mills in the west were wholly dependent upon locally produced saltpeter to compete effectively against eastern manufacturers. When local production was in stasis, their inland freight cost alone for imported saltpeter was often greater than the entire cost of the material to their eastern competition. As a result, large established firms such as du Pont, with the well-known Eagle brand of powder, were often able to undersell local powdermen even in their own home markets.

The powder mill industry was not quite as reactive as the saltpeter industry, as commercial powder production was continuous in the west from 1793 through the Civil War; however, periods of peak production similarly corresponded to the incidence of war. Powder mills sprang into being just prior to each war period, peaked in numbers during the conflict, and dwindled rapidly afterward. A few of the most durable managed to cling to existence in the interior for several decades after 1815.[10]

SALTPETER MINE SITES

The areal geologic structure of Kentucky defines where saltpeter caves and rockshelters may be found. Cave formation is dependent upon the occurrence of limestone at or near the land surface. These limestone, or karst, areas comprise at least 50 percent of the land area of the state, divided into two distinct regions. The limestones of the Inner Bluegrass are of Ordovician age, while the larger Mississippian Plateau consists of younger rocks. The Bluegrass region contains numerous caves, but very few of them are suitable for nitrate accumulation, generally being very wet. At present there are no confirmed sites of historic saltpeter mining in the Inner Bluegrass.[11] In contrast, there are numerous saltpeter caves throughout the Mississippian Plateau, and a few in the Outer Bluegrass.

During the earliest settlement epoch of the state, small quantities of gunpowder were made, using cave deposits and also the barnyard/cellar method. In 1790, William and Thomas Rogers were residents of Bourbon County in the Inner Bluegrass Region. Their corn crop was being devastated by squirrels, and gunpowder was not yet a plentiful commodity in Kentucky. As there were no suitable caves in the vicinity, the two men resorted to traditional sources for a small saltpeter supply. As recalled by William's son:

> Father and Uncle Thomas...gathered up the dry dirt from under old houses and tried their hands to make saltpeter. They succeeded to make two or three pounds. Uncle had been in a powder mill once in Virginia, so they made a trial and after several days' experimenting, got powder (Rogers 1871).

The earliest recorded occurrence, 1780, of both saltpeter mining and gunpowder manufacture in Kentucky is attributed to Monk Estill, a black slave of Captain James Estill at Estill's Station in Madison County (Outer Bluegrass region). Monk, who had originally lived in the Greenbrier Valley of Virginia, possessed the requisite knowledge. In 1780, powder supplies were dangerously low. It was a time of conflict with the Shawnee, and the safety of both the station and neighboring Fort Boonesborough was measured by the dwindling supplies of black powder. Monk located a suitable cave near the station,[12] purified a small quantity of saltpeter earth, and made sufficient powder to ease the crisis. For this and other services to the white settlement he was later granted his freedom (George 1987b).

The early explorers and settlers of Kentucky were impressed by the abundance of natural caves in the state. Writing in 1784, Filson (1784:30) noted that:

> Caves are found in this country amazingly large; in some of which you may travel several miles under a fine limestone rock, supported by curious arches and pillars: In most of them runs a stream of water.

As Monk had earlier discovered, Kentucky caves were more than mere curiosities. Thomas Rogers (1871) recalled that, "About this time [1790], saltpeter began to be found in the dry caves in the mountains..." Shortly thereafter (1792) Gilbert Imlay (1792:135) had more to say on this subject:

> [N]itre is made from earth which is collected from caves and other places to which the wet has not penetrated. The making of this salt, in this country, is so common, that many of the settlers manufacture their own gunpowder. This earth is discovered in greater plenty on the waters of Green river, than it is in any other part of Kentucky. But perhaps still farther southward, it will be found in greater plenty. However, it is so common in every part of the country, that it might be made a considerable article for exportation....

This last statement proved prophetic. Only ten years after the publication of Imlay's Topographical Description, market scarcity and rising prices created conditions under which Kentucky saltpeter might be profitably shipped out of the state.

Caves were not the only nitrate source exploited during the boom years of production. A major topographic feature known as the Cumberland Escarpment forms the eastern edge of the Mississippian Plateau, traversing the state diagonally from northeast to southwest. The escarpment is a region of transition, from plateau to mountains, from Mississippian limestones to Pennsylvanian sandstones. Throughout much of the escarpment are found numerous natural sandstone arches or bridges and an abundance of rockshelters.

In 1806 Thomas Jefferson wrote to Pierre Samuel du Pont that:

> It has lately been ascertained that the supplies of saltpeter which the Western country can furnish are immensely beyond what had been expected... The caves are numerous. But an important discovery has been made: that there are immense precipices of sandy rock, which pulverized yields about 20 lbs. of salt petre to the bushel, whereas the earth of the Caves yields but 1 lb to the bushel (Malone 1930:90).

Jefferson's Kentucky correspondent was Dr. Samuel Brown of Lexington. In a later monograph, Brown (1809:241) lyrically described the sandstone shelter sites:

> These sand rocks are generally situated at the head of a ravine or narrow valley, lead up a steep hill or mountain; ascending the streamlets which run through these valleys, the banks close in upon you and become perpendicular. The rocks are frequently from sixty to one hundred feet in height, and jutting over their bases, which rest on a calcerous stratum, often form a shelter large enough to secure a thousand men from the inclementies of the weather.... The summits of all the hills in the vicinity of Rock castle, Licking and Sandy are still covered by masses of these rocks, which from their beauty and variety of figure, might at a small distance be mistaken for the ruins of Gothic cathedrals or Baronial castles.

Although the deposits for any individual rockshelter were generally less than those in caves of more extensive dimensions, the nitrates from such shelters were more concentrated and more easily

processed, being in the desired form, potassium nitrate. In contrast, the nitrates found in caves were predominantly calcium nitrate and required chemical conversion (Figure 1).

There are a number of situational and morphological factors that influenced whether a particular site had potential to develop into a large producer or could even be mined at all. Most of these factors apply to both rockshelters and caves. Obviously the most important was whether a site had saltpeter. Seepage of nitrates probably occurs into nearly all caves where surface conditions are appropriate. The environment within a particular cave determines whether and where deposition may occur. Significant deposits will accumulate only in those caves that have dry passages subject to no more than slow seepage infiltration. This aspect eliminates caves that are commonly subject to inundation, as floodwaters would carry away the highly soluble nitrates. Also usually eliminated were caves whose configuration would make mining extremely difficult or impossible. Included in this category are caves that have tiny entrances, intervening long crawlways, sharp narrow bends or constrictions, shafts and any other internal feature that would prevent easy movement within the cave.[13]

Exterior ease of access was another important consideration. If the cave could only be entered from a deep pit, or reached only by tiny ledges midway up a cliff, a production operation would be extremely onerous. Reasonably convenient access to the cave site also was needed. Caves that were many miles from a good wagon road or otherwise difficult to reach were less likely to be operated as a major site (George 1986a:197).

There were other site considerations that affected location and construction of the saltpeter works. Foremost among these was availability of a water supply, as abundant water was needed in processing. The best water supply configuration for a saltpeter operation would be adjacent to and at somewhat higher elevation than the processing area to allow gravity piping. A water supply could be either a stream within the cave or a source on the surface. Also required was a readily available source of timber. Wood was needed to build the refining equipment and to stoke fires under large kettles of boiling water.

It has not been possible to even roughly estimate the number of sites in Kentucky that have been mined for saltpeter. Certainly it must number close to 1,000, including both caves and rockshelters. The number of known Kentucky caves, mined or not, is estimated at approximately 4,000 at present, and more are discovered every year.[14] A systematic inventory of caves has not been made, nor of mining sites.[15] Such locational information as exists is correlated from personal visits, reports from cave explorers, historical accounts, place names, and other sources.[16] U.S. Forest Service archaeologist Cecil Ison estimates from field reports that in the Daniel Boone National Forest (which largely covers the Cumberland Escarpment and the area of concentration of sandstone shelters) there are more than 500 rockshelters known to have been mined for saltpeter (Cecil R. Ison, personal communication 1993).[17] Owing to the lack of complete inventory these figures must be only considered as interim approximations.

TESTING FOR SALTPETER

In 1629 Pietro Sardi recommended three European methods for detection of saltpeter earth: "putting a little on the tongue, if there be sense of a biting taste;" thrusting a hot iron into suspect earth, allowing it to cool and examining it for a whitish color; and sprinkling over burning coals, "if there be perceived any crackling noise, and if any sparkles issues forth speedily, it shall be a sign of Saltpetre-Earth" (quoted in Stubbe 1670).

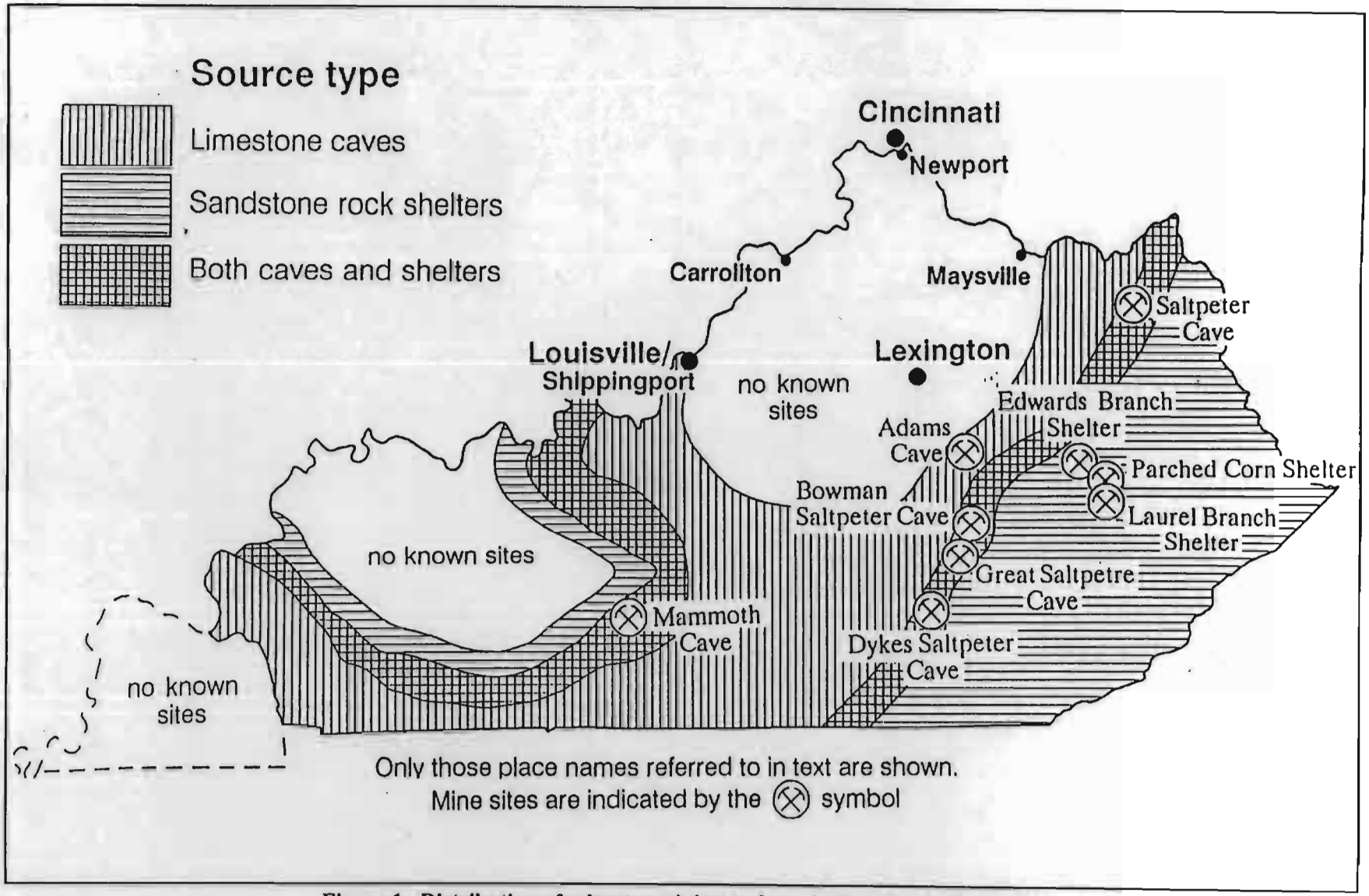


Figure 1. Distribution of saltpeter mining and marketing sites in Kentucky.

Instructions for making saltpeter and gunpowder abounded in newspapers during the American Revolution. One such notice in the January 1, 1776 Boston Gazette gave this advice for detecting the presence of saltpeter: "[A] little experience will teach you to chusz [sic] that [soil] which is loose, light, and crumbly, and has a bitterish or sourish ailum like salt upon the tongue; light sandy or loomy earth, such as water easily penetrates." Thirty-three years later Charles Wilkins of Lexington used the same method in reverse to detect bad lots of saltpeter delivered to him as broker. He complained in a letter to his major client (E. I. du Pont de Nemours & Co.) that some of the miners were attempting to cheat him. Such persons were not above occasionally filling a barrel with sand and gravel and then topping it off with a sufficient layer of good saltpeter, or mixing sand and saltpeter together. Wilkins (1809) stated that:

> I find the most ready mode of discovering the sand is to sift a small quantity of the finest out of the parcel & by tasting it is discovered by the teeth this leads to dissolving it by which means I have frequently detected it.

Dr. Samuel Brown of Lexington performed extensive research on the occurrence of saltpeter, and during the first decade of the nineteenth century was owner of one of Kentucky's largest saltpeter mines, Great Saltpetre Cave in present Rockcastle County. In regard to detecting rich deposits in caves, Brown (1809:239) noted that:

> The workmen have different modes of forming an opinion with regard to the quantity of nitre with which the earth may be impregnated. They generally trust to their taste; but it is always considered as a proof of the presence of nitre, when the impression made on the dust by the hand or foot is in a very short time effaced. Where the nitre is very abundant the impression made to-day, will be scarcely visible tomorrow.

Burton Faust, writing in 1964 (1964:38-39), similarly observed:

> One such [test] was to collect and taste some of the whitish needle-like crystals generally found between pieces of broken rocks which are partly embedded in the cave earth. If the crystals have a bitter taste and produce a cooling effect on the tongue, the material has passed the first test. If crystals are not readily found a few grains of the earth can be used in the taste test. There is always the possibility that such crystals might be Epsom Salts, in which event the taste test is not conclusive. A second test used by the saltpeter hunters, was to locate a surface of the cave-earth which was smooth, and even, then scratch, roughen, or furrow this surface with a stick. If upon a return inspection a few days later, it was found that the previously roughened surface was smooth and even, this situation was considered to be another indication of the presence of saltpetre.

Faust indicated that he had no explanation for this latter phenomenon but that he had made the experiment several times and found this occurred as described. Webb and Funkhouser (1936:145-146), reporting on mining from sandstone shelters, also noted that the imprint of a hand in loose soil on a flat surface would disappear in a few hours if the soil was nitrate-rich, but otherwise not. They attributed this effect to the presence of hydrophilic impurities in the nitrates that caused the disturbed soil to soften.[18] This odd characteristic was evidently the primary method by which the richest deposits were located in cave or shelter.

SALTPETER MANUFACTURE PROCESS

Saltpeter mining and processing were generally conducted in tandem. Processing involved concentration and purification of nitrate crystals. Nitrate-impregnated soil was mined by pick and shovel and carried to large wooden hoppers, usually centrally located within the cave. If the cave was very small, leaching operations might be conducted at the entrance or outside. Water was poured over the soil from time to time and percolated downward, gathering nitrates in solution along the way. Filtered through materials such as pine needles or gravel, the fluid was collected and boiled down in kettles to a whitish crystallization. The miner would clear the old "spent" earth out of his vats and begin again.

Larger operations had more hoppers or vats and more boiling kettles and more laborers. The basic process was the same regardless of the saltpeter source, so that mining and processing operations varied from site to site and era to era only in details of construction and scale. Minor design details were highly individualized and indicate that the technology slowly diffused into the region. The two largest sites, Mammoth Cave and Great Saltpetre Cave, were exceptions to this and are discussed later.

A one or two-man operation was quite feasible for production of small quantities from small caves and rockshelters, but economies of scale favored large operations in large caves containing extensive nitrate concentrations. Regardless, there were a great many small operations and only a few large ones, and combined production from the smaller sites is greater than that of the large. Historical accounts and preserved in-situ remnants of the Kentucky saltpeter industry suggest, unsurprisingly, that the largest operations used the most advanced and efficient equipment and methods and small operations used more primitive forms.

Once the presence of significant nitrate deposits had been determined, a saltpeter cave was developed into a mine. The cave environment was full of natural obstacles (boulders, shafts, narrow passageways), all of which must be overcome or accommodated in the area to be worked. Trails were made, rocks moved and piled in stacks against the cave walls. A fair proportion of such rock piles in saltpeter caves represents rock that was broken out of cave walls to obtain deposits in crevices, as well as rocks encountered buried in mined soils.

Cave nitrate deposits primarily occur in loose dry soils on floors and on ledges at various levels. The basic tools of the saltpeter miner were mattock and wooden paddle, both with short handles due to the often constricted workspace. The mattock was used to loosen the soil, and the paddle to shovel it onto cloths or into wooden buckets for transport. Tool marks may still be seen in a number of Kentucky caves. To provide lighting, at Saltpeter Cave in present-day Carter Caves State Park, miners hung lamps from iron pintle hooks pounded into ceiling and wall crevices (Duncan 1993:101).

In some large mining operations with sizable passages the soil was then dumped into carts pulled by oxen (McDermott 1963,47). At Great Saltpetre Cave, a long section of passage about five feet high today displays myriad long grooves caused by ox horns scraping along the ceiling. Ox-drawn carts were not a viable alternative for most caves, though, due either to the small scale of the operation or from lack of passages open and smooth enough for this haulage.

The cave environment differed from that of shelters in several considerations. Most bothersome, caves exist in a state of perpetual darkness. The mining operation must be conducted by primitive and feeble lighting, torches or lamps. Additionally, although nearly all caves have sufficient ventilation for ordinary work, the smoke from boiling operations would overwhelm the natural atmosphere and must be located outside the cave.[19] The advantage of a cave site lay in that caves are

often much larger than shelters and contain more extensive, if less concentrated, nitrate deposits. Consequently larger and more stable operations were able to develop at certain caves. There were in Kentucky many sizable caves that were exploited over a longer term with a greater investment in equipment than was generally true for shelters.

Shelters could be mined with greater ease. Lighting and smoke were not problems. Often many shelters along a single cliffline were mined with the aid of a portable leaching vat which could be knocked down and set up again at the next site. Miners could quickly extract nitrates from a shelter and set up at the next, a mobile operation using many small sources. Cave mines often were permanent or semipermanent, although there are many small caves in the state that probably were mined as rapidly as were sandstone shelters. Cliffline shelters were more exposed to the elements, particularly temperature, whereas caves were possessed of a uniformly and mildly cool temperature throughout the year. This strongly influenced the seasons in which specific sites could operate. A cave mine was more likely to operate year-round.

Substantial modifications were seldom needed within rockshelters, although sometimes considerable effort and ingenuity were expended in gaining access to sites generally located at the bottom of steep cliffs. Most of what is known about shelter mines has been documented from the abundant sites on the Daniel Boone National Forest. In the sandstone shelters of the Boone Forest are numerous traces of historic mining activity. The dry sandy environment under the eaves of the shelters has often preserved such items in very good condition.

The largest piece of equipment used was the V-vat. From colonial times, V-shaped wooden hoppers had been used in several industries and were easily adapted to refining saltpeter. These were large, easy-to-construct containers with inward-sloping sides of flat wooden slabs supported by a framework of timbers or poles. The ends of the wooden slabs came together at the bottom in a wooden trough to collect the leachate, called "liquor" or "beer." During the mining era, at least three distinct variations of the V-vat were used in sandstone shelters (Fig and Knudsen 1984:69-71). The simplest of these was a frame of poles with the vat sides made of long strips of bark placed vertically (Figure 2). These vats were stationary and were abandoned after the site had been exhausted. A more durable type was made using hewn wood slabs vertically arranged for the sides (Figure 3).

The third form was apparently mobile, intended to be disassembled when a site was finished and put back together at a new location. Such vats were the product of a more careful craft and showed both considerable ingenuity and elegant simplicity in their design. The vats at the Laurel Branch shelter had no unnecessary part and could be taken apart and moved rather easily. This was far more efficient than building a vat from scratch at every site, particularly when sites were closely grouped in a locale. The trough at the bottom was made from a single large log from which the center had been scooped out. The sides each consist of a single very large hewn slab, about eight feet long, two feet wide, and four inches thick on the upper side. The lower edge tapers sharply and rests on two notched crosspieces at either end. The top is held together by two more notched crosspieces (Figure 4).

Unlike caves, rockshelter soils were not mined. Instead, the sandstone walls of the shelter were broken up, being saturated with nitrates to far greater concentrations than found in caves. The rock face was drilled, using a star drill which was hammered and turned, hammered and turned until finally a borehole of sufficient depth had been made to accommodate a powder charge. Large boulders were blasted away. Stout pry poles were used to handle them.

The miners then set about reducing the rocks to a coarse rubble. As the sandstone was very porous it was possible to leach nitrates from inside rocks of any manageable size. It was not necessary

Figure 2. Type I vat, two bark-lined hoppers, Parched Corn Shelter, Wolfe County (Photograph courtesy of Fred E. Coy).

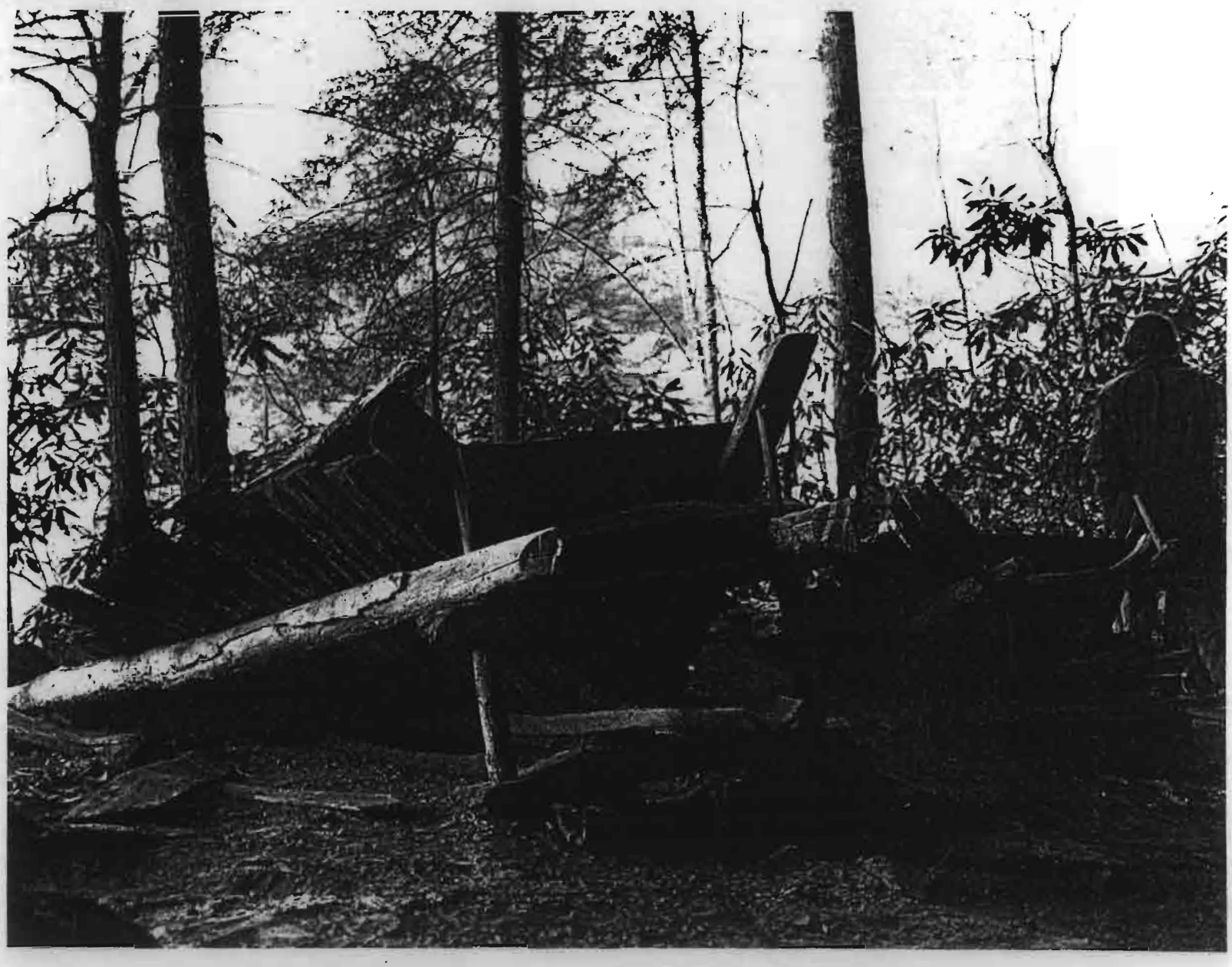


Figure 3. Type II vat, Edwards Branch Shelter, Menifee County (photograph courtesy of Fred E. Coy).

Figure 4. Portable vat, Laurel Branch Shelter, Wolfe County (photograph courtesy of Fred E. Coy).

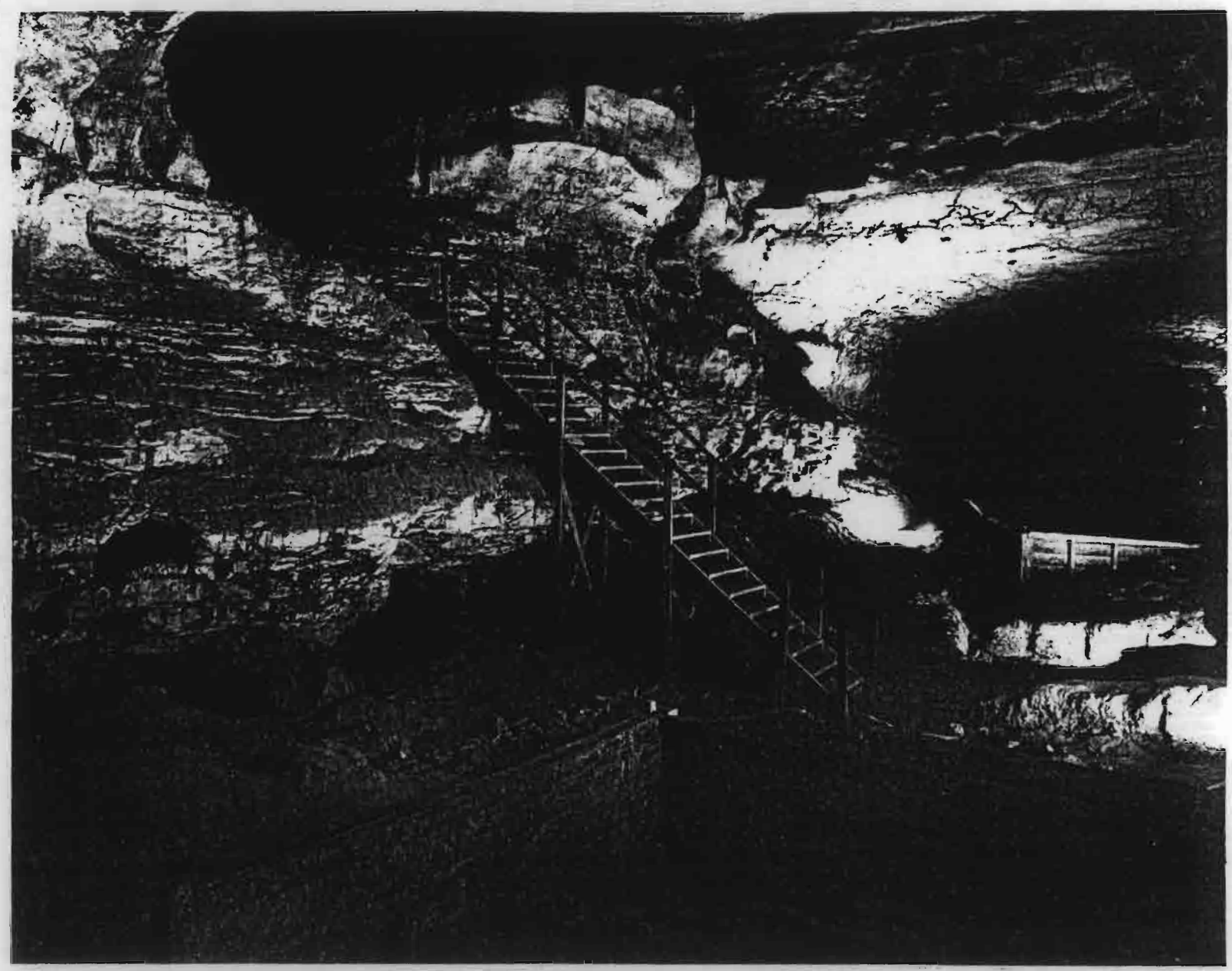


Figure 5. Rectangular vat, Mammoth Cave, Edmonson County (photograph courtesy of Diana E. George).

Figure 6. Rectangular vats, Great Saltpetre Cave, Rockcastle County (photograph courtesy of Diana E. George)..

to reduce all to sand. The basic tool to accomplish this task was a hammer or single-bit axe with which the miner simply pounded the rocks into smaller pieces. Brown (1809:242) reported that the miners shattered some of these rocks into sand by plunging them into boiling water. The rock and boulders preexisting in the shelter were also broken up with gunpowder and axe and fed into the vats, for through soil contact these also had absorbed high nitrate concentrations. The most distinctive mark of a mined shelter site today is the talus pile heaped about the walls. Often it is possible to see traces on the walls and large boulders of former drill holes (Coy et al. 1984:57).

The leachate captured by the troughs was boiled in large iron kettles, adopted from the salt-making industry.[20] Impurities were skimmed off the liquid as it neared crystallization. As nitrate deposits found in rockshelters occurred as potassium nitrate, the simple process of solution/ evaporation sufficed to concentrate the compound. To produce a particularly pure grade of saltpeter, the crystals might be redissolved in water and boiled down again.[21] At several sites on the Boone Forest are flat slabs of rock that are believed to be drying tables, on which the finished product was spread to dry.

The process used to refine cave nitrates was more involved. Cave soils contained predominantly calcium nitrate. The desired end product was potassium nitrate. Once calcium nitrate had been concentrated through leaching and boiling, in a simple chemical conversion, potassium was swapped for calcium. This was accomplished by pouring concentrated saltpeter liquor through a second vat filled with wood ashes or potash and adding more water. The chemical expression of this process is:

$$CaNO_3 + KOH \text{ ---> } KNO_3 + CaOH.$$

Calcium hydroxide and other impurities (called "white curd") settled to the bottom of the resulting clear leachate. The liquid collected would be boiled down again to crystallization. As in rockshelter operations, the mush of precipitated crystals would sometimes then be redissolved and evaporated for greater purity.

Brown (1809:238-239) reported that the earth of caves would yield from one to two pounds of processed saltpeter per bushel.[22] Modern analytical testing of saltpeter cave earths show nitrate deposits in caves in concentrations ranging up to four percent of total soil weight (Hill 1981:117-118). Supposing a bushel of soil to be about 100 pounds, this is consistent with Brown's figure. In comparison, Brown (1809:242) quoted Fowler, who with his associates, had made saltpeter from "28 different rock houses or caverns...on the north side of the Kentucky River." Fowler told Brown that he generally obtained at least 10 pounds, and often as much as 20 or 30 pounds, of saltpeter per bushel (8-25 percent, sand being heavier than soil). According to this account, saltpeter was sometimes found in pure lumps that might weigh several pounds each (Brown 1809:242). It is apparent that the sandstone rocks of shelters were a far richer source of nitrate. Because of this, Brown (1809:243) reported:

> most of our saltpetre-makers find it their interest to work the sand rock rather than the calcareous caverns.... The rock saltpetre is greatly preferred by our merchants and powder-makers, and commands a higher price.

In the late eighteenth century, the highest technology for saltpeter production existed in France. The French Regie des poudres was under the astute guidance of scientist Antoine-Laurent Lavoisier prior to the French Revolution. Although Lavoisier was consigned to the guillotine, his pupil Eleuthère Irénée du Pont de Nemours safely migrated to the opportunity of America in 1800. Here, in 1802, he established a major gunpowder works in Wilmington, Delaware (Dutton 1942:10-

40). The Wilmington powder mills of E. I. du Pont were destined to become the single largest consumer of Kentucky saltpeter. The technical skills of another talented European immigrant, John James Dufour, designed the advanced and efficient equipment that was used to extract nitrates from Kentucky's two largest saltpeter mines.

Dufour, a Swiss horticulturist, arrived in the United States in 1796 and soon moved to Kentucky's Inner Bluegrass region, where he met Dr. Samuel Brown of Lexington. In 1805 he was hired by Brown to design and build a saltpeter works at his "Great Cave" in Madison (present Rockcastle) County. Within three months, Dufour had provided Brown with a highly efficient system. Instead of V-vats, which had been used previously, large rectangular vats were used for leaching soil. The style of these vats was only one of many Dufour innovations, with a large capacity and an effective wooden piping system to transport the leachate or "liquor" to the exterior for evaporation. In a few years technology at Great Saltpetre would be copied by Charles Wilkins of Lexington at his own works in Mammoth Cave (George 1987a, 1988b).

Charles Wilkins, one of the largest saltpeter brokers in the state, had formed a partnership with Fleming Gatewood in 1810 to purchase Mammoth Cave. During 1810-1811 a large, state-of-the-art refining operation was constructed, generally modeled upon the works at Great Saltpetre. Two processing areas of large rectangular hoppers were set up in the cave near the Historic Entrance and connected by hollow log pipelines (Figure 5). A tall tower equipped with a hand-operated pump was built at each site, and later a pump was also installed at the entrance. These towers pumped the liquid concentrate from the hoppers to the evaporation furnaces outside the cave (George and O'Dell 1992:8).

Another major mine site was Saltpeter Cave in Greenup County (present-day Carter County). Several different vat styles were identified in the cave, ranging from the common V-vat seen at many cave and shelter sites to a variation with horizontal lapped sideboards. The investigators calculated, based on volume of spoil deposits, that from 51,600-80,000 pounds of saltpeter may have been processed at the site (Duncan 1993:112, 116-119, 124-128).

As saltpeter miners constantly shoveled out old spent earth from the vats or hoppers and reloaded them with new cave soil, the floor level gradually rose up about the equipment. When the soil apron grew too high, the hoppers were disassembled and put back together at a higher elevation (Duncan 1993:60, 111, 115; George and O'Dell 1992:6, 8-9). V-vats are found in Mammoth at a higher elevation than rectangular hoppers, suggesting that the V-vats were built and worked in tandem with the rectangular hoppers or afterward. In Great Saltpetre Cave today are casts of rectangular hoppers whose tops are at the feet of the modern visitor (Figure 6).

The practice of wastefully discarding the spent soil was present at nearly all mining sites. The experience of several centuries, that spent saltpeter earth would replenish its nitrate content in a few years if replaced in the passages from which it came, was ignored (Brown 1809:239; Bradbury 1819:247; George 1988b:17-18; O'Dell 1990b:29). In most caves mined during the 1812 period, passages were scraped down to bare rock and soil discarded wastefully after leaching. Failure to practice conservation of a normally renewable resource may have resulted in exhaustion of the richest cave deposits.

THE LABOR FORCE

During the early years of Kentucky's settlement some persons explored caves out of curiosity and for recreation, just as today. During the saltpeter boom from 1808-1814, many Kentuckians

combed the mountains and valleys of the cave regions. It was probably the greatest era of cave exploration prior to modern caving clubs, and was motivated mainly by profit. For many men, the rising price of saltpeter as war approached made such mining a viable alternative to other forms of labor. Nor was the mining boom limited to the local folk; speculation in saltpeter was rampant and entrepreneurs flourished. The price of land containing a good saltpeter cave followed the steadily rising prices paid for saltpeter.

It appears that saltpeter manufacture was, with the exception of a few large operations, rather a small-scale cottage industry often engaged in by residents of the rural cave regions for supplemental income, rather than as a primary occupation. There were apparently others who did devote full-time effort to the search for and extraction of nitrates. Charles Wilkins described the saltpetermen in 1809 as being "so numerous & generally living in caves and mountains on our frontiers that I should have no knowledge of them again," meaning that he was unable to keep track of individual suppliers (Wilkins 1809). Brown (1809:242-243) noted that three men could make 100 pounds of saltpeter per day at the small rockshelters, though 40 pounds was nearer the average for this number of workers. According to his account (Brown 1809:243):

> The workmen being badly provided with tools and apparatus, desert a rock whenever its size or hardness renders it difficult for them to manage it, and go in quest of a new establishment. Several caves and rocks which these strolling chemists have deserted, still contain many thousand pounds of nitre. These men are continually searching for masses of pure nitre, or rich veins of ore, by which much of their time is unprofitably dissipated.

Many of the sites mined were probably not owned by any of the men who worked them. Eastern Kentucky was settled relatively late, and large tracts had not yet had title issued to claimants. In some cases caves and shelters were leased to mining operations.

During the boom period many of the saltpeter makers operated on a semi-contractual and seasonal basis. Wilkins informed McCall that he doubted that he would be able to fill an order late in fall, as "Having closed my purchases for the season and it generally being the case in this country [it will] be some weeks before information can be [com]municated to the caves that I will purchase again..." (Wilkins 1810a). This and other clues indicate that much saltpeter was manufactured to order; Wilkins and other middlemen would send word to the manufacturing region that purchases were being made, and manufacture would then commence and continue until receipt of word to the contrary or the end of the season. Apparently saltpeter manufacture was considerably reduced during the winter months, due to difficulties in both land and water transport of the finished product. Wilkins stated that large quantities of saltpeter would be made in the months of April and May 1810 (McCall 1810b).

One indication of how small the scale could be is given in the account of Thomas Rogers (1870), whose father made occasional small lots of gunpowder.

> Every summer after the corn was laid by and harvest over we would make powder a month or so and attend at the courts to sell it....This was a pretty profitable business at that time and when [father] concluded to move to Ohio [in 1797], he made a couple of bags full, 75 pounds each, and packed them on a horse. When we came to Chillicothe I sold them for one dollar and twenty-five cents a pound to James and McCoy, merchants.

Although this statement refers to gunpowder, it implies to several conclusions about the related industry of saltpeter mining. Gunpowder making was sufficiently profitable for rural Kentuckians in the late eighteenth century that it was worth working at for a few months per year, preferably after essential other labor had been finished at farm or homestead. Quite a number of rural dwellers may have worked at this and/or saltpeter mining as a part-time occupation. It seems likely that the requisite knowledge, if not experience, was widespread among the population, as during the Revolution recipes and technology had been published numerous times in the popular press. Secondly, gunpowder (and saltpeter) were commodities sufficiently compact and valuable to export from Kentucky's back country. Thirdly, merchants were willing to purchase supplies of such in small quantities.

The mention of court sales is an important indication of the manner of flow of products. This refers to the "court days", which are still important annual town holidays in many Kentucky communities. Today these affairs resemble a giant downtown swap meet and flea market.[23] During the nitrate mining era, these served as local markets for the concentration of produce such as saltpeter and gunpowder. Bidermann (1815a) reported that "all the merchants from the towns near the saltpeter works used to load their wagons with it when they came [to Lexington] to get their merchandise."

For a few large operations, such as Mammoth Cave in Warren County (present Edmonson) and Great Saltpetre Cave in Rockcastle, slave labor was used. The slaves were generally hired at a seasonal rate from their owners. On November 13, 1804 an advertisement was placed in the Kentucky Gazette for slave laborers to work in the newly acquired Great Saltpetre Cave:

> Brown, Hart & Company
> wish to hire for 12 months
> 15 or 20 NEGRO MEN
> To be employed at their Salt Petre Works in Madison county, for each of whom they will give 80 dollars, and they will in addition to the above, give to each negro 20 dollars at the end of the year, provided he conducts himself with propriety.[24]

During the War of 1812 as many as 70 workers, mostly slaves, labored at the Mammoth Cave operation (Meriam 1844:319).

Larger operations had several classes of workers according to skill. In addition to administrative and supervisory personnel (owners, white overseers for slave laborers or white wage-earners, clerks), there were two main classes of workers, the "saltpetre maker" and the "petre-monkey". The peter-monkeys were the men who mined and leached cave soils. The saltpeter maker was a more esteemed occupation and required more knowledge. Burton Faust described the saltpeter maker as a man who "had to have a clear understanding of a number of aspects of physics and chemistry," such as chemical compatibility, filtration practices, solubility of materials, controlled and selective crystallization, and melting points (Faust 1967:58-59). To a certain extent this is true, but the author would contend that this is a considerable overstatement. These terms sound far more impressive than they were in actual practice. Saltpeter manufacture did not require an extensive background in chemistry or physics. As noted, details of the process had been widely published in newspapers of the Revolutionary period, and many persons had tried their hand at refining saltpeter. Much of the technique of this relatively simple process could be learned rather quickly through trial and error. Additionally, although highly refined saltpeter was made at some sites, others produced a much cruder grade.

It seems likely that, for the larger operations, there would be a man or men with expertise in selecting the areas to be mined and knowing how to test for saltpeter content. In many cases this might be the owner. There would have been a large number of men digging and hauling cave soil to

the vats; this would be the lowest form of labor. A lesser number would be employed at the leaching vats, to run water through the soil and collect the liquor. Outside, at least one man with appropriate knowledge would be in charge of the evaporation furnaces, with assistants to cut wood, keep the fires fed and ash hoppers filled. Other and sundry tasks attended the operation, such as construction and maintenance of water pipelines, disassembling and rebuilding existing vats and constructing new ones, and blasting rock. Duncan (1993:53) reports that a separate party of hunters was employed at Saltpeter Cave to keep the miners supplied with fresh meat. All in all, a very labor intensive industry is indicated. At smaller mines, a handful of men might have to fill all these functions.

Accounts that place slave workers in Mammoth Cave at 2 a.m. are a strong indication that nitrate processing was conducted around the clock (George and O'Dell 1992:15-16). It seems logical that this schedule was often used at sites mined by free workers, as the operations required constant tending. This was particularly true for kettles. Having expended considerable wood and effort to bring a large kettle to boil, the saltpeter maker was not apt to shut it down when the sun set. In addition, it was always dark within the cave so that any shift would meet identical conditions.

The mining industry suffered a setback during the winter of 1811-1812. There was an evil portent in the sky; the Great Comet of 1811 had appeared in September and would last until January 1812. In mid-December, 1811 the first earthquake struck, a tremor greater than that which would devastate San Francisco a century later. There were several more hard shocks and aftershocks and hundreds of smaller shocks that occurred for months. Surprisingly, there was very little falling rock reported in mined caves, but the effect of the quakes upon the superstitious miners was electric. Charles Wilkins gave this report on his Mammoth Cave mine:

> [T]he 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 (McCall 1812c).

This was not confined to Mammoth, he wrote, but the earthquake had the effect of temporarily stopping saltpeter workers all through the country. The fine-tuned processing machine at Mammoth never recovered; production dropped by two-thirds, from approximately 3,000 pounds per week to about 1,000 pounds per week. At Lexington in early 1812, there was little saltpeter at market (George and O'Dell 1992).

TRANSPORTATION

Before discussing the operation of the market, it is helpful to understand the condition of commodity transportation during the era. As Lexington was the central market, transportation routes to and from the community were of great importance, since saltpeter was used both in local industry and as an export item.

Although saltpeter makers could certainly have worked at their trade during the winter months, and some undoubtedly did, the shipping season was limited to fairer weather due to the appalling condition of the roads during the wetter season. Of this situation, Wilkins wrote in January 1811 that "The roads are so bad & water courses so high during the Winter that little [saltpeter] will be brought to town" (Wilkins 1811b). Even roads between major communities were little better. William Blane, an English traveler[25] through Kentucky in 1822-1823, had much to say on the subject of land transportation (Blane 1969:[1824]:103-104):

> During the fine weather, a sort of stage-coach goes regularly from hence [Maysville] to Lexington; but it cannot be depended upon during the autumn and winter, which latter season was beginning to set in when I was at Maysville. The roads being very bad, I determined to buy a horse, and indeed riding is the only practicable and safe manner of travelling through most of the Western states. I knew, moreover, that beyond Lexington I could not have proceeded otherwise.

Blane (1969 [1824]:104) continued, describing his travel to Lexington:

> The road was beyond all comparison the worst I had ever seen. It was full of holes, and in many places nearly up to the horse's knees, in mud intermixed with large stones and pieces of rock, which seemed if put there on purpose to annoy equestrians. To convey any idea of such a road by mere description is impossible. Moreover, the road is a natural one, that is to say, it is a track left open and cleared, but which has never had a single cart load of gravel or stones thrown upon it. Add to this, a great many heavily laden waggons are obliged to travel over it, when carrying goods to Lexington.

Blane stated that it was impossible to travel more than about 30 miles per day, and that there were only two bridges between Maysville and Lexington. Of the numerous creeks and streams along the way, he observed that, "On coming to one of them after a fall of rain, the traveller is obliged to either halt or to swim" (Blane 1969 [1824]:105).

Such was the condition of the arterial roads along which so much Kentucky produce was hauled during the first quarter of the nineteenth century. Bad as it was to Blane on horseback, it must have been a nightmare for teamsters and their wagons. Such roads would limit the number of trips that a shipper could make each season.

Maysville was one of the primary points of departure for Kentucky produce, and handled nearly all of the trade bound upriver to Pittsburgh. Barge traffic bound downriver to New Orleans departed from Shippingport and Carrollton. Shippingport was the river facility that served Louisville and vicinity, located safely downriver from the nearby Falls of the Ohio.[26] Saltpeter and other produce was also hauled to the Kentucky River for barge shipment. As the Kentucky river was situated no more than 10 to 20 miles south and west from Lexington, this required only a short haul overland. Kentucky River shipping points used during the era were generally from Woodford County to Franklin County, this stretch of river being the usual upper limit of barge traffic due to shallows further upstream. In a January 22, 1810 letter, Archibald McCall refers to a recent communication from Wilkins in which the latter stated that "as fast as a wagon load was collected he would send it to the Kentucky River to be shipped to New Orleans" (McCall 1810j). Carrollton was situated at the mouth of the Kentucky and thus became a shipping center. Newport, across the river from Cincinnati, became the major point for transhipment of military supplies (including Kentucky gunpowder) to the armies in the campaigns of the northwest.[27]

For the eastern trade, under normal conditions it was most economical to send saltpeter to the Ohio River ports, where it was loaded onto barges and taken downriver to the confluence with the Mississippi and thence on to New Orleans. New Orleans had recently been acquired with the 1804 Louisiana purchase, so that the long sought "free navigation of the Mississippi" was at last guaranteed. This trip took about 30-35 days. Upon reaching New Orleans, some of the bargemen elected to return to Lexington overland, a difficult journey of 40-45 days. Others went on by sea to east coast ports, following in the wake of the produce they had brought downriver, thence to Pittsburgh or western Virginia and home to Kentucky (Michaux 1805:239-240). At New Orleans saltpeter was loaded onto

sailing ships along with other produce of the interior and transported from the Gulf of Mexico around Spanish Florida north to ports such as New York, Boston, and Philadelphia. This rather long route was more economical than poling barges up the Ohio against the current to Pittsburgh.

Each leg of the trip added a separate shipping cost. Wilkins reported haulage costs from the mining region to Lexington as one or two cents per pound in late 1811 (Wilkins 1811a). The cartage from Lexington to Maysville was reported to be one-half cent per pound in summer 1814 (McCall 1814b, attached invoice). In 1810 the freight bill for downriver shipping of saltpeter was one cent per pound (McCall 1810i). Among the boats that hauled this commerce to New Orleans was the "Kentucky Gazette," operated by John Lewis (McCall 1810i). From New Orleans to Philaadelphia was a voyage requiring about four weeks (McCall 1810d). Freight costs for this leg of saltpeter transport were about an additional cent per pound in 1810 (McCall 1810c). As there were additional handling charges and sundry expenses at various points, the difference between the price of saltpeter in Lexington and saltpeter in Philadelphia was 10-12 cents per pound, (McCall 1810a-j) or more than half the original cost of the material added as transportation charges.

A lesser amount of Kentucky commerce, including saltpeter, was sent up the Ohio River against the current. This occurred sometimes even when access to the high seas was not restricted. Pittsburgh was the major Ohio River port of call in the east, and here were many agents and brokers for trade with the frontier. Saltpeter shipped up the Ohio by Charles Wilkins was received by his brother John Wilkins at Pittsburgh, and stored there until arrangements could be made for transshipment to Philadelphia.

Travel up the Ohio River was very difficult; not only must barges be poled against a strong current for hundreds of miles, seasonal vagaries of the river also limited the shipping seasons. In November of 1809, Wilkins noted that he had sent all of his saltpeter purchases to the Ohio River, but did not know whether it had yet been shipped, as the river "has been so low this season that boats could neither ascend or descend" (Wilkins 1809). The Ohio river between Pittsburgh and Limestone (Maysville) was navigable only during the spring and autumn. During the drier months there were so many shoals and islands exposed that boats frequently ran aground. Consequently the shipping season began at the end of February and lasted three months; the fall season began in October and lasted until the end of November (Michaux 1805:159, 164-165; Maccoun 1812).

Floating ice on the Ohio River evidently prevented shipping during the coldest months. Wilkins, in several letters to McCall, doubted that he would be able to obtain a sufficient quantity of saltpeter to forward before the shipping season closed for the winter due to ice upon the river. Wilkins informed him that he would purchase saltpeter during the winter and be ready to ship it in early March, as soon as the ice cleared and boats again could ascend the river (Wilkins 1810a, 1810b).

Overland cartage between Pittsburgh and Philadelphia followed the Pennsylvania state road built 1785-1787, generally laid out over the crude road cut by General John Forbes' army in 1758 en route to occupy Fort Duquesne (Fort Pitt). This state road, generally known as Forbes' Road, was the primary route for land shipment between the east and the interior until construction of the National Road in 1818 and remained significant even thereafter. Over this road produce was hauled in large covered wagons drawn by four horses, a journey of 20-24 days (Michaux 1805:158).

Saltpeter was usually shipped from the Lexington market in large wooden containers of two sizes, referred to in bills of lading as single barrels and double barrels. Single barrels were packed with from 320 to 390 pounds of refined saltpeter, and double barrels held as much as 785 pounds (McCall 1810f). Smaller containers were sometimes used, referred to as casks and half-barrels. Cost of barrels to the shipper in Summer, 1814 was $1.00 for singles and $1.50 for doubles (McCall 1814b,

attached invoice). Some of these barrels were provided by the saltpeter makers and some were provided by the wholesaler who often repacked nitrates received in small quantities (Wilkins 1809). As reported by Wilkins, on at least one occasion shipment was delayed due to a lack of sufficient barrels in Lexington (McCall 1810h).

Shipments from Philadelphia or New Orleans for du Pont via the Wilmington boats carried as little as 3,000 pounds of saltpeter in barrels to as much as 10,000 pounds, along with other commodities from the interior (McCall 1810e, 1810f). Some of the ships out of Wilmington that carried this trade were the "Julia," "Mary," "Betsey," and "Hope". The cargoes they carried were insured at a cost of about two percent of the value of the goods (McCall 1814b). Ships from New Orleans evidently stopped first in Philadelphia for inspection by McCall or his representative before delivering at nearby Wilmington (McCall 1810a-j). Eastern mills other than du Pont also received saltpeter from Pittsburgh delivered by wagon or from New Orleans by sailing vessel.

As there were several large powder mills including du Pont in the east that purchased Kentucky saltpeter, as well as a burgeoning powder mill industry in the state, there was a brisk commerce in saltpeter during the war years. Producers rushed it to the central market of Lexington, and the wholesalers rushed it eastward in a multistage journey by whatever means were appropriate for the particular stage, river barge or wagon or sailing ship. It was often stockpiled at intermediate points (Lexington, Pittsburgh, New Orleans) awaiting transhipment.

MARKET

At the time of the War of 1812, Lexington was the foremost city in the region in population and infrastructure. Lexington was centrally located with respect to both the nitrate-producing cave region and to the belt of sandstone rockshelters. The state road network converged upon Lexington, and so naturally Lexington became the major Kentucky market for trade in saltpeter and other regional produce.[28] In the years immediately preceding the 1812 war and during the conflict, a large number of powder mill operations arose in the Bluegrass to take advantage of proximity to the source of the major component.

Lexington became a market as soon as the mining industry began. The first commercial gunpowder mill in Kentucky, that of Richard Foley, was established at South Elkhorn near Lexington in 1793. This date helps establish the time frame in which saltpeter was first mined in commercial quantities. By 1812 gunpowder manufacture had become a traditional occupation for more than a half-dozen families in the South Elkhorn community area, just south of Lexington in Jessamine County. In that year Lexington's Samuel Trotter, co-owner of the largest wholesale/retail mercantile in the state, wrote that "Cotton, Tobacco, Yarns, Salt-Petre, Powder &c" were the principal exports of the region (Trotter and Trotter 1812). He further noted that he had, since 1806, purchased more than 50,000 pounds of gunpowder from the South Elkhorn mills for resale. The making of this quantity represents the use of about 40,000 pounds of refined saltpeter over a six-year period. As other powder mills had also been constructed throughout the Blue Grass and in the production area, saltpeter was becoming an important item of commerce.

The saltpeter market, up to about 1808, had not yet become distinct. Saltpeter was purchased by local merchants as it was brought in, in gunny sacks or barrels, by the rural people. Nitrate processing sites were then generally small, with few large operations, so that only small quantities came in at any one time. A sack or two might be packed on horseback, or more likely, tossed into a wagon as part of a trip to town for some other purpose. Larger operations may have shipped entire wagonloads. It seems likely that, for small amounts of saltpeter, payment may have been made in the

form of credit at the store. An ad such as that of Lexington merchant William Leavy in 1800 offered "cash or merchandise" for saltpeter.[29] At this time, high-grade saltpeter was valued at about 6 1/2 cents per pound (Michaux 1805:202). Additional evidence is in the emphasis with which newspaper advertisements shrilled "CASH for saltpeter" during the highly competitive boom era to follow.

The early commercial trade in saltpeter appears to have been limited to supplying gunpowder mills in Kentucky and minor export to adjoining regions. Subsequently, the Embargo (1807) and Non-intercourse (1809) Acts blocked the free flow of saltpeter into eastern ports, so that the large powder mills of the coast were desperately seeking domestic sources in quantity. The cave mines of the interior began to fill this need. Large eastern mills set up purchasing agents in the cave region, issuing them letters of credit at local banks. By 1809 Charles Wilkins, an established merchant of Lexington, had begun to handle saltpeter purchases on contract to du Pont and other major consumers. James Maccoun, another prosperous merchant in the same town, also began to make large purchases for eastern consumers. These saltpeter brokers operated on commission.

The du Pont company in Wilmington was one of the largest consumers of exported Kentucky saltpeter, and it is fortunate that much of their correspondence concerning this article is preserved in the archives of the Hagley Library in Wilmington. From these archives, considerable information is gained on the details of the saltpeter export market. Between Charles Wilkins' saltpeter and E. I. du Pont's powder mills existed a middleman, a man named Archibald McCall, in Philadelphia.[30] McCall purchased in bulk and arranged for delivery of the many items needed to supply the Wilmington mills; saltpeter, sulfur, gunny sacks, and so on down a long list.[31] Saltpeter was only one of McCall's concerns, albeit an important one. Wilkins, too, purchased many locally-produced items other than saltpeter which he resold both wholesale and retail (Figure 7).

The Lexington saltpeter market began slowly, with small amounts coming into town from the cave region on a rather casual and often seasonal basis. It appears likely that many of the rural miner/refiners did not travel to Lexington for a small amount of product. They may have combined saltpeter with other products to take to market, or many small miners may have pooled their output to send in bulk. A strong possibility is that much of the saltpeter was collected at smaller peripheral markets, mainly the county seats of the production area, and forwarded to Lexington.

Local merchants and a few powder mills purchased saltpeter as it arrived. When the boom period began shortly before the 1812 war, saltpeter arrived in Lexington in larger quantities. The same local wholesale/retail merchants accustomed to handling regional trade accommodated increased demand for saltpeter by becoming buyers on contract to large companies. Examples of such Lexington merchants are Charles Wilkins, James Maccoun, and Samuel Trotter. Charles Wilkins had begun his career in Lexington as a storekeeper. He was one of the first to begin contract buying in Lexington, as early as 1808. Wilkins was a major supplier of saltpeter to several large eastern powder mills; by 1810 he was doing so well at the saltpeter business that he decided to purchase Mammoth Cave. He and Fleming Gatewood installed advanced equipment of the Dufour design to meet greatly expanded obligations (George 1987a).

Wilkins hired a foreman, Archibald Miller, to supervise the day-to-day mining operation at Mammoth Cave. As a consequence of the series of earthquakes, Wilkins and Gatewood were unable to meet contractual obligations to du Pont, and developed financial difficulties. In April 1812, partner Gatewood left the Mammoth Cave operation and bought another saltpeter cave in the area. Hyman Gratz, a Philadelphia merchant prominent in the saltpeter market there, bought out Gatewood's interest in Mammoth. Wilkins retained his own interest, but was squeezed out of the operation by Gratz. Wilkins continued to purchase saltpeter on the Lexington market for resale east, but had lost du Pont as a client (George and O'Dell 1992:20-22).

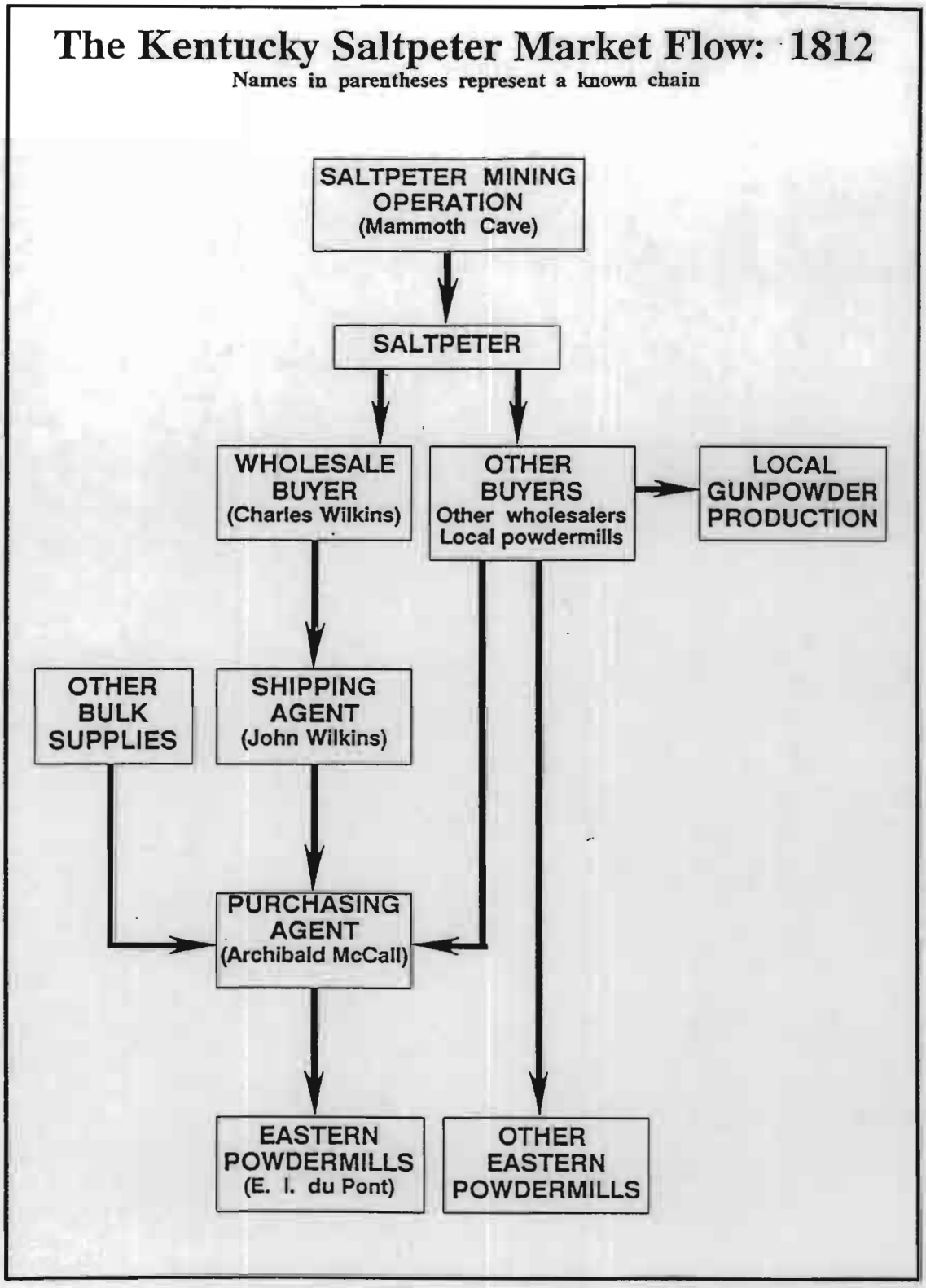


Figure 7. Flow chart of Kentucky saltpeter market.

James Maccoun stepped into the picture. Maccoun was another prosperous Lexington merchant and had been competing against Wilkins in the general saltpeter market, accepting orders from du Pont and other eastern firms. When Wilkins had difficulties meeting production requirements following the earthquakes, Maccoun began to fill much larger contracts for du Pont. One such contract, in Autumn 1812, was for 180,000 pounds saltpeter (McCall 1812a). An indication of some of the headaches of saltpeter buyers was a wry comment by Maccoun (1815):

> We were rather unfortunate last season [1814] in advancing money to two men who failed to deliver us Salt Petre one of them went home to Connecticut & took $700 of the money advanced with him.

Samuel Trotter was a merchant and entrepreneur[32] who was quick to try new ways of making money and had the capital to do it properly. Like others of his occupation he sold saltpeter and gunpowder and, in a time of increasing demand for these items, saw the advantage of value added. In 1810 Samuel purchased a large tract of land near Lexington and set about to build what became the largest gunpowder mill in Kentucky, and one that survived the depression that followed the War of 1812. Becoming a large scale producer, Trotter diverted to local use much of the saltpeter desired by eastern firms. By this time, powder mills had proliferated in the state, particularly in the Blue Grass. At least 14 powder mills were operating in 1810 in the Inner Blue Grass; more were built during the boom (Coxe 1814). In Spring, 1814, Maccoun informed McCall that "the manufacture of Powder is greatly extended in this state & a large quantity [of saltpetre] is used in that way..." (McCall 1814d). During the height of the boom, Samuel was described as "the greatest wholesale merchant in the western Country, & and has the means from his arrangements of procuring more salt petre than any individual perhaps in the state of Kentucky" (Johnson 1812).

During Spring 1810, Wilkins had the Lexington market virtually to himself. In April he reported that "There were no purchasers of Salt Petre then in [the] market and large quantities might be had" (McCall 1810g).[33] Wilkins repeated this in May, adding that "the manufacturers keep it in the Country, but...a considerable quantity is made" (McCall 1810f). This was soon to change; with war imminent, newspapers blossomed with advertisements "giving the highest price, in CASH." Wholesale buyers proliferated, and had to step lively to fill their obligations in a highly competitive market. In March, 1811, Wilkins wrote, "There are persons in every direction buying and sending it to the southward in Waggons" (McCall 1811). By fall, he noted, "It has become a custom to purchase it up on the frontiers & it is now sold only in waggon-loads at this place" (Wilkins 1811a). James Maccoun, in March, 1812, reported that he was sending money in advance to the saltpeter makers, as "the competition had become so great that none of the article came then to Lexington unsold" (McCall 1812b).

The wholesale buyers were not above arranging deals among themselves. Wilkins, having some difficulty meeting his contracts for Spring, 1811, made an agreement with the other buyers in Lexington: Wilkins was to be allowed preference in purchasing until he filled his contracts, whereupon afterward he does not buy until they have met theirs. The advantage of this, he noted, was to reduce competition and keep the price down (Wilkins 1811b).

In 1812, Samuel Trotter's powder mill enterprise, through quick action, beat the local competition to land two lucrative government contracts for military gunpowder, totalling 140,000 pounds (O'Dell 1990a). At the same time, James Morrison, U.S. Deputy Quartermaster, was in town trying to procure military supplies, including saltpeter. The Secretary of War had recommended to a congressional committee the purchase of five hundred tons of saltpeter and of lead. Referring to this, Morrison replied that he knew of "no place these articles can be procured within the U. States, save in this section of Country." The saltpeter was to be delivered to Baltimore or Philadelphia and

the lead to New Orleans (Morrison 1812). Morrison made several contracts for powder with unspecified Blue Grass mills, and presumably for saltpeter, and departed for Ohio.

The 1810 national census of manufacturers showed Kentucky production to lead all others, at just over 200,000 pounds brought to market (Coxe 1814). Two years later, in 1812, reported annual production had increased by 50 percent, to just over 300,000 pounds (Coxe 1814). By comparison, Kentucky's nearest competitor, Virginia, had produced 59,175 and 48,000 pounds for 1810 and 1812, respectively.[34] It is likely that some production went unreported (Figure 8).

Thus stood the saltpeter market in 1812. The saltpeter buyers in Lexington must have felt slightly dazed as hundreds of thousands of pounds of saltpeter passed through their hands amid demands of "more, more!" Prices climbed upward, from twenty cents per pound at Lexington in January, 1811 to twenty-eight cents a year later. As their costs increased, the big eastern mills made a critical error; they formed a trust and set a price ceiling above which they would not pay for saltpeter, and passed word down to their buyers in Kentucky. Push the price down. Down it went, to twenty cents, then to eighteen. This idea originated with Archibald McCall (1814e), who in April, 1814, had advised his patron:

> It becomes a matter worthy of consideration, whether it would not be advisable to order a purchase at a limited price, say 12 to 15 Cents pr lb. After fixing upon our price, I should think it is better that the order should be in the hands of the agent. It frequently happens, that when an article falls very much in price, it is reduced below its standard for a time, & again recovers in part. This may be the case with Salt Petre... .

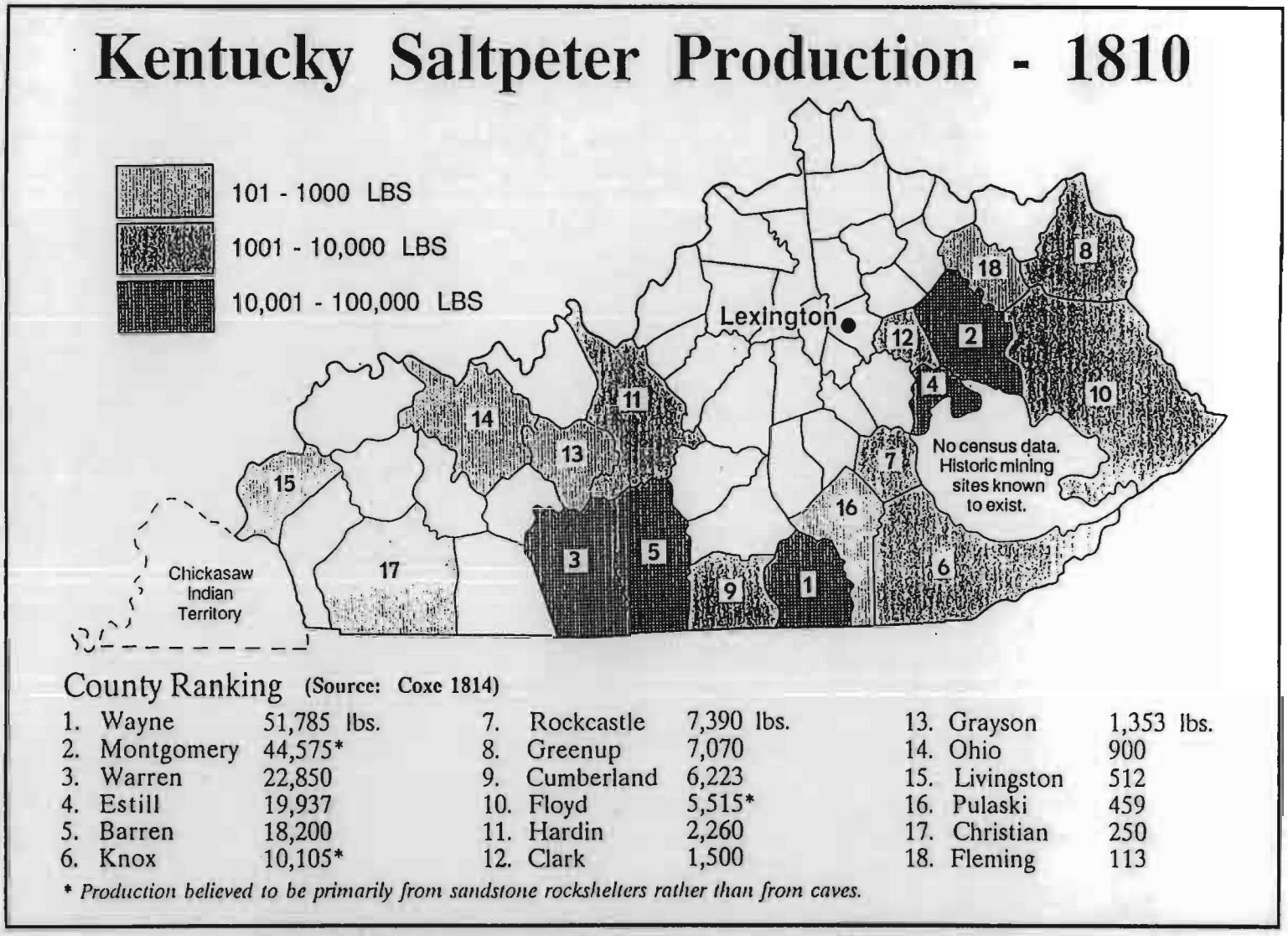
In August, McCall (1814a) gave strict instructions to James Maccoun:

> You will by no means exceed the limits of 18 Cents pr lb & I must further beg that you suspend your purchases for some time--that is to say, long enough to let the owners of the Caves feel the effect of the Market being glutted with Salt Petre which may induce them to lower their prices.

McCall had seriously misjudged the miners.

At a time in 1814 when wholesale buyers were operating under the price ceiling, one saltpeter maker became enraged at the price he was offered in Lexington. The man, not named, had made a wagonload of high-quality saltpeter and hired transport to Lexington. The price ceiling in Lexington was 18 cents per pound, down considerably from earlier months. The man "determined to seek a market for it amongst the powder makers here, or store it, rather than take less [than 20 cents]" (McCall 1814c). He subsequently made a deal with Maccoun at 19 cents, with a contract for 5,000 pounds more.

A year after McCall proposed a price ceiling, he wrote, "I am told that in Kentucky & Tennessee almost all the Salt Petre makers have stopped making the article & that there is not a great deal in the Country" (McCall 1815a). McCall had been previously warned by James Maccoun in June, 1814, who cautioned, "A number of persons have declined making Salt Petre & we have no doubt but it will be generally declined if after the expence of waggoning it to this place 20 Cents cannot be had for it" (McCall 1814d).



County Ranking (Source: Coxe 1814)

1.	Wayne	51,785 lbs.	7.	Rockcastle	7,390 lbs.	13.	Grayson	1,353 lbs.
2.	Montgomery	44,575*	8.	Greenup	7,070	14.	Ohio	900
3.	Warren	22,850	9.	Cumberland	6,223	15.	Livingston	512
4.	Estill	19,937	10.	Floyd	5,515*	16.	Pulaski	459
5.	Barren	18,200	11.	Hardin	2,260	17.	Christian	250
6.	Knox	10,105*	12.	Clark	1,500	18.	Fleming	113

** Production believed to be primarily from sandstone rockshelters rather than from caves.*

Figure 8. Map showing areas of saltpeter production in Kentucky in 1810.

The Kentucky saltpeter industry had vanished virtually overnight. The miners put down their tools and went back to more traditional pursuits. The price ceiling, combined with failure by the miners to practice cave soil recycling, caused a fatal collapse. In 1815, du Pont sent his son-in-law, Antoine Bidermann, into Kentucky and Tennessee posing as a real-estate speculator but secretly having the mission to determine what was the true situation regarding saltpeter. Bidermann received doleful reports as he traveled that summer through the production region. He had been told by Wilkins that the caves "were showing signs of exhaustion" (Bidermann 1815d). When he reached Louisville, he heard that "it is not possible that the caves are giving out; and that even if they are, the banks of the Green River are full of it and only need to be worked" (Bidermann 1815c). In Lexington, a Mr. Thompson, a saltpeter buyer, told him (Biderman 1815b):

> [N]o more saltpetre is to be had in Kentucky. It is not because the caves are exhausted for new ones are found every day, but because the price has become so low since the peace that no one will work them; it is even said that they stopped before then because of the large quantity on the market and that they will not start again until the price is 20c.

The trade was never again practiced in Kentucky in commercial quantities. The dependent powder mill industry in Kentucky also disintegrated, with only a few of the most efficient struggling on a few decades. Post-war, saltpeter from British India became available as low as 7 cents per pound at dockside; shipping alone to Kentucky was 8 cents per pound. The situation was now reversed from wartime, in that the Kentucky mills were now on the wrong end of the shipping pipeline. Eastern powder mills could now compete effectively in price against western mills in their own markets.

The end of the war and resumption of international free trade begat a flood of inexpensive, high-quality European imports of numerous commodities to America. During the war years, cut off from trade, America had built up its industries to replace commodities no longer available. After the Treaty of Ghent, European (mainly British) manufacturers looked uneasily across the Atlantic and saw the stirrings of potential rivals. In consequence, the British practiced "dumping" of goods at low cost to drive the American factories out of business. The absurdly low cost of post-war saltpeter is a prime example. Ultimately American businessmen pressured the government for protection, which was forthcoming in the Tariff Act of 1816. This Act levied high duties on manufactured goods shipped into the United States and was intended to protect the infant industries. Unfortunately this was of little assistance to producers of an essentially raw material such as potassium nitrate.

The effect in Kentucky was grim. In March, 1815, McCall wrote to Wilmington of the state of affairs in the former saltpeter production region, where some contracts made before the end of the war had not yet been filled (McCall 1815b):

> I have written to them myself pressing this business as strongly as I could. The last letters I had from them beged [sic] very hard for time. The people in Kentucky have lately felt the effects of the War very severely. There is great embarrassment amongst them--but I think there is no danger of ultimate loss to you.

Some of the merchant houses had been caught off-guard by the cession of mining in the state, and overextended in their affairs. In the cave region, the post-war depression was grimmer and more widespread. The saltpeter boom had been a bonanza for the small towns of the cave region, causing rapid expansion similar to the gold-rush days of a later time.

William Blane (1969 [1824]:255-256) described his impression of the region in 1823:

> Most of these villages, throughout the greater part of the division of Kentucky, called the Green-river Country, are very much upon the decline, and will no doubt shortly cease to exist. They were founded during the late war with Great Britain, and owed their existence, not to any want of villages in these places, but to the unnatural state of things caused by a great war expenditure, by an immense issue of paper money, and by the efforts of speculators to enhance the value of their lands in the neighborhood. As soon as the war ceased, the great expenditure ceased also, as well as the demand for produce, &c, &c. The currency was also changed from paper to specie, and hence those who had easily borrowed money found it impossible to repay it. This occasioned the ruin of numbers of industrious people....

Saltpeter had bolstered the economy of the mining region, particularly in the Mammoth Cave area, and removal of demand for this commodity had wreaked economic havoc.

MODERN TRACES

The cave environment provides nearly ideal conditions for preservation of remnants of the former mining industry. Many of Kentucky's caves and rockshelters at present contain substantial remnants of the former industry. Where they have not been disturbed, the artifacts are in surprisingly good condition despite being almost entirely made of wood. The even temperature and moisture of the saltpeter cave environment have preserved such items for nearly two centuries. The nitrate salts saturating all porous materials would also have a preservative effect. Experience has shown that when wooden artifacts are removed from the cave, severe shrinking and cracking occurs to the near destruction of the artifact. Saltpeter mining equipment is best left in place when encountered unless effective measures are immediately applied to prevent desiccation.

Kentucky law (KRS 433.879) prohibits removal of artifacts from caves without a permit from the Office of State Archaeology at the University of Kentucky. At present, the extant traces of saltpeter mining in this state are vanishing with alarming rapidity. The most frequently visited sites have suffered most, yet a cave or shelter unvisited for a century may be devastated by a single person with destructive intent. The most destructive and sadly, most common, form of vandalism is fire. In one example, wooden equipment of an advanced design on a major site was removed from Great Saltpetre Cave and burned, many decades past, as firewood to heat a home through the winter. More often, artifacts are simply broken apart and used to build small fires for a party atmosphere. One particularly frustrating episode was personally witnessed. A friend led the author to a cave site in Pulaski County (Dykes Saltpeter Cave) with a promise to show the well-preserved remains of an operation that may have operated during the Civil War period. Anticipation became shock upon the discovery that every single artifact in the cave had been removed since a trip made by my friend less than a year previous. There were no traces of burning in the cave. The present whereabouts of the artifacts is unknown.

The saltpeter and gunpowder industries have been far underrated in histories of the Commonwealth. Each was conducted over a significant period of time, employed large numbers of persons, and represented important export commodities for the developing state. During the mining boom, large quantities of cash flowed into Kentucky for the purchase of ordnance supplies and thus helped to develop the economy. These articles played a significant role in the security of the region and the United States during troubled times, and today the historic remnants certainly deserve preservation.

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ENDNOTES

1. The nitrate minerals found in Kentucky were known collectively by two interchangeable names and their variants: saltpeter and niter. "Saltpeter" derives originally from the Latin "sal petrae." Similarly,"niter" derived from the Latin "nitrum," describing any of several sorts of nitrate salts obtained from surface soils. In modern usage these minerals are more properly referred to by the exact chemical name, such as "potassium nitrate." Contemporary usage of the terms during the mining era was generally expressed by "salt petre," "petre," and "nitre." The modern usage of the suffix "er" rather than "re" is adopted throughout this manuscript with the exceptions of place names, quotations, and titles.

2. E. I. du Pont de Nemours (established 1802) was the exception to this situation. See below.

3. The 18th century laws of droit de fouille in France gave the government the right to enter private property and remove any nitrate-enriched soils from barns, stables and other structures without the owner's consent.

4. An explosive powder for large and small arms, developed in Europe during the 1880s and subsequently perfected in this country by the DuPont company. The introduction of smokeless powder eliminated the need for saltpeter from any source as black powder ceased almost immediately to be used.

5. For more information on saltpeter and gunpowder production during this period see Faust (1964); Salay (1975); Calvert (1961); O'Dell(1990b).

6. The mechanism by which nitrates become concentrated in soils of cave and rockshelter is not yet fully understood. Theories on this subject may be divided into two broad classes: (1) generation of nitrates on-site from decomposing organic materials present within the cave, such as from bat guano or washed-in debris; and (2) accumulation in cave soils and rock of nitiates brought in from the surface by groundwater seepage. Hess (1900) proposed the first seeping groundwater hypothesis for the origin of nitrates in caves, in which bacterial decomposition of surface organic matter released nitrate ions which were subsequently transported into caves by percolating groundwater. More recently, mineralogist Carol Hill (1981, 1992) proposed a process by which nitrifying bacteria both in surface soils and in the underground environment acted upon nitrogen compounds transported by groundwater to the site of deposition. Local groundwater seepage is attracted to caves and shelters due to a moisture-density gradient within the bedrock created by evaporation at the air-bedrock interface, resulting in concentration of nitrate salts. Experimental data recently collected by Olson and Krapac (1995) tends to support the Hess hypothesis. See George (1986a:200-201, 203); Hess (1900:113), Hill (1981:117-120,124; 1992:31-32); Lewis (1992:28-30); Olson and Krapac (1995:115); and Thrun (1982:120).

7. Data to support this is taken from figures quoted in the Wilkins/McCall/DuPont correspondence for various dates, DuPont company archives. See in particular McCall 1810a, 1810b, 1812b; George 1988b. See also Flint 1822:135.

8. Current usage of the company name is DuPont. As this manuscript primarily deals with family members and the company during the early nineteenth century when the usual spelling was "du Pont," the "du Pont" form is used throughout the manuscript.

9. A good account of this period may be found in Brant 1970 and Malone 1974.

10. For accounts of some Kentucky powder mills that operated post-1815, see O'Dell 1988, 1989, 1990a; George 1986b.

11. Pioneer accounts described the Inner Bluegrass as a region of prairie grassland and cane, lacking the forest cover believed to be conducive to nitrate formation (George 1986a:200-202). There are persistent rumors of a saltpeter mine in Clark County, which the author has not been able to verify. Coxe (1814) reports production from this county.

12. Accounts refer to the cave mined by Monk as Peyton Cave. George (1987b) identifies this as Adams Cave on Peytontown Road near Richmond, in present Madison County. Accounts of the life of Monk Estill provide an outstanding example of the black pioneers in Kentucky, a chapter in Kentucky history which is otherwise poorly documented.

13. Several writers have noted numerous instances where tiny, twisting passages have been mined down to bare rock. Such was the entrepreneurial fever in war-time! In Dykes Saltpeter Cave in Pulaski County a substantial saltpeter mining works was operated in a cave that seemed to break most of the rules regarding suitable morphology. This cave has a crawlway entrance passage, and saltpeter deposits in the same passage as a flowing stream. This was made possible by the natural entrenchment of the stream five or six feet lower than the broad ledges containing nitrate-enriched soils, and a generally sluggish stream that did

not flood above this height.

14. This is the best current estimate by William M. Andrews, who with the assistance of members of the Blue Grass chapter of the National Speleological Society is developing a private data base of Kentucky caves.

15. Angelo George has been compiling data on location of Kentucky's saltpeter caves for many years. Readers with knowledge of mining sites are encouraged to contact Angelo in Louisville or myself in Frankfort.

16. A few examples of saltpeter mine site determination from place names are taken from U.S. Geological Survey topographic maps: Saltpeter Branch, Saltpeter Knob, Saltpeter Cave (several), Peter Cave Creek, Peter Cave (several). A good discussion of place names and the mining industry may be found in George (1986a, 193-195).

17. As of this date, only a minor portion has been surveyed of the region in which sandstone shelters are found.

18. George (personal communication, 1994) suggests that the presence of epsomite impurities may be responsible for this effect.

19. There are exceptions to this. Boiling kettles were located inside caves in a few special circumstances. One example of this is found in Bowman Saltpeter Cave in Jackson County, where the smoke was carried away through a large skylight in the ceiling.

20. Salt had been made in Kentucky by various Indian tribes from the mineralized waters of certain springs, a practice that was to continue with the arrival of the first white settlers. A forge at West Liberty, near Greensburg in Pennsylvania, was reported to have manufactured many of the kettles used for this purpose. See Michaux (1904, 149).

21. Some gunpowder mills routinely re-refined saltpeter to be assured of the purity of the product.

22. George Hunter, who visited Great Saltpetre Cave with Samuel Brown in 1802, reported in his journal yields of from 1-3 pounds per bushel (McDermott 1963:47).

23. For an interesting if highly romanticized account of Kentucky "court days" see Allen, J. L. (1889) "County Court Day in Kentucky," Harper's New Monthly Magazine 74(471):383-398. This was subsequently published as part of Allen's 1892 The Blue-Grass Region of Kentucky (New York: Harper & Bros.)

24. Lexington Kentucky Gazette November 13, 1804.

25. Traveller's accounts of the New World were popular reading in educated European households of the nineteenth century. Blane, unlike some, was a meticulous and fair observer, a self-labelled "English gentleman" who set out to explore the wilds of America on horseback and riverboat while chancing the accommodations. He was impressed by the hospitality of Kentucky residents, and liked the "backwoodsmen" best of all, in whose company he spent some time roughing it. He was highly critical of exaggeration found in some other travelers' accounts, noting that "Works on topography should not be written by lovers of the marvellous" (Blane 1969 [original 1824]:177).

26. Not true cascades, but rather a series of submerged and exposed rock ledges that created a dangerous rapids across the river, seriously impeding navigation.

27. Newport originated as a military ordnance depot in 1804, one of a series of forts erected along the western frontier to strengthen American influence in the area.

28. During the mining era Lexington was the dominant regional trade center. Soon after the War of 1812, with the advent of steamboat navigation on the Mississippi and Ohio Rivers, landlocked Lexington lost its place as commercial center to Louisville and Cincinnati.

29. Lexington Kentucky Gazette, October 13, 1800.

30. McCall, a Philadelphia merchant, was one of the original investors in E. I. du Pont's American enterprise. He sold his shares in 1805 to co-investor Peter Baudey of Wilmington, but maintained a profitable connection with the du Pont firm.

31. Charcoal was made on site at the du Pont operation, although a safe distance away from the other mills. Barrels were constructed in company cooper's shops.

32. Samuel Trotter had once been a clerk in Charles Wilkins store. For a more detailed account of the Trotter enterprises, see O'Dell 1990a).

33. By this Wilkins presumably meant that there were no large purchasers. Lexington merchants such as William Leavy and Samuel Trotter probably took in small lots in trade at this time.

34. Niles Weekly Register June 6,1812:227.