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Rock-Shelter Saltpeter Mines of Eastern Kentucky

ABSTRACT

Saltpeter (niter) is a naturally occurring nitrate mineral historically used to make gunpowder. Domestic production was economically viable only during times of international tension or conflict, when less expensive imports were curtailed. During the period leading up to the War of 1812, speculators and war preparations stimulated a saltpeter boom. Kentucky was the most significant source of nitrates, derived from caves and rock shelters, that supported regional gunpowder mills and was also shipped to eastern manufacturers. Prior research mainly concerned production from limestone caves; sandstone shelters received little notice. The only systematic survey of shelter sites was conducted by archaeologists for the Daniel Boone National Forest in eastern Kentucky, prompted by a need to assess prehistoric cultural resources. Examination of site inventory reports allowed identification of 165 shelter sites associated with saltpeter mining. This information, combined with primary historical documents, has allowed the authors to assess better the nature, distribution, and significance of this early Kentucky industry.

Introduction

Historically, the terms saltpeter (saltpetre) and niter (nitre) have been applied to any of several naturally occurring nitrate minerals that can be used to manufacture explosives: potassium nitrate, calcium nitrate, and sodium nitrate. Only the chemical form potassium nitrate is suitable for the production of high-quality gunpowder, although in a substitution reaction calcium nitrate can be converted to potassium nitrate through a relatively simple process. Nitrate deposits found in limestone caves and sandstone-outcrop concavities, known as "rock shelters," appear to be primarily a product of bacterial decomposition of organic matter in surface soils and subsequent transport by seeping groundwater. The generation and depositional processes are complex and remain poorly understood, even by modern scientists, producing longstanding controversies and an extensive literature on the subject (Craig 1862; Hess 1900; Nichols 1901; Gale 1912; Ross 1914; Mansfield and Boardman 1932; Faust 1967; Hill 1981; Hill and Forti 1997).

Prior to the War of 1812, the United States had little industrial capability. Colonial America provided Britain with both raw materials and customers for manufactured goods, a situation that remained largely unchanged for many years after political independence was achieved (Sellers 1991; Peskin 2003). Among the finished goods supplied to the American colonists was high-quality English gunpowder, on the frontier an essential commodity to put food on the table and for self-defense. As long as relations were amicable, imports of gunpowder flowed freely through American ports at low cost. So low was the cost, in fact, that domestic saltpeter production and gunpowder manufacture were not economically viable. Whenever relations between Great Britain and her former colonies were tense or in a state of war, the supply of gunpowder and other commodities of potential military significance were cut off or greatly restricted. The American, and thereby Kentucky, saltpeter industry was thus highly sporadic, being stimulated only at those infrequent times when commerce between the United States and the rest of the world was hindered (O'Dell 1995).

At the beginning of the American Revolution, the former colonies were ill-equipped to fight a war, gunpowder being one of the critical items in short supply. Various "committees of safety" attempted to organize nitrate production based upon organic sources found in cellars and barnyards. Actual production was relatively low; fortunately, beginning in 1776 adequate supplies were smuggled into the country from France, Spain, and the West Indies. Not until after active hostilities had ceased did it become widely known that nitrates were plentiful in many of the dry caves of Virginia's frontier. 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

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correspondingly developed a dependent industry of gunpowder manufacture that took advantage of proximity to the mining area. Other powder mills were scattered through the mining belt, but generally were more transient than those closer to the trade center. At the end of the war, when normal international commerce resumed, domestic saltpeter proved to be far more expensive than imported saltpeter. In Kentucky, local industries of nitrate mining and gunpowder production collapsed permanently, save for small-scale local efforts (O'Dell 1995).

The usual method of extracting saltpeter from cave sites involved mining of calcium nitrate–containing soil from dry passageways. The soil was then brought to a central processing area in the cave where wooden V-shaped hoppers or vats had been constructed. The soil was placed inside the vats and water added, and the whole was thoroughly mixed to allow the water-soluble nitrates to dissolve. The enriched solution, called "mother liquor," percolated to the bottom of the vats and was collected in wooden troughs. The mother liquor would next be added to a vat containing wood ashes or potash to promote conversion to potassium nitrate, and the resultant liquid transported to an area outside the cave where it was boiled down in large iron kettles until crystallization. A more advanced technology was employed at major saltpeter "factories," such as Great Saltpetre Cave and Mammoth Cave in Kentucky, that were equipped with larger, box-style hoppers and complete plumbing systems using hollowed log pipes and wooden pumps. Operations at rock-shelter sites were similar to those conducted at small-cave mines, save that sandstone rubble rather than soil was processed for its nitrate content (O'Dell 1995; George 2001, 2005).

In Kentucky beginning in about 1780, manufactured saltpeter was derived almost exclusively from caves, although some small lots appear to have been made from deposits associated with manure piles and other surface organic sources. The occurrence of nitrate deposits in sandstone rock shelters was initially unsuspected. About 1802, however, saltpeter men discovered abundant deposits in many of the sandstone rock shelters of the Cumberland Plateau of eastern Kentucky (Brown 1809; Mather 1839; McDermott 1963; Coy et al. 1984; Fig and Knudsen 1984; O'Dell 1995) and northeastern Tennessee (Des Jean 1997a, 1997b). According to Brown (1809:243), saltpeter miners "found that the sand rock itself tasted strongly of saltpetre, and immediately commenced the new method of working," extracting the "rock saltpeter" impregnating the porous sandstone bedrock and boulders of shelters.

Whereas the saltpeter found in limestone caves was calcium nitrate, which was undesirable for gunpowder production, requiring chemical conversion due to its hydrophilic properties, saltpeter obtained from sandstone shelters was potassium nitrate, and the additional step was unnecessary. Gunpowder manufacturers preferred to use rock-shelter saltpeter, and so the finished product commanded a higher market price than that derived from caves. In 1809, Samuel Brown observed that "most of our saltpetre-makers find it their interest to work the sandrock rather than the calcareous cavern" (Brown 1809:243).

Brown's observations provide the only known primary source concerning the nature of saltpeter-mining operations at rock shelters. Samuel Brown, M.D., was a resident of Lexington, Kentucky, during the earliest years (1797–1806) of the saltpeter boom preceding the War of 1812. He was the first naturalist to take up residence west of the Appalachian Mountains and acquired his training in medicine and the sciences at the University of Edinburgh and Marischal College, Scotland, during the latter days of the Scottish Enlightenment. Brown wrote a lengthy monograph on the manufacture of American saltpeter, published by the American Philosophical Society in 1809. Other investigators wrote on the subject before and after him, but Brown provided the most detailed and thorough analysis, and his text would stand as a benchmark for the later works of Hovey (1882), Maxson (1932), and Faust (1967). His monograph contains the first published American reference to mining saltpeter in rock shelters, using methodologies then in general practice in France but independently developed by American saltpeter workers (Diderot 1790:169,177–178; de Buffon 1798:182–185; George 2005:135–159). Conventional manufacture of saltpeter from soils in limestone caves was familiar to Brown, an entrepreneur who, in 1804, established the era's largest and most advanced niter mine operation at Great Saltpetre Cave in southeastern Kentucky (George 2001). The concept of extracting saltpeter from native bedrock in sandstone rock

shelters was, however, new to Brown and the saltpeter workers of the region.

In his monograph, Brown described the appearance of cliff lines and shelters in Kentucky, which he said might be taken at a distance for the ruins of Gothic cathedrals or baronial castles:

> 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 [18 to 30 m] in height, and jutting over their bases ... often form a shelter large enough to secure a thousand men from the inclemencies of the weather (Brown 1809:241).

The first mention of eastern Kentucky's numerous rock shelters was made on 11 May 1750 by Dr. Thomas Walker. With his exploring party in the vicinity of the Rockcastle River and drenched by spring showers, Walker noted in his journal that "[w]e left the River, found the Mountains very bad, and got to a Rock by the side of a Creek Sufficient to shelter 200 men from Rain. Finding it so convenient, we concluded to stay." They remained in this refuge for the rest of the day and here discovered "a Soft Kind of Stone almost like Allum in taste," this apparently being a first reference to deposits of potassium nitrate (Walker 1888:53–54). Discussing the merits of cave saltpeter, George Hunter's 1802 eastern Kentucky diary entry (McDermott 1963:49) also mentions "that perfect Nitrat of potash is afforded in considerable quantities by some sandy Rocks—This stone ought to be examined and analyzed." Eureka moments like this could have been all that was needed to launch a widespread mining assault upon the shelters of the region.

Shelter mining proved a real bonanza—the sandstone rocks of shelters yielded proportionately more saltpeter, of higher quality, than could be obtained from cave soils, and in less time with fewer workmen. The earth of Great Saltpetre Cave, according to Brown (1809:238,242), yielded but 1 or 2 lb. (0.45 or 0.9 kg) of niter per bushel, whereas 10–30 lb. (4.5–13.6 kg) was typical for a bushel of rock-shelter sand. Rock mining for nitrates became well known and practiced throughout the mountains of eastern Kentucky and Tennessee, where shelters were common. The rock deposits were so rich in saltpeter that the sandy soils of shelter floors were generally ignored; only a few eastern Kentucky rock shelters show any evidence of soil excavation for nitrates. Soon the practice of mining bedrock for nitrates would also be employed in certain limestone caves, notably Mammoth Cave, Dixon Cave, Short Cave, and a few others in central Kentucky; some caves in southern Indiana; and Big Bone Cave in east-central Tennessee (George 2005:101–133). In eastern Kentucky, bedrock mining for nitrates is known from only one limestone cave (15Ja379) in our inventory.

After the War of 1812 the methodology of saltpeter extraction from sandstone and limestone rock was largely forgotten. The only primary written record of its use after 1820 is associated with the James D. Canon Saltpeter Cave, Hart County, Kentucky (George 2001:101). There is some evidence that, in northeast Tennessee, shelter-rock mining for saltpeter was resumed on a small scale during the Civil War era and continued until about 1880 (Des Jean 1997a, 1997b). No such resurgence occurred in Kentucky, a border state that remained under Federal control during the Civil War, where no documentation or physical evidence exists for saltpeter mining from any site type during this later period. As a significant industry, saltpeter mining in Kentucky was restricted to a brief span of a single decade (1804–1815); afterward, only occasional and limited mining activity occurred, associated with production of small quantities of gunpowder for local use. For all its brevity, however, during the boom period saltpeter mining was a major component of the regional economy.

Saltpeter-Mine Distribution

Former niter-mine sites tend to be localized in specific areas in response to a number of geological, geographical, and cultural factors. Distribution of site types is chiefly a function of regional geology and lithology, related to the surface expression of the respective rock types, limestone and sandstone, involved in cave and shelter development. Location analysis of known sites indicates that most of the saltpeter mining in eastern Kentucky rock shelters and caves was conducted in localities served by a well-connected transportation network of roads,

trails, and navigable streams. The great number of mining sites suggests thousands of people participated in the Kentucky industry. Although this paper is primarily focused upon rock-shelter mining, comprehension of the historical saltpeter-mining industry also requires that attention be given to the distribution of saltpeter caves, many of which were located within the shelter zone and mined concurrently.

At present, 322 known saltpeter-mining sites, both caves and rock shelters, have been cataloged in Kentucky. The majority of known sites (248) is concentrated in a band just east of the Cumberland (Pottsville) Escarpment, a west-facing cuesta that comprises the margin of the Appalachian Plateaus physiographic province and a transition to the gently rolling plains of the Bluegrass region. In Kentucky, the Appalachian Plateaus, a dissected peneplain surface, consists of two more-or-less parallel sections, the Cumberland Plateau, and, farther east and northward, the Kanawha Plateau (Fenneman 1938; Fenneman and Johnson 1946). The Cumberland Plateau is a coarsely eroded surface and generally capped by lower Pennsylvanian, east-dipping conglomeritic sandstones of the Corbin Sandstone Member of the Grundy Formation. Beneath the caprock are Upper Mississippian carbonate rocks (primarily limestone) of the Slade Formation. Where valley erosion intercepts Mississippian carbonates, primarily along the highly dissected margin of the escarpment, numerous caves have developed, which are often positioned directly below sandstone rock shelters. Eastward, the slight regional dip carries the carbonates beneath the surface rocks so that karst features, such as caves, are absent, and only shelters may be found throughout this region.

In eastern Kentucky, the authors have identified 83 known saltpeter caves and 165 rock shelters with verifiable mining evidence (Table 1). Examination of available unpublished documentation, suggestive place-name referents (i.e., "Peter Trace," "Powder Mill Hollow"), onsite reconnaissance, and interviews and correspondence with other researchers suggest there are probably a great many more former cave and shelter niter-mine locations in the state than the existing inventory contains. Unpublished archaeological reports written prior to the mid-1980s give a distorted view of this early industry. Archaeologists, frequently focused on prehistoric rather than historical traces, often failed to recognize shelter niter mines as such. Reports written by cave explorers, newspaper reporters, or commercial cave exhibitors might, for example, mistakenly identify a series of parallel earth mounds as human graves rather than the remains of V-vats, as longstanding oral tradition held to be true in Great Saltpetre Cave. Troughs carved from large logs to collect leachate from saltpeter vats have sometimes been identified by laypersons as Indian canoes. Much of the evidence in saltpeter mines, in terms of industrial associations, is unrecognizable to untrained eyes. Only with educated observation and study does the true character of a saltpeter mine become obvious. Once farmers, looters, or campers alter a site, much of the evidence is destroyed or becomes questionable as to its context and function.

Hiring of archaeologists to inventory and assess prehistoric and historical resources in the Daniel Boone National Forest (DBNF) of Kentucky began in the mid-1970s with the establishment of the forest's heritage program (Ison et al. 2008:1). During 2009, coauthor O'Dell examined every available archaeological survey report, numbering in the thousands, in DBNF paper files in Winchester and the Kentucky Office of State Archaeology (OSA) in Lexington. These reports were recorded on standard OSA site survey forms. This arduous task was necessitated by the fact that the existing electronic database of surveyed sites contained only minimal information, and much of that was erroneous, even in regard to identification of site type. Nearly half the hardcopy files concerned investigations of rock shelters, but only a small fraction of these reports have any indication of saltpeter mining. Mine sites in these files were identified by mention of specific diagnostics, including extant saltpeter hoppers and identifiable remnants, soil/rock excavations and associated talus piles, and drilled shot holes. In reviewing the written reports, the authors have taken the liberty, in a very few cases, of identifying a site as a niter mine when the original investigator noted the existence of rubble piles without being aware of the significance. There were also several sites noted that might possibly be associated with saltpeter mining, having the remains of wooden structures of various sorts, but without distinctive telltale signals,

TABLE 1
KNOWN AND SUSPECTED EASTERN KENTUCKY NITER MINES

County Name	County Code[a]	Rock Shelter (Possible Site)	Cave	Place Name
Bath	BH	—	—	2
Bell	BL	—	2	—
Breathitt	BR	—	—	1
Carter	CR	—	7	1
Clay	CY	5	—	1
Clinton	CT	—	6	1
Cumberland	CU	—	2	—
Elliott	EL	—	—	1
Estill	ES	—	2	2
Greenup	GP	—	—	3
Jackson	JA	19	9	3
Johnson	JO	—	—	1
Knott	KT	—	—	2
Laurel	LL	7	—	1
Lee	LE	18	1	1
Letcher	LR	—	3	—
Lewis	LW	—	—	3
McCreary	MCY	24	2	2
Magoffin	MG	—	—	1
Martin	MT	—	—	3
Menifee	MF	51	1	—
Metcalfe	MC	—	4	—
Morgan	MO	—	—	1
Powell	PO	22	—	—
Pulaski	PU	2	17	9
Rockcastle	RK	—	6	2
Rowan	RO	1	—	—
Russell	RU	—	—	1
Wayne	WN	—	20	1
Whitley	WH	1	1	1
Wolfe	WO	15	—	1
Totals	**—**	***165***	***83***	***45***

[a]County code is used as part of the Smithsonian designation for archaeological site numbers, as in 15JA96, where 15 is the state code, JA the county code, and 96 the number of the specific site.

such as talus piles, and so were not included in the tally. For example, many shelters were used during the historical period as livestock pens, and in at least one case the user carved a wooden trough to water his stock. Only 164 of these 165 shelter sites were actual niter mines; site 15Ja87 contained a developed spring, apparently improved by the miners to use in processing operations at neighboring shelters, but was not itself mined.

The majority of the shelter mine sites lie in two clusters centered in Menifee, Powell, Wolf, and Lee counties (109 sites or 66% of the shelter population). These clusters may represent primary focal areas for saltpeter mining, or it may simply be that the region around the Red River Gorge, a major tourist attraction, has been investigated and documented more thoroughly by modern archaeologists, or a combination of these factors. Similar clusters for saltpeter caves are also apparent in some regions dominated by carbonate lithology and karst terrain, specifically areas in Wayne, Pulaski, Rockcastle, Jackson, and Carter counties (Figure 1). In terms of specific sections along the Cumberland Escarpment, mining clusters can be broadly designated as the

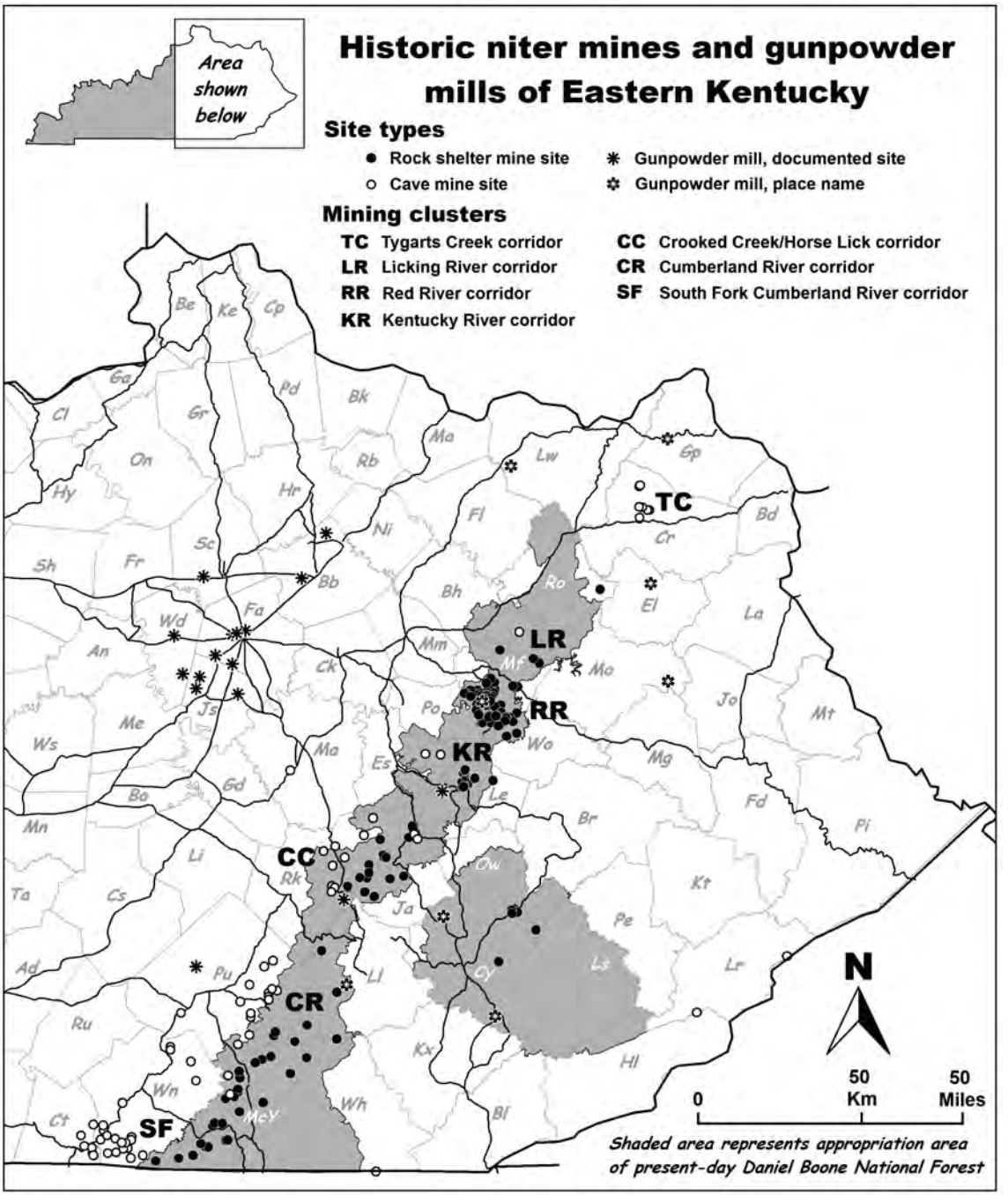

FIGURE 1. Distribution of historical niter mines and gunpowder mills in eastern Kentucky. Road network shown is based on the Munsell (1818) and Lee (1856) maps of Kentucky. (Angelo I. George, Gary A. O'Dell, Diana E. George, and Timothy Hare, 2012.)

Tygarts Creek Corridor, Licking River Corridor, Red River Corridor, Kentucky River Corridor, Crooked Creek/Horse Lick Creek Corridor, Cumberland River Corridor, and the South Fork Cumberland River Corridor. Such corridor labels are useful in conceptualizing a thriving industry associated with these geographic features. Although cave and rock-shelter mine sites are

found all along the margin of the Cumberland Plateau in Kentucky, site distribution outside the major clusters is not uniform. Extensive swaths of apparently unmined terrain separate core areas of mining activity, even though caves and rock shelters abound in these localities. Eastward, deeper into the Appalachian Plateaus, sites are far less numerous and widely scattered.

Most of the sampled localities are on lands owned by the United States Forest Service (USFS), part of the DBNF, since this is the only area where there has been a sustained effort at rock-shelter mine site reporting, conducted primarily by USFS archaeologists. Even so, a recent evaluation as to the status of cultural resource assessment in the DBNF by the USFS estimated that no more than 6% of the land has been systematically surveyed using modern investigative and documentation methods since 1990 (Wayna Adams 2011, pers. comm.). Modern cave explorers are the primary source for saltpeter cave locations and descriptions of mine artifacts at such sites. The DBNF occupies a narrow northeast–southwest band along the Cumberland (Pottsville) Escarpment and the separate Redbird District of southeast Kentucky. Extrapolating from these sampling areas as representative of the whole of eastern Kentucky, it appears that shelter niter-mine sites in the region are likely to be found wherever sandstone cliffs exist. A secondary hypothesis might be that a greater density of sites is found along the escarpment, since this is the western edge of the rougher Appalachian terrain, with a better integrated transportation network than the mountain counties and closer to the Bluegrass transportation hub and saltpeter market center of Lexington, Kentucky.

Another consideration in regard to the Cumberland Plateau sample area is that, while DBNF is shown on maps as occupying a large and contiguous tract, this is really only the "appropriation area" in which the USFS has been authorized to purchase lands. The actual lands owned by the USFS (for which archaeological site reports were generated) total less than half of the appropriation area. USFS landholdings in Wayne, Pulaski, Rockcastle, Carter, and Greenup counties are both limited and fragmentary, and, so, relatively few site reports were produced in these areas concerning either prehistoric or historical sites. In the case of Rockcastle County, for example, there are no documented shelter mine sites, although reports from cave explorers have identified six saltpeter cave operations. This does not mean there are no niter-mine shelters in Rockcastle County (witness the large number—19—in adjacent Jackson County, which also has 9 saltpeter caves), just that the area sampled by site documentation in this county is relatively limited compared to other counties. Figure 2 shows the highly fragmented nature of USFS land ownership in a section of southeastern Kentucky compared to documented shelter mines. Along with the limited extent of USFS surveys, this pattern strongly implies that there are many more mine sites than have been presently identified, because most of the land along the plateau margin is privately held and has not been professionally investigated and documented.

The Forest Service is, in contrast, a major landowner (more than 142,000 ac., a little more than half the total land area) in McCreary County, which hosts a high-density swath of 24 niter-mine shelters across the county and might give a more representative picture of the general distribution of sites along the Cumberland (Pottsville) Escarpment. It is of interest that in adjacent Wayne County, where only one niter-mine shelter has been documented because the Forest Service owns almost no land there, reports by cave explorers have identified 20 niter-mine caves, the highest concentration of saltpeter caves in the state. Farther east, away from the escarpment into the Appalachian Plateaus, actual USFS land ownership in the Redbird District (Clay and Leslie counties) is, as in McCreary County, proportionately high, but only six niter-mine shelters have been identified in this region.

The relatively low frequency of reported niter-mine sites in the Redbird District is not primarily attributable to either a lack of archaeological investigation of the district or even to the rough terrain and minimal road network during the mining era. There are, instead, geological considerations at work. Mather (1839:280), almost 20 years removed from the heyday of saltpeter mining, accounted for the sparseness of mining sites by the change in lithology eastward, noting that "rockhouses and nitre deposits are also found in the sandstones of the coal formations, but they are not so numerous as in the conglomerate sandstone at the base of the coal series." Geologic structure causes outcrops of massive sandstone covering the Cumberland

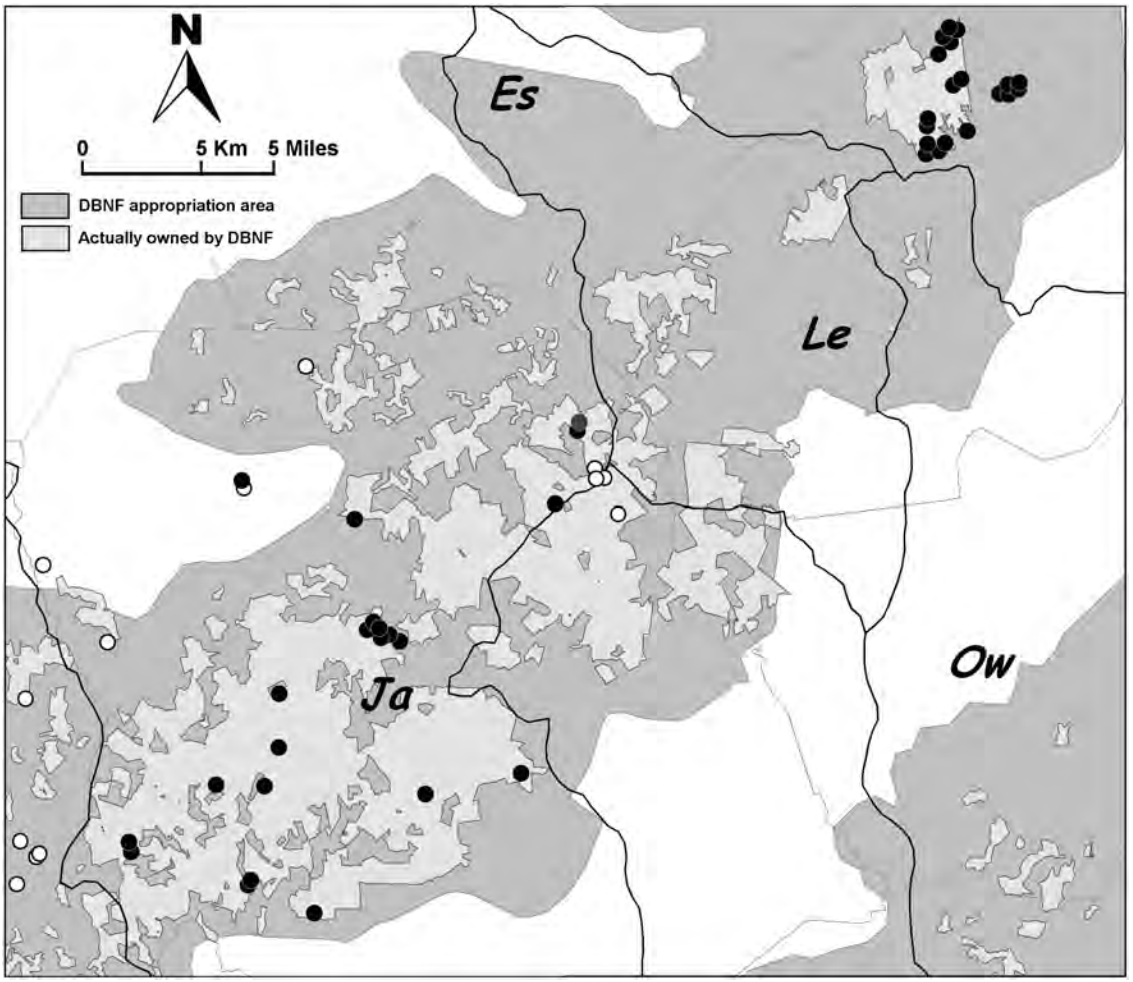

FIGURE 2. Detail of Daniel Boone National Forest. (Angelo I. George, Gary A. O'Dell, Diana E. George, and Timothy Hare, 2012.)

Plateau to dip below coal-bearing units of thinner clay, shale, and sandstone at land surface, creating a less favorable setting for the formation of rock shelters. This alone accounts for the relative sparsity of rock shelters in the USFS Redbird District. The tentative conclusion, based on available evidence, is that niter mining was conducted east of the Cumberland Escarpment, but less intensely because there were fewer suitable sites.

Thousands of caves and rock shelters are distributed along the escarpment, the up-dip edge of the Appalachian Plateaus, yet only a small proportion have evidence of saltpeter mining. Between each mine cluster are areas devoid of known mine sites, even though caves and rock shelters remain relatively abundant in these locations. The character of associated caves undergoes a distinct transition along the structural strike from the Tennessee border to northeastern Kentucky, generally diminishing in size, length, and complexity northeastward, as a result of changes in lithology and thinning of suitable carbonate strata. Cavern size, however, had little or no effect upon either the accumulation of nitrates or whether the site was mined; saltpeter miners were as likely to utilize a small cave as a large one. Along the escarpment, in sections where both saltpeter caves and shelters are present in close proximity, both site types may have been worked in tandem by miners of the region.

George (1986) showed an association between saltpeter mines and population centers/

transportation routes of the "New Republic" era in Kentucky. Further analysis based on both cave and shelter sites reveals that many of these locations occur in tight clusters in deep valley drainage networks connected to adjacent transportation arteries; e.g., wagon roads, traversable stream valleys, or (more-or-less) navigable streams. Mine locations show a close correspondence with the pattern of roads shown on early maps, such as Luke Munsell's (1818) *A Map of the State of Kentucky* and the Edmund F. Lee (1856) *New Map of Kentucky* (Figure 1). For example, the stream valley in western Menifee County, long known as Peter Trace, was almost certainly one of the transportation arteries for saltpeter production in the adjacent production cluster of the Red River Corridor. A "trace" was the pioneer designation for well-trampled trails produced by the seasonal peregrinations of eastern bison. The Peter Trace would have provided a connection to a major pioneer route, known as the "Old State Road," that led from central Menifee County to Mount Sterling in the Bluegrass (Jillson 1934:62–63).

The bulk of Kentucky saltpeter was shipped out of state to eastern manufacturers, of whom the Eleutherian Mills of E. I. Du Pont in Wilmington, Delaware, was a major purchaser (O'Dell 1995; George 2005). In order to minimize transportation costs, however, regional gunpowder manufacturing facilities ("powder mills") were usually constructed in close proximity to the source of the bulkiest component, saltpeter. According to the 1810 federal census of manufacturers, on the eve of the War of 1812 Kentucky was by far the leading producer of saltpeter and operated at least 63 powder mills, more than any other state. Most of the mills were located in the Bluegrass, in and near Lexington, hub of the state's transportation network, market center for the region, and central to the surrounding saltpeter production region (O'Dell 1989). Seventeen of the state's powder mills were located in eastern Kentucky. In addition, gunpowder production was reported for several of the regional counties—Rockcastle, Estill, Wayne, and Greenup—in significant quantities in the first two cases, but no factories were enumerated for these counties (Coxe 1814:3.33,42).

Other than the federal census, there is little primary documentation or archaeological evidence locating gunpowder mills in eastern Kentucky. An historical record exists for only one site in Lee County, the Pinnacle Powder Mill (Henderson 1977:246). Circumstantial evidence in the form of suggestive place names, such as Powder Mill Hollow (Greenup County) and Powder Mill Creek (Laurel County), indicates the possibility of an additional 10 powder mills in the region. The largest saltpeter-mine cluster, the Red River Corridor, is centered around the place name Powder Mill Branch, in Menifee County. Some of the powder mills known only by place name are relatively distant from corridor mining activity, but are, as one might expect, located in close proximity to wagon roads or major water courses (Figure 1). The presence of such place names also suggests a more extensive saltpeter-mining zone than present field documentation supports.

Mine Workers, Mine Camps, and Market Centers

At the outbreak of the War of 1812, eastern Kentucky was thinly settled, having a population density of less than four persons per square mile, and lacked any major centers of population and commerce. The most significant settlements near the mining corridors, such as Irvine (Estill County), Mount Vernon (Rockcastle County), Somerset (Pulaski County), and Monticello (Wayne County), were all recent in origin and little more than villages. Of these, Monticello was the only community considered of sufficient significance to warrant a separate listing in the 1810 federal population census, yet was inhabited by only 37 persons (United States Bureau of the Census 1811).

During the pioneer settlement of Kentucky, the rugged terrain of eastern Kentucky was initially passed by as settlers flocked to the Bluegrass region, attracted by the reports of early explorers who described the land of central Kentucky as a paradise on Earth, fertile and teeming with game (Hammon 1986:247–48; Smith 1999:77–78). Not until after the conclusion of the Revolutionary War did immigrants turn their attention to the virtually empty mountain country, only to find that distant speculators had preempted their opportunities to claim these lands. Most of the land in eastern Kentucky at that time was held by absentee owners, a development arising from Virginia land policies that deliberately

encouraged rampant speculation. Using county tax records, Dunaway (1996:56–57) calculated that 56% of the land in the Appalachian counties of Kentucky was owned by absentees, but estimated that the true figure may have been closer to 75%. Most of these land speculators resided outside the region, east of the mountains, but some were elite capitalists in the population centers of the Bluegrass. All believed that fortunes were to be made from inevitably rising land prices and through exploitation of mineral resources thought to be abundant in the region. Time proved the speculators correct in these assumptions; by 1810, Kentucky led the nation in salt and saltpeter production, and the abundant timber, iron, and coal reserves of the mountain region were beginning to be tapped (Coxe 1814:3.34,42).

The case of Thomas Duckham, although somewhat later in time, appears to be fairly typical of these speculators. In about 1816 or 1817, Duckham, a wealthy merchant in Frankfort, the capital city of Kentucky, acquired more than 50,000 ac. of land in three tracts lying along the Red River, and another tract, nearly as large, in Lee County; all this land is situated among the densest cluster of known niter-mine sites. In 1818, Duckham granted a power of attorney to Jacob Meadows of Montgomery County, authorizing Meadows to "demand and receive" rents from "all such persons as are working Salt Petre Caves" on his Red River tracts, and to rent out any saltpeter caves on whatever terms he thought proper. For his efforts, Meadows was to receive a third of the profits from rentals of caves then being worked, and half the rents from "such caves as Meadows shall hereafter find himself" (Duckham 1818). This arrangement, although specifying "caves," would also apply to rock shelters being mined for nitrates, since the designation "cave" seems often to have been applied colloquially as a generic term for any large cavity in bedrock (Brown 1809:242). Numerous conveyances recorded in the offices of the county clerks for Montgomery and Estill counties, Kentucky, indicate that Duckham held onto these properties for about 20 years and then began to sell them off, mostly in large tracts of 500 to several thousand acres. For the largest land transactions, he reserved the rights to all, or half, the "minerals and mines in the bowels of the earth." For the Lee County land, he also excepted saltpeter caves from the conveyances. The timeframe involved, from the 1818 power of attorney through the transactions in the late 1830s, was well past the boom years for niter mining, so profits from these particular resources were probably not great.

Such speculation greatly retarded settlement of the region, as large blocks of land were held off the market in anticipation of rising prices. Absentee owners initially preferred to lease rather than to sell, because occupancy discouraged squatting, and improvements made by tenants increased the value of the land, which reverted to the owner at the expiration of the lease. When finally offered in the market, land was often too expensive for the average resident of the mountain region. Many of the early settlers of eastern Kentucky were forced to become squatters, occupying the most rugged terrain with little prospect of acquiring land of their own. Most Appalachian households were thus landless, a situation that promoted tenant farming and sharecropping, residence in small towns, and an available nonfarm labor pool (Dunaway 1996:66–70,87–108). During the first two decades of the 19th century, participation in extraction industries such as salt and niter processing offered work and income to many landless residents of the region. Certainly there were many persons involved in saltpeter production in eastern Kentucky. In 1809, Charles Wilkins, a wealthy merchant and saltpeter wholesaler in Lexington, observed that the niter miners were "so numerous and living in caves & mountains on our frontier" that he could not keep track of all the persons from whom he purchased saltpeter (Wilkins 1809).

Some inferences about the nature and organization of the labor force involved in niter mining can be drawn by examining the contemporary pioneer industry of salt production from the numerous saline springs, or "licks," in Kentucky. The basic manufacturing process for both industries was very similar, involving the heating of a solution of dissolved minerals in large iron kettles to evaporate the liquid content and leave the marketable crystalline residue. Despite obvious similarities in the nature of the work, a certain amount of speculation is required to describe saltpeter mining and processing at rock shelters, because of the lack of detail in primary sources concerning

such sites. Salt- and saltpeter-making operations differed primarily in the longevity of the resource at any given site and, hence, the size and stability of the associated mining operation. The perennial nature of most saline springs, providing an unceasing flow of mineral waters, encouraged the establishment of multiple, fixed-site processing camps in their vicinity. Such clustering was exhibited, for example, by the Bullitt's Lick grouping in Bullitt County, and the operations in Clay County, of which the Goose Creek Salt Works was a leading regional producer until the time of the Civil War. The Bullitt grouping alone employed as many as 800 individuals in various production and support roles. Some of the more successful salt-camp communities ultimately developed into towns, as in the case of present-day Shepherdsville in Bullitt County, founded in 1793, and Manchester in Clay County, established in 1807 (Verhoeff 1917:148–157; McDowell 1956; Jakle 1969).

Although the nitrate deposits in rock shelters were self-renewing over time, through continuing groundwater seepage and evaporative crystallization in the porous sandstone rock, the process most likely required years for replenishment of significant quantities. The niter content of any given shelter was quickly mined out, but shelters were numerous along the sandstone cliffs, and mining crews needed only to relocate their activity to another shelter a short distance away once the existing supply was exhausted. The transient nature of shelter operations would tend to discourage establishment of large and permanent mining camps, as was the case for salt manufacture. Although temporary camps may have been set up in proximity to a cluster of shelters, it was far more likely that individual shelters served as habitats for workers engaged in saltpeter extraction. There is ample archaeological evidence that many shelters in eastern Kentucky were occupied on a temporary or long-term basis from prehistory to the present era, since the overhangs provided living space and protection from the weather. Charles Wilkins's 1809 reference to niter miners "living in caves & mountains" was apparently literally descriptive. In valley enclaves containing numerous active or potential mine sites, workmen quite possibly gathered together in one large shelter abode for camaraderie, as well as the utilitarian and mutual support advantages. Des Jean (2001:14) drew similar conclusions during his survey of the Burrows Rock Shelter in the Big South Fork locality, Tennessee.

Although evidence, such as Wilkins's observation, indicates that a considerable number of workers were involved in regional saltpeter mining, the abundance of rock shelters along valley cliff lines and the confined space within most suggests that the work crews at any given shelter site were generally comprised of only a few individuals. In 1809, Samuel Brown noted: "At some of these rock houses three hands can make one hundred pounds [45 kg] of good nitre daily, but forty pounds [18 kg] may be considered as the average product of the labour of three men at those works which I had an opportunity of visiting" (Brown 1809:242). His repetitive use of the phrase, "three men," is an indication of the size of a typical work crew directly involved in mining and processing in most shelters, where usable floor space was often limited by the presence of numerous large boulders. Along valley perimeters marked by extensive sandstone cliff lines, many such small teams might be at work simultaneously in different shelters, constituting the workforce of one or more employers, as well as independent or "wildcat" crews.

There is very little available documentation concerning the industrial structure of shelter mining in eastern Kentucky. Such evidence as exists suggests that the industry was highly fragmented, consisting of numerous, small, independent operators with a few entrepreneurs or contractors functioning on a larger scale. The existence of many small mining operations is supported by Charles Wilkins's observation of the large number of persons bringing saltpeter to market in Lexington in 1809, and the authorization given by Thomas Duckham to his agent in 1818 to seek out and collect rents from any persons making saltpeter on his Red River lands. Larger, more highly organized ventures are indicated by Samuel Brown's (1809:242) statement concerning a "Mr. Fowler and his associates," who made about 100,000 lb. (45,360 kg) of saltpeter from 28 different "rock houses or caverns" located on the north side of the Kentucky River. There is some indication that saltpeter was, at least in some cases, manufactured to order. In November 1810, Charles Wilkins informed Archibald McCall in

Philadelphia, a purchasing agent for the Du Pont company, that he had "closed his purchases for the season," and, if more saltpeter were needed, it would be several weeks before word could reach the miners that he was buying saltpeter again (Wilkins 1810).

Not all of the men at a mining locale would be able to work fulltime at making saltpeter. A certain amount of support and supply would be necessary to maintain the mining operation. The division of labor at rock-shelter mine operations in the rugged terrain of the Escarpment region most likely resembled that of ad hoc salt-making expeditions into the wilderness during the pioneer settlement era in Kentucky. On one such occasion in January 1779, Daniel Boone led a party of about 30 men to make salt at the Lower Blue Licks in Nicholas County. Most of the men were engaged in the arduous work of salt manufacture: cutting wood, tending the fires, and scraping and packing the salt. Two or three men acted as couriers to transport bags of salt back to the settlements as it was made, and two or three ranged through the area around the Blue Licks, serving as scouts and hunters to supply meat to the salt boilers (Belue 1994).

A saltpeter-mining operation employing several teams working different shelters in a valley would require at least as many support personnel as actual bedrock miners, if not a greater number. At each individual shelter, the mining team would break apart the bedrock walls and large boulders into loose rubble and sand by drilling and blasting. The rock fragments were initially boiled in a kettle to break down the material and to dissolve some of the nitrates, and then the rubble and liquid were transferred to wooden vats. The miners would next add cold water to the vats to dissolve the nitrate crystals, and then collect the leachate as it seeped into wooden troughs below the vats (Brown 1809:242). From this point onward, the operational steps were nearly identical to salt manufacture. The leachate solution was boiled in kettles, evaporating the mineralized waters to the point of crystallization, and the valuable residue scraped and bagged, or packed in barrels. Just as in salt making, the boiling process required enormous quantities of wood to keep the fires burning, day and night, under the boiling kettles, and this would necessarily involve a large number of persons dedicated to cutting and hauling timber to the shelters, over ever-increasing distances. Huge tracts of land, even entire valleys, would have been deforested, as confirmed by observers reporting environmental devastation in the vicinity of salt-boiling operations (McDowell 1956:256–257; Billings and Blee 2000:65). For efficiency in a given locale, functions, such as wood cutting and food preparation, were most likely handled by a cadre of workers dedicated to providing these services for all the mining teams associated with a specific employer.

Independent saltpeter miners, most likely cooperative ventures of small, self-supporting groups of local residents seeking to generate income during the saltpeter boom period, were necessarily less efficient than larger-scale operations involving multiple teams. There was only so much workspace, uncluttered by boulders and debris, beneath the roof of a typical shelter, which limited the number of persons who could actually engage in mining and processing the sandstone rock. For an independent team working a single shelter, members of the work crew providing support services would have carried out tasks on an as-needed basis, rather than specializing in a specific activity. This would have had the effect of limiting the size of independent operations to include only those workers who could maintain more-or-less continuous employment, since excess workers would only reduce the share of profit for everyone involved. In some cases, the workforce may have been so small that the bedrock miners would have to provide some services for themselves, temporarily suspending mining, for example, to lay in a supply of firewood sufficient to keep the kettles boiling for a few more days.

The role of African Americans in eastern Kentucky saltpeter-mining operations is difficult to assess, given the lack of available documentation. Although the greatest number of slaves was associated with agriculture, the use of slave workers in industry was widespread throughout the antebellum South. Many of these slaves were leased from slaveholders, rather than owned outright by the employers. Manufacturing tended to be concentrated near cities; in the resource-rich mountain counties of the Appalachian region, extractive industries such as logging, production of turpentine and salt, and the mining of iron ore and coal were

dominant (Dunaway 2003:103–105,113). The slave population of the mountain counties was relatively low, compared to the non-Appalachian South. According to the 1810 federal census, more than 25% of the population in the fertile inner Bluegrass region was enslaved (36% in Lexington, the regional market center), whereas slaves constituted only 8.5% of the residents of eastern Kentucky. The proportion of slaves was even lower for some of the more prominent saltpeter-mining regions: only 6.4% in Estill County and 4.2% in Wayne County (United States Bureau of the Census 1811).

In the mountain counties, during the first decades of the 19th century, concentrations of slave workers in extractive industries appear to have been associated primarily with fixed-site operations, such as iron furnaces and saltworks (Boles 1984:118–126; Billings and Blee 1995:237–238; Dunaway 2003:115–119). Slaves were employed in a few large, cave-based, factory-style saltpeter-mining operations, but in eastern Kentucky the only site of this distinct type was Great Saltpetre Cave in Rockcastle County (George 2001) and, possibly, Saltpeter Cave in Carter County, for which primary documentation is lacking, but was apparently also operated on a large scale (Duncan 1995, 1997). Although it is likely that slave labor was involved to some extent in the dispersed-site rock-shelter mines of Kentucky's mountain region, there seems little reason to believe any large numbers of slaves were employed in this industry.

Most of the finished saltpeter was probably bagged and taken out in relatively small lots as it was made, initially transported by packhorses because of the generally rough terrain in the immediate vicinity of the shelter mines. Upon reaching a wagon road, the packhorse train either continued directly on to Lexington or to one of the smaller regional market towns, or else made rendezvous with a wagon driver who would take the load on the next stage of its journey. Market towns in the mining zone, such as Irvine or Monticello, probably served as staging areas where saltpeter was accumulated and stored temporarily, and possibly repacked into barrels. Being waterproof, barrels were desirable for long-distance transport of a highly water-soluble material like saltpeter. Charles Wilkins (1809), one of the largest purchasers of saltpeter in Lexington, noted that some of the saltpeter he received arrived in barrels, but that generally "it has been bought in small quantities & repacked by myself & in the same barrel have put salt petre of different manufacturers." This suggests that most of the saltpeter arriving in Lexington was transported in bags or small barrels, rather than standard barrels, which, when filled with saltpeter, were far too heavy to handle in the rugged, roadless terrain in the immediate vicinity of the mines; a typical full-size barrel of saltpeter weighed 350–400 lb. (160–180 kg) (McCall 1810).

On the eve of the War of 1812, heightened tension between the United States and Britain, and restrictions on international trade increased the demand for and the cost of saltpeter. Competition for this resource encouraged regional wholesalers and speculators to seek out the manufacturers in the hinterlands, rather than wait for the material to be brought to market. At Lexington in October 1811, Charles Wilkins observed, "The dificulty of procuring large quantities has increased much—it has become a custom to purchase it up on the frontiers & it is now sold only in waggon-loads at this place" (Wilkins 1811). This situation was confirmed in March 1812 by Philadelphia wholesaler Archibald McCall, who noted that he had received a letter from Lexington merchants James and David Maccoun stating that "competition had become so great that none of the article [saltpeter] came then to Lexington unsold" (McCall 1812). Rather than visiting the remote mountain valleys where saltpeter was actually made, wholesale buyers probably made contact with representatives of the manufacturers in market towns in the production region, such as Irvine or Monticello, and there established warehousing facilities to accumulate and store the material.

The abundant natural resources of the mountain region promoted establishment of towns in favorably situated locations, and it is probably no coincidence that Irvine, located in Estill County proximate to dense concentrations of mine sites, was laid out at the height of the saltpeter boom. Estill County was created on 27 January 1808 by an act of the Kentucky legislature that authorized the erection of a courthouse and other public buildings. In December 1811, the county seat of Irvine was laid out on a wide floodplain of the Kentucky River at the junction of two principal wagon roads (Littell 1811:442; Park

1906:12–13). Navigation of the river was hazardous, but, by 1805, a steady traffic of shallow-draft flatboats brought iron and salt down the upper Kentucky and its tributaries to markets in Frankfort, Lexington, and Louisville (Littell 1811:249; Johnson and Parrish 1999:11). Estill County was not only central to the Kentucky River and Red River saltpeter-mining corridors, but to the Red River iron district as well. The first iron furnace and forge in the district was established prior to 1806 on the Red River in northern Estill, although its pig-iron production was shipped down the Red River and thus bypassed the site of nearby Irvine (Moore 1878:206). The presence of a regional workforce engaged in ore mining and processing, along with the numerous saltpeter miners distributed through the mountain valleys in the vicinity, encouraged the establishment of local population centers capable of providing supplies and amenities, such as taverns, for these workers.

Twelve miles upriver from Irvine was the Pinnacle Powder Factory, which, like a handful of other gunpowder mills in eastern Kentucky, took advantage of proximity to the production area and served to further divert quantities of saltpeter from more distant markets in the Bluegrass region. The Pinnacle mill was located on the high ground next to the Kentucky River gorge; access to river transportation was provided at a nearby site that, even in 1838, was referred to as "Old Landing" (Kentucky General Assembly, Senate 1838:265; Henderson 1977:246). Clustering of saltpeter production sites in the vicinity of this mill, and the one represented by "Powder Mill Branch" in Menifee County, suggest that similar clusters could be associated with mills farther eastward on the Appalachian Plateaus, where few mine sites have been documented. The interception of saltpeter production by newly established powder mills in the mountain counties and by urban brokers, who, bypassing the supply chain, went directly to the production region, must have caused a certain amount of anxiety among Bluegrass saltpeter buyers, such as Charles Wilkins and the Maccoun brothers, as they lost market share to merchants and manufacturers closer to the source. Wilkins attempted to address difficulty in meeting his contract obligations by purchasing Mammoth Cave in 1810, in which he intended to establish the largest saltpeter-processing factory in Kentucky (George 2005).

Site Selection

Although sandstone rock shelters are abundant in eastern Kentucky, entrepreneurs who wished to locate potential mine sites in the nearly trackless maze of remote mountain valleys required local knowledge of the terrain. Such knowledge could best be obtained from the indigenous population, which in large part, given the widespread engrossment of eastern Kentucky lands by speculators, consisted of squatters. According to Dunaway (1996:106), in the mountain region "[m]ost squatters wandered the countryside endlessly. ... To avoid public scrutiny, squatters selected abandoned tracts in some of the most rugged terrain." This itinerant population would have been well acquainted with local caves and rock shelters, features they would have encountered while hunting or tending cattle, or used as temporary living quarters until they could build a lean-to or cabin. Squatters would make the best guides for locating potential mine sites, and many probably found employment in the industry as suppliers of fresh meat or produce, or were more directly involved in mining and processing. In some cases, mining activity may have displaced transitory squatter settlements and forced them to move deeper into the hinterland. Workers involved in other dispersed extractive industries in the mountain counties, such as logging, charcoal production, or tar-kiln operation, would also have been good potential sources of information.

The distribution of known saltpeter-mine sites, both caves and rock shelters, suggests that saltpeter men were reluctant to exploit sites that were located more than a few miles from an existing transportation route. Stream valleys served as access corridors to rock-shelter concentrations located in headwater zones. Saltpeter men scouting for potential mining sites would venture off the wagon roads into the wilderness, their departure point based on information gained from local inhabitants or perhaps led by a guide, and explore up major valleys and tributaries until they found promising sites to investigate and test for the presence of saltpeter.

Taste was an important criterion in determining the presence of naturally occurring nitrate salts. The *Boston Gazette* for 1 January 1776, offering advice on saltpeter manufacture, noted that soil deposits containing saltpeter have "a bitterish or sourish ailum like salt upon the

tongue" (Whiting 1776). More recently, geologist Hoyt S. Gale (1912:7) drew a rather fine distinction between the taste of two nitrate forms: calcium nitrate (nitrocalcite) found in caves imparts "a sharp and bitter taste" upon the palate, whereas, the potassium nitrate of rock shelters produces "a cooling, rather sharp, saline taste." Saltpeter men prospecting for nitrate deposits may have used more than their sense of taste to locate rich deposits. Some former shelter mines, such as 15Po181 (White Wall Shelter), well-protected from the weather, today exhibit highly visible and luxuriant expanses of granular crystalline niter growths spread out along sandstone walls, or rock seams cemented by niter (Figure 3). This phenomenon is also noted by Mather (1839:279–280), Mansfield and Boardman (1932:12–15), and Coy et al. (1984:55,57). During the mining era, several saltpeter men told Samuel Brown of finding large deposits of pure potassium nitrate exceeding 100 lb. (45 kg) weight or more; one such mass weighed nearly 1,600 lb. (726 kg). Brown himself collected several specimens from shelters, observing that these deposits generally occurred in crevices between sandstone boulders or within bedrock fractures (Brown 1809:242). When such deposits of pure potassium nitrate were first encountered by explorers (e.g., Thomas Walker) and inhabitants of the mountain country, curiosity must have impelled some individuals to taste the white crystalline substance, and so the widespread mining of rock-shelter saltpeter commenced soon afterward.

Aside from the necessary headroom or working space, site conditions that generally precluded a shelter from being mined for niter are those that limited the availability of accessible nitrates. These would include shelters with extremely wet interiors, shelters located so low in the topography as to be subject to flooding by surface streams, shelters whose entrances

FIGURE 3. A thick coating of pure potassium nitrate, resembling cake icing, covers the eastern wall of an alcove in the White Wall Shelter (15PO181) in Powell County. (Photo by Johnny Faulkner, USDA Forest Service, 2000.)

faced toward prevailing weather fronts, and shelters with insufficient overhang to protect the interior from precipitation. In each of these cases, the conditions described would hinder the retention of water-soluble niter.

John Fowler, a saltpeter miner, told Samuel Brown (1809:242) "that he has never seen a rock facing the north or west, which was very rich in nitre." This observation is probably attributable to the westerly wind direction prevailing across the United States; shelters facing west would be exposed to oncoming weather systems that would tend to remove water-soluble nitrate salts. Rock shelters with a southern or eastern aspect would be more likely to retain significant accumulations and would thus be preferred mining locations. To test Fowler's statement, rock-shelter entrance orientations taken from site maps and descriptions included in archaeological reports of 142 known niter-mine shelters were graphed on a rose diagram (Figure 4). The diagram indicates a preference (71%) for shelters with aspects ranging between southwest and east. The frequency for mine sites with openings facing west, northwest, north, and northeast is considerably less (29%). Knowledgeable saltpeter men such as Fowler, who had gained experience in operating productive sites,

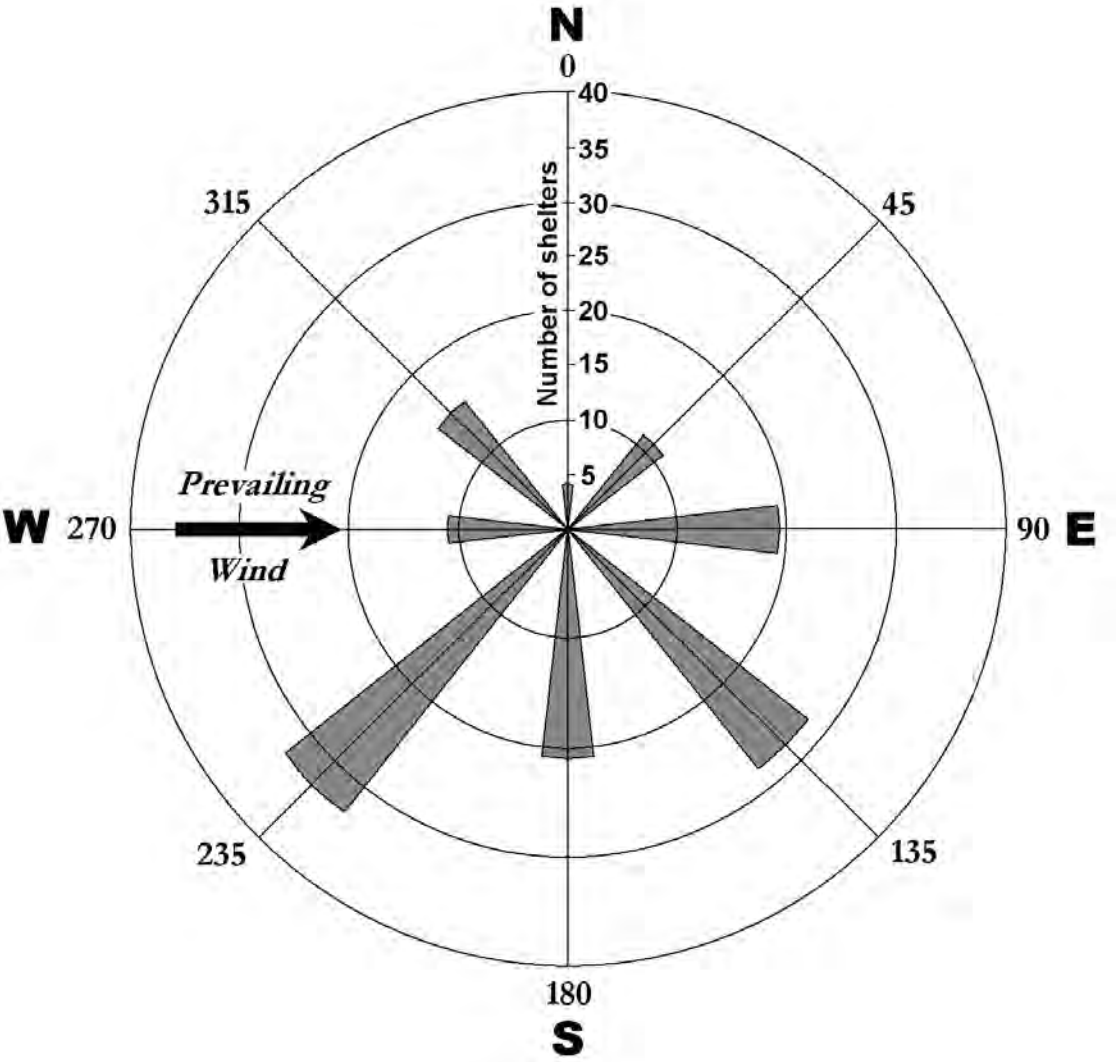

FIGURE 4. Rose diagram for rock-shelter entrance orientation. The pattern suggests that saltpeter miners tended to select shelters with some protection from precipitation, which would preserve the highly soluble nitrate minerals. (Diagram by authors, 2012.)

would tend to select shelters with more favorable aspects and thus greater potential.

The availability of a source of water for the leaching process was another important consideration. Most shelters are located some distance up steep slopes from the valley watercourse, and although workers may have been required in some cases to perform the arduous task of toting water uphill to the mine site, an onsite supply would be far more desirable. Describing the rock shelters he had observed, Samuel Brown noted (1809:241) that many of these shelters had runoff cascades from the top of the cliff during winter, or springs that discharged from the base of the shelter during the summer months. Brown's account is borne out by modern observations contained in USFS site reports of waterfalls and springs associated with shelters. Not all shelters possessed such conveniently located water sources, however, often requiring that one source provide water for several shelters, as in the case of 15Ja87. Because shelter clusters in a given valley are all located at about the same elevation, lateral transport of water was a much less demanding chore. There is no documentary or extant physical evidence to indicate that process water was conveyed through hollowed-out log pipes, as was the case at large-scale fixed-site operations, such as the saltpeter works at Mammoth and Great Saltpetre caves (George 2001, 2005), or salt-brine operations, such as Bullitt's Lick (McDowell 1956:257). The considerable effort required for construction of such water-supply systems would be precluded by the transitory and dispersed nature of these small, individual, shelter-mine clusters.

In the heady atmosphere of the saltpeter boom, niter miners operated with much the same disregard for resource conservation as their counterparts in the coal industry in these same mountain counties many years later, taking only what could be acquired easily and wastefully leaving what was difficult to extract. According to Brown, saltpeter miners, "being badly provided with tools and apparatus, desert a rock whenever its size or hardness renders it difficult for them to manage, and go in quest of a new establishment" (Brown 1809:243). Saltpeter-mine operators were well aware that the boom, stimulated by war and the desperate need for gunpowder, was likely to be of short duration, and they were determined to cash in on the bounty while it lasted. With obvious disapproval Brown noted, "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." Several of the niter-mine shelters described in USFS site reports (for example, 15Cy194 and 15Mf651) appear to have been worked only partially, perhaps as a test for saltpeter content or, as Brown observed, abandoned when the material proved too difficult to extract.

Site Diagnostics

The most distinctive and reliable diagnostics of niter mining, and those most likely to be preserved, are the presence of talus piles (Figure 5) and of rocks exhibiting broken edges, hammer marks, and drill holes (Figure 6). Shelters with these features are almost certainly former niter mines. Of the 165 sites in our inventory, 88% contain significant talus piles and 45% display visible drill holes on boulders or walls. The presence of leaching-vat remains is also a sure diagnostic, but these artifacts have been preserved in only a handful of sites. Certainly, abandoned leaching vats, more-or-less intact, must have persisted at many sites well into the mid-20th century, but the tremendous increase in dispersed public recreation in the DBNF (especially the Red River Gorge area) during the last quarter of the prior century resulted in the widespread destruction of *nearly all* wooden artifacts in all but the most remote shelters, burned in campfires by thoughtless shelter campers. Belated recognition of such destruction led the USFS to ban all camping and fire building in shelters in April 2000 (Ison et al. 2008:3–4).

The object of shelter miners was to break up the rock, from preexisting rockfalls and from the rear walls of these shelters, into fragments small enough to pile into the leaching vats. It was not necessary to reduce the sandstone to its granular components, since the rock was more or less permeable, and interstitial nitrates could be dissolved and removed in solution by water percolating through vats filled with rubble. In some sites, the sand rock was very friable and could be broken apart by hand. Maxson (1932:1858)

FIGURE 5. Seen here in 15PO53, substantial piles of talus, or rock fragments, are among the best diagnostic indicators of historical niter mining in rock shelters. (Photo by USDA Forest Service, ca. 1980.)

FIGURE 6. Drill holes and associated spalling along the rear wall of the JFB Niter Mine (15WO21) in Wolfe County. (Photo by Gary O'Dell, 2004.)

observed: "[T]he richest rocks were very hard, colored brown or yellow, and often times showing deposits of the oxides of manganese and iron." Shelters with honeycomb weathering and *liesegang* banding were favored localities. Rocks could be broken apart and maneuvered using an assortment of tools: pry bars, wedges, gluts, mauls, sledgehammers, and even old blunt axes used as hammers. Very few iron tools have ever been recovered from niter mines; these were too valuable to be left behind. Even broken tools could be repaired and made serviceable again by a blacksmith. Des Jean (1997a:234–235) recovered a number of metal tools from northeast Tennessee rock shelters.

Numerous shelters exhibit boulders with broken edges and hammer marks where the miners hacked off chunks of the relatively soft sandstone, and a lesser number display drill holes used to split the boulders into smaller chunks with explosives (Figure 6). These shot holes, generally 1½ in. (3.8 cm) in diameter, were laboriously drilled by hand using a star drill or chisel drill, implements that could be easily manufactured and resharpened by any competent blacksmith. The methods employed would later be referred to as single-jack, double-jack, or triple-jack drilling, a terminology derived from Cornish immigrants, known as "Cousin Jacks," who became famed throughout the American West for their skills as hard-rock miners (Payton 2005). The "jack" in the phrase referred to both the weight of the hammer and the number of persons directly engaged in drilling. Single-jack drilling was carried out with a 3–4 lb. (1.4–1.8 kg) hammer by a single person, who would rotate the drill with each blow of the hammer. Double-jack involved two persons, one to hold and rotate the drill, while the other wielded the 6–8 lb. (2.7–3.6 kg) hammer. Triple-jack drilling required careful synchronization, as two men with hammers alternated blows upon a drill held by another. Most of the holes produced were relatively shallow, usually not more than about 50 cm deep.

Once the hole was drilled, black powder was rolled in paper, forming a tube, and then the paper was twisted at one end. A simple fuse was inserted into the other end of the paper cartridge, and the charge inserted into the shot hole and sealed with mud, sand, or drill cuttings (Young 1976:10). Some years ago, USFS archaeologist Cecil Ison surveyed the shelter 15Mcy1306 in McCreary County, an obvious niter mine with extensive piles of talus covering the floor, and remnant boulders all exhibiting broken edges or drill holes. Lodged in a drill hole in a boulder near the rear wall, he discovered a fragment of cane with soil packed tightly around it to hold it in place, which he interpreted as a fuse leading to a powder charge in the drill hole. As wild cane was abundant throughout much of Kentucky during this time, such fuses were probably often used by niter miners, although this is the only preserved example known at present. More recently, Ison also expressed the opinion that some of the gourd fragments found in the shelters, always attributed to prehistoric occupation, may in some cases represent powder flasks used by the miners (Cecil Ison 2000, pers. comm., 2010, pers. comm.).

Not all of the drill holes bored into boulders were intended for explosive charges. White (2006:33) notes that in some shelters wooden pegs have been found driven tightly into holes. This was evidently an effort to split the rock by soaking a row of such pegged holes with water, in expectation that the pegs would then expand and shear off a section of rock.

Although rock-shelter soils also contained nitrates (Mather 1839:279–280), site reports by USFS investigators note only a few cases where the existing sandy soils of the shelters appeared to have been processed for their saltpeter content, for example, 15Mf65, 15Mf719, and 15Po435. Saltpeter miners apparently did not, as a general rule, attempt to extract niter from shelter soils because there was relatively little disturbance of the prehistoric cultural context resulting from their operations. Certainly, the miners would have been prone to pick up any obvious surface relics, such as arrow points, and may even have dug up some burial sites, but their activities have, in fact, often served to preserve prehistoric middens from later generations of looters and relic hunters. In many of the shelters substantial talus piles have protected the prehistoric cultural context that lay beneath them, since the largest piles of broken rock represent too much labor for even the most determined relic hunters to shift. As the visiting archaeologists noted in their site reports, this was apparently the case for several

shelters, including 15Cy190, 15Cy264, 15Le63, 15Mcy1115, and 15Mf90.

At 15Le63, for example, the initial archaeological assessment made in 1985 described the shelter as extensively vandalized, having suffered 95%–100% disturbance. On a later visit to the site in 1992, Ison and Faulkner (2000:3–5) reappraised the shelter as having been little disturbed, except for two pillaged prehistoric graves "with large talus piles covering or sealing over the prehistoric components of the site," concluding that the previous investigator had mistaken the talus piles for back dirt thrown up by looters. In 1995, a series of excavations and intensive study of the prehistoric components of the Mounded Talus Shelter led Ohio State University investigators Gremillion and Mickelson (1996:1,9) to conclude that "niter mining activity at Le77 was believed to have contributed toward the protection of the shelter from vandalism," specifically by "the presence of large amounts of rock and talus." This recognition served as partial motivation for new excavations at certain shelter sites (for example, 15Le6, a niter mine) reported by previous investigators as heavily disturbed (Gremillion et al. 2000).

Extant processing vats are all variants on the basic V-vat construction style, but are too few in number to draw any conclusions as to whether certain styles were associated with specific regions, shelter groupings, or time periods. Based on the examination of niter-mine shelters in the vicinity of the Red River Gorge, Fig and Knudsen (1984:69–71) identified three distinct types of V-shaped vat or hopper. The Type I vat consists of a framework of small poles supported by forked uprights, the sides made up of heavy bark slabs (usually hemlock) aligned vertically, with vertical slabs comprising the ends; the whole formed a rectangle tapering to the bottom (Figure 7). Type II vats exhibit greater craftsmanship, constructed of bored poles pegged together to support sloping sides of vertically oriented, hand-hewn planks (Figure 8). The third vat type was of simple construction, built using single, large, hand-hewn boards to form each slightly

FIGURE 7. Two Type I leaching vats in the Trinity Niter Mine (15WO206) in Wolfe County contained within a pole framework 3 m deep and 3.7 m wide. (Photo by Fred E. Coy, ca. 1982.)

FIGURE 8. Examples of Type II vats located within the Tar Ridge Niter Mine rock shelter (15MF227) in Menifee County. (Photo by Fred E. Coy, ca. 1982.)

sloped side wall, held in place by a removable locking brace. Smaller upright boards placed against the cross brace formed the ends (Figure 9). The investigators believed this latter vat style was intended to be portable, the design allowing the vat to be taken apart and reassembled at another shelter. Each of the vat types was constructed over a hollowed-out half log that collected the leachate seeping through the sandstone rubble, directing the liquid into a trough. Once nitrates had been leached from the rock, the fragments and sand were discarded to form talus piles. Many piles of mining talus exhibit central depressions, and some talus collections have been described as being "doughnut-shaped" (e.g., 15Cy1270, 15Mf424, and 15Ll204). These and similar depressions have been interpreted by investigators as representing the former locations of leaching vats, where discarded rock fragments accumulated around the vats after processing.

At the time of the initial USFS shelter surveys, wooden artifacts potentially identifiable as the remains of saltpeter leaching vats were present in 30 (18%) of the 165 niter-mine shelters in our inventory. Most of these remnants consist of scattered pieces, such as hand-hewn planks and pole supports, removed from their original context by campers and other shelter users since the mining era. At 10 of these sites, all that remains of the vats are sections of the basal collection trough, often embedded in the soil and thus more difficult for vandals to remove. Where shelters have not been disturbed by relic hunters or campers, the state of preservation of vat remains in the dry interiors is often remarkable. Seven shelters, all in the Red River Corridor, contain partially or nearly intact processing vats. Sections of vats that extend beyond the shelter drip line have generally decayed completely, but the protected sections often remain in nearly pristine condition, in some cases appearing as though the saltpeter miners just walked away yesterday. In an effort to protect these artifacts from vandalism, the USFS has, in recent years, erected chain-link fencing enclosing the top and sides of some of

FIGURE 9. An example of a Type III vat at the Laurel Branch Shelter (15WO35) in Wolfe County. (Photo by Fred E. Coy, 1977.)

the best preserved saltpeter vats.

Isolated remnants of hand-hewn boards in some shelters may suggest the former presence of leaching vats, but given the other historical uses made of shelters, these cannot be reliably attributed to vats unless the context suggests otherwise. The same situation exists for hand-hewn troughs made from logs. Troughs were a necessary accessory to leaching vats, used to collect the leachate, but troughs found in some shelters were apparently carved by more recent farmers to provide water for livestock penned in the shelter. Farm implements of this nature may have also been recycled from the saltpeter era. Dendrochronology would help resolve any ambiguity in establishing a time period of manufacture—see e.g., Blankenship et al. (2009). Less common artifacts that may be associated with niter mining are wooden mauls and pegs/wedges used to split boards or rocks, and pry poles used to move large rocks (Figures 10 and 11). Mauls in good condition have been found at 15Mf662 and 15Po160. At 15Ja96, a wooden wedge was found lodged within a crack in a boulder, evidently used in an effort to split the rock, and pegs or wedges have also been found at 15Mcy1261, 15Mf124, 15Po54, and 15Po160. Wooden artifacts interpreted as pry poles were found at a dozen of the shelters in our inventory.

In nine shelters, tables were constructed by leveling a large flat slab with smaller rocks; good examples can be observed at 15Wo205 and 15Wo206. As niter, unlike common salt (sodium chloride), is combustible in a dry state, such tables may have been used in the finishing process to dry damp niter that had been boiled just to the point of crystallization, although some rock tables may have been constructed for other purposes after the mining era. Such tables were probably not common features of mining operations, since any large, relatively flat rock surface would serve the purpose as well.

Nearly all shelters exhibit hearths of some sort, although most prehistoric hearths are not readily detectable without excavation. There can be considerable difficulty in determining

FIGURE 10. Small wooden wedge, tentatively identified as made from beech wood, collected from the niter mine known as Cookin Rock House Shelter (15MF328) in Menifee County (Ison et. al. 2008:802–803).

FIGURE 11. Wooden mallet recovered from a crack between large boulders at the Yellow Beech Niter Mine rock shelter (15MF662) in Menifee County (Ison et. al. 2008:803).

the historical period associated with construction of visible hearths, given the multiple uses of shelters since European American settlement of the region. A hearth was almost certainly built within or near every shelter mined for saltpeter, since it would have been quite difficult to convey the collected leachate any great distance from the vats. Most of these hearths have since been destroyed by relic hunters or disassembled by campers during the modern era; only 18 shelters in the inventory contain hearth structures today. A survey of the floor of shelter 15Le63, which contains abundant talus, drill holes, and possible vat remains, located a fragment of a cast-iron kettle, although no hearth structure was extant (Ison and Faulkner 2000:4). Similarly, a kettle fragment with an indented groove and small handle, interpreted by the investigators as being used in processing nitrates, was found at 15Le234, a shelter

with a large talus mound but no existing hearth (Gremillion et al. 2000:86). Kettle fragments have also been found in 15Mf65 and 15Po24.

Some of the existing hearths may have been built by moonshiners during the era of Prohibition, as several of the shelters containing hearths also show evidence of still construction and operation, but it is also quite likely that distillers may have adapted existing hearths dating from the mining era to their own purposes. Well-built and sturdy U-shaped hearths were probably associated with processing niter (Figure 12). In contrast, modern camper hearths are usually very crude in form, often no more than a fire ring of rocks.

Sequent Occupancy and Use of Rock Shelters

Woven throughout the text of this paper is the recognition that niter mining represents but an historical eyeblink in the long procession of uses and occupations of eastern Kentucky's rock shelters from prehistory to the present day. The groups utilizing these shelters have left representative artifacts and other traces of their occupation. Our current understanding of the lives of the region's prehistoric inhabitants is largely derived from cultural deposits in the shelters along the Cumberland Escarpment and elsewhere in the state. More than 10,000 years ago, the people of the late Paleoindian Period were the first to make use of Kentucky's rock shelters on a regular basis (Tankersley 1996:35). Through every successive period of prehistory, local populations continued to make use of shelters in a variety of ways: as campsites, habitats, workshops, and food repositories. These attractive natural resources provided living space protected from the worst weather effects, and cultural deposits provide evidence that shelters were preferred locations for substantial, long-term, and repeated occupation (Railey 1996:86;

FIGURE 12. A rectangular rock hearth seen in the Buzzards Wing Shelter (15PO211), constructed of rough sandstone blocks. (Photo by USDA Forest Service, ca. 1982.)

Tankersley 1996:45,65; Ison et al. 2008:17–27; Jeffries 2008:253–260,268–279,289). By the time of the European American settlement, however, rock shelters as abodes for Native Americans had largely been superseded by nucleated villages and served mainly as temporary camps (Sharp 1996:177–178; Ison et al. 2008:26–27)

During historical times, from ca. 1800 to 1820, niter miners utilized these sites. Survey reports indicate that some USFS archaeologists were under the mistaken impression that the niter-mining era persisted until at least the 1890s. This belief may have been derived from statements to this effect in Webb and Funkhouser (1936:143), pioneering research with which every Kentucky archaeologist is quite familiar. There is, however, no documentation or physical evidence to support this contention. After the War of 1812 period, some individuals may have mined small quantities of saltpeter to manufacture crude gunpowder as a local cottage industry or for personal use (O'Dell 1989:101; Duncan 1995:63), but commercial niter mining really died off long before the Civil War.

Contemporary with the niter miners, small-scale pine-tar manufacturers in eastern Kentucky occasionally used rock shelters as processing shops and living quarters, their limited production intended only for personal use. A number of shelters today exhibit petroglyphs, associated with tar production, etched onto bedrock or the surface of a large sandstone slab. The most common form is a shallow circular groove bisected by a linear drainage groove extending to the edge of the rock. An inverted iron kettle was placed over a small heap of slivered pitch-pine heartwood and pine knots, and a small fire built on and around the kettle. Pine resin was melted by the heat and flowed down the linear trench, and was collected in a container at the edge of the kiln (Hockensmith and Ison 1996:5–8). A circle-and-line petroglyph cut into a scorched sandstone slab is visible in the niter-mine shelter 15Mf590.

From the saltpeter-mining era to the present day, rural residents have used shelters as livestock stables and storage warehouses, leaving traces in the form of remnant wood fencing and watering troughs. Relic hunters have been persistently engaged in visiting and looting shelters since the early settlement period, so that scarcely a shelter today has not been disturbed, and many have been severely affected. Saltpeter merchants in pioneer Lexington, especially Charles Wilkins and John D. Clifford, collected Indian artifacts from shelters and caves, including rare prehistoric Indian "mummies" found in saltpeter caves by niter miners (George 1994). During the 20th century, primarily during Prohibition (1920–1933), numerous illicit whiskey distillers, or "moonshiners," made frequent use of rock shelters in remote valleys to conceal their activities. Beginning mainly in the late 1970s, with a great increase in dispersed recreational activities in the DBNF, rock shelters became popular attractions for hikers, campers, and rock climbers.

Although these various groups are separated in time, activities of successive shelter users were often influenced by previous occupations. Relic hunters are the obvious example here, but the other groups also responded to the prehistoric presence, if in no other way than, when not otherwise occupied, spending their idle time looking for arrow points. Niter miners do not appear to have made any determined effort to unearth prehistoric materials; such damage as occurred was a byproduct of the mining operation, which was focused on the shelter's bedrock walls and the boulders contained within, and the talus piles produced during reduction of the rock matter in many cases has served to protect the prehistoric layers from later disturbance. The hearths built by the niter miners were often used, many years later, by operators of moonshine stills and, still later, by modern hikers and campers.

Both prehistoric and historical users selected shelters for use based on certain common characteristics. Primary among these attributes were accessibility, sufficient room, dry working or occupation space, and a convenient water supply. Prehistoric people could, however, occupy shelters that were too low to be easily mined, and moonshiners could use shelters that were too wet for other groups. Niter miners were able to exploit shelters in which the floor was almost completely covered by boulders and rock slabs, allowing little space for prehistoric habitatation, but providing plenty of rock to be broken up and processed. Many of the shelters mined for niter had water present onsite, in the form of seeps and springs within the shelter, or water falling over the upper edge of the shelter,

but in many cases the nearest water supply was several hundred meters away.

Rock shelters served the various groups as both habitats and activity areas. For prehistoric cultures, archaeological evidence indicates that shelters could serve as sites for long-term and intensive habitation, as seasonal camps, as one-time camps for small groups or individuals, or as workshops. Shelters were also short-term habitats for some of the historical groups. At least one of the niter-mining sites (15Mf250) contains remains of a domestic bed made from logs covered with woven bark, apparently used during the mining era. Site evidence also indicates that in another rock shelter (not a niter-mine site), a moonshine distiller used an adjacent dry shelter as sleeping quarters, because the shelter housing the still apparatus was too damp. One would expect that in many, perhaps most cases, the niter miners (and moonshiners) resided onsite during the period they were engaged in working the shelter, simply because travel through the rugged terrain was too difficult to simply pack up and come back the next day. Modern-day campers and hikers, of course, use the shelters on a very temporary basis, but for the same reason as prehistoric peoples: the shelters provide protection from the weather.

USFS site survey reports and the observations of Fred Coy (2009, pers. comm.) indicate that some niter-mine shelters in eastern Kentucky contain small built structures, or rooms, constructed of dry-laid stacked rocks, unroofed and usually located next to a wall. For example, a Wolf County shelter, 15Wo35, has a small room of this type measuring 2 × 4 m. A rock wall enclosure measuring 2 × 2.5 m is in a Menifee shelter (15Mf719), and most such structures have similar dimensions, although a few are larger. A Powell County structure in 15Po403 measures 2 × 6.4 m with a rock wall divider in the middle. Although such rooms are large enough to provide sleeping quarters for three or four individuals, there is no conclusive evidence to determine whether these were intended as habitats or were used for some other purpose. If used for occupation, the rock walls would act as a windbreak and thus provide an additional level of protection from the elements. Such rooms may also have been used to store processed saltpeter, or were possibly built during a later period to serve as animal pens. Most of the structures have walls that are less than 1 m in height. This does not preclude their use as habitats, since this would be sufficient to provide protected sleeping space within the shelter, but does appear to make it more likely that these were storage areas for saltpeter or livestock pens, conclusions shared by several of the reporting archaeologists. Several shelters in the inventory also contain natural cave-like tunnels extending farther into the bedrock, some of which (e.g., 15Ja235) have low walls erected across the opening and may have served similar functions.

Conclusion

For all its brevity, saltpeter mining and processing was one of the most important components of the Kentucky economy during the period leading up to the War of 1812 and during the conflict, generating both a valuable export commodity and a stimulus to development of regional gunpowder manufacture. The industry provided employment for hundreds, possibly thousands, of workers during this time, and, by securing an essential war material, helped to assure the continued independence of the American nation.

Most of the previous research and literature on the subject has focused upon mining operations conducted in caves, particularly large, factory-style sites, such as Mammoth Cave and Great Saltpetre Cave. A very limited quantity of primary documents, particularly Samuel Brown's 1809 monograph on the subject of niter mining, indicates that nitrates were also obtained from sandstone rock shelters in the region. Commencing in the mid-1970s, the United States Forest Service began a survey of archaeological resources located within Kentucky's Daniel Boone National Forest that continues today, accumulating thousands of site reports in its files. A large proportion of these reports concerned rock shelters, since these were favored sites for use and habitation by prehistoric peoples of the region. Archaeological assessments were focused on prehistoric resources, so that even though some of these shelters contained immediately recognizable niter-mining artifacts, primarily in the form of remnant leaching vats, it was not until the 1980s that USFS archaeologists came to recognize more subtle diagnostics, such as talus piles, as representing

widespread utilization of rock shelters as niter mines during the early 19th century. Although individual investigators subsequently included evaluation of historical niter mining in regard to specific shelter sites, no systematic analysis of the industry was conducted for the region until this present effort; indeed, the actual number of recorded mine sites in the DBNF files was unknown and could only be estimated as numbering in the hundreds.

The authors' examination of DBNF surveys and investigator reports revealed that there are, at present, 165 rock-shelter sites in eastern Kentucky known to be associated with historical niter mining, twice the number of known cave niter mines. Since our inventory is based primarily upon limited surveys undertaken exclusively for property owned by the DBNF, and the national forest lands are fragmentary rather than continuous through the region, the actual number of potential, unrecorded mine sites on private land is likely to be far greater than the number of presently known sites on federal land. The distribution of reported shelter mines is related to several physical and cultural factors. Foremost among these is regional geologic structure and lithology, which accounts for the abundance of these cliff-line concavities along the western edge of the Appalachian Plateaus, and their less frequent occurrence eastward into the mountains. Those shelters most likely to have been developed as mine sites appear to be those in relatively close proximity to navigable streams and wagon roads of the era. The distribution pattern displays eight mining clusters or corridors, each bisected by a central transportation route or navigable stream.

As the most easily accessible nitrate deposits in shelters could be quickly extracted, mining operations were quite transitory, as miners moved rapidly from one shelter to the next. This situation discouraged the development of large, fixed-site processing centers, such as existed for common saltworks in Bullitt and Clay counties, and favored the employment of numerous small mining teams, either as independent groups or working many shelters simultaneously under the coordination of a labor contractor. Such teams generally consisted of a handful of workers, three men appearing to be typical, rather than the much larger labor force required for even relatively small cave-mining operations. Field evidence indicates that the mined ore was processed onsite at each individual shelter, and available documents suggest that the refined product was transported first to local market towns and then onward to Lexington, the regional market center. As the saltpeter boom developed, the mining region was invaded by brokers and speculators who sought to purchase nitrates directly from producers and thus minimize competition.

Relatively little disturbance of the prehistoric cultural context can be attributed to the niter miners, whose activities, in fact, often preserved underlying strata beneath massive accumulations of talus; far more damaging has been the relentless plundering of shelters by relic hunters and looters, and the thoughtless vandalism of campers and hikers in recent years. The relic hunters have targeted the prehistoric components, and few shelters have been undisturbed, but the traces of historical activities, such as niter mining, are subject to the depredations of modern recreational users. During the last few decades, most of the wooden artifacts, which otherwise are remarkably preserved in the dry environments within shelters, have been consumed as firewood by shelter campers unaware or unconcerned as to their historical significance. Efforts by the DBNF to preserve such remnants, ranging from protective enclosures to hidden cameras, although well intended, fall far short of real deterrence because of limited budget and personnel; even shelters containing significant remains may not be visited for months or even years, let alone monitored on a regular basis. In truth, recent reassessments of several sites suggests that many site reports made by DBNF archaeologists several decades ago are very likely records of prehistoric and historical resources that no longer exist. A significant historical legacy is fast disappearing.

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