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THE DENDROARCHAEOLOGY OF CAGLE SALTPETRE CAVE: A 19TH CENTURY SALTPETER MINING SITE IN VAN BUREN COUNTY, TENNESSEE, U.S.A.

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ABSTRACT

During the historic mining episodes at Cagle Saltpetre Cave, wooden leaching vats needed for the lixiviation of calcium nitrate from mined sediments (from which saltpeter was then produced) were constructed and used in the cave. When mining operations ceased, these features were abandoned and preserved *in situ*, some remaining virtually intact. Their remarkable preservation enabled tree-ring dating of timbers associated with these vats to be accomplished. Tree rings from oak planks used in the construction of the leaching vats were measured to 0.001 mm precision on a Velmex measuring system. Using COFECHA software, we crossdated the measurement series to both the Norris Dam State Park and Piney Creek Pocket Wilderness white oak reference chronologies, spanning the years from 1633 to 1982, obtained from the International Tree-Ring Data Bank. Graphical comparisons via scatter plots were inspected to ensure correct temporal placements. The final chronology developed from 39 dated series correlated very highly with the Norris Dam State Park reference chronology ($r = 0.49$, $n = 170$ yrs, $t = 7.29$, $p < 0.0001$) and verified that our site chronology extends from 1692 to 1861 The results of our analyses indicate that saltpeter was mined and processed at the site during separate episodes throughout the 19th Century. Additionally, saltpeter-processing technology changed throughout the course of the mining operations.

Keywords: Tree rings, dendrochronology, dendroarchaeology, archaeology, saltpeter mining, southeastern U.S.

INTRODUCTION

Tree-ring analyses make possible the assignment of precise calendar years to wood specimens from a variety of contexts; thus the application of dendrochronological techniques to archaeology has allowed unparalleled accuracy in establishing specific ranges of dates for archaeological structures (*e.g.* Douglass 1921, 1935; Stallings 1939; Smiley 1951; Schulman 1952; Bannister 1965, 1969; Nash 1996). In the southeastern U.S., dendrochronology has been used only sparingly in archaeological research on prehistoric sites (Hawley 1938; Bell 1952) and historic structures (Stahle 1979; Stahle and Wolfman 1985; Langley 2000; Bortolot *et al.* 2001; Mann 2002; Wight and Grissino-Mayer 2004; Grissino-Mayer and van de Gevel 2007). Contributing to this paucity of studies is a long history of regional timber exploitation and deforestation in the southeastern U.S. that has removed many of the older tree specimens required for developing the reference chronologies needed to date archaeological samples. Additionally, the warm, humid environment of the Southeast is not conducive to the preservation of wood, as it generally promotes more rapid fungal decay (Wight and Grissino-Mayer 2004).

Dry caves, common in the karst plateaus of the southeastern U.S., provide an environment in which conditions are often favorable for the

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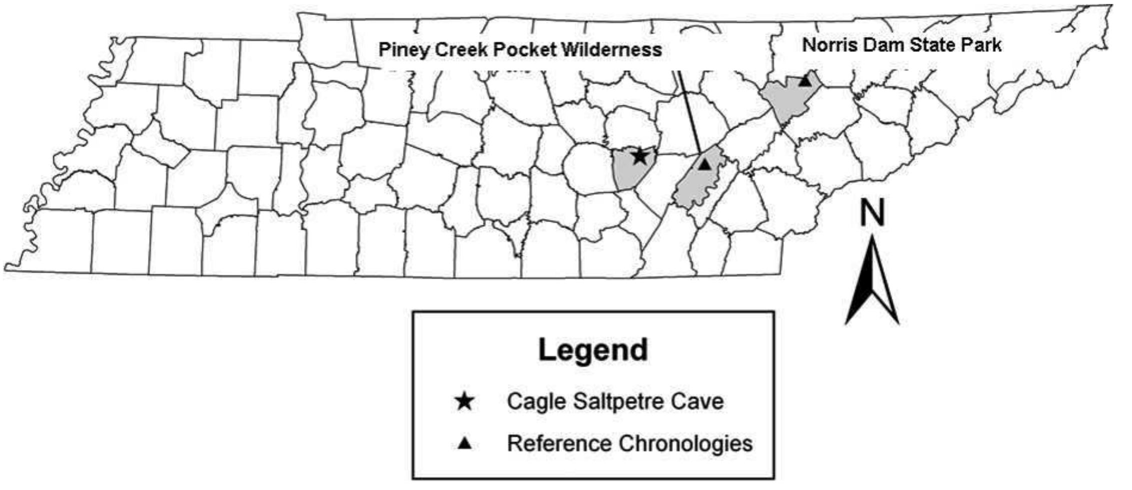

Figure 1. Locations of Cagle Saltpetre Cave (Van Buren County, TN), the Piney Creek Pocket Wilderness reference chronology (Rhea County, TN), and the Norris Dam State Park reference chronology (Anderson County, TN).

preservation of wood and other organic materials. Throughout the Southeast in areas dominated by limestone geological substrate, numerous limestone caves dot the landscape, a number of them containing well-preserved organic, lithic, and metallic materials resulting from both historic (Faust 1964, 1967; DePaepe 1985; Douglas 1993; Duncan 1997; Douglas 2001; George 2005) and prehistoric use (Watson 1969, 1974; Faulkner 1986; Crothers 1987; Munson *et al.* 1989; Simek *et al.* 1997; Faulkner and Simek 2001).

The exceptional preservation of extant wooden artifacts at one such site, Cagle Saltpetre Cave in Van Buren County, Tennessee (Figures 1 and 2), provided a unique opportunity to use tree-ring analyses to better understand the historic mining operations that occurred at the site. During the 19th Century, this cave was one of hundreds in the Cumberland Plateau region mined for saltpeter, a principle ingredient of gunpowder (DePaepe and Hill 1981; Hill *et al.* 1981; Fig and Knudson 1984; Douglas 1993; Plemons 1993; Des Jean 1997; Douglas 2001). True saltpeter, or potassium nitrate, is a naturally occurring mineral in certain soils, although few deposits on the Earth's surface contain the quantities needed for large-scale gunpowder manufacture. In the eastern United States, nitrates present in the sediment of many dry caves and rockshelters became important sources for the mineral. Although saltpeter mining was one of the earliest and most important extractive industries in the southeastern U.S., little is known about the mining operations that occurred at these sites. Most accounts of saltpeter mining pertain to the few large-scale operations, such as Great Saltpetre Cave (George 1998, 2001) and Mammoth Cave (Faust 1967; DePaepe 1985; George 2001, 2005) in Kentucky. Because the majority of the operations were small, documentation of mining activities is often non-existent. Furthermore, very little archaeological research has been undertaken at specific saltpeter mining sites (but see, Duncan 1993, 1995, 1997; Blankenship 2007, 2008).

Although no records exist as to whether Cagle Saltpetre Cave was ever commercially mined, extensive modifications to the cave environment, such as the enormity of excavated sediment and ceiling breakdown moved during the course of mining, suggest that it was larger than a cottage-industry operation. Furthermore, throughout the mined passages, rows of scratches, or "tally marks," are present on the walls and ceiling of the cave. Generally interpreted as a counting system for miners (Matthews 1971; DePaepe 1981), their association with mining areas implies an incentive for recording the amount of sediment removed and collected at a given time and may signify an economic aspect to the mining operations (Blankenship 2007, 2008).

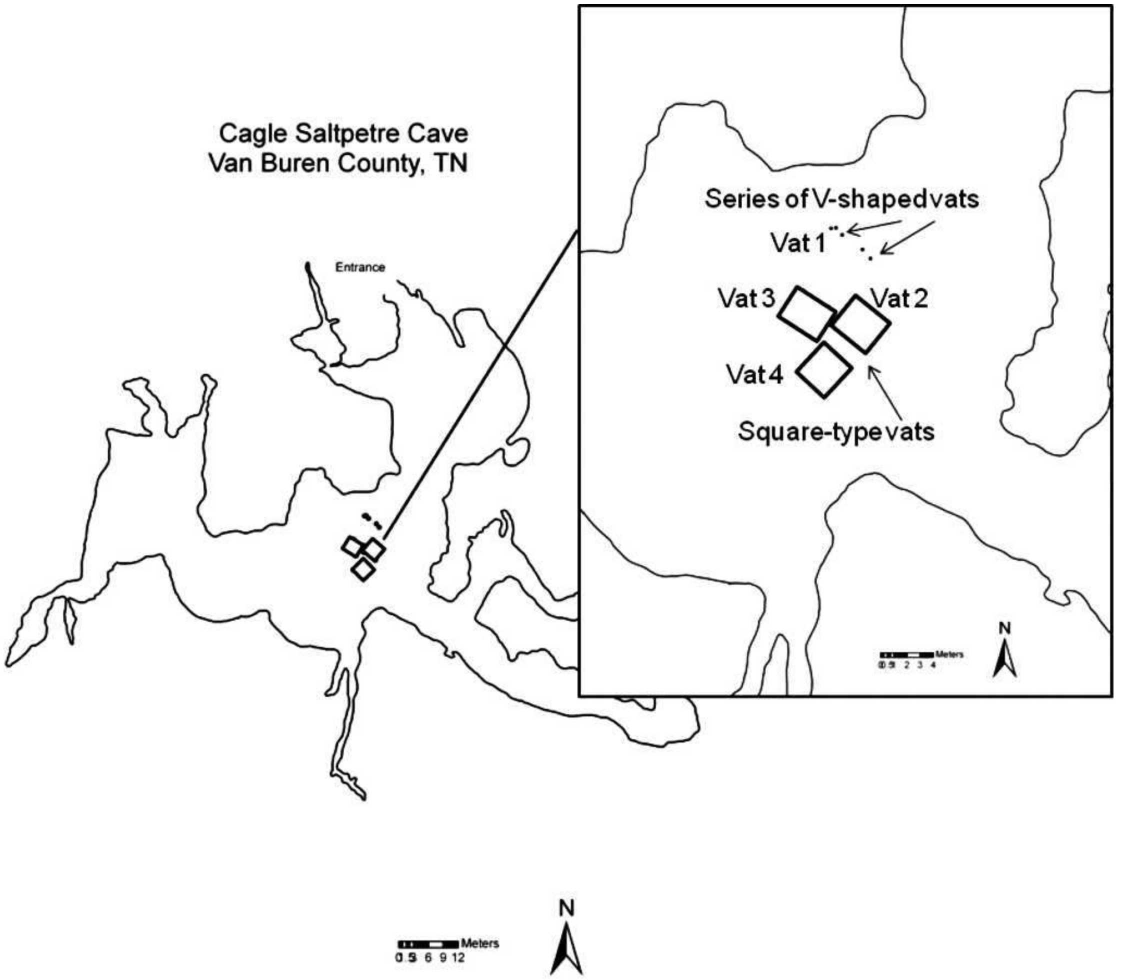

Figure 2. Plan view map of Cagle Saltpetre Cave, showing the locations of preserved V-shaped vats and square-type vats.

SITE DESCRIPTION

During the historic mining at the site, wooden leaching vats needed for the lixiviation of saltpeter from mined sediment were constructed and used in the cave (Figures 2 and 3). After being filled with several tons of mined sediment, water was poured on top of the vats until they were completely saturated. The result was a thick mud that was allowed to stand for one or two days to thoroughly dissolve the calcium nitrate crystals in the sediment. The resulting solution was then collected and combined with potash, which chemically converted it to potassium nitrate, or gunpowder niter. It was later boiled, refined, and converted to crystals (for a more in-depth discussion of saltpeter processing techniques see: LeConte 1862; Rains 1862; Faust 1964; DePaepe 1981; Duncan 1995).

When mining operations ceased, these vats were abandoned and preserved *in situ*. Later vandalism damaged the upper-level production area, but in the lower level of the cave, three large, square-type vats remain virtually intact (two of which are shown in Figure 3). The vats are roughly square in shape and of a somewhat standardized size, approximately 3.05 m × 3.05 m wide and 1.22 m in height. Each consists of a log frame secured by peg-and-hole construction, hewn by hand at the end of each log. Split timbers, or planks, were placed vertically inside the structure to form the vat walls. Buried beneath

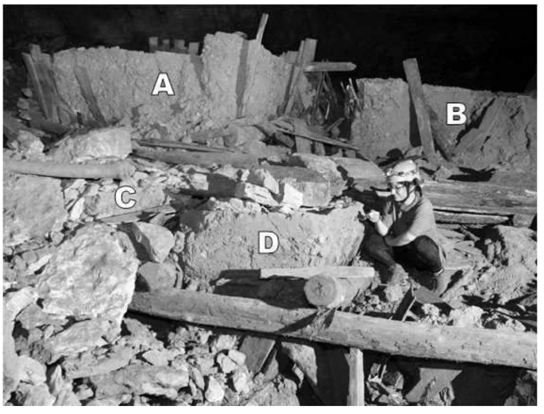

Figure 3. Vats with square-type construction (A and B) overlying V-shaped vats (C and D) at Cagle Saltpetre Cave (photograph by Alan Cressler).

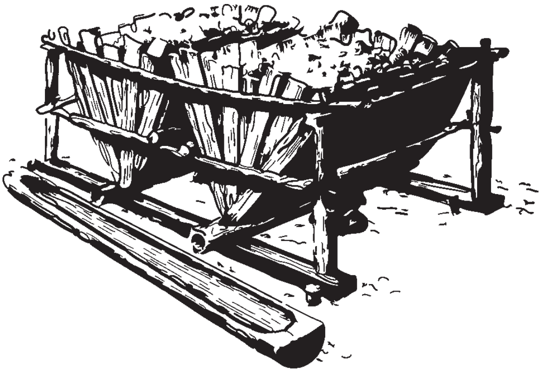

Figure 4. Artist's rendering of V-shaped vats built using a single log frame (drawing by Matthew Stewart, adapted from Faust 1967:47).

the square-type vats are a series of smaller, V-shaped leaching vats (approximately 1 m × 1 m wide and 0.9 m in height), which are of a different construction (Figures 3 and 4). This form was built using a single log frame, in which two or more vats were secured. Wooden planks were placed with their lower ends resting in the groove of a hollowed log, their upper ends resting against the outside frame, thus a "V" shape to the vat was formed.

The remarkable preservation of these structures enabled tree-ring dating of timbers associated with these vats. Our study had two primary objectives: (1) to establish specific ranges of dates, such as when mining activities took place; and (2) to understand changes in mining technology. This study represents the first, successful dendrochronological dating of a saltpeter mining site in the United States, and the data should aid subsequent studies of similar sites throughout the region.

METHODS

In the summer of 2005, 93 sections of wood from white oak (*Quercus alba* L.) planks used in the construction of the leaching vats at Cagle Saltpetre Cave were removed for tree-ring analysis. Samples were taken from each of the three square-type vats (designated Vats 2, 3 and 4) and the exposed V-shaped vat (designated Vat 1). To maintain provenience, each sample was mapped using a Trimble® total station prior to removal and labeled accordingly. Because the majority of the vats are buried, only one exposed V-shaped vat could be dated by tree-ring analyses; therefore the total number of V-shaped vats used in the cave cannot be known. However, the V-shaped vat analyzed is directly associated with at least one other, as they were built within a single log frame (Figures 3 and 4). Before we began the dating process, the samples were qualitatively examined to assess their crossdating potential. We chose for analysis samples that were both well preserved and exhibited 50 or more annual rings with variable widths. The variation in ring width from year to year is particularly important, as it is the recognizable sequence of wide and narrow rings that makes crossdating possible.

In the laboratory, each sample was sectioned by band saw and surfaced using progressively finer sandpaper, beginning with ANSI 100-grit (123–149 μm) and ending with ANSI 320-grit (32.5–36.0 μm) (Orvis and Grissino-Mayer 2002). We began the dating process by assigning relative dates to 62 undated series. The innermost ring on each sample was set to the relative year "0" and every subsequent tenth ring was marked by mechanical pencil.

We measured all tree-ring widths to the nearest 0.001 mm using a Velmex measuring system interfaced with Measure J2X measuring software. The measurement series from the 62 undated samples were next statistically crossdated to regional chronologies (International Tree-Ring Data Bank [ITRDB] 2008) using COFECHA, testing 40-yr segments (with a 20-yr overlap) of each undated segment series with the respective segment contained within the reference chronology (Holmes 1983; Grissino-Mayer 2001). The Piney Creek Pocket Wilderness (Duvick 1983) and Norris Dam State Park (Duvick 1981) (in the neighboring Valley and Ridge physiographic region) white oak reference chronologies were selected to represent similar elevation sites in the Cumberland Plateau physiographic province, where Cagle Saltpetre Cave is located (Figure 1). When a series was shown to be significantly correlated (usually $p < 0.001$) with other series within a regional reference chronology, we checked the temporal placement suggested by COFECHA graphically using scatter plots to ensure that the match was convincing both statistically and graphically. We also carefully noted specific marker rings that would help to ensure crossdating (*i.e.* the list method; Yamaguchi 1991). If a series could not be confidently crossdated, it was excluded from further analyses.

We next used the EDRM (Edit Ring Measurement) program (Holmes 1992a; Wight and Grissino-Mayer 2004) to assign absolute dates to each of our samples. Those series that were confidently crossdated to a regional reference chronology were then compiled to build an intrasite chronology. Again using COFECHA, the intrasite chronology was used to statistically crossdate the remaining undated series. The CRONOL program (Cook 1985; Holmes 1992b) was used to create a final chronology from all dated series.

Finally, we examined the outermost dated ring on each plank at high magnification and then assigned a standardized symbol to determine the likely period of cutting (Bannister 1962; Nash 1999):

B: bark is present, indicating the outer ring is fully intact (certainly a cutting date);
r: outermost ring is continuous and intact around a smooth surface, but no bark is present (considered a cutting date);
v: the date is within a few years of the cutting date, based on presence of sapwood;
vv: impossible to determine how far the outer ring is from the true outer surface (no sapwood present and rings in the heartwood are likely missing).

RESULTS

Of our 62 measured series, 23 could not be confidently crossdated. The lack of confident dating for these samples likely occured because (1) preservation of these samples was inferior, which would lessen the accuracy of annual ring measurements, or (2) their ring segments were complacent, thus precluding definitive crossdating by statistical and graphical techniques. The latter explanation is most likely, as the average mean sensitivity of our crossdated series (0.18) is lower than the average mean sensitivity (0.22) for other white oak data from the eastern U.S. (ITRDB 2008) (Table 1).

When we compared the first few undated series with each individual regional chronology, only one match was found that was statistically and graphically convincing. Eight of our undated series showed significant correlations ($p < 0.0001$) with the Norris Dam State Park white oak chronology from Anderson County, Tennessee, which spans the period 1633 to 1980 (Duvick 1981). We also observed many significant ($p < 0.0001$) inter-series correlations among the remaining series and the intrasite reference chronology (Table 1). The average inter-series correlation coefficient (which indicates the quality of crossdating among all series with the master chronology) for our 39 samples was 0.59, a very high value by southeastern dendrochronological standards (Table 1). COFECHA flagged only seven 40-yr segments for possible errors out of the 161 segments tested (4.3%). Closer inspection of these seven segments indicated significant correlations at the current dated position, whereas the alternative placements suggested by COFECHA were unrealistic. Such unrealistic alternative placements can be identified when the segments on either side of the segment being tested are not flagged, *i.e.* are correctly placed in time (Grissino-Mayer 2001).

The final chronology developed from the 39 dated series correlated very highly with the Norris Dam State Park reference chronology ($r = 0.49$, $n = 170$ yrs, $t = 7.29$, $p < 0.0001$) and verified that

Table 1. Descriptive statistics and results from the segment testing conducted by COFECHA for the 39 measured series.

Series	Inner Date	Outer Date	Outer Date Type *	Length	No. Segments Tested	No. Flagged Segments	Correlation With Master	Prob <	Mean Sensitivity
Vat 1:									
CAGV1003	1749	1807	vv	59	3	2	0.32	0.0067	0.15
CAGV1005	1751	1811	r	61	2	1	0.31	0.0075	0.16
CAGV1006	1752	1811	r	60	2	0	0.38	0.0014	0.17
CAGV1007	1756	1811	r	56	2	0	0.43	0.0005	0.14
CAGV1008	1747	1811	r	65	3	0	0.49	0.0001	0.19
Vat 2:									
CAG0V2001	1746	1861	r	116	5	2	0.41	0.0001	0.15
CAGV2003	1760	1861	r	102	4	0	0.51	0.0001	0.22
CAGV2005	1779	1858	v	80	3	0	0.67	0.0001	0.18
CAGV2006	1774	1861	r	88	4	0	0.66	0.0001	0.16
CAGV2008	1774	1861	r	88	4	0	0.59	0.0001	0.18
CAGV2009	1776	1861	r	86	3	0	0.54	0.0001	0.15
CAGV2013	1763	1861	B	99	4	0	0.61	0.0001	0.15
CAGV2015	1786	1855	vv	70	3	0	0.51	0.0001	0.19
CAGV2016	1784	1861	r	78	3	0	0.70	0.0001	0.13
CAGV2017	1750	1861	r	112	3	1	0.32	0.0003	0.20
CAGV2018	1769	1861	B	93	4	0	0.73	0.0001	0.14
CAGV219B	1791	1861	B	71	3	0	0.64	0.0001	0.13
Vat 3:									
CAGV3001	1724	1854	B	131	6	0	0.62	0.0001	0.22
CAGV3006	1697	1853	v	157	7	0	0.68	0.0001	0.18
CAGV3009	1705	1854	r	150	6	0	0.59	0.0001	0.23
CAGV3013	1705	1854	B	150	6	0	0.62	0.0001	0.22
CAGV3017	1733	1854	r	122	5	1	0.52	0.0001	0.18
CAGV3019	1752	1854	r	103	4	0	0.60	0.0001	0.19
CAGV3021	1692	1854	B	163	7	0	0.56	0.0001	0.19
CAGV3023	1753	1859	vv	107	4	0	0.63	0.0001	0.20
CAGV3031	1701	1854	B	154	6	0	0.68	0.0001	0.19
Vat 4:									
CAGV4001	1743	1860	v	118	5	0	0.48	0.0001	0.19
CAGV4002	1781	1860	B	80	3	0	0.57	0.0001	0.16
CAGV4003	1743	1859	v	117	5	0	0.60	0.0001	0.17
CAGV4004	1705	1854	vv	150	6	0	0.72	0.0001	0.21
CAGV4006	1771	1860	B	90	4	0	0.65	0.0001	0.17
CAGV4008	1765	1860	B	96	4	0	0.61	0.0001	0.15
CAGV4009	1765	1860	r	96	4	0	0.62	0.0001	0.15
CAGV4010	1748	1860	B	113	5	0	0.61	0.0001	0.15
CAGV4011	1702	1859	v	158	6	0	0.64	0.0001	0.16
CAGV4012	1795	1860	R	66	3	0	0.70	0.0001	0.16
CAGV4014	1772	1860	r	89	4	0	0.64	0.0001	0.14
CAGV4015	1751	1859	B	109	4	0	0.67	0.0001	0.15
CAGV4016	1772	1860	r	89	4	0	0.59	0.0001	0.13
Total or Mean:	[1692–1861]			102	164	7	0.59		0.18

* vv = cutting date can not be determined; v = outer date within a few years of cutting date; r = outer ring appears continuous = cutting date; B = bark present = cutting date. See text for additional details.

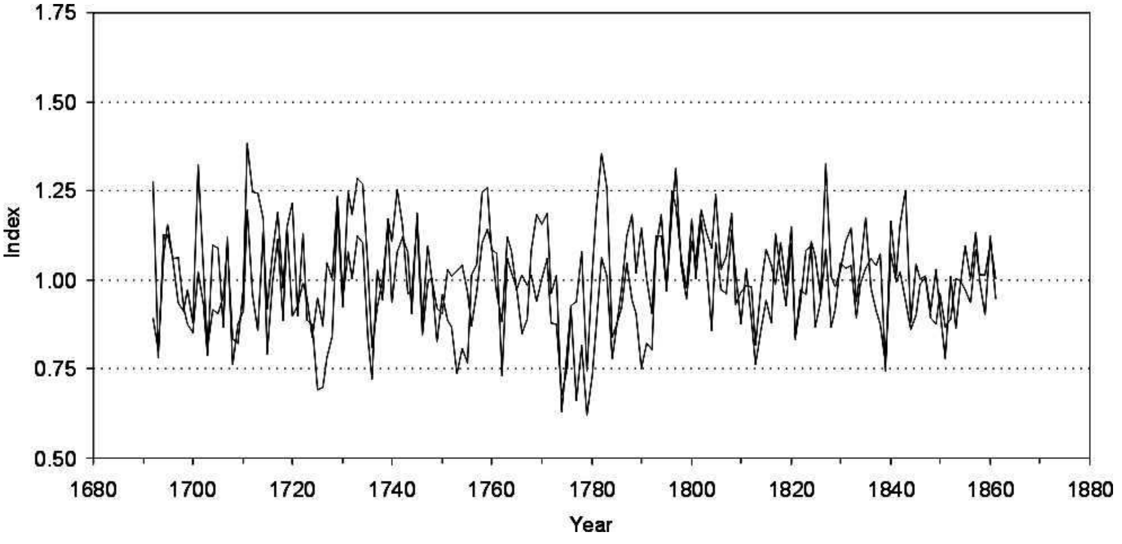

Figure 5. Comparison of the Norris Dam State Park reference chronology (gray line) and the Cagle Saltpetre Cave white oak chronology developed in this study (darker line) ($r = 0.49$, $n = 170$ yrs, $t = 7.29$, $p < 0.0001$).

our site chronology extends from 1692 to 1861 (Figure 5).

Cutting Dates

Because the bark or outermost rings are still present, we were able to determine the exact year in which the trees were harvested for 30 of our 39 crossdated samples. Establishing a range of dates for an archaeological site based on tree-ring dates, however, can be difficult, as timbers can be stored, reused, and replaced throughout the occupational history of a site (Dean 1996, 1997; Grissino-Mayer and van de Gevel 2007). To minimize possible errors when interpreting crossdated cutting dates, observations are based on the degree of temporal clustering associated with these dates (Ahlstrom 1985; Stahle 1979; Grissino-Mayer and van de Gevel 2007). The cutting dates of our samples do provide initial construction dates of the leaching vats at Cagle Saltpetre Cave.

The cutting dates for four of the five dated samples associated with Vat 1, the V-shaped vat, cluster in 1811. The outer ring on the remaining sample is an 1807 non-cutting date because the bark and outermost rings had been removed, possibly when the timbers were scored and hewn. Samples from the three, overlying square-type vats yielded later dates. Seven of the crossdated series from Vat 3 had cutting dates of 1854. The outermost ring on one sample is 1853, which was a non-cutting date as the bark and outer rings were no longer present. The outermost ring of the remaining sample from Vat 3 is 1859, a later date than all other crossdated series associated with this vat. This sample could indicate later repair and reuse of Vat 3, or may simply be an issue of provenance. In comparison to the other square-type vats, Vat 3 is in a more advanced state of disrepair. Given their close proximity, it is possible that this sample may have been associated with Vat 2 or Vat 4. Cutting dates for Vat 4 cluster in the year 1860. Four timbers have outer dates in the 1850s, all non-cutting dates. Ten of the 12 dated planks associated with Vat 2 cluster in 1861, with the remaining planks having dates in the mid- to late 1850s, all being non-cutting dates.

INTERPRETATIONS AND DISCUSSION

When considering the political and economic conditions in the United States during the early 19^{th} Century, an 1811 construction date for the underlying V-shaped vat is certainly plausible. Prior to this time, the United States and earlier American colonies had not developed an extensive saltpeter industry and relied heavily on imported gunpowder and refined saltpeter from England (George 1988; Smith 1990; O'Dell 1995). In regions of British India, high concentrations of potassium nitrate were found in certain surface deposits, which gave England control over one of the world's most extensive and easily obtainable supplies of saltpeter. Imported English saltpeter was of such high quality and low cost, U.S. domestic sources were often not worth mining. The period 1807 to 1815, however, was characterized by disrupted shipping in the Atlantic, as France and Britain, engaged in war since 1803, both restricted trade in any ports controlled by their adversaries. The American responses to these blockades, the 1807 Embargo Act, the 1809 Non-Intercourse Act, the 1810 Macon's Bill Number Two, and finally the American war with the United Kingdom (declared in June of 1812), further hindered U.S. trade with Europe (George 1988; Hickey 1989; Smith 1990; O'Dell 1995).

As a result, the demand and price for saltpeter increased as the U.S. became reliant on domestic sources. This is illustrated in an 1829 correspondence from E.I. du Pont, then proprietor of America's largest gunpowder manufacturer, the du Pont Powder Works, to Lieutenant-Colonel George Bomford, of the U.S. Ordance Department (quoted in George 1988: 19):

> "The high prices of Saltpetre and brimstone from 1804 to 1807 were due in part to the general war in Europe and more to the circumstance that at that time the greatest proportion of Gunpowder used in the country being imported and but a few powder mills being in operation, no regular supply of materials had yet been established… It is to be observed that during the Six years of restrictions on commerce and war, the whole supply of saltpetre was furnished from the caves of Kentucky, Virginia and Tennessee; that although the great encrease of capital and industry which had been directed to the extraction of Saltpetre from the natural caves contributed until 1814 to prevint an extraordinary rise in the value of the article, a much greater change would have taken place if the war had continued a year longer."

The value of the saltpeter caves in the Mid-South states is evident in the 1810 Arts & Manufactures Census (Coxe 1814), in which Kentucky, Tennessee, and Virginia are listed as supplying the bulk of the country's domestic saltpeter. In addition, White County, Tennessee, which at the time would have encompassed Cagle Saltpetre Cave, and adjacent Warren County, is listed as producing close to 130,000 pounds of saltpeter in 1810, more than three-quarters the total amount produced in western (now middle) Tennessee. The majority of saltpeter produced in White County likely came from Big Bone Cave (Maddox 1813, 1821; Bayless 1982; Smith 1985), a large 19th Century saltpeter-mining site located in present-day Van Buren County, Tennessee.

A substantial commercial enterprise was in place in western Tennessee during this time, as 22 caves are listed as being mined for saltpeter in 1810, 19 of which were in White County; this number, however, is likely understated (Joseph Douglas, personal communication, 11 April 2007). Twenty-one gunpowder mills were also in operation, and three in White County produced the majority of gunpowder in the western district (Coxe 1814; see pages 42, 138–139 and 142–143). Although caves were commercially mined prior to the early 19th Century, a large number of smaller caves throughout the Southeast, such as Cagle Saltpetre Cave, may have been mined during the 1807 to early 1815 period as a result of the embargoes and the War of 1812 with Great Britain.

A possible construction date of 1854 for Vat 3 could again reflect disrupted shipping of refined British saltpeter. The United Kingdom and France entered into the Crimean War with Imperial Russia in 1854, which may have necessitated stricter British control over the export of saltpeter (Anderson 1967). In the mid-1850s, there is other evidence of a renewed interest in saltpeter mining in Tennessee (Smith 1990: 7–8), specifically at Big Bone Cave:

> "By a deed dated December 3, 1855, David Williams granted Thomas B. Eastland and Montgomery C. Dibrell use of water and timber adjoining Big Bone Cave for saltpetre manufacturing. In February, 1856, Eastland and Dibrell were incorporated by the legislature, with the name "White County Mining and Saltpetre Mining and Manufacturing Company"… Also in the late 1850's, additional Van Buren County deeds show that Charles, Charles C., and George Henshaw of Boston Massachusetts, and William Campbell and M.D.W. Loomis of Cincinnati, Ohio, each briefly held shares in the mining of Bone Cave" [quoted in Smith 1985: 1].

In addition, the mining of Cagle Saltpetre Cave and other caves throughout the Cumberland Plateau during the first half of the 19th Century was certainly caused in part by the inaccessibility of the region. At the time, poor roads and the absence of railroads undoubtedly made travel through the Cumberland Mountains and to and from middle Tennessee difficult. Thus, Tennessee was incompletely integrated into the greater saltpeter market. Gunpowder was needed for both hunting and protection, and therefore local production was essential (Des Jean 1997).

Later construction dates of 1854, 1860, and 1861 for the square-type vats denote changes in saltpeter-processing technology during the course of mining at Cagle Saltpetre Cave. Documentation of the mining operations at the site has not been found, and therefore we cannot say for certain why the square-type vat was used during the later mining episodes. One apparent advantage of this particular type of construction was its ability to hold several hundred cubic feet of cave sediment. During the leaching process, this would have provided a greater yield of leachate compared to the smaller, V-shaped vats. Changes in the processing technology may therefore be indicative of a more intensified and perhaps, larger-scale operation, as it would have taken several men to mine and process the cave sediment.

Even before Tennessee withdrew from the Union in June 1861, Tennesseans took quick action to ensure that the state would be prepared for war. Among their chief concerns was securing an adequate supply of gunpowder, of which saltpeter was the critical component. Prior to secession, the Tennessee legislature established a three-member Military and Financial Board to encourage the production or purchase of gunpowder and saltpeter (Horn 1965; Smith 1990, 1997). "To acquire saltpeter, contracts were made with individuals or companies, and up to $2,000 per contractor was advanced to help start an operation" (Smith 1990: 8). In July of 1861, board member James E. Bailey gave the following instructions to Edwin Glascock, one of the Board's employed saltpeter agents (quoted in Smith 1997: 102):

> "We wish you to visit salpetre caves near Chattanooga; viz Nicajack, Lookout, & Sauta Caves (the latter in Jackson cty Ala) the Big bone caves in Van Buren Cty worked by Mr Randal & other caves in that & adjoining counties, & the caves being worked through the mountains…We wish you…to get parties to work all the Caves where sal-petre can be made. To this end we authorize you to make contracts for all the salpetre that can be made in eight & Ten months for 25 cents per pound delivered on the railroads."

Although no written records exist that indicate Cagle Saltpetre Cave was commercially mined during this time, the Military Board records do suggest that, in addition to Big Bone Cave, a number of other caves in Van Buren County may have supplied the Confederate war efforts.

CONCLUSIONS

We used tree-ring analyses to establish a significant level of chronometric control to determine when mining activities occurred at Cagle Saltpetre Cave, Tennessee. Cutting dates established for the preserved leaching vats clustered on four discrete dates: Vat 1 (V-shaped type) dates to 1811; Vat 3 (square-type) dates to 1854; Vat 4 (square-type) dates to 1860; and Vat 2 (square-type) dates to 1861. Cagle Saltpetre Cave was likely mined during these times in reaction to both local and global politico-economic pressures. The earlier mining episodes at Cagle Saltpetre Cave and furthermore, the intensification of the saltpeter industry as a whole during the early 19th Century, reflect domestic responses to fluctuations in the global saltpeter market during the years 1807–1811 and 1854. During the Civil War, Union blockades of southern ports caused the Confederate States to place heavy priority on the production of saltpeter. Consequently, a number of caves in the region, including Cagle Saltpetre Cave, were mined during the initial years of the Civil War (1860–1861). The results of our analyses also demonstrate that throughout the 19th Century, saltpeter processing technology used at the site changed during the course of mining, *i.e.* processing technology shifted from the use of V-shaped vats during the War of 1812-era mining episodes to the use of the square-type vats during the mid-19th Century. This study represents the first, successful dendrochronological dating of a saltpeter-mining site. We also developed the first tree-ring chronology from saltpeter mining features preserved in a cave context in the United States. Furthermore, it may now be possible to obtain dendrochronological dates for other saltpeter mining sites from the region by using this new reference chronology.

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