River of Gray Gold: Cultural and Material Changes in the Land of Ores, Country of Minerals, 1719 – 1839

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Abstract of the Dissertation

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In this dissertation I uncover a narrative about Indians, Europeans, and Americans who created a mining amalgam. What I have learned is that long before the technological exchange that extended across the Atlantic to the United States, Native American and European miners engaged in complicated interactions regarding their environmental knowledge and their respective prospecting, extracting, and smelting methods. In effect, between 1719 and 1839 miners interacted to create a cross-cultural dialogue that involved a hybrid of mining techniques that shaped their attitudes about each other during multiple encounters on the mining frontier. This study also shows that Native Americans, despite the limitations of their technologies, engaged in yet another form of environmental manipulation as opposed to positing a pre-colonial past of ecological harmony.

What we will gain by examining the convergence of Indian and European mining practices is to highlight Native American knowledge and technological experiences that are most

often ignored. Without Native American influence European style mining development would have unrolled far more slowly. Scholars have written important tribal histories, as well as essays about western Native Americans. However, most authors of the frontier have failed to integrate Native American, European, and Euro-American mining practices' into early American history. Currently, for the most part, Indian history remains a preliminary chapter or introductory lecture, which is followed by the invasion of European cultural practices and ideas that significantly contributed to changes to Indian people's lifestyle and to the physical environment.

By the early nineteenth-century, guided by technological advancement, travelers, geologists, and miners had made their way west to survey the Missouri lead mines, and to promote the region's resource potential. Acting like American boosters and improvers they believed the mining frontier-borderland to be incomplete and only expected it to become complete by introducing more advanced mechanical interventions. Assumptions about material advantage in modernization caused Euro-Americans and Europeans' to question the knowledge and expertise of Native Americans and French settlers whose practices enabled them to ensue America's "civilizing" project. American miners viewed technology as a means to replace the "primitive" methods with European practices, thereby embarking on a program to civilize the mining frontier and ultimately erase any remnant of Indian traditions.

To Mom and Dad

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Acknowledgments

Almost thirteen years ago I started work on this project as an undergraduate. After learning that I required an additional history course to complete my application to a master's program in education, I enrolled in a course about colonial Ste. Genevieve taught by Dr. Carl Ekberg. Over the course of the semester Dr. Ekberg continually made reference to the need for more scholarly attention to colonial lead mining. Since that course, and subsequent papers written in my first environmental history course, this project has grown, with many changes, into this dissertation.

As a flight service manager might be grateful for the long domestic or international layover where he hoped to be regenerated for the return trip back home, I am very grateful for all the institutions and people who have made this a most valuable and worthwhile journey. I owe more debts than I can count to the many friends, co-workers, generous family members, and scholars who made this dissertation possible. What follows is only an unfinished list. Those whom I could not include here know my appreciation.

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Introduction

He searches the sources of the rivers and brings hidden things to light.

Job 28:11

Sometime between the sixth and fourth centuries, before the Common Era, Job opens his twenty-eighth chapter with a mining expedition. He carefully explains the procedures ancient miners used to extract silver, gold, and precious gems from the depths of the earth. He provides particulars of how miners cut shafts, dangled, and assaulted the flinty rock while enduring the arduous struggle to reach the darkest places in the earth. He then traces miners' steps as they moved through their shafts following secreted paths and digging great tunnels. Finally, Job notes, how the successful miner would then behold all the treasures of the earth and "bring hidden things to light."[1] We do not know exactly why Job decided to begin this chapter by outlining the difficulty miners faced as they tried to recover the minerals of the earth. In fact, often the name Job brings to mind suffering or loss of family, wealth, and one's livelihood. Or we bear in mind the wisdom he acquired following these tumultuous events. What we may not be accustomed to hearing about are his references to age-old mining practices. The opening verses of this particular chapter of Job offer intriguing insight into ancient mining techniques, but also serve as an allegory for what this dissertation seeks to do: to recover hidden cultural aspects of one early North American mining frontier.

Just as many readers of Job have hardly noticed his references to ancient mining techniques, American historians too have somehow passed over eighteenth and early nineteenth century descriptions of longstanding Native American mining practices. These remain deeply buried in the travel narratives of little discussed European explorers.

[1] *New International Version,* (Nashville: Holman Bible Publishers, 1986), Job 28:1-11.

For example, during the summer of 1723, several Kaskaskia Indians guided Mr. Renaudiere, a French miner, along the St. Francis River to the lead mines called Mine La Motte. Along the way, Renaudiere composed copious notes that gave a clear picture of the mining country more than two hundred and eighty years ago. The Native Americans pointed out to Renaudiere their trails to what would become known as some of the richest lead mines in the United States. Renaudiere explained the method by which the Kaskaskia "procured much lead from these trenches." He wrote "If a settlement could be formed [workers] could be placed under the management of capable persons, and a good living could easily be made" by extracting, smelting, and refining "millions of pounds of lead per year."[2] Similar to Job's opening description of ancient mining practices, Renaudiere's of Kaskaskia Indians' mining offers an original opportunity to track early North American mining customs, just as they were on the cusp of change. Renaudiere was one of the first French miners, but not the only one, to record the knowledge and practices Native American miners used to prospect, extract, and smelt lead ore in the area that became the state of Missouri as it emerged from its frontier origins.

Unlike the miners in Job's story, the Kaskaskia Indians did not attempt to dangle in shafts. Instead they applied their strength by digging shallow trenches to locate galena. It was not an accident that Renaudiere documented how the Kaskaskia procured their lead from openings that were like trenches. It was also not an accident that he wrote "when they go to make lead, they carry with them only their weapons and ammunition,"

[2] On August 23, 1723, the French engineer documented his experiences at the lead mines and titled it, "Memoirs of the Mines of M. De la Motte" or "Account of the Mines of M. de la Motte". Hereafter noted as "Account of the Mines of M. de la Motte." The original French document was translated by Msgr. F.G. Holweck. The French copy was deposited in the Archives of the Missouri Historical Society. The translated copy was published in, John E. Rothensteiner, "Earliest History of Mine La Motte," *Missouri Historical Review*, 20 no. 2, (Jan 1926): 199-213.

a clear acknowledgement of indigenous smelting ability.[3] Witnesses to Native Americans extracting and smelting lead ore clearly show that the mining frontier began earlier than otherwise understood, and was influenced first by Native American, second by French, and third by Euro-American experiences.[4]

From prehistoric times, Native American societies mined and exchanged crushed and melted galena throughout North America. Correspondence from early French mining engineers highlight Indian miners who acted as not only guides to their mining sites, but also as skilled miners who possessed their own techniques to prospect, extract, and melt lead ore in this early North American mining frontier. Because early settlers lacked the tools and capital to dig deep shafts or lacked the bricks to construct furnaces, they adopted the Kaskaskia Indians practice of trench mining and using log furnaces to extract and melt lead ore. The cultural practices highlighted in this dissertation will show how the Kaskaskia and French created new alliances to produce and trade lead ore.

So too, this study reveals how Americans fervently imported European technologies to the mining frontier borderland, which began to influence the way that mining would be conducted in the years after 1800. In 1803, the Louisiana Purchase gave the United States control over both banks of the Mississippi River including the Missouri lead mines. Beginning with the mining reports of Moses Austin, engineers' and geologists' from the late eighteenth century, Americans started to describe the Native American and French amalgam as useless and inefficient because, in their eyes, miners

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[3] "Account of the Mines of M. de la Motte."
[4] Jack D. Forbes, "Frontiers in American History and the Role of the Frontier Historian," *Ethnohistory* 15, 2 (Spring 1968): 203-235; Also see, William Cronon, George Miles, and Jay Gitlin, eds., "Becoming West: Toward a New Meaning for Western History," *Under an Open Sky: Rethinking America's Western Past* (New York: W.W. Norton, 1992), 3-27.

were "unacquainted with the utility of machinery."[5] At the same time, American natural philosophers attempted to explain the need for miners to employ European mining practices, which they deemed to be more sophisticated. Subsequently, the victory of the new mining methods over the old mining practices confirmed Euro-Americans' indifference to the Native American and French hybrid that had persisted following contact. American miners viewed their technology as a means to replace the amalgamated methods with European practices, to civilize the Mississippi Valley, and to remove any remnant of Indian traditions.

One example of the erasure of the Native American mining technology occurred in the nineteenth-century with Garland C. Broadhead's rewriting of America's early lead mining history. Broadhead's *Report of the Geological Survey of the State of Missouri* is one example of such early geological histories that documented the exercise in forgetting the contributions of Native Americans to this industry. At the time of Broadhead's publication hardly sixty years had passed since Native Americans and settlers worked these mines using the well-established Native American and French hybrid. Failing to locate any evidence of Native American mining and smelting skills, Broadhead concluded that if Native Americans mined or smelted lead it would be "found in the mounds of the aboriginal inhabitants" located along the Mississippi River.[6] Broadhead was not alone in his view. The archaeologist Hubert Howe Bancroft also believed that

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[5] Moses Austin, *A Summary Description of the Lead Mines in Upper Louisiana. Also, An Estimated of their Produce for Three Years Past* (City of Washington: A. and G. Way Printers, 1804), 8.

[6] Garland C. Broadhead, et.al., *Report of the Geological survey of the State of Missouri, Including Field Work of 1873-1874, Missouri Geological Survey* (Jefferson City: Regan & Carter, State Printers and Binders, 1874), 632.

"the mound builders were ignorant of the arts of smelting and casting" ores.[7] However, two other archaeologists Ephriam G. Squier and Edwin G. Davis stated, "From the presence of galena in the mounds it seems almost impossible that the builders could have been ignorant of the manufacture of lead."[8] Because most nineteenth-century archaeologists were unable to locate evidence in the form of melted lead, they had come to believe that Native Americans did not begin to melt or smelt lead until contact with Europeans.

Working less than a century later in the same region and in a different medium, the St. Joseph Lead Company continued to reshape the image of the early Missouri mining district. In their 1950 documentary *Lead to Metal*, the St. Joseph Lead Company proposed that the history of lead mining began with the arrival of Europeans in 1720.[9] In the film, the company reenacts how the French transferred their mining knowledge and skills to Missouri, and how they began to extract, to smelt and to refine lead ore without mentioning a Native America presence. The film confirms that Indian mining skills are not so much silent as silenced.

I now realize that the late nineteenth century rewriting of history not only has implications for the way we remember history, but also has material implications. Approximately ten years ago while contemplating my study I decided to travel to the Missouri lead mines. At the time, I knew that Native Americans and French explorers traveled to Mine La Motte together; however, I did not understand the significance of

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[7] Hubert Howe Bancroft, *The Native Races of the Pacific States Vol. IV* (New York: A.L. Bancroft & Co., 1875), 775.

[8] Ephriam G Squier and Edwin G. Davis, *Ancient Monuments of the Mississippi Valley* (Washington: Smithsonian Institution, 1848), 906.

[9] Phone interview with State Historical Society Research Center, Rolla by Mark M. Chambers (17 January, 2007).

their mining amalgam. Today visitors to the Missouri mining district can stand in the presence of a 19,000 square–foot powerhouse, built in 1907, which holds artifacts that symbolize the development of Missouri mining and view remnants of mineral resources from the late-nineteenth century.

During a recent phone conversation with the museum supervisor, I asked about Native American contributions. The supervisor continued to silence Native American influences that began over one hundred and twenty years ago.[10] Following our conversation, I was reminded that in addition to seeing mining equipment, I also came in close contact with giant chat piles near homes and businesses that inhabit much of the surrounding area of the mines. Mining companies had dumped thousands of tons of "chat," a coarse sand-colored residue of milled rock. Over the years tons of this material had been used in road construction or as land fill. However, in 2003, two of the largest piles of mining waste still remained as among the most visible symbols of any mining that began long before the arrival of Americans. Today I am not only reminded how in the early nineteenth-century, doctors' medical observations and a miners' health report recorded the high incidence of unhealthy settlements associated with new mining methods, but also of the longer term environmental consequences associated with those who were impressed with new technological systems to extract, smelt, and refine lead.

My study opens a window into how historians might bridge both cultural and material environmental history to reveal what impact intellectual change had on the mining environment through the lens of technology. Recently J.R. McNeill summoned historians to search out new paths to connect the cultural and material wings in

[10] Phone interview with Missouri Mines State Historic Site of the Missouri Department of Natural Resources, by Mark M. Chambers (12 September, 2011).

environmental history. He suggested that we do history from the bottom up—beginning "with the soil and its history."[11] My study reveals the importance of fully being alive to not only how the fur trade or maple sugar production helped Indian, European, and American forge alliances that contributed to significant environmental transformations, but also how we need to search for similar exchanges between indigenous and settler behaviors during contact.

Endeavoring to uncover a narrative where Indians, Europeans, and Americans were not continually opposing each other, my study recovers another set of alliances. What I have learned is that long before the technological exchange that extended across the Atlantic to the United States, Native American and European miners engaged in lengthy and complicated interactions regarding their environmental knowledge and their respective mineral extractive methods. Europeans learned to mine and smelt lead ore according to Native American techniques, and in turn Indians adopted European tools to extract and refine lead ore. Successively, French miners and Americans also adopted the Indian French amalgam. In effect, for over one hundred years miners interacted to create a cross-cultural dialogue that involved a hybrid of mining practices that shaped their attitudes about each other during multiple encounters on the mining frontier. This study also shows that Native Americans, despite the limitations of their tools, engaged in yet another form of environmental manipulation as opposed to positing a pre-colonial past of ecological harmony.

In this respect, I have reexamined explorers' ethnographic descriptions to better understand Indian contributions to newcomers' extractive efforts. Although Native

[11] J.R. McNeill, "The Nature of Environmental History: Observations on the Nature and Culture of Environmental History," *History and Theory, Theme Issue* 42 (2003), 5-43.

American histories are fragmentary at best, my reading about Native American mining practices guided me on a journey to archaeological sites and reports, which all combined have uncovered the since forgotten longstanding Native American mining methods. Carefully interpreting the accounts of European and American mining specialists has aided in the recovery of what impact Native American prospecting, extracting, and smelting skills had on settlers from 1719 to 1839. Moving beyond relaying narratives about Indian warrior activity, agriculture, and fur trading skills will mean that most modern Americans will be made aware of other forms of Native American skills such as, mining and metallurgy that occurred in this region. Instead what we have come to remember is that the mining was of a very primitive character until new European technologies invaded the region.

A number of years ago Michael Adas examined the influences of scientific and technological development on the ways in which Europeans viewed non-Western peoples mining cultures in frontiers, borderlands, and bordered spaces. He insightfully notes how European perceptions of indigenous practices affected European polices toward mainly African and Asian societies and landscapes they came to dominate during the industrial era.[12] I agree with Adas that historians also need to study how Europeans and Americans gauged their technological superiority against Native Americans following contact. However, such an approach leads to a sort of mining corollary to manifest destiny. Additionally, another shortcoming is the tendency to view the nineteenth century mining industry as evolving its own ideology of conquest over nature and native peoples and their practices. The significance of my study is an attempt to understand both people's

[12] Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca and London: Cornell University Press, 1989).

mining knowledge and mining techniques during contact. Such an approach highlights how Indians were secure, well adjusted, and self-reliant peoples.

Though many scholars have written about the American mining frontier and miners' methods, I began this dissertation with the realization that we have not fully understood how Native Americans effected North American mining, even though they appeared in such early travel narratives.[13] And we have missed the occasion to investigate how local miners adjusted to American miners who introduced their mining practices and technologies to miners in the middle Mississippi Valley, a place where, like other American frontiers, multiple exchanges occurred. Skimming over descriptions of Native American and French mining expeditions, historians have also missed the opportunity to fully appreciate what role technology played in accommodations between the Kaskaskia Indians and French miners.

To the Kaskaskia, accommodation had meant many different things: trade goods, intermarriage, negotiation, and frequent exchanges with other tribes. They also learned to cultivate relationships with different groups of outsiders, associations that varied by ethnicity and time period and that influenced many Indian activities. Within these interactions they also assisted French settlers by leading them to their lead mines, and revealing their prospecting, extracting, and smelting methods along the way. To

[13] The following reference early lead mining in Missouri; however, the role of Native American mining and smelting methods is absent. For example, see A. Winslow, "Lead and Zinc Deposits," *Missouri Geological Survey,* 5, (1894); Ruby Swartzlow, "The Early History of Lead Mining in Missouri," *Missouri Historical Review*, 28 Part 1 (April, 1934): 184-194; Part 2 (July, 1934): 287-295; Part 3 (October, 1934): 27-34; *Missouri Historical Review*, 29 Part 4 (January, 1935): 109-114; Part 5 (April, 1935): 195-205; Carl Ekberg, *Colonial Ste. Genevieve: An Adventure on the Mississippi Frontier* (Tucson: Patrice Press, 1985); *French Roots in the Illinois Country: The Mississippi Frontier in Colonial Times* (Illinois: University of Illinois Press, 2000), 99, 171; Hugh Davidson, "The George Cresswell Lead Plantation," in *Material Culture,* 23, no. 2 (1991): 1-23; Carl J. Ekberg, *Francois Valle and His World: Upper Louisiana Before Lewis and Clark* (Columbia: University of Missouri, 2002), 22-41; Walter A. Schroeder, *Opening the Ozarks: A Historical Geography of Missouri's Ste. Genevieve District 1760-1830* (Columbia: University of Missouri Press, 2002), 284-339.

Renaudiere, and other newcomers, accommodation also had meant many different things: trading goods, appropriating and exploiting the natural resources of the land. Within these relations Renaudiere, and other French and American miners also desired to establish settlements near the mines, and transfer new practices to extract lead ore from deep shafts and to smelt lead ore in brick furnaces. To accomplish these tasks, miners planned to import skilled European miners and produce 10,000 pounds of lead ore each month.

The meeting between the Kaskaskia and French miners in the middle Mississippi Valley fits, in some sense, with American mining long before the western gold rushes. Faced with increasing numbers of French settlers searching for gold and silver during initial contact, the Kaskaskia Indians set about to accommodate French miners by sharing when and where they mined lead, and how they extracted and smelted lead ores. In exchange, French miners mutually agreed to share their tools, and together they created a new alliance centered on mining lead ore. I suggest that their partnership represents an alternative middle ground, akin to but also distinct from that described by Richard White in connection with the fur trade.[14] Along this mining frontier, the Kaskaskia and French miners deployed a variety of customs to forge longstanding cross-cultural mining practices.

Examining the material and cultural changes at the lead mines in the present state of Missouri from 1719 to 1839 requires applying a framework from the perspective of

[14] For discussion on Native American and European contact, accommodation, and exchange as it existed during the early fur trade see Richard White, *The Middle Ground: Indians, Empires and Republics in the Great Lakes Region, 1650-1815* (New York: Cambridge University Press, 1991); Daniel H. Usner Jr., *Indians, Settlers, & Slaves In A Frontier Exchange Economy: The Lower Mississippi Valley Before 1783* (North Carolina: University of North Carolina Press, 1992).

frontier—borderland—border histories.[15] During recent decades, historians have reconsidered when and how a specific place became a frontier, a borderland, and eventually a bordered community. First, if the mining frontier is a gathering place where people—Native Americans, Europeans, and Americans—found themselves in a multi-cultural crossroads, then the frontier was a place where no firm cultural or technological boundary existed.

Like other frontiers, the landscape near the lead mines became a zone of intercultural penetration. In this particular mining frontier, I stress the persistence of miners, Native American and French, willingness to adapt their environmental knowledge to create syncretic practices to mine, smelt, and refine galena. As the Kaskaskia and the French continued to appreciate and blend their environmental knowledge and technological skills, there appears to be little evidence of competition between both groups. However, and secondly, after seventy years of amalgamation on the mining frontier, by the late 1790s a mining frontier-borderland began to develop. To understand how the Native American and French mining methods and American and European practices cohabitated, I show local miners using the Native American and French amalgam even as new settlers from the United States and Great Britain employed their practices along the perimeter of Mine La Motte, separating their respective technologies from the hybrid residuals of earlier encounters.

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[15] David J. Weber, "Turner, the Boltonians, and the Borderlands," *AHR* 91(February 1986): 66-81. In response to Weber and other students of the frontier, Jeremy Adelman and Stephen Aron injected three terms to provide, what they believed to be, a fuller understanding of the frontier in North American history. I use the terms to show how technology was also a contributing factor to the development of the frontier. See "From Borderlands to Border: Empires, Nation-States, and the Peoples in Between in North American History" *The American Historical Review*, 104, no. 3 (Jun 1999): 814-841. For a recent updated discussion regarding these terms, see Stephen Aron, *American Confluence: The Missouri Frontier from Borderland to Border States* (Bloomington and Indianapolis: Indiana University Press, 2006), xvi.

In like fashion to Howard Lamar and Leonard Thompson, I view the frontier as opening when the first representatives of an invasive society settled, and proceeded to maintain continuous contact with indigenes; finally, I suggest that the mining frontier-borderland began to close after a singular hegemonic technology emerged in the contact zone.[16] In particular, the arrival of American miners applying their new practices represented a type of technological hegemony, which they used to exert control over the early practices miners had been accustomed to utilizing. What surfaced was a bordered mining district where Euro-American technologies dominated at both Mine a Breton and Mine La Motte, and eventually erased any trace as well as memory of the earlier amalgam. The significance of the frontier's opening and closing in relation to the study of American expansion has long been associated with narratives about American triumph, but today, the frontier is better understood as a place of intercultural penetration. I apply this more recent understanding to explore how the progression of the mining frontier to a bordered mining district can be pushed back more than 150 years prior to the California Gold rush.[17]

Historians have paid particular attention to minerals and metals sold by the ton or by the ounce; and they have paid less notice to metals, like lead, sold by the pound. Historians' have also gravitated towards the precious metals—gold and silver. Tracking the human pursuit of gold and silver has proved an alluring task, as witnessed by the forty-niners and other nineteenth-century prospectors who went in search of these metals. However, lead, which still remains an important metal today, was extracted and used

[16] Howard Lamar and Leonard Thompson, "Comparative Frontier History," in Limerick, Milner, and Rankin, eds., *The Frontier in History: North America and Southern Africa Compared* (New Haven: Yale University Press, 1981), 7-8.

[17] Andrew C. Isenberg, *Mining California: An Ecological History* (New York: Hill and Wang, 2005).

from the very inception of metallurgy, and indeed may have been the first metal to be smelted.[18] Lead also has an important story because Native Americans had mined and melted it before the arrival of Europeans by applying their own systems. For example, Mississippians and later Native Americans exchanged galena in the form of crystals and nodules. These shiny lead cubes were used as ornaments in rituals and were buried with the dead. Native Americans produced a metallic blue-gray pigment by crushing galena and grinding it into powder with a hand-held stone. They also combined crushed galena with plants, like beeweed or tansy mustard, and with hematite and manganese to make glaze paints.[19]

Scholars writing histories of early settlements and environments in North America's middle Mississippi Valley have had much to say about the fur trade, farming, and cultural exchange, but little about mining.[20] As noted above, the history of mineral extraction usually begins much later, and is located in the far west. Treating mining as a later stage of frontier development suggests that it is inherently a more modern and post-agricultural industry. Such histories also tend to erase cross-cultural relations that

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[18] For a very early discussion regarding lead ore's significance to society, see Robert H. Lamborn, *A Rudimentary Treatise on the Metallurgy of Silver and Lead* (New York: J. Weale, 1861), 132.

[19] For the types of ores and minerals Native Americans mined and what they made see, Frederick W. Hodge, ed., *Handbook of American Indians North of Mexico, Vol. 2* (New York: Pageant Books, 1960); For recent archeological research regarding early Native American galena workings, see Richard A. Bice, Phyllis S. Davis and William M. Sundt, *Indian Mining of Lead for Use in Rio Grande Glaze Paint: Report of the AS-5 Bethsheba Project Near Cerrillos, New Mexico* (Albuquerque: Archaeological Society, 2003); For a historical study on the importance of lead ore to early Native Americans, see Lucy Eldersveld Murphy, *A Gathering of Rivers: Indians, Métis, and Mining in the Western Great Lakes, 1737–1832* (Lincoln: University of Nebraska Press, 2000), 77-100.

[20] For early fur trade and farming practices, see James Axtell, *The Invasion Within: the Contest of Cultures in Colonial North America* (New York: Oxford University Press, 1985), 23-127; Helen Hornbeck Tanner, ed., *Atlas of Great Lakes Indian History* (Norman: University of Oklahoma Press, 1987); Thomas E. Emerson and R. Barry Lewis, eds., *Cahokia and the Hinterlands: Middle Mississippian Cultures of the Midwest* (Urbana: University of Illinois Press, 1991); James B. Stoltman, ed., *New Perspectives on Cahokia: Views from the Periphery* (Madison: University of Wisconsin, 1991); Daniel H. Usner, Jr., "An American Indian Gateway: Some Thoughts on the Migration and Settlement of Eastern Indians Around Early St. Louis," *Gateway Heritage* 11 (Winter 1990-91): 44-45.

defined frontiers and borderlands, while also missing the fluidity and inclusiveness of indigenous and European technologies.

One of the more daunting tasks in writing early mining history that addresses the concerns of historians is to marry both the cultural and material wings of environmental history.[21] Broadly speaking, since material environmental history concerns how changes in the physical environment affect human societies, this project stresses the technological side of human affairs in mostly rural areas. Additionally, since the cultural wing emphasizes how representations of nature in the arts and letters changed and what those changes reveal about people and societies that produced them, we can better understand the culture of indigenous peoples through those sources. Viewing mining through the material and cultural lens can highlight encounters between colonists and indigenes, as well as the syncretic residuals of meetings that predate primarily Euro-American mining practices and technologies.

The historian most credited with recognizing the advancement of a mining frontier in the late nineteenth century is Frederick Jackson Turner. By examining mid-nineteenth century gold rushes, Turner became representative of a long tradition of historians who viewed frontier mining only as an imposition of American intelligence and performance. In the American imagination the frontier became a stage for American progress. Miners, pioneers, cowboys, log cabins, and wagon trains developed into national icons. In popular portrayals of such histories, American miners displayed their core values—democracy, equality, and individualism—in their purest form.[22] Eventually, historians of the early twentieth century connected these popular images to

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[21] J.R. McNeill, "The Nature of Environmental History," 5-43.

[22] For Turner and popular culture see, Leroy Ashby, *With Amusement for All: A History of American Popular Culture Since 1830* (Lexington: The University Press of Kentucky, 2006), 80-81.

the Turner thesis and academic orthodoxy. However, Turner's portrait leaves little room for imagining the existence of an early colonial mining frontier, not entirely dominated by Europeans or Americans, where Native Americans and French peoples cohabitated a space where geographic and cultural borders were not clearly defined.[23]

Since Turner's seminal work, historians have pointed to the development of the mining frontier in the United States by noting the significance of the California Gold Rush. They then examine late nineteenth-century mining expeditions, camps, and industrialization. Rodman Wilson Paul's thesis, presented most magisterially in *Mining Frontiers of the Far West*, is that a series of rushes occurred that brought the first permanent settlers to Western America.[24] Paul's emphasis is on the enduring phases of Western mining and on the men who made significant contributions to frontier history. Paul writes about Americans who were the ingenious contrivers of new techniques or machinery, the capitalists who subsidized the development of the most promising mines, and the railroad builders who constructed transportation routes that linked mining camps with markets. In the years since Paul's work, the study of the American frontier has deepened in its level of analysis.

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[23] Reference to frontier should tip off the reader to the comparatively recent historiography trends that my work draws upon challenging Frederick Jackson Turner's thesis. The literature on early North American frontiers has steadily grown over the past ten to fifteenth years, and will be highlighted in subsequent notes. Frederick Jackson Turner, "The Significance of Frontier in American History," *American Historical Association Annual Report for the Year* (1893): 199-227. For Turner's idea of a frontier community development see, D. W. Meinig, *The Shaping of America: A Geographical Perspective on 500 Years of History, Vol. 2, Continental America, 1800-1867* (New Haven: Yale University Press, 1993), 255-257.

[24] Rodman Wilson Paul, *Mining Frontiers of the Far West, 1848-1880* (University of New Mexico: Albuquerque, 1963). Paul focuses on American technological and scientific innovations and the progress of economic and political institutions that made mining possible. Other historians like Otis E. Young, Jr., the noted historian of western mining, direct attention to the lead mines of the Mississippi Valley. Otis E. Young Jr., *Western Mining, an Informal Account of Precious Metal Prospecting, Placering, Lode Mining, and Milling on the American Frontier from Spanish Times to 1893* (Norman: University of Oklahoma Press, 1970); Duane A. Smith, *Rocky Mountain Mining Camps, the Urban Frontier* (Indiana: Indiana University Press, 1967); Mark Wyman, *Hard Rock Epic, Western Miners in the Industrial Revolution, 1860-1910* (Berkeley: University of California Press, 1979).

In recent decades, to recover hidden aspects of Indian-white accommodation historians have discarded how Turner portrayed the frontier, and recast it as a zone of intercultural infiltration. The new work completed by frontier and environmental historians focuses on region and process. Those historians who emphasize the process of settlement recognize how many women, Indian peoples, and nonwhites Turner's frontier thesis obliterated, and they have included them in their histories. Patricia Limerick highlights the forgotten history of the West as a site of conquest, but also that Native Americans and newcomers continued to create a distinctive pattern of mixing and interaction.[25] In *Women and Men on the Oregon Trail* and *Sugar Creek*, John Mack Faragher presents histories about connections between frontier and newly settled communities of the West.[26] Scholars who emphasize region argue that the term frontier still carries Turnerian baggage. What matters to these regionalists is the physical and cultural space where cohabitants created new communities.

But these historians still tend to focus on Euro-American technological progress, without recognizing the existence of pre-colonial mines where Native Americans developed their own set of mining procedures. In this vein of relevant literature, John Stilgoe's *Common Landscape of America* shows how Europeans shaped the American landscape out of wilderness and produced enduring features. He describes a New Spain

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[25] Among critics of the frontier construct, see Patricia Nelson Limerick, *The Legacy of Conquest: The Unbroken Past of the American West* (New York: W. W. Norton & Company, 1988), 18-32; John Mack Faragher, "Afterword: The Significance of the Frontier in American Historiography," *Rereading Frederick Jackson Turner: The Significance of the Frontier in American History and Other Essays* (New York, 1994), 237-241. Nancy Shoemaker reviews much of this research in *Negotiators of Change: Historical Perspectives on Native American Women* (New York: Routledge, 1995).

[26] For a discussion of different Native American and Euro-American extraction practices, see John Mack Faragher, *Sugar Creek: Life on the Illinois Prairie* (New Haven: Yale University Press, 1986); John Mack Faragher, *Women and Man on the Oregon Trail* (New Haven, 1979); Ronald Trosper, "That Other Discipline: Economics and American Indian History," *New Directions in American Indian History*, ed. Colin G. Calloway (Norman: University of Oklahoma Press, 1988), 208, 219; William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: 1991).

mining landscape where European miner's knowledge and culture contributed to the extraction of gold and silver. Stilgoe's analysis of the technological transfer of mining practices from Europe suggests that primarily Spanish expertise and only indigenous labor made possible the construction of a mining settlement resembling the European model.[27]

Recognition of mining amalgamation can help chart European, Native American, and American interactions and the hybridity of their influences that evolved during the establishment of early settlements. Such an alternative formulation offers a sense of the complexity of the North American scene as colonial miners developed the frontier. While historical records reveal that lead was a vital and valuable resource for Native Americans, French, and Americans, there has been little discussion regarding their prospecting, extracting, and smelting methods. For example, Lucy Eldersveld Murphy's in-depth study of lead mining and frontier exchange economy does a wonderful job investigating the social and economic history of Native American and immigrant communities in Southern Wisconsin and northwestern Illinois. Murphy presents their relationship and conflicts with various Native American neighbors, while simultaneously noting that Native American and European mining technology was separate, and not the result of an amalgam of practices.[28] Although historians increasingly examine models of assimilation on the frontier during the century before removal, most do so in terms of social and economic exchanges.

By contrast, my study affords a window into a history when early Native Americans and Europeans prospected for and extracted minerals using a fusion of

[27] John R. Stilgoe, *Common landscape of America, 1580 to 1845* (New Haven: Yale University Press, 1982), 282-286.
[28] Murphy, *A Gathering of Rivers*, 77-100.

techniques. Such a narrative points to the consistent importance of lead ore to indigenous peoples, explorers and settlers long before American prospectors, miners, families, prostitutes, and industrialists flooded the west in search of gold and wealth. I examine both the physical environment and the cultural practices, which required not only the convergence of their mining techniques, but also the meeting of inhabitants and migrants. Judith Carney argues that slave knowledge and culture contributed to Southern agricultural production.[29] Carney locates multiple convergences between Africans and English colonists at sites of production where humans interacted and understood their natural environment through their labor. In a similar fashion, I show how the early convergence of mining practices assisted French miners in their quest for mineral extraction.

Historians also examine the shared cultural practices of Europeans and Native Americans. Albeit the starting point focused on the fur trade, Richard White's *Middle Ground* marked another way of rejecting Turner, one that has been especially important for my project. White did not expand his study to the Mississippi River, but he did something else: he described American history from the perspective of peoples of the *pays d'en haut*, which was a new vantage point for understanding why Native Americans mattered and how they influenced historical outcomes. White is interested in their search for accommodation and common meaning. During a period in which neither Europeans nor Native Americans predominated power relations were important, and both

[29] Judith Carney, *Black Rice: The Origins of Rice Cultivation in the Americas* (Cambridge: Harvard University Press, 2001); Max Edelson, Gwendolyn Midlo Hall, Walter Hawthorne, David Eltis, Philip Morgan, and David Richardson, "AHR Exchange: The Question of "Black Rice" *American Historical Review* Vol. 115, No. 1 (February 2010), 123-171.

cultural groups mixed to create new systems of meaning and exchange on the frontier.[30] Indeed, in a different context, Daniel H. Usner's work on the cultural milieu of early Louisiana complements White's research and represents a concerted effort to recast the customary American frontier narrative.[31] White and Usner, and others, have pointed out that the convergence of Native American and European practices carry the potential for highlighting frontiers and borderlands not as places of straightforward conquests, but as places where invaders and indigenes constructed accommodations.

Scholars now look to understand the complex process of cultural agency, which can also be applied to comprehending the construction of a Native American-French mining frontier, and a American mining frontier-borderlands, and eventually an American bordered mining district. Cultural interactions accounted for a sizable portion of how Native American and French miners adopted each other's practices to create an eighteenth-century mining mixture as opposed to fur exchanges and agricultural practices. I see this dissertation as continuing that project within the field of environmental history.

Where Rodman Paul traced the evolution of the mining frontier across the Mountain West noting the role of Americans during a series of gold rushes, Elliot West stresses the different roles that Native Americans played during intercultural contacts. In *The Contested Plains*, West examines how the numerous stampedes over the plains of the west in 1848 affected scores of Native Americans during the mass migration of Euro-Americans and seriously impacted Indian livelihood. West also opens a window into the plains environmental history before the gold rush. Although he neatly recovers the

[30] White, *The Middle Ground*, x-xv.
[31] Usner, *Indians, Settlers, & Slaves*, 6-9.

social, cultural, and geographical histories of several tribes of the central plains, he makes no mention of their mining skills.[32]

As approaches of differing historians suggest, the field has undergone internal revisions. In addition, environmental historians have greatly expanded the variety of sources that scholars could use to access and understand changes over time. Cultural historians too have expanded the interpretation of sources, emphasizing the myriad of experiences and patterns of historical actors. Additionally, the extension of cultural history to frontier-borderland history has also been the result of new work in environmental history, histories of settlement and community formation, and Native American history.[33]

The methods of material, cultural, and environmental historians are instructive, particularly for examining the hidden aspects of the subaltern's mining knowledge and practice.[34] Their contributions can also assist in explaining how and when the transition from frontier practices, to borderland techniques, and eventually bordered technologies occurred.[35] Particularly, in terms of the actual lead mines, introducing more cultural methods, as this dissertation does, enhances the dynamics of long standing Native American customs. Additionally, this study will show the myriad ways they influenced European and American miners who settled the mining frontier-borderlands. Finally, this study emphasizes how the multiple syncretic technological formations that Native

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[32] Elliott West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University Press of Kansas, 1998).
[33] Peggy Pascoe, "Western Women at the Cultural Crossroads," Patricia Nelson Limerick, et. al., *Trails: Towards a New Western History* (Lawrence: University Press of Kansas, 1991), 40-58.
[34] Christopher V. Hill, *South Asia: An Environmental History: Nature and Human Societies*, (Santa Barbara: ABC-CLIO, 2008), xi.
[35] Aron, *American Confluence*, 100; In addition, people in Newfoundland cod fishery had a keen sense of customary rights of access to fishing grounds and understood fishing ecology. But when new technologies entered the picture people objected. See Sean Cadigan, "The Moral Economy of the Commons: Ecology and Equity in the Newfoundland Cod Fishery, 1815-1855," *Labour/Le Travial*, 43 (1999): 9-42.

Americans and French miners forged to establish this early mining frontier were erased following the arrival of Americans who applied their mining practices and made the lead mines a bordered mining district.

To highlight how Native American mining culture influenced French and American miners who decidedly settled near the lead mines in the present state of Missouri from 1719 to 1839, I invoke the work of Jeremy Adelman and Stephen Aron. Their frontier, borderland, and bordered regions terminology is applied here to examine the invasion of extracting, mining, and smelting technologies. I do this to separate each stage in the process using Adelman and Aron's political territorial hegemonic narrative. Adelman and Aron's approach focuses on the competitive nature of Native American and European powers to identify the transition from frontier to bordered states during the eighteenth and nineteenth centuries. Although this approach places emphasis on the cross-cultural relations that defined frontiers and borderlands, I examine various mining, smelting, and refining traditions to show how the gradual emergence of a hegemonic technology transformed the mining frontier to a bordered mining district.

For the purposes of this study, the frontier is not just a contact zone where peoples intermixed through trade, agriculture, and marriage but also where miners' traditions converged. For example, explorers, traders and missionaries adopted Native American communication and transportation methods before descending deep into the interior of the continent. In similar fashion, from 1719 to 1763, the Kaskaskia Indians and French miners learned to barter and even work mines together using their respective environmental knowledge and practices. The middle ground they forged around lead ore was replete with syncretism and alliances. What the French and Kaskaskia miners did was to blend their practices, which were the by-product of frontier cohabitation. Since this mining fusion between native and settler traditions has been least understood by historians, in my study, I examine the mining and smelting mixture that the indigenous and French formed to reveal the development of not only a frontier, but also its transition to a mining frontier-borderland.[36]

To uncover more material and cultural intricacies, I extend the term frontier to borderland. If frontier is a meeting place of peoples' customs, then the designation of borderland denotes the arrival of a set of alternative mining techniques that tried to oppose preexisting practices, as well as transform the landscape. Broadly speaking, the borderland terminology also is a way to describe how miners using the hybrid responded to Americans using their technologies, which transformed the mining frontier to a borderland with contested boundaries. I propose that the emergence of a frontier-borderland occurred after Spanish officials, who now controlled the Louisiana Territory, encouraged American and British lead miners to relocate to the Territory in the 1790s. The beginning of the regional redefinition of the mining frontier began when Spanish officials focused on increasing the population adjacent to the mines. They enticed "a considerable number of industrious" Americans and Europeans by offering them liberal land grants as a necessary step to build a mining settlement.[37] Therefore, by the late

[36] Andrew R. L. Cayton and Frederika J. Teute eds., *Contact Points: American Frontiers from the Mohawk Valley to the Mississippi, 1750-1830*, (Chapel Hill and London: University of North Carolina Press for the Omohundro Institute of Early American History and Culture, The Newberry Library, and the Historic New Orleans Collection, 1998), 291-298; Also, see Colin G. Calloway, *New Worlds for All: Indians, Europeans, and the Remaking of Early America* (Baltimore: Johns Hopkins University Press, 1997).

[37] Louis Houck, *The Spanish Regime in Missouri: a collection of papers and documents relating to upper Louisiana principally within the present limits of Missouri during the dominion of Spain, from the Archives of the Indies at Seville, etc., translated from the original Spanish into English, and including also some papers concerning the supposed grant to Col. George Morgan at the mouth of the Ohio, found in the Congressional library, Vol. 2* (Chicago: R.R. Donnelley and Sons Company, 1909), 102, 365-366.

eighteenth century, a good deal of what is now called *technology transfer* began as miners settled near Mine La Motte creating a mining frontier-borderland.[38]

In this study, I also connect this transition to the emergence of a single hegemonic technology. For example, when the Spanish or the United States controlled the lead mines, American miners initiated prospecting, extracting, experimenting, smelting, and refining lead ore according to European methods, while local miners continued using Native American French syncretic practices. As Richard White has argued, similar to how Native Americans exploited the imperial authorities during the fur trade, miners initially were able to resist the invasion of new technologies. American travelers described local miners as digging trenches using "crude methods to discover lead ore," and building ancient log furnaces to smelt galena.[39] American miners excavated deep shafts with more advanced equipment to access richer veins of lead ore, or they built masonry furnaces to smelt their lead ore. Although cross-cultural mixing continued at the mining frontier-borderland, earlier syncretic techniques began to slowly disappear in the shadow of new techniques.

The final stage in the lead mines evolution from a somewhat fluid mining frontier-borderland to a structured bordered-mining district occurred between after the Missouri Compromise of 1820. Following Missouri statehood in 1821, the number of American miners migrating to Mine La Motte increased. While the manifestation of borderlands highlights contested boundaries, after 1821, the number of miners using hybrid methods decreased, and the number of miners and their slaves using alternative

[38] David Nye, *America as Second Creation: Technology and Narratives of New Beginnings* (Cambridge: MIT Press, 2003), 133; John Opie, *Nature's Nation: An Environmental History of the United States* (New Jersey: New Jersey Institute of Technology, 1998), 221-225; Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997), 67-91.
[39] Moses Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 14-15.

technologies increased, which represented the advent of bordered lead mines. Additionally, the presence of their mining machines and methods progressively dominated the lead mines. For example, one visitor to the mines commented, "When I approached the mines there was opened to my view a large space of cleared ground" where "three miners [were] surveying and working the mines using windlasses" that seemed to blanket Mine La Motte.[40] During this period, European and American material achievement affected their assessment of miners who still used Native American mining methods. Another visitor to the mines in 1819 described the lead mining amalgam using words such as "simple" or "disorganized."[41] Since American improvers and naturalists viewed the Native American amalgamation as "primitive," they deemed that more sophisticated knowledge and technology was necessary to redefine and recreate the mining frontier-borderland according to longstanding European traditions.

Combined, the invasion of new technologies and new perceptions of miner practices would seal the fate of the French and Kaskaskia cross-cultural mining systems created during early eighteenth century encounters. These turning points resulted in the erasure of the hybrid, which could no longer survive in what was once a middle ground. The final sign that a bordered mining district had emerged was the arrival of American geologists who applied European scientific methods to describe the mining district's wealth.[42] This dissertation examines how these cultural and material changes shaped the

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[40] Charles-Alexandre Lesueur, *Drawings and sketches of the places we passed on the way from Philadelphia to Pittsburgh and from Pittsburgh to New Harmony during our voyage on the keelboat while descending the Ohio from November 27, 1825 to January 26, 1826*.

[41] Henry Rowe Schoolcraft, *A View of the Lead Mines of Missouri, including some observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, population and Productions of Missouri and Arkansas, and other sections of the Western Country* (New York: Charles Wiley, 1819), preface, 4, 114.

[42] As referenced in Michael Adas, *Machines as the Measure of Men*, 5-6. Accordingly, as the meaning of science and technology changed over the same period, I have adopted A.R. Hall and Edwin Layton definitions. For Hall, scientific endeavors are aimed at gaining knowledge of the natural environment. He

environment between 1719 and 1839, thus broadening our understanding about the role of technology in the creation of a mining frontier, borderland, and a bordered mining district.

The setting for this study is crucial. The eighteenth-century middle Mississippi Valley is commonly associated with the fur trade phenomenon, perhaps most famously captured near Ste. Genevieve, Missouri. By the 1670s, French Canadian traders, trappers, and missionaries, including Louis Jolliet and Father Jacques Marquette, traveled on the Mississippi and Illinois rivers, and in 1682 Robert Cavelier, built the first European outpost in Illinois—Fort St. Louis. By 1688, the French cartographers labeled the region, south of lakes Superior and Michigan, *Le pays des Illinois*. This phrase was coined to describe the center of North America. Although the expression Illinois Country was first used to designate the territory occupied by the Illinois Indians, it soon came to encompass the French colonial regime in what is now the state of Missouri. When the Spaniards acquired sovereignty over Louisiana in the 1760s, they continued to employ French geographic terms. This continued until the Louisiana Purchase in 1803. During Native American, French, Spanish, and American control, the middle Mississippi Valley was a major center for lead mining and trading that reached the Upper Mississippi Valley, the Gulf Coast, and the east coast. Indeed, lead mining and trading were substantial attractions for Native American, French, and American settlements. In the years following Missouri statehood, in the early nineteenth century, territorial dominion

views technology as efforts to exercise a "working control" over that environment. Layton understands fundamental entities as the essence of science, and technology as a method to seek to solve more practical and immediate problems. See A.R. Hall, "Science, Technology, and Utopia in the Seventeenth Century," Mathias, *Science and Society,* 33-53; and Edwin Layton, "Mirror-Image Twins: The Communities of Science and Technology in 19th-Century America," *Technology and Culture* 12, 4 (1971), 562-80.

was no longer contested. The new guiding framework of power rested in the struggle between which mining techniques would be allowed to progress.

The narrative of this dissertation moves chronologically from 1719 to 1839, and is divided into three sections. The first part examines the arrival of the Kaskaskia and French settlers to the middle Mississippi valley, and convergence of their prospecting, mining, and smelting practices. Part one includes chapters one and two. Chapter 1 explains how longstanding Native American prospecting and extracting practices converged with French prospecting and extracting methods to form a cross-cultural mining frontier. These amalgams reveal the influence of Native American knowledge and practice, as opposed to only impositions of European mining applications. I use amalgam not only as a metaphor for the melding of techniques, but also for the process that united Native Americans and Europeans with the environment. Indeed, Chapter 1 also examines the ways that French explorers began to redefine the mining region's resource potential in terms of settlement.

Chapter 2 continues the frontier narrative, picking up with the recovery of longstanding Native American smelting techniques, and the desire to create a mining settlement. Eventually, following a discussion of European mining methods, this chapter recreates another part of the amalgam after the convergence of Native American and French miners smelting methods in the 1740s. In these sites of production, before recovering the French adoption of the Kaskaskia Indian longstanding smelting methods, I trace the origins of Native American smelting practices in North American prior to European contact.

In part two, as miners continued to employ the new Native American and French hybrid they did meet with success on the mining frontier, so Chapter 3 examines the beginning of the mining frontier-borderland. Following the arrival of American and British miners during the Spanish period, they endeavored to construct a mining association and settlement in the center of the district. Chapter 3 traces miners' actions from the successful planting of a settlement and mining frontier's transition to a frontier-borderland. This chapter demonstrates the ability of merchants, farmers, and miners to establish one settlement, Mine a Breton where they worked year-round and another settlement Mine La Motte where miners continued to employ seasonal mining practices. The task of the numerous prospectors, miners, and smelters was to construct a plan to locate, extract, and manufacture this useful metal that included both Native American and European mining practices to increase lead production. Most importantly, Chapter 3 explains how Americans began to view miners who used the amalgam as inefficient. The chapter concludes by showing how miners at Mine La Motte employed the amalgam while miners at Mine a Breton began to employ Euro-American technologies.

Chapter 4 continues the frontier-borderland narrative in the months following the Louisiana Purchase. By 1804, American and British miners successfully established a settlement at Mine a Breton and began to apply European technologies to dig the region's first shaft and build a reverberatory furnace to smelt lead to produce shot and sheet lead. Most significantly, this chapter examines the Louisiana Territory's first mineralogical report of American and British miners who conducted field observations in search of new veins of lead, and then conducted experiments in rudimentary frontier laboratories. This chapter recovers mineralogical surveys, which are currently under explored territory in environmental history.

In part three, the final section, chapter 5 begins around the years leading to Missouri statehood in the 1820s, as promoters of lead mining successfully encouraged American and European miners possessing European skills to relocate to the mining district. American geologists and entrepreneurs desired to see miners extract and smelt lead ores efficiently by employing what they consider to be sophisticated knowledge and complex machines. Most significantly, improvement became the motivating force to create a bordered mining district. Promoters and boosters hoped to impose power over nature and transform the land. These changes did not just come in how Americans viewed the landscape; their vision included industrializing the mining district. New technologies and practices enabled miners to dig more shafts, build more furnaces, and export more lead. Miners now combined their mining and farming near their settlements year-round instead of following a seasonal schedule, as was the practice of Native American miners. New European practices continued the gradual transition from Native American knowledge, influence, and actual work in what was now a bordered mining district.

One irony of excluding Native Americans practices from the idea of early mining frontiers is that they undoubtedly played a significant part in supplying missionaries, traders, and merchants with a variety of lead products. Without a Native American presence, European-styled mining development would have unrolled far more slowly if at all. Records of Native American mining traditions are fragmentary; yet early European explorers' ethnographic descriptions and archaeological sites have revealed longstanding

Native American mining methods. In this respect, examining indigenous actions through the eyes of contemporary explorers also helps us to understand Native Americans contributions to European mining efforts since the two groups of miners exchanged their mining tools and methods to extract galena and refine it into useful objects for local use and distant trade.

Part 1: Longstanding Mining Practices on the Frontier

Frequently, frontier histories dismiss the pre-colonial past as prehistory, which tends to discard much of the history of the landscape and early occupants. Just as Europeans and Americans who came to settle near Americas' gold, silver, and lead mines carried with them their own cultural practices, so too, did the Native Americans who came to settle particularly near lead mines bring their own mining methods prior to European contact. Native Americans near present day Santa Fe, New Mexico and Cahokia, Illinois, used stone tools to dig trenches along the surface of the soil to locate branches of lead ore. After extracting their lead ores, they would abandon their trenches and begin to either crush or melt small quantities of ores.

For at least four thousand years Indian miners had extracted galena from deposits in the middle Mississippi Valley and traded it as far away as the present states of Ohio, Alabama, Mississippi, and Georgia. Archaeologists using trace-element analysis on unearthed lead objects discovered that Native Americans used lead from this region to make ornaments such as beads, buttons, pendants, and bird effigies.[1] Often early indigenous cultures used ground lead as sparkling paints for masks and mortuary purposes. Such examples from recent archaeological discoveries reveal that long before European contact multiple Indian tribes understood how to mine and melt lead ore.

Previous to the French, as early as the 1540s, Spanish explorers had come close to the neighborhood of the lead mining region. In 1541, the Spanish explorer Hernando De Soto, and a number of Europeans, Africans, and Indians departed Florida to travel the

[1] Kathleen DuVal, *The Native Ground: Indians and Colonists in the Heart of the Continent*, (Philadelphia: University of Pennsylvania, 2006), 17.

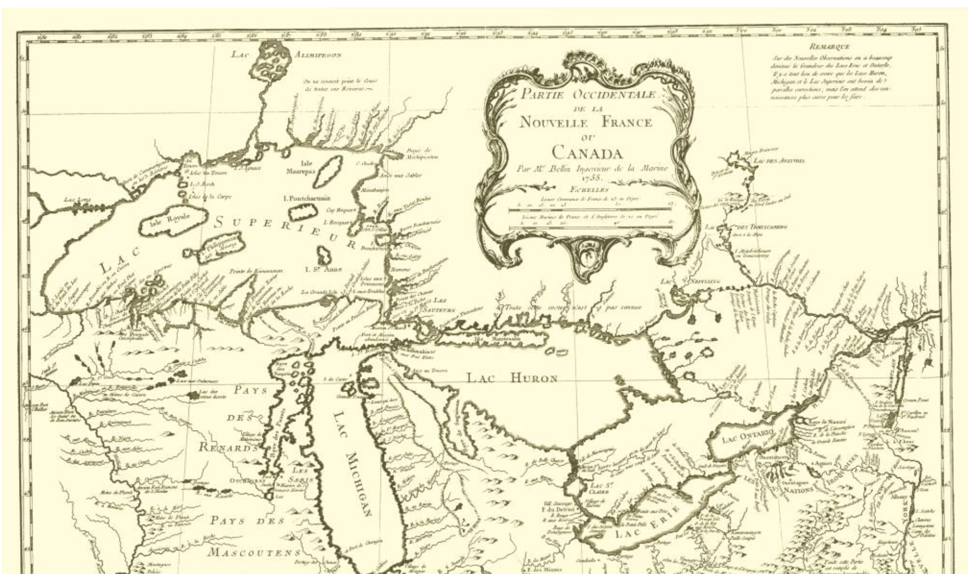
lower Mississippi Valley. De Soto hoped to discover riches similar to those found by Cortez in Mexico and Pizarro in the Andes.[2] However, De Soto's party discontinued their search far south, and discovered no precious metals and drew back before learning about the lead mines further north near Cahokia. Over one hundred years after De Soto's travels and throughout the seventeenth and eighteenth centuries, France also hoped to take advantage of America's riches, preferably in the form of gold or silver.[3]

When the French began to arrive in the region during the seventeenth century, they found Native Americans living in numerous villages who were part of a confederacy of Algonquin-speaking tribes, the Illinois. The Illinois lived, hunted, and gathered in what is now known as Wisconsin, Iowa, Illinois, and Missouri. Other resident Indian tribes also included the Kaskaskia and Tamaroa who were also part of this confederacy, which included the Sac, Fox, and Shawnees. The Kaskaskia, Tamaroa, Peoria, and other Illinois tribes lived along the Mississippi, Illinois, and Missouri Rivers. The Kaskaskia and the Tamaroa Indians established themselves near Cahokia, Illinois. Their village had approximately 180 lodges in 1682, enough to house over 3,000 men, women, and children. Although we have little information about the Tamaroa, they did unite with the Kaskaskia a few years prior to the arrival of French mining engineers near the mouth of the Kaskaskia River in Illinois.[4]

In the Illinois Country, *le pays des Illinois*—a phrase coined in the late seventeenth century to describe the center of North America—was where the Kaskaskia Indians, French officials, traders, trappers, and miners converged, traveled and settled.

[2] Stephen Aron, *American Confluence: The Missouri Frontier from Borderland to Border States* (Bloomington and Indianapolis: Indiana University Press, 2006), 11.
[3] William E. Foley, *The Genesis of Missouri: From Wilderness Outpost to Statehood* (Columbia: University of Missouri Press, 1989), 2.
[4] Foley, *The Genesis of Missouri*, 1-7.

The Kaskaskia originally settled on the eastern side of the Mississippi River along with French traders, and Jesuit fathers in the autumn of 1700. Rowing in their canoes along the Ohio, Mississippi, and Illinois rivers during the opening decades of the 1700s Kaskaskia and French miners reached what would become the most important frontier mining region. Eventually, the Kaskaskia Indians moved across the Mississippi, and settled near present day St. Louis, Missouri where they remained for approximately the next three years, after which, they reestablished themselves near the mouth of the Kaskaskia River. By 1703 missionaries and French traders had founded a village in North America claimed by King Louis XIV of France—Kaskaskia.[5]



Map 1: Nicolas Bellin, Map of Canada and New France, 1755[6]

[5] Foley, *The Genesis of Missouri*, 15.
[6]The Association of Canadian Map Libraries and Archives, (February 23, 2012). http://atlas.nrcan.gc.ca/auth/english/maps/historical/preconfederation/newfrance1740/64.gif/image_view

Maps of the region drawn in the 1740s and 1750s by Jacques-Nicolas Bellin labeled areas inhabited by various Native American tribes. Jacques-Nicolas Bellin, was a French geographer. Although Bellin never traveled to North America, he used explorers' journals to produce a large map of Canada and of French territories in North America such as New France and Louisiana. Bellin showed the Kaskaskia Indians on the east side of the Mississippi, but west of the river his maps depicted no Indian villages near the lead mines.[7] During the first half of the eighteenth century, numerous exploratory expeditions were made from Kaskaskia on the east bank of the Mississippi. For the purposes of this study, however, the short and less dramatic surveys across the Mississippi in search of lead were more important, for it bore directly on the early history of Native American and French lead mining in the region.

During the late seventeenth-century after the French learned about the lead mines in the middle Mississippi River valley, what emerged represented a "middle ground" interaction. That is, an Indian adaptation of a product they had long known about and utilized it according to European practices. The French colonial presence increased both Native and French demand for lead in several ways. First, French traders bought lead—as they did furs—in exchange for trade goods from the seventeenth century onward.[8] Second, traders sold Indians a product that consumed lead: the gun, a tool that not only enhanced the Indian's ability to hunt but also increase their effectiveness as warriors. Third, the French introduced activities that promoted Native uses of lead as ammunition for hunting. Native and French demand for lead increased with their involvement in both

[7] Ekberg, *Colonial Ste. Genevieve*, 16-18.
[8] Concerning the fur trade in the middle Mississippi Valley, consult the splendid bibliography in Foley, *The Genesis of Missouri.*

the fur trade and colonial and local wars during the eighteenth century as they made their own musket balls with lead.[9]

Mutually the Kaskaskia, Tamaroa, and French accepted one another into Indian and European exchange networks. The goods offered by the French included glass beads, metal balls, and pieces of jewelry, which the Native Americans viewed as attractive adornments. Equally iron tools and pots eased the work of women cultivators and food processors. The most effective trade good for men were firearms, gunpowder, and lead balls. In exchange, the French wanted beaver skins to be converted into hats. Further to the south, in the lower Mississippi valley, instead of beavers, other Indian tribes supplied the French with deerskins in greater numbers. For example it took twenty skins to barter for one musket and a selection of lead balls.[10]

Although not the precious metals the French had coveted, for centuries lead was a valuable resource. As will be seen in the ensuing chapters, efforts to profit from mining ran into complications from the start. French miners lacked the capital and the technical knowledge to extract and smelt lead according to European standards, therefore, they had to combine their limited abilities with Native American methods to get the lead out of the ground and melt it before shaping it into musket balls. Additionally, because miners usually stopped working as soon as they had extracted enough ore to supply their own needs, mining engineers also lacked a consistent labor force. By 1723, a couple of mining engineers had recommend putting African slaves to work in the lead mines, but the expense of shipping slaves to New Orleans and upriver to the mines limited this alternative and kept operations small throughout the eighteenth century.

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[9] Ekberg, *French Roots in the Illinois Country*, 274.
[10] Usner, *Indians, Settlers, &* Slaves, 25-31; Ekberg, *French Roots in the Illinois Country*, 244-249.

Chapter 1: Amalgamation: Early Indigenous and European Mining

Introduction

Before daybreak on June 6, 1719, Marc Antoine Des Ursin, the civil governor of the Illinois country and a man "skilled in mineralogy," departed the village of Kaskaskia to begin a twenty-eight mile expedition to the lead mines. After three days, Des Ursin arrived at Mine La Motte. As was the practice of earlier explorers, Des Ursin penned numerous topographical observations. Des Ursin was pleased to see the "numerous smaller rivers" because he believed they made it "easy to construct mills—as many as you would wish—as good as might be desired."[11] Des Ursin exclaimed that the landscape appeared undulating where "you find similar mines everywhere, so to say, on the surface of the earth."[12] Following Des Ursin's arrival at the mines, the Kaskaskia Indians accompanying him instructed his soldiers to "dig into the four-foot deep shaft" where they discovered "grains of lead" imbedded in a six inch vein.[13] The mine, filled with pellets of lead along the riverine landscape previously worked by the Kaskaskia, encouraged Des Ursin to envision the possibility of exploiting these lead mines and eventually establishing a mining settlement.

The story of the joint efforts of Des Ursin and his Native American guides to locate lead ore offers a glimpse into the cross-cultural significance of lead mining in one early North American frontier. The Native American and French expedition to the lead

[11] On July 10, 1719, 1723, the French engineer Des Ursin documented his experiences at the lead mines and titled it, "Relation of the Journey to the Mines in Illinois Country by des Ursin," Hereafter noted as "Relation of the Journey to the Mines." The original French document was translated by Msgr. F.G. Holweck. The French copy was deposited in the Archives of the Missouri Historical Society. The translated copy was published in, John E. Rothensteiner, "Earliest History of Mine La Motte," *Missouri Historical Review*, 20, no. 2 (1926): 199-213.
[12] Ursin, "Relation of the Journey to the Mines."
[13] Ursin, "Relation of the Journey to the Mines."

mines represents the presence of indigenous prospecting and extracting skills in the middle Mississippi Valley prior to European contact. To fully understand the phenomenon, we must first consider early Native American mining knowledge and technology. Then, we need to examine French practices to explain the convergence of prospecting and extracting methods. Most significantly, the lead mines in the Mississippi Valley became amalgams of European and Native American practices. These amalgams reveal the impact of Native American know-how and practice that were a mixture of indigenous environmental knowledge, as opposed to only impositions of European mining applications. I use amalgam not only as a metaphor for the melding of techniques, but also for the process that united Native Americans and Europeans with the environment. Looking back, we see various cultural groups amalgamating, but we too must amalgamate in our minds to get at truths of their past.

Along the French colonial frontier, Native American and European knowledge, instruments, and power shaped the lead mines visited by the Kaskaskia and Des Ursin. Recently, scholars have argued that the production of colonial commodities relied on contributions from powerful as well as less powerful, or subjugated, groups. For example, Judith Carney argues that slave knowledge and culture contributed to Southern agricultural production.[14] Carney's analysis of the transmission of rice cultivation practices from Angola suggests that African women's expertise made possible the construction of engineering systems to grow rice. Carney locates multiple convergences between Africans and English colonists at sites of production where humans interacted and understood their natural environment through their labor. On the other hand, John

[14] Judith Carney, *Black Rice: The Origins of Rice Cultivation in the Americas* (Cambridge: Harvard University Press, 2001), 6-8.

Stilgoe's analysis of a New Spain mining landscape paints a picture of European knowledge and culture contributing to the extraction of gold and silver. Stilgoe's analysis of the technological transfer of mining practices from Europe suggests that Spanish expertise and indigenous labor made possible the construction of a mining settlement resembling the European model.[15] What we note by examining the convergence of Indian and European mining influences is the presence of Native American mining knowledge and technology.

Frontier mining came about earlier than historians have examined. Historians writing the history of early settlement and environmental contact in North America's middle Mississippi Valley have had much to say about the fur trade and farming, but little about mining.[16] A discussion of the history of mineral extraction usually begins much later, and is located in the far west.[17] Treating mining as a later stage of frontier development suggests that it is inherently a more modern and post-agricultural industry.

Frederick Jackson Turner is representative of a long tradition of historians who see frontier mining only as an imposition of European knowledge and practices. Turner notes that Americans who flooded the Pacific Coastline in search of gold were part of "a sudden tide of adventurous miners" not only to California, but also to Oregon and Utah. Turner suggests that by 1880 the settlement areas progressed "into northern Michigan,

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[15] John R. Stilgoe, *Common landscape of America, 1580 to 1845* (New Haven: Yale University Press, 1982), 282-286.
[16] For a discussion of the importance of wheat farming and lead mining in Ste. Genevieve, see Carl Ekberg, *Colonial Ste. Genevieve: An Adventure on the Mississippi Frontier* (Tucson: Patrice Press, 1985), 126-157; *French Roots in the Illinois Country: The Mississippi Frontier in Colonial Times* (Illinois: University of Illinois Press, 2000), 99, 171.
[17] Duane A. Smith, *Rocky Mountain Mining Camps, the Urban Frontier* (Indiana: Indiana University Press, 1967); Mark Wyman, *Hard Rock Epic, Western Miners in the Industrial Revolution, 1860-1910* (Berkeley: University of California Press, 1979); Rodman Wilson Paul, *Mining Frontiers of the Far West, 1848-1880* (University of New Mexico: Albuquerque, 1963); Andrew Isenberg, *Mining California: An Ecological History* (New York: Hill & Wang, 2005).

Wisconsin, and Minnesota, along Dakota rivers and in the Black Hills region, and was ascending the rivers of Kansas and Nebraska" traversing trails to Montana and Idaho, as well.[18] However, Turner's frontier portrait fails to acknowledge the existence of an early North American mining frontier that existed in the Mississippi Valley more than a century prior to Native American and European contact. The account of early explorers affords a window into a forgotten story when early Native Americans and Europeans prospected for and extracted minerals using a hybrid of techniques. Such a narrative points to the importance of lead ore to explorers and settlers long before Americans flooded California, Oregon, and Utah in search of gold.[19]

Recognition of mining amalgams offers one additional environmental landscape to chart European and Native American interaction and the hybridity of influences that evolved during the establishment of early settlements. Such an alternative formulation offers a sense of the complexity of the North American scene as colonial miners developed the frontier. While historical records reveal that lead was a vital and valuable resource for the French and various Native American tribes, there has been little discussion regarding their prospecting and extracting methods. Lucy Eldersveld Murphy's in-depth study of lead mining and frontier exchange economy presents Native American and European mining technology as separate, and not the result of an amalgam of practices.[20]

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[18] Turner included a "miner frontier" but fails to not see the significance of mineral exploitation in frontier Missouri. Frederick Jackson Turner, *The Frontier in American History,* (New York: Henry Holt and Company, 1920), 9-10, 183-184. For a discussion of prospectors and miners pioneering the Far West during the California Gold Rush, see Rodman Wilson Paul, *Mining Frontiers of the Far West, 1848-1880* (University of New Mexico: Albuquerque, 1963), 1-11.

[19] For a discussion of Native American presence in the Mississippi Valley and on the Plains and their land use practices, see Elliott West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University Press of Kansas, 1998), 26-48; Aron, *American Confluence*, 3-26.

[20] Murphy, *A Gathering of Rivers*, 79-100.

If we forget that Native Americans guided the French to the lead mines, then we will also never understand how missionaries, traders, and merchants supplied themselves with a variety of lead products. Without a Native American presence, European-styled mining development would have unrolled far more slowly. Records of Native American mining practices are fragmentary; yet early European explorers' ethnographic descriptions and archaeological sites have revealed longstanding Native American mining methods. In this respect, examining indigenous actions through the eyes of contemporary explorers also helps us to understand Native Americans contributions to European mining efforts. Carefully reading the accounts of French mining specialists Des Ursin, Renaudiere, and De Gruy, will help recover the presence and impact of Native American prospecting and extracting skills.

The Convergence of Lead Ore's Value and Use

To expose hidden stories of Native American mining knowledge and technological influences in the past requires three steps. The first is *acknowledging* the possibility that Native American mining knowledge and practice may have had an influence on European mining techniques.[21] The second is the *recovery* of Native American mining knowledge and methods and additional hidden elements within mining expeditions. The third step is *reconstruction* of the lead mining area as a place where Native Americans and Europeans amalgamated their mining knowledge and technology. Mississippian societies developed mining knowledge and technology to extract and

[21] For a detailed discussion on the use of acceptance and reconstruction to locate the hidden meaning in Native American maps, see J.B. Harley, *The New Nature of Maps: Essays in the History of Cartography* (Baltimore, John Hopkins University Press, 2002), 169-196; J.B. Harley, "Rereading the Maps of the Columbian Encounter," *Annals of the Association of American Geographers*, 82, no. 3 (1992): 552-536.

prepare lead ore for trade throughout eastern North America.[22] Archaeological studies help piece together Native American practices and moments of interaction with their mineral environment. Since early Native American mining accounts are difficult to uncover, archeological evidence reveals facets of Native American mining skills, manufacturing processes, and consumer practices that eventually influenced early French settlers. Archaeologists have recovered crushed and prepared galena from sixty-five Mississippian sites in clusters from the central Mississippi Valley to the southern Appalachians. Mississippians exchanged galena in the form of crystals and nodules. These shiny lead cubes were used as ornaments in rituals and were buried with the dead. By the late fourteenth century, in order to produce a metallic blue-gray pigment, galena was crushed and ground into powder with a hand-held grinding stone. Crushed galena was combined with plants, like beeweed or tansy mustard, and with hematite and manganese to make glaze paints.[23]

The Mississippians most likely worked with what Des Ursin, Renaudiere, and De Gruy recognized to be carbonate of lead. Occurring in masses, and often in a crystallized state, it was shaped like a rectangular octahedron. Because of its richness, the Mississippians used it with very little preparation as a glaze for coarse pottery, and it was exchanged and appropriated by the Indians of North America for centuries. This

[22] Recent archaeological research suggests Mississippians obtained their lead ore from the Potosi Formation and developed interregional exchange. For the types of products Native Americans mined and made, see John A Walthall, *Galena and Aboriginal Trade in Eastern North America* (Springfield: Illinois State Museum, 1981), 37-41; Kathleen DuVal, *The Native Ground: Indians and Colonists in the Heart of the Continent*, (Philadelphia: University of Pennsylvania, 2006), 13-28.

[23] J. Lyman Hayward, *The Los Cerrillos Mines [N. M.] and their Mineral Resources: A description of the mines in the Los Cerrillos and Galisteo mining districts, accompanied by a map of the same, drawn from actual surveys* (C. Clark Printing Co., 1880), 10, 26, 28; For recent archeological research regarding the Pueblo societies galena use and trade networks see, Richard A. Bice, Phyllis S. Davis and William M. Sundt, *Indian Mining of Lead for Use in Rio Grande Glaze Paint: Report of the AS-5 Bethsheba Project Near Cerrillos, New Mexico* (Albuquerque: Archaeological Society, 2003).

particular galena was probably similar to what Des Ursin described as "a fine-grained uneven and splintery or imperfectly fibrous state."[24] Europeans preferred this type of galena, free of contaminates, for manufacturing.

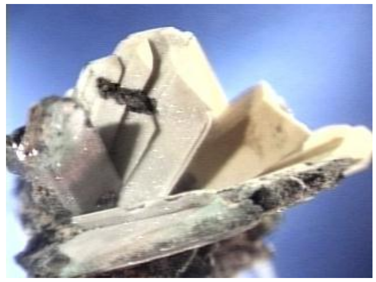

Figure 1: In galena's purest state it appears like colorless glass.[25]

Beginning with the De Vaca and De Soto expeditions, Europeans searched for ore they could mine—but of a shinier sort than lead.[26] Although lead had less raw or

[24] Des Ursin and other European miners would have been familiar with Gabriel Plattes, *A discovery of subterraneal treasure: of all manner of mines and minerals, from the gold to the coal; with plain directions and rules for the finding of them in all kingdoms and countries. And also, the art of melting, refining, and assaying of them is plainly declared, so that every man that is indifferently capacious, may with small charge presently try the value of such oares an shall be found either by rule, or by accident. Also a perfect way to try what colour any berry, leaf, flower, stalk, root, fruit, seed, bark, or wood will give: with a perfect way to make colours that they shall not stain, nor fade like ordinary colours* (London: Printed for J.E. and are to be sold by Humphrey Moseley at the Prince's Arms in Saint Paul's Church-yard, 1653), 7-8; Thomas Houghton, *Royal Institutions: Being proposals for articles to establish and confirm laws, liberties, & customs of sliver & gold mines, to all the king's subjects, in such parts of Africa, and America, which are now (or shall be) annexed to, and dependent on the crown of England. With rules, laws, and methods of mining, and getting precious stones; the working and making of salt-petre; and also, the digging and getting of lead, tin, copper, and quick-silver-oars, in any or either of those countries; whereby navigation, and trade, with the subjects interest and riches, together with the Crown's Revenues, would be greatly Increased, in a little Time. Most humbly offered to the consideration of the King's most excellent Majesty, & this present Parliament* (London: Printed for Author, 1694); Thomas Houghton, *Rara avis in terris: or The compleat miner, in two books; the first containing the liberties, laws, and customs, of the leadmines, within the weapontake of Wirksworth in Derbyshire. In fifty nine articles: to which are added, some new standing laws never printed before. The second teacheth the art of dialling and leveling*, (Derby: Printed by Samuel Hodgkinson, 1729), 7-9.

[25] http://www.galleries.com/minerals/carbonat/cerussit/cerussit.jpg, (November 16, 2008).

[26] For significance of metals to societies, see Herbert Clark Hoover & Lou Henry Hoover, trans., *Georgius Agricola, De Re Metallica; Translated from the First Latin Edition of 1556 with Biographical Introduction, Annotations and Appendices upon the Development of Mining Methods, Metallurgical Processes, Geology, mineralogy & Mining Law from the earliest times to the 16th century* (New York: Dover Publications, 1950), Book I.; Orlando C. Harn, *Lead The Precious Metal* (New York: Century, 1924); Robert B. Gordon and Patrick M. Malone, *The Texture of Industry: An Archaeological View of the Industrialization of North America*, (New York: Oxford, 1994); John Opie, *Nature's Nation: An Environmental History of the United States* (New Jersey: New Jersey Institute of Technology, 1998), 223-225.

romantic value than silver or gold, it was still a very valuable commodity for Europeans who hoped to gain wealth from their new environment. Early European settlers often considered lead to be an agent of death. Molten lead had long been used to draw confessions from the guilty and innocent, and by the time of the discovery of the New World, was being made into musket balls, inflicting wounds and death to many. During the seventeenth and early eighteenth century, after Native Americans directed French explorers to their lead mines, the region's possibilities captured French imaginations. As the French continued to rely on Native American prospecting and extracting knowledge, they began to envision the possibility of mining lead ore. Eventually the French also desired to construct a settlement in closer proximity to the mines, and they began manufacturing musket balls.[27]

The *recovery* of the convergence of European and Native American practices is clearly depicted in European mining expeditions. Their writings reveal how the amalgam developed during distinct phases shaped largely through Native American and French relations centering on lead ore. The lead mine expedition accounts of Des Ursin and Renaudiere provide a window into early Kaskaskia and French mining practices. A combined reading of the Des Ursin and Renaudiere accounts reveals early indigenous prospecting and extracting techniques. French and Spanish narratives, despite their

[27] Eighteenth century settlers carried 200 pounds of lead and 71 pounds of musket balls. Thereafter, settlers and Native American societies molded bullets. Daily life in Kaskaskia is described in the Kaskaskia Manuscripts and Parish Registers, which reconstructs the social structure, activities, and customs of the French. For example, Apr. 25, 1746. Versailles. Minister to Lenormant. Colonial supplies; Indian goods; lead for bullets; New Orleans butchers. AC., B 83:307. (LC.) See, Accounts of European exchanges with the Kaskaskia throughout N.M. Miller Surrey, trans., *Calendar of Manuscripts in Paris Archives and Libraries Relating to the History of the Mississippi Valley to 1803* (Washington: Carnegie Institution of Washington Department of Historical Research, 1926), 297; Dunbar Rowland and A.G. Sanders, *Mississippi Provincial Archives, 1702-1729 Vol. 2* (Jackson: Press of Mississippi Department of Archives and History, 1927), 170; Natalia Maree Belting, *Kaskaskia under the French Regime* (Urbana: University of Illinois Press, 1948), 29, 43; Joe J. Bauxar, "The Historic Period," *Illinois Archaeology* 1, (1973): 40-58.

ethnocentrism, suggest that while the French adopted various Native American mining practices, by 1743, Native Americans in turn began to embrace European tools. For example, the De Gruy mining expedition report not only highlights continued French reliance on Native American prospecting practices, but also reveals how their practices changed to include more European tools and methods.

In the third step, *reconstruction* shows the lead mining area as a place where Native Americans and Europeans amalgamated their mining knowledge and technology. To recover a new contact narrative, contemporary narratives and archaeological evidence help fill the silences in expedition records. Native Americans and French miners combined their mining methods in this middle ground. Prospecting and extracting techniques had the ability to clarify perceptions of land, water, and environmental resources. As French and Native American worlds allied, a hybridization of their mutual understanding of the land occurred in this region. They actively created new systems of meaning and exchange while mining their world. Unearthing additional evidence in the realm of indigenous mining knowledge and practices reveals syncretic methods on this early North American frontier.

Pueblo and Mississippian Mining Techniques

Native American mining and lead manufacturing practices developed near Santa Fe, New Mexico, and later in the Mississippi Valley. For example, centuries before Don Hernando Alvarado came to New Mexico in 1540 to find gold and silver, Pueblos were already extracting, using and exchanging galena.[28] The Bethsheba Mine near Santa Fe, New Mexico substantiates that Native Americans extracted lead ore from vertical trenches using prehistoric mining tools before 1350.[29] These discoveries suggest that, whether in Santa Fe or Kaskaskia, Illinois, between 1200 and 1700 lead represented an important trade commodity primarily used in the making of artifacts to be buried with the dead.[30] In a similar fashion, Mississippians also extracted, used, and exchanged galena in a variety of forms long before Hernando De Soto arrived in the Mississippi Valley searching for precious metals.

After arriving at the mines, Native Americans in the region of Santa Fe, New Mexico, assembled their tools by combining stone, wood, and animal bones. Native American miners used stone tools with notches and grooves attached to wooden handles. Once miners put together their tools, they began to dig six-to nine-feet deep trenches along the surface of the soil.[31] Native Americans did not have the capacity to go deeper in search of the solid body of lead ore because of the type of tools they used. They worked in teams of two trying to locate a branch or a vein of lead ore. If they encountered rock or water, they would abandon their trench and move elsewhere. Later, Native Americans discarded their broken tools intermixed with the mining rubble, and only carried crushed or nodules of galena to their village. After returning to their village,

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[28] George P. Hammond and Agapito Rey, trans. *Narratives of the Coronado expedition, 1540-1542, Don Hernando Alvarado, An Account of Don Hernando Alvarado's travels among the Pueblos in 1540*, (New York: AMS Press, 1977).
[29] Bice, *Indian mining of Lead for Use in Rio Grande Glaze Paint*, Ch. 3:1-8.
[30] Cyrus Thomas, *Report On The Mound Explorations of the Bureau of American Ethnology, Bureau of American Ethnology Twelfth Annual Report* (Washington, D.C., 1894); Discovery of turquoise mining near the lead mines in 1855. Archaeologist stated, "On reaching the locality I was struck with astonishment at the extent of the excavation." Hodge, *Handbook of American Indians North of Mexico,* 66; Gregory Perino, "The Krueger Site, Monroe County, Illinois," *In Mississippian Site Archaeology: Illinois Archaeological Survey Bulletins*, 8, (1971): 1-148.
[31] For the formulas used to estimate the weight of Native American mining tools. Bice, *Indian mining of Lead for Use in Rio Grande Glaze Paint*, Ch. 5, pp. 18 & Ch. 6, pp. 1.

Pueblo miners manufactured ornaments, magical charms, and pigments. They also combined red ochre and galena to produce a sparkling red pigment to be used as paint.[32] Lead isotope studies suggest that by 1300 AD Native Americans in Pueblo and other sites, began to incorporate glaze paint onto their pottery.

By 300, Zuni Indians were already introducing glaze paint into the middle Rio Grande Basin.[33] What appears to have followed was a lead mining enterprise that continued through the glaze-ware period. Pueblo Indians began to produce glaze paints for decorative motifs on their pottery. By grinding the ore into a fine powder, miners were able to mix it with plants or other minerals in order to manufacture a particular color of glaze paint. Similar to the way that the Zuni Indians from the west transferred their glaze-ware knowledge to the Pueblos in the east, Pueblo skills extended east towards the Mississippi River, where Mississippian societies also applied glaze paint to their pottery. Following routes across the Rocky Mountains to the Great Plains, indigenous people's trading and mining practices influenced North America. What becomes clear is that long before European contact, Native Americans established cross-cultural communications. Traversing the Americas Native Americans were hunting buffalo, mining, and meeting to exchange pottery and ideas with one another centuries prior to European contact. Following contact with the Spanish and the introduction of firearms, Native Americans added the production of musket balls to their skills.

Along these same well-worn pathways the Mississippian (900-1500) of Cahokia established mining practices and trading networks similar to the Pueblo. The

[32] For a discussion of isotopic studies in the New Mexico context, see Bice, *Indian mining of Lead for Use in Rio Grande Glaze Paint*, v-vi; For the Mississippi Valley, see A.V. Heyl, "Isotopic Study of Galena from the Upper Mississippi Valley, the Illinois-Kentucky, and Some Appalachian Valley Mineral Districts," *Economic Geology*, 60: 693-714.
[33] Hodge, *Handbook of American Indians North of Mexico*, 481.

Mississippians settled between the Arkansas and lower Missouri Rivers. Although they are better known for their well-developed horticultural production of maize, beans, and squash than for their early mining experiences, nevertheless, on a seasonal schedule, Mississippians mined, manufactured, and transported lead across North America for indigenous consumption.

Map 2: Mississippian Era Lead Exchange Locations[34]

The Kaskaskia Indian probably worked their lead mines in the same fashion as the Pueblo and Mississippian Indians. Using stones and animal bones as tools in a similar

[34] Walthall, *Galena and Aboriginal Trade in Eastern North America*, 14.

manner to the way Europeans used hammers, axes, and a pick, individuals or teams of two miners carved vertical trenches to dig shafts and remove the ore from the mines' walls. Native Americans worked the quarries near the village of Mill Creek in southern Illinois, which contained pits covering approximately four to twelve acres. Native Americans used the trenching method and stone hammers to mine flint and bluish-gray hornstone.[35] The hammers and other tools found in the Mississippi Valley are similar to those used by the Pueblo miners in Santa Fe.[36] Centuries later, following contact, the French adopted this same method to extract galena.

The trench mining methods and stone tools discovered at the Pueblo sites and the Mill Creek quarry close to the Mississippians suggests longstanding Native American mining knowledge and technology. Although there is little archaeological evidence to suggest that Mississippians manufactured their mining tools on site, the journal of Renaudiere suggests that whenever the Kaskaskia went to the mines they only carried their weapons and ammunition.[37] This passage suggests Native Americans went to mine lead without their implements and planned to make their tools from the regional stones.

Further support that they made their tools on site comes from the fact that the types of stones—quartzite, sandstone, or limestone—used for making tools were all readily available near the mines.[38] The tools Native Americans made included pounding hammers, picks, and axes that were notched and grooved to accommodate wooden handles. Hand axes with sharp edges would have been used as choppers. Hafted axes

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[35] For a discussion of early trench mining and quarrying as well as tools used in Southern Illinois, see W.A. Phillips, "Aboriginal Quarries and Shops at Mill Creek, Illinois*," American Anthropologist, New Series*, 2, no. 1 (1900): 37-52.
[36] Benjamin Silliman, "The Turquoise of New Mexico," *Science*, 1, no. 24 (1880), 289.
[37] Renaudiere, "Account of the Mines of M. de la Motte."
[38] Broadhead, *Report of the Geological survey of the state of Missouri*, 67, 75, 80-81.

were curved at the bottom and probably used similarly to a European-styled spade. Hafted picks also contained a concave curve at the bottom with a flat top. Their use of picks and axes indicate that extracting the ore from a vein with sharp, pointed tools was more effective than simply shattering the ore body with hammer blows.[39]

Near the eighteenth-century Kaskaskia and French contact sites in the Mississippi Valley, archaeologists have recovered arrowhead shapes, stone knives, maces, and spades, and pottery trowels constructed from buckhorns.[40] These tools are similar to those used by the Pueblo to mine. Artifacts also include pottery vessels in the form of bowls, jars, and animal-shaped effigies.[41] The recovery of pottery samples with traces of glazed paints near Kaskaskia Village suggests that Native Americans were mining near the same locations where they guided Des Ursin, Renaudiere and De Gruy.

Mississippian lead production practices most likely influenced the Indians living near the lead mines close to Kaskaskia before the French arrived in the Mississippi Valley. Mississippian societies manufactured and transported lead across North America for indigenous consumption. Mississippian sites show evidence of Native Americans grinding galena crystals into powder to manufacture a metallic blue-gray pigment. Mississippians exchanged galena in the form of crystals and nodules. Shiny galena cubes, which were used in rituals to bury the dead, further explain how mining and production practices from the Southwest flowed to the Mississippi region.[42]

Lead represented an important trade commodity primarily used to be buried with the dead in Santa Fe and Cahokia. The galena and red ocher discovered at Mississippian

[39] Bice, *Indian mining of Lead for Use in Rio Grande Glaze Paint*, Ch. 6, 6.
[40] Thomas, *Report On The Mound Explorations of the Bureau of American Ethnology*, 108.
[41] Thomas, *Report On The Mound Explorations of the Bureau of American Ethnology*, 77.
[42] Perino, "The Krueger Site, Monroe County, Illinois," 1-148.

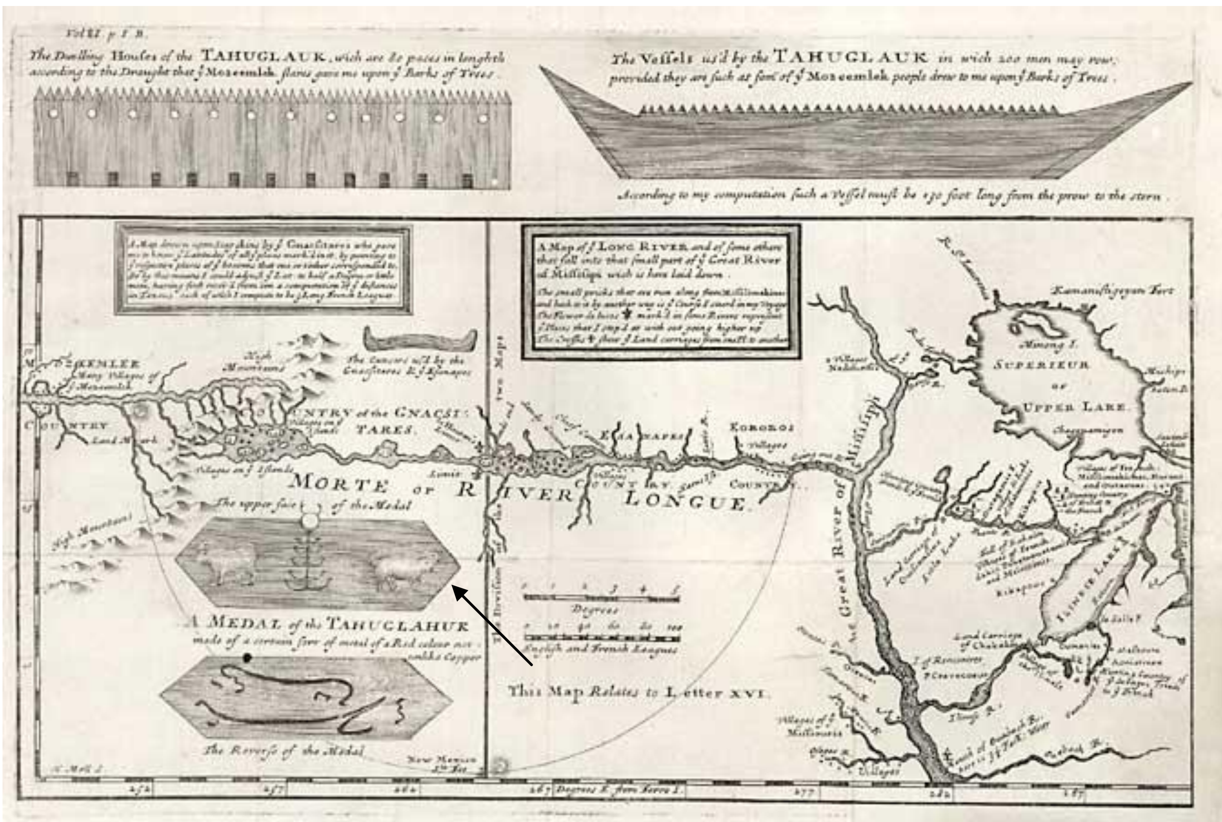
worksites aids our understanding as to how Native Americans extracted, crushed, and ground lead ore for use as paints or ceremonial powder prior to European contact. Following contact with the French, lead objects made for exchange with the Europeans, as well as with other Native Americans, included the following: (1) polished cubes and rectangles; (2) perforated beads; (3) bird effigy pendants; and (4) perforated buttons made from catlinite (red clay and sand stone) molds of Native American manufacture.[43] Catlinite was extensively quarried not only to make molds, but also to manufacture tobacco pipes and ornaments.

Figure 2: Lead widely used as inlay in catlinite pipes.[44]

Additional evidence from the central Mississippi River Valley worksites where lead ore was extracted, smelted, and distributed includes an early burial ground worksite from which over 500 pounds of lead has been recovered.[45] The galena uncovered from these sites was a valued commodity for interregional exchange, making the Mississippi Valley an original mining frontier where lead ore was extracted, manufactured, and distributed. Eventually, Mississippian societies dismantled and dispersed further south as

[43] Carl Chapman, "The Little Osage and Missouri Indian Village Sites," *Missouri Archaeologist* 21, (1959): 1-67.
[44] Bird effigy pipe, http://www.atada.org/stolen/wolf8_t.JPG
[45] Thomas, *Report On The Mound Explorations of the Bureau of American Ethnology*, 202-205.

part of a broader and still incomplete movement of peoples. Beginning in the mid-fourteenth century, this population shift may have been related to the little ice age as new Native American groups arrived from farther North to settle the area. The Kaskaskia Indians were probably the first to do this, and continued the tradition of extracting, manufacturing, and trading lead with distant tribes and eventually with the French. By the late seventeenth and into the early eighteenth century, Jesuit missionaries, explorers, travelers, and prospectors documented this Native American mining tradition in written and visual sources.



Map 3: Louis Armand Baron de Lahontan's drawing of a Native American Medal.[46]

[46] Map showing the importance of metals to early Native Americans, by Louis Armand Baron de Lahontan, *New Voyages to North America Containing an Account of the several Nations of that Vast Continent; their Customs, Commerce, and the Way of Navigation upon Lakes and Rivers; the several Attempts of the English and French to dispossess one another; with reasons of the miscarriage of the former; and the various Adventures between the French and the Iroquois Confederates of England, from 1683 to 1694; A Geographical description of Canada, and a Natural History of the Country, with Remarks upon their*

Native American guides, French explorers mapping the mines

By the early eighteenth century, Upper Louisiana's lead mining region captured the interest of the French. The French Jesuit, Father Jacques Gravier, noted in his journal that, with the help of the Kaskaskia, "We discovered the River Miaramigoua [Meramec], where the very rich lead mines are situated, twelve or thirteen leagues from its mouth. The ore from this mine yields three-fourths metal."[47] Clearly, Gravier is describing the lead mines where Mississippians extracted ore near what would become known as Mine La Motte. His reference to the extracted lead ore yielding seventy-five percent metal also signifies his ability to assay minerals.

Gravier carried with him across the Atlantic the skills, tools, and techniques to test the quality and quantity of lead ore in the early eighteenth-century. Since the time of Agricola, assayers acquired an intimate knowledge of many chemical substances. Assaying was a sampling process in which a small amount of ore was tested for its quality and quantity. Europeans understood that the purpose of assaying was, first, to determine if some metal was present in the ore, and second, to measure what proportion of one or more metals might be present. To assay ores Gravier, and other explorers who would follow, carried with them a cupola. This European practice eventually became part of the early eighteenth-century Native American and French amalgam. The cupola was a shallow vessel used in assaying ores. Assayers had an intimate knowledge of many chemical substances and their reactions. The assayer knew that different metals

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Government, and the Interest of the English and French in their Commerce. Vols. 1 & 2 (London: Printed for H. Bonwicke in St. Paul's Church-Yard; T. Goodwin, M. Wotton, B. Tooke, in Fleetstreet; and S. Manship in Cornhil, 1703), 29-30.

[47] Newton D. Mereness, ed. " Journal of Diron D'Artaguiette," *Travels in the American Colonies, 1690-1783, Edited Under the Auspices of the National society of the Colonial Dames of America*, (New York: Antiquarian Press, 1961), 15-94.

dissolved to different extents. The purpose of assaying ores was to determine if some metal was present in the ore, and also to see what the quality and quantity of one or more metals might be contained in the ores.[48]

The French were determined to find mineral wealth in the vast province, and if precious metals could not be found, lead would have to do. In 1713, Antoine de La Motte Cadillac became governor of Louisiana. He was well aware that "there are mines west of the Mississippi," further stating that "all the tribes north of the Red River know about these mines."[49] Within two years he traveled up the Mississippi River to the Illinois country to conduct exploratory diggings for lead. La Motte Cadillac not only left his name to Mine La Motte in northern Madison County, Missouri, but also documented, similar to earlier explorers, with the assistance of his Native American guides, the mining location for French court officials. These accounts reveal that Native Americans told French explorers about Mine La Motte. The Gravier and La Motte expedition were also significant because their accounts became a guiding reference for future expeditions.

By the early eighteenth century, Native American knowledge of the mining region filtered into the cartographic catalogs of European geographers.[50] The maps created by official cartographers from the period of exploration passed through the hands of other explorers. The publication of maps during this period represents the reproduction of Native American environmental knowledge and the potential for mining activity.

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[48] Hoover, *Georgius Agricola, De Re Metallica*, Book VII.

[49] Mereness, ed. " Journal of Diron D'Artaguiette," *Travels in the American Colonies*, 67-75.

[50] G. Malcolm Lewis ed., *Cartographic Encounters: Perspectives on Native American Mapmaking and Map Use* (Chicago: University of Chicago Press, 1998); Conrad E. Heidenreich and Edward H. Dahl, "The French Mapping of North America, 1700-1760," *Map Collect*or 19 (June, 1982): 2-7; Conrad E. Heidenreich, "Mapping the Great Lakes: The Period of Imperial Rivalries, 1700-1760," *Cartographica* 18,3 (1981):74-109.

The French cartographer Guillaume Delisle, who never visited the New World, accomplished his reconstruction of early eighteenth-century maps depicting the Native American mines by interviewing explorers. He most likely collected the data from soldiers, missionaries, fur traders, and explorers who returned to France. For example, Gravier probably communicated to Delisle the location of Native American villages, rivers, mountains, and mines. Following the Native American and Gravier expedition to Mine La Motte, Delisle worked to produce a detailed map of the little known Mississippi Valley. By 1703, the map first appeared and clearly showed the major tributary rivers along with several lead mines. The Delisle maps began the visual reproduction of the Indian lead mines location, which circulated throughout France in order to guide newly arriving explorers.[51] Mapmakers Guillaume Delisle and Jacques Nicolas-Bellin described the region as the *country full of mines*. It appears that both cartographers transformed Des Ursin and De Gruy's verbal information into visual form on their 1718 and 1744 maps of the Mississippi River valley. While Delisle noted the Native American mining site as a Bellin cites the discovery of a new lead mine in much closer proximity to Kaskaskia. Cartographic reproductions were significant valuable tools for merchants contemplating commercial ventures. Following the publication of the Delisle and Bellin maps, the knowledge of these lead mines continued their circulation throughout France.

[51] Robert W. Karrow, Jr. and David Buisseret, *Gardens of Delight: Maps and Travel Accounts of Illinois and the Great Lakes from the Collection of Hermon Dunlap Smith, An Exhibition at The Newberry Library 29 Oct – 31 January 1985* (Chicago: Newberry Library, 1984); Alan Gallay, *The Indian Slave Trade: The Rise of the English Empire in the American South, 1670-1717* (New Haven: Yale University Press, 2001), ix-xi.

Map 4: Guillaume Delisle 1703 Map showing the "Country full of Mines"[52]

Native Americans and French Consumer Practices

During the late seventeenth century, the Kaskaskia relocated to the middle Mississippi Valley, and settled east of the Mississippi River. In 1700, they moved west of the Mississippi River, settling for three years below St. Louis. There is no written historic documentation of Kaskaskia activities during this interval. However, the archeological record reveals their desire to remain in close proximity to the southeastern Missouri galena mines because they were still working with lead ore. The presence of the Kaskaskia Indians in the central Mississippi Valley is linked to their locating, extracting, and smelting lead ore. There they smelted galena into lead and then poured

[52] Hargrett Rare Library, http://www.libs.uga.edu/darchive/hargrett/maps/1718d4.jpg, (February 28, 2012).

the molten lead into catlinite molds to make finished products such as musket balls, baling seals, and gaming pieces. Like the French, the Kaskaskia were contemporary newcomers who would become important players in prospecting, extracting and molding lead ore. [53]

When the Kaskaskia relocated to the Mississippi Valley, they made contact with the recently established French mission at Cahokia, near present-day East St. Louis, Illinois, which attracted traders and merchants. Soon afterwards, an even larger French community grew up near the Kaskaskia village. In 1703, the Kaskaskia relocated back across the Mississippi River, settling along the Kaskaskia River. Another Indian tribe, the Michigamea, settled nearby in 1720, and later joined the Kaskaskia's mining activities.[54] The Michigamea were an Algonquian-speaking people located in the southernmost section of the Illinois. In 1673 Father Jacques Marquette visited their principal village, which was then situated along the Mississippi River in northeast Arkansas. The Michigamea later migrated north and settled near the mouth of the Kaskaskia River before moving closer to Fort de Chartres in 1720. Both villages eventually became centers where explorers gathered before beginning their expeditions to the lead mines. In most cases, it appears that after Native Americans and French miners prospected and extracted galena, they returned to these villages. Subsequently, Kaskaskia became the earliest site for the production and exchange of both Native American and European lead products. The Kaskaskia continued to manufacture their

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[53] Carl H. Chapman, "A Preliminary Survey of Missouri Archaeology. Part I. Historic Indian Tribes," *Missouri Archaeologist*, 10, (1946): 19-20; Margaret B. Brown, "The Zimmerman Site: Further Excavations at the Grand Village of Kaskaskia," *Illinois State Museum Reports of Investigations*, no 9 (1975), 116-120.
[54] Walthall, *Galena and Aboriginal Trade in Eastern North America*, 18-25.

own galena products using catlinite molds by carving certain designs into the stone.[55] These designs are triangles, circles, crosses, or some shape suggestive of small ornaments, such as earbob, and the Kaskaskia eventually continued to use catlinite to produce European products such as baling seals, musket balls, and crosses.[56]

Figure 3: Lead baling seals, known as fabric seals used to bundle furs or identify trade goods.

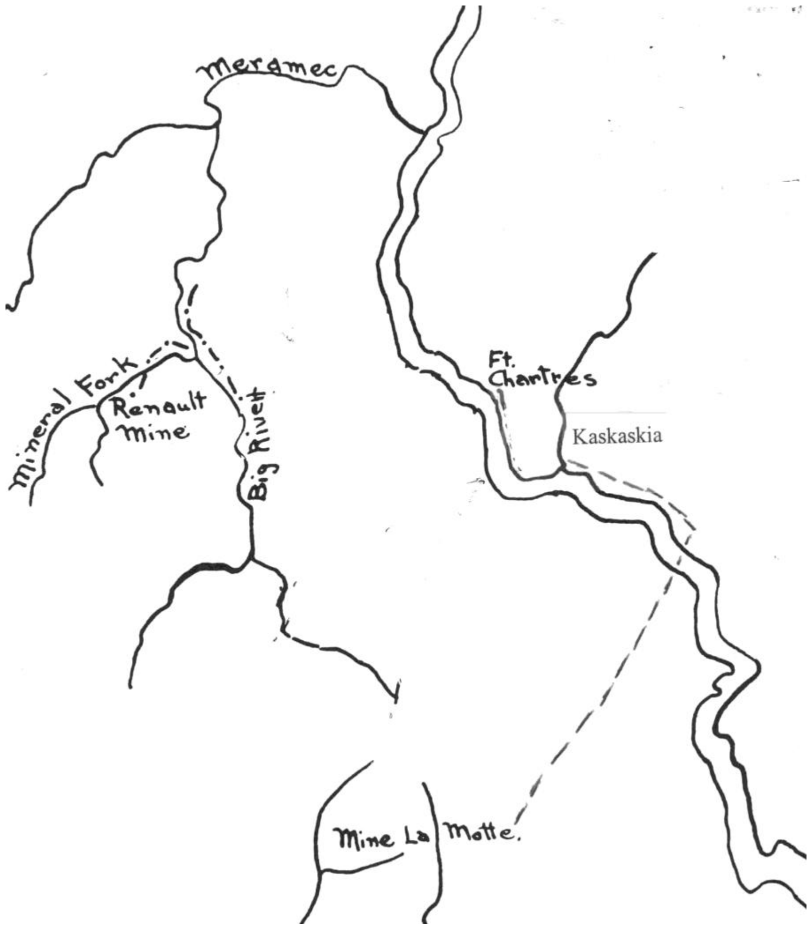
These artifacts have been recovered from the Guebert Site, known as a place where Native Americans and French miners worked with lead. The Kaskaskia lived and worked there while the French lived nearby in the village of Fort de Chartres where miners manufactured and traded lead products.[57] Pottery samples with traces of glazed paints have also been recovered near Kaskaskia Village. This combined evidence suggests that like the Mississippians who came before, the Kaskaskia also mined galena

[55] For designs similar to objects made by the Indians, see William H.R. Lykins, "On the Mound-Builders' Knowledge of Metals," *Kansas City Review of Science and Industry*, (1882): 535; George E. Fay, "Lead-Silver Molds of the Osage Indians," *Transactions of the Kansas Academy of Science (1903-)* 52, no. 2 (1949): 205-208.

[56] George I. Quimby Jr., "Indian Trade Objects in Michigan and Louisiana," *Michigan Academy of Science, Arts, and Letters* 27, (1941): 543-551; Brown, "The Zimmerman Site: Further Excavations at the Grand Village of Kaskaskia," 80-91.

[57] Catlinite or pipe clay is a type of mudstone, usually brownish-red in color, which occurs in a matrix of Sioux quartzite. Because it is fine-grained and easily worked and was prized by Native Americans for making sacred pipes was commonly referred to as peace pipes, or calumets. John S. Sigstad, "A Field Test for Catlinite" *American Antiquity* 35, no. 3 (1970): 377-382.

and molded lead near where the Native Americans eventually guided Des Ursin and Renaudiere.



Map 5: The Des Ursin and Kaskaskia Indians Route to the Mines.[58]

By 1718, explorers' accounts and maps pinpointing Native American lead mines attracted the attention of French court officials. Still hoping to locate mines, Louisiana Territory governor Antoine de La Motte Cadillac requested the assistance of two accomplished mining engineers, Des Ursin and Renaudiere.[59] Cadillac wanted both men

[58] Lucy Elizabeth Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period" (unpublished master's thesis, St. Louis University, 1942), 15.
[59] Stanley Arthur, trans., M. Le Page Du Pratz, *The History of Louisiana, or of the Western Parts of Virginia and Carolina: containing a description of the countries that lie on both sides of the river*

to extract lead ore samples and to test the quality of those samples. In addition, Des Ursin and Renaudiere's accounts suggest that they surveyed Mine La Motte to judge its suitability for establishing a settlement. Closely following Cadillac's request, Des Ursin and Renaudiere, along with the Kaskaskia Indians, prospected and extracted limited samples of lead ore for local and distant exchange. Clearly, both expeditions not only reveal frontier convergence of the Kaskaskia, Des Ursin, Renaudiere, and later De Gruy's environmental knowledge and mining practice, but also the possibilities for the French to develop a mining settlement.

"Infinite number of holes from which they drew lead"

The Des Ursin and Renaudiere journals each reveal the perception and impact of Native American know-how on the practice of prospecting and extracting. When Des Ursin describes in his journal the "infinite number of holes from which [Native Americans] drew lead" from the surface, he is recounting a venerable Native American method of extracting lead ore.[60] Des Ursin's observations reveal that the Kaskaskia Indians worked their mines in the same fashion as the Pueblo, and the later Mississippians who mined for stone.

Following a strenuous journey from New Orleans up the Mississippi river, both Des Ursin, in 1719, and Renaudiere, in 1723, arrived in Kaskaskia. There they sought the assistance of Native American guides who directed them to the lead mines. Together, the Kaskaskia and French miners carried with them prospecting and extracting knowledge to Mine La Motte. Each explorer's narrative paints a picture of the possibilities for

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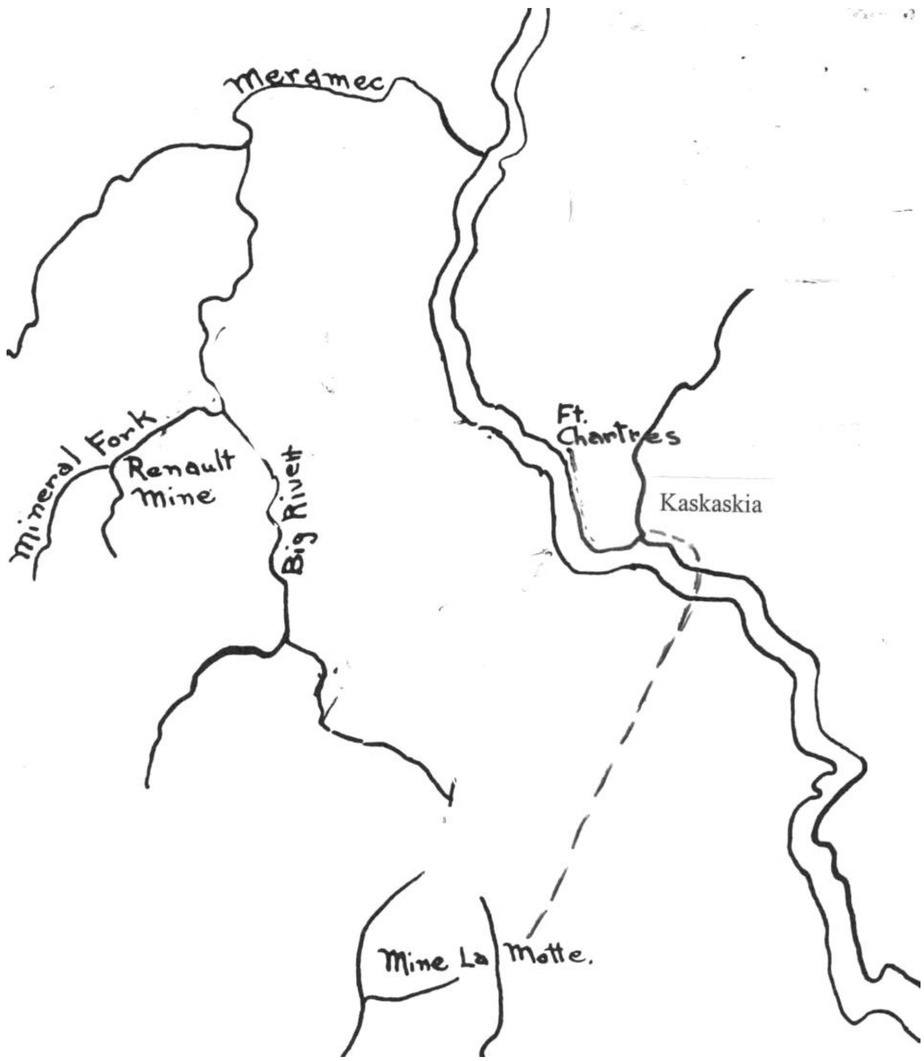
Mississippi: with an account of the settlements, inhabitants, soil, climate, and products, (London, 1764). 33-58.

[60] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin."

settlement near Mine La Motte. Both comment how "There are rivers in which fish abound, also turtles, and a large number of water fowls."[61] Each account highlighted the possibility of constructing an eighteenth-century miner's frontier to extract lead ore for the production of symbolic as well as practical items. What these explorers had in mind was to gradually transform the surrounding landscape into a European-style farming and mining settlement.



Map 6: La Renaudiere and Kaskaskia Indians Route to the Mines

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[61] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; Renaudiere "Account of the Mines of M. de la Motte."

Recovering the hidden prospecting elements

The Des Ursin and Renaudiere accounts note the convergence of early Native American and French prospecting and mining activities. Des Ursin and Renaudiere each suggest that the important and foremost step occupying the minds of miners was to locate a lead mine. Significantly, Des Ursin and Renaudiere also observed Native American prospecting techniques that revealed Native American environmental knowledge.[62] The Kaskaskia developed an acute sense of how to determine the location of minerals. As Renaudiere's observations show, indigenous peoples knew that the color of plants, stones, and soil suggested the possibility of locating minerals. Renaudiere describes how Native Americans guided him to "a large number of mountains where the color of plants and stones gives strong indication of mineral wealth."[63] Renaudiere observed additional evidence of Native American acumen after he finished digging a Native American style trench and located a vein of galena running underneath the unhealthy plants. Therefore, when Native Americans approached open spaces that lacked clusters of plants in rows, such environmental markers suggested that a vein of metal could be found in the spaces between the rows directly underneath the earth's surface.

Des Ursin also describes his initial worksite, where he judged the layers of veins to be lead based on what he learned from the Kaskaskia. On the first day of the digging, Des Ursin wrote, "The earth is very black and heavy; then we found two feet of yellow earth also with lead—deeper down we met with a layer of ground, black and yellow,

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[62] For comprehensive writings on early mining processes, see Alvaro Alonso Barba, *A Collection of scarce and valuable treatises upon metals, mines and minerals…Being a translation from the learned Alvaro Alonso Barba and the observations of several persons of our own country, founded on many years experience*, (London, Printed for J. Hodges, 1684), 38-40, 89-91.
[63] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin."

mixed with pieces of lead."[64] During his expedition to the mines, Renaudiere's recognized the presence of lead ore by the natural appearance of stones stating "We found a quantity of stones of verdigris, which is a sure indication of the presence of copper, mingled with veins of lead one half foot in thickness—On the other side of the St. Francis river where a large number of [colorful] stones gives strong indications of mineral wealth."[65] Des Ursin account depicts how the Kaskaskia, Des Ursin and Renaudiere each understood the importance of recognizing various shades of color when prospecting for galena, just like the Native Americans did.[66] These French men observed Native Americans using an environmental knowledge and practice that Europeans also used in their mining environments.

To discover the purity of ores, indigenous miners applied their sense of taste and of smell. After Native Americans located a section of earth with a "good smell," it was a sign of mineral richness.[67] European mining engineers also depended on olfactory tests to judge tin or lead deposits. Lead miners were sensitive to whether or not "the metal that comes out of the mines is of good smell, if they light not upon some bastard mineral that accompanies, and has infected it."[68] A variety of metals were "said to have a bad taste due to the possible mixture with other metals or stones and their juices."[69]

Europeans also acquired an acute ability to judge the quality of lead ore, or any mineral, by taste. They too developed a number of steps to prepare the soil for tasting. First, the miner mixed water with a small sample of earth. Second, he boiled the mixture

[64] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin." Also, see Clarence Walworth Alvord, *The Illinois Country, 1673-1818* (Illinois: Illinois Centennial Commission, 1920), 154.
[65] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; Renaudiere "Account of the Mines of M. de la Motte."
[66] Houghton*, Royal Institutions: Being proposals for…the digging and getting of lead*, 169-170.
[67] Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 41.
[68] Barba*, A Collection of scarce and valuable treatises upon metals, mines and*, 4-6.
[69] Barba*, A Collection of scarce and valuable treatises upon metals, mines and*, 4, 59, 118.

several times, and finally, after boiling the mixture once or twice, he then discerned the mixture's quality by sampling the distilled liquid. European miners understood that the pure earth had no significant taste; however, the miner commonly alleged that soil mixed with minerals carried a bad taste. The careful preparation and standardized technique of Native Americans paralleled European knowledge and practice of the period.[70] Europeans applied their sense of taste and smell when searching for metals. The experienced miner was sensitive to the taste and odor of a particular mining region's water and air. This determined the liquids emanating from the mines and helped them to find out their chemical character.[71]

Renaudiere expected the local water to have an acidic taste because he was searching for lead ore. He understood this taste to indicate the presence of sulfur. Renaudiere reported, "In the neighborhood [of the mines] there are many mountains—the waters flowing from them are bitter. There is no doubt that if these were excavated and dug into, very good mines would be found." Renaudiere definitely tasted the water of the mining area to ascertain whether galena would be found. His next comment suggests the location to be a good place to construct a settlement where miners could extract "approximately three hundred million" pounds of lead "each year from many trenches."[72]

As Des Ursin and Renaudiere continued to rely on Native American prospecting practices, they also begin to indirectly explain to their readers how Native Americans extracted lead ores. The Renaudiere journal, more so than Des Ursin's, is replete with information associated with the North American Indian mining technique. Des Ursin

[70] Houghton, *Royal Institutions: Being proposals for…the digging and getting of lead*, 5-9.
[71] For understanding Native American environmental knowledge and their early prospecting practices see, Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 9.
[72] Renaudiere "Account of the Mines of M. de la Motte."

fails to clearly describe the method by which Native Americans extracted lead ore; there is a problem with the terminology he was determined to use. For example, when Des Ursin arrived at Mine La Motte, he directed his "workmen to dig into the shaft which Mr. De La Motte had made," and on the second day at the mines he states, "We commenced a shaft which is larger than the two preceding ones."[73] The term "shaft" is clearly representative of Des Ursin's European experience of digging larger and deeper holes to extract more ore.

Europeans dug their shafts vertically until miners approached a vein, mountain, or hill.[74] According to European standards, shafts were twice as high as wide, and roomy enough for miners to pass through while carrying their galena loads. These holes went beyond a depth of thirty feet, sometimes to seventy or one hundred feet, to reach ores. Des Ursin's shaft "was only four feet deep" or "six feet deep," which was similar to the Native American trench.[75] Although it appears that Des Ursin recognizes the lead mines as an indigenous location, the term shaft did not apply to the Native American extracting method. The mines that Native Americans worked at Bethsheba and Mine La Motte produced lead close to the surface; therefore, it was necessary to only dig a trench no deeper than six feet. Because of this problem with terminology, we must turn to Renaudiere's account.

Des Ursin and Renaudiere mean the same thing when they employ the terms "shaft" and "trench." Though using both terms, each engineer describes what appears to be a longstanding Native American tradition of extracting minerals from trenches

[73] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin."
[74] Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 3, 18, 28.
[75] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; J. Lyman Hayward, *The Los Cerrillos mines [N. M.] and their mineral resources*, 26-28.

measuring one to six feet in depth. During the expedition in August 1723, Renaudiere accepted Native American mining knowledge and technology and used the term shaft to describe the "holes" created by Native American miners: "Six men can operate three shafts, two at each shaft," he wrote. "In order to procure much mineral from these openings, they are like trenches, and one must follow the veins which are found on the rock."[76] Here, he implies that these "shafts" are more like the Bethsheba "trenches," and different from shafts in Europe.

Des Ursin and Renaudiere not only depended on the Kaskaskia to direct them to the lead mines, they also adopted Native American tools to dig their trenches. Both explorers recorded trouble using the Native American mining implements, at one time referring to their tools as "primitive." Renaudiere noted that the greatest portion of lead ore at Mine La Motte could be found imbedded in a thick stratum of marl clay adjacent to limestone. According to Des Ursin, when his workers reached the limestone, they found it difficult to continue digging because of "a hard rock which we could not pierce and which ruined most of our tools."[77] This suggests that instead of Ursin and his workers using iron tools, they had to accept the tools Native Americans constructed after arriving at the mining site.

Native American implements included wooden spades and stone or buckhorn hammers to dig trenches, and picks to separate galena from other matter. The Kaskaskia also used baskets and hide ropes to haul lead ore from the trenches to nearby rivers for washing to prepare the galena for the smelting.[78] Following European contact, a

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[76] Renaudiere "Account of the Mines of M. de la Motte."
[77] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin."
[78] Reuben Gold Thwaites, "Notes on Early Lead Mining in The Fever (or Galena) River Region," *Collections of the State Historical Society of Wisconsin*, 13, (1895): 271-292.

transition began to occur, as Native Americans became increasingly accustomed to using trade goods such as iron hoes, picks, shovels, and crowbars to replace many of their tools.[79] Though they used different tools, the mines themselves were probably of the same type during the early period of mining described above.

Native Americans followed "the crevice deposits by digging inclined trenches into the sides of hills."[80] In cases where Native Americans approached rocks, they applied an alternative method. There is no evidence that gunpowder was used to blast the rock at Mine La Motte. However, when the Fox and Sioux Indians encountered limestone at the lead mines located near present day Galena, Illinois, they ignited large fires along the rock face. Next, they doused the rock with cold water. This cracked the rock, making it easier to pry apart and remove the lead ore. There is no mention of this practice at Mine La Motte; however, since Des Ursin and Renaudiere report that the lead veins usually were lined in limestone, the Kaskaskia may have employed this same technology.

Europeans referred to this process as "fire setting." Ancient miners used this technology, and it was eventually replaced with the use of gunpowder after 1627.[81] Fire setting was recommended for mining even the hardest rocks. It was a slow and dangerous process. If miners did not take precautions, the vapors and fumes might cause headaches, or also could cause ill health or even death from suffocation. For this reason, Europeans, like Native Americans, also practiced setting fires just before sundown, and

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[79] September 26, 1738. Fontainebleau. Minister to Bigot de La Mothe [Lamothe]. AC., B 67:157. Surrey, *Calendar of Manuscripts in Paris, Vol. 1*, 297.

[80] Philip Millhouse, "A Chronological History of Indian Lead Mining in the Upper Mississippi Valley from 1643 to 1848," (Unpublished Paper for History Special Projects, Illinois: Galena Public Library, April 22, 1993), 8-9; Larry Abbott, "Frontier Lead Mining in the Upper Mississippi Valley," *Journal of the Iowa Archaeological Society*, 35, (1988): 9-12.

[81] Hoover, *Georgius Agricola, De Re Metallica*, Book V.

they returned to their mines early the following day to inspect and remove chunks of lead ore. Fire setting involved the placing of dry logs against the wall that was to be tunneled. The fire chipped and splattered the stone.

After digging their trenches using Native American stone implements, Des Ursin and Renaudiere discovered the galena in a small layer four feet below the surface of the ground. Usually the veins were located either above or below limestone, and often mixed in with the soil. Des Ursin and Renaudiere described the veins at Mine La Motte "as a small layer of lead four feet below the surface of the ground which is yellow, intermingled with black, green, gray and reddish; below it is a very hard rock, mixed with grains of lead, six inches thick; deeper down is another layer, three to four inches thick."[82] Adhering closely to the directions of their Native American guides, Ursin and Renaudiere dug trenches revealing galena, suggesting the beginning of amalgamation. Since lead is metallic but not shiny, it was different from most other kinds of ores that explorers prospected for in the soil.[83] Both engineers confirmed that the layer just four feet deep was indeed galena prior to constructing a worksite. This required a certain level of skill and knowledge. Therefore, using the trench method to "break the earth's surface," miners could view the layers of lead ore, and in some cases, both engineers observed small grains of lead intermixed with the soil.[84]

Pellets of lead shaped like grain were either galena or granular sulphuret of lead. Native Americans and Europeans prized galena as the most important type of lead ore. Known to Europeans as galena, or potter's lead ore, it was the most common of all the

[82] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; Renaudiere "Account of the Mines of M. de la Motte."
[83] Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 38-39.
[84] Houghton, *Royal Institutions: Being proposals for…the digging and getting of lead*, 17.

lead ores, and it is shaped like moderate-sized cubes or grains.[85] Des Ursin and Renaudiere must have been excited to recognize the dark blue "fine steel grain" mineral from Mine La Motte, since it was known to possess a high percentage of sulfur.

Europeans carried with them to Mine La Motte the knowledge and technology to test the quality of lead ore. Assaying ores was an important part of the European mining experience. As a rule, engineers reported not only the quality but also the quantity of lead contained in the ore. The early explorers of these mines were also willing to conduct tests using rudimentary techniques in early eighteenth-century North America. It was important to assay lead ores in order to determine the amount of metal contained in a sample of ore. After acquiring a small sample from each mine, both European miners skillfully conducted their test. Any error made was multiplied many times over when the bulk ore was smelted. For example, if assaying was incorrectly performed, several thousand pounds of ore could be lost due to overheating. In addition, if the metal was under-heated, it could evaporate in fumes.[86] Indigenous miners in this area did not apply the art of assaying as an organized practice. If they did, the evidence does not appear in the accounts of Des Ursin and Renaudiere.

Prior to smelting the ores, European miners measured a mineral's quality to determine the quantity of metal in a particular ore. Des Ursin recorded this type of test. He instructed a number of workers to cut enough timber to test samples of lead ore, which they apparently were successful in doing near the extracting site of production: "at a depth of seven and a half feet we found a layer of lead which at its narrowest was 8 inches wide—In the center of this shaft we found a very good vein similar to the one of

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[85] Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 74.
[86] Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 75.

which we have taken the samples, which we have tested and of which I send you samples sufficient to let you judge of its value yourself."[87] Renaudiere also adds details to the subject of testing lead ores. In the location where the veins "are well-formed," Renaudiere continues, "the mineral is found to be good, and produces as much as from 40 to 45 percent" metal. In addition, he writes of other mining trenches that "are very rich in lead. They produce as much as 80 percent." Renaudiere and Ursin assayed lead ore to determine its quality, and it's required smelting time. By the 1700s, the art of testing ores appears to be a European practice, which can be seen as a European contribution to this amalgam.[88] Testing metals required a set of tools, such as the cupola, which was a very absorbent shallow vessel. To conduct a successful assay of the lead ore at Mine La Motte, Renaudiere and Des Ursin understood that, when heated, lead dissolved into a slag after a certain length of time.

However efficient the Europeans' method appeared, it did not work. Des Ursin seemed to encounter problems because "the crevets and skillets have melted several times in the fire," and they were "obliged to gather from the cinders what could be recovered." He must have resorted to another technique.[89] His tools melted due to the excessive heat during the testing or possibly the smelting phase. Renaudiere's journal reminds us that, "when [Native Americans] go to make lead, they carry with them only their weapons and ammunition," suggesting that Native Americans most likely developed a smelting method. Des Ursin lacked the "crevets and skillets and bricks" to construct a furnace in

[87] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin."
[88] Hoover, *Georgius Agricola, De Re Metallica*, Book VII.
[89] Crevet is a type of crucible or melting pot used to test the quality of a mineral. Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin."

which he would melt and mold the lead ore.[90] Therefore, he most likely adopted Native American lead ore smelting techniques. Both accounts are silent on North American Indian smelting technologies; that process will be discussed in a subsequent chapter. Nevertheless, the accounts of Des Ursin and Renaudiere *recover* the convergence of Native American and European practices. Their journals also highlight the amalgamation of prospecting methods and French adoption of indigenous tools and extracting methods.

Mid-eighteenth century discovery practices

By 1743, before Antoine De Gruy approached the Kaskaskia to seek out where new lead deposits might be found, he "asked the commandant of [Fort de Chartres], if I could myself go and verify with the Indians the report they had so often made to me."[91] For example, after De Gruy and his Kaskaskia guides arrived at one open prairie, the Kaskaskia directed him toward a "five to six feet high" ridge. Once they ascended the ridge, the Kaskaskia pointed to a "vein of lead above the ground."[92] De Gruy's acceptance of the Kaskaskia Indian's guidance continues to suggest that without their assistance, early French mining efforts would have continued to face difficulty.

Antoine Valentin de Gruy was a young French officer stationed at Fort de Chartes, where he moved to from New Orleans. The historical record is silent regarding De Gruy's whereabouts before 1741. It appears that while he was in the military service of the army he learned to supplement his income by lead mining. De Gruy's narrative is

[90] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin".
[91] On April 5, 1743, Antoine Valentine de Gruy documented his experiences in, "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country." The original French document was translated by Carl J. Ekberg. The original French copy is in the Archives Nationales, Paris, series G1 465, folios 3-15, Photostat in the Illinois Historical Survey in Urbana, Illinois. See Carl J. Ekberg, "Antoine Valentin de Gruy: Early Missouri Explorer," *Missouri Historical Review* 76 (January 1982): 136-150.
[92] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

representative not only of Native American presence and environmental knowledge, but also indicates a place where Native American and French prospecting and mining skills continued to converge. The Kaskaskia and French miners both understood that the most important step was to locate mineral indications. While Des Ursin, Renaudiere, and the Kaskaskia prospected for lead ore during the summer season of 1719, the two Kaskaskia Indians directing De Gruy to the mines departed Fort Chartres in early April of 1744. Both seasons were the traditional time when the Kaskaskia and Osage Indians departed their villages to hunt after enduring the long winter season. According to De Gruy, "the snow still blanketed the ground in certain areas."[93] Following days of walking and building a bark canoe to cross the Meramec River, the Kaskaskia and De Gruy proceeded approximately twenty miles downstream to a rock cliff. To reach the top of the cliff, they went around to the rear and climbed a steep slope to an open prairie.

When the expedition arrived on the top of the open prairie, De Gruy was confident that his guides had directed him to a lead deposit. Similar in fashion to early Europeans, De Gruy observed how Native Americans carefully studied the prairie's surface before probing the earth's surface for lead ore. He described the appearance of the landscape as a site where

> the snow that sometimes lies on the ground for six weeks or two months in this country melts immediately in this spot. This means that in an area three or four leagues in circumference the land produces nothing but a few oaks that seem to grow only reluctantly, and uniformly for there is no other species of tree or moss, nor is there any other kind of stone, and the soil is about the same color as the previous lead mines I visited.[94]

[93] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

[94] Alonzo Barba recognized Native American prospecting techniques near Potosi, Peru. Similar to De Gruy, Barba offered additional evidence regarding prospecting techniques that seem to have been also applied near Mine La Motte. The Native American accompanying Barba suggested, "If plants were not growing strong or if their color was visibly weak, it could only mean that the soil had difficulty breathing in the necessary nutrients." Barba, *A Collection of scarce and valuable treatises upon metals, mines*, 68.

De Gruy illustrates the spot where galena might be discovered. The space lacked snow or trees, and the soil reflected a particular color. Plants lacking color suggested that lead ore would create a dwarflike plant.

Environmental markers such as snow, plant color, or absence of dew signaled to the Kaskaskia and De Gruy the presence of lead ore. By searching for minerals early when "the morning dew and the snow which falls is gone from those mountains," De Gruy clearly understood that veins of lead ore might possibly become visible.[95] As De Gruy notes, the absence of the snow confirmed that his guides did direct him to a new lead discovery only known to them. As prospectors and miners, the Kaskaskia and Antoine De Gruy viewed the landscape similarly to those who came before, and developed an acute sensitivity for locating minerals. Miners carefully followed the arrangement of trees and other plants. Their experience also taught them to examine the healthiness of plants to determine the location of mineral veins.

Further evidence comes from the Upper Mississippi basin where the Winnebago Indians applied a method of prospecting that early geologists attributed to them, but was also later adopted by Euro-Americans.[96] The Winnebago, too, depended on vegetation's color as a guide. The plant known as *lead weed*, or prairie shoestring, commonly grew in elongated patches over clay-filled lead crevices. Also known as *Amorpha Canescens*, it was "perhaps the most conspicuous and characteristic shrub of the upland. Amorpha may develop into bushes two-and-one-half to four-feet tall and when abundant," the landscape

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[95] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

[96] I carefully use the term geologists to refer to geological research in North America developed from a few isolated inquires in the eighteenth century to a descriptive science by 1818. In 1771, the study of earth science in America was limited to a few observations on diverse subjects. See Robert M. Hazen, "The Founding of Geology in America: 1771 to 1818," *Geological Society of America Bulletin*, 85, (1974): 1827-1834.

appeared to be a "leaden" color.[97] When a traveler visited the lead mines of Galena, Illinois, he noted, "We saw the mineral plant with its blue leaves and most beautiful [purple] flowers, growing in clusters, bunches and rows, indicating where beds and veins of lead ore existed beneath the surface."[98]

Figure 4: Lead Weed

One example of a Euro-American who adopted this Native American practice occurred when Esau Johnson, a prospector, miner, and smelter, noted

> I then went out on the prairie searching for my oxen, and there in a ravine I noticed a place about one rod wide and near twenty rods in length, that the grass and weeds looked very thrifty and blue, and all around it there was very little of anything growing; I looked it over and then commenced [to did] on the south side of the range. As I spaded and shoveled off the fourth time, my spade touched [sic] mineral all the way across the range.[99]

From his discovery, Johnson raised more than 3000 pounds of lead before nightfall, and ultimately a total of 154,550 pounds of mineral from the location. It is apparent that

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[97] John Weaver, the botanist who specialized in prairie vegetation, wrote of this legume that the roots of this plant sometimes penetrated the clay to a depth as much as forty feet. John E. Weaver, *North American Prairie* (Lincoln: Johnsen Publishing Co., 1954), 69-70.

[98] Caleb Atwater was from Ohio, and served as a commissioner at Prairie du Chien in 1829, where he viewed the lead mines. Caleb Atwater, *Writings of Caleb Atwater's Travel in America,* 1833, http://books.google.com/books?id=H88i3y35liEC&pg=PP2&lpg=PP2&dq=Caleb+Atwater+writings&source=bl&ots=IHPmcKXIhz&sig=6lwTqA4AkcnWBowDcKyGJzHQ5uA&hl=en&ei=fmbiTrn6E6H50gG0i4X3BQ&sa=X&oi=book_result&ct=result&resnum=10&ved=0CG8Q6AEwCQ#v=onepage&q=Caleb%20Atwater%20writings&f=false,340, (June 17, 2010). Also, see Walter Havighurst, "Wilderness for Sale: The Story of the First Western Land Rush, (New York: Hastings House, 1956), 140; Charles R. Birk, "Shortest Route to the Galena Lead Mines: The Lewistown Road," *Journal of the Illinois State Historical* Society, 66, no. 2 (1973): 187-197.

[99] Esau Johnson Reminiscence, Johnson Papers, Wisconsin Room, Karrmann Library, University of Wisconsin-Platteville, B34-B35, B40.

Native Americans, Europeans, and Euro-Americans all used environmental markers to prospect for veins of lead ore lying beneath the soil.

The De Gruy report, as well as evidence from the Upper Mississippi basin, suggests that Native American prospecting methods influenced mining in the central Mississippi River Valley. When the Kaskaskia and De Gruy approached plants clustered together or approached a space lacking snow or dew, or noted the color of particular vegetation, they located veins of ore clustered beneath the soil. More importantly, both shared a familiar and intimate knowledge of the environment. Upon reaching the lead mines, both Native American and French miners applied their longstanding practices to locate lead ore. De Gruy also tells of a large area where the color of plants and stones suggested a strong indication of mineral wealth. After probing through the trench, he recovered a vein of galena running directly underneath the unhealthy plants.

The convergence of new mining implements

On Monday April 15, 1743, two Kaskaskia Indians and Antoine Valentine de Gruy prepared to depart the village of Kaskaskia to locate new lead mines. Prior to leaving the village, they loaded carts with the "necessary implements for making excavations." De Gruy closely followed his Kaskaskia Indian guides along a route he describes as "most practical for pack horses to transport mining equipment and lead ore." De Gruy's account continues to reveal the convergence of Native American and European prospecting and extracting techniques.[100]

As Native American guides continued to direct French miners through the mining region, Native Americans also started to use a combination of stone and iron tools to

[100] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

extract and remove galena from their trenches. To their mining implements the Kaskaskia adopted European metal crowbars, hammers, and chisels to remove the ore from the wall. The miners then hauled the lead ore from the trenches using baskets tied to hide ropes. They hammered the ore into a movable size and placed it in baskets or wheelbarrows, and then carried it to the smelting station.

By the time of De Gruy's arrival to the mining frontier, Native American and European miners were using iron tools.[101] The first French miner to successfully transport iron tools from Europe to the Mississippi Valley was the mining engineer Renault. Commandants of Kaskaskia and New Orleans often requested that French court officials send iron tools not only to build their settlements, but also to exchange for furs acquired by Native Americans. Miners in search of lead ore crossed the Atlantic and traveled from New Orleans in bark canoes up the Mississippi River to Kaskaskia Village, carrying with them tools to extract minerals from the soil.

The adoption of European tools on the part of the Kaskaskia was a significant change. The development also signifies European miners transitioning away from using Native American tools such as stone hatches and buckhorn picks to extract lead from trenches, a welcome change. Des Ursin complained that when he employed Native American tools, they snapped in half. Renaudiere added that when the Kaskaskia go "to make lead" without carrying tools except "their weapons and ammunition."[102] For years the Kaskaskia worked their lead mines using stones and animal bones to carve vertical

[101] Shipping documents note this transfer of tools between New Orleans and Kaskaskia. May 14, 1740. Kaskaskia, Illinois. Bill of exchange in payment for supplies from Grignon. AC., C 11, 73:276. Surrey, *Calendar of Manuscripts in Paris*, 297.

[102] Renaudiere "Account of the Mines of M. de la Motte."

trenches, similar to the way Europeans used hammers, axes, and picks to dig shafts and remove the ore from the mines' walls.[103]

In like fashion to reports made by Des Ursin and Renaudiere of Native American and French prospecting and extracting methods, De Gruy's account also illustrates the experiences of the Kaskaskia and French miners in this lead mining landscape. De Gruy immediately notes the presence of the Kaskaskia Indians. This suggests his acceptance of their guidance and knowledge to locate new lead deposits. Additionally, De Gruy records the transition from Native American tools to European-styled mining implements by the mid-eighteenth century. This suggests that Native American and French miners no longer manufactured their mining implements from quartzite, sandstone, or limestone, all readily available near the mines. Instead the full incorporation of European iron implements had occurred on the mining frontier. Each of these attributes provides further evidence of the French desire to construct a mining settlement near the deposits.

As the demand for lead increased, European trade goods also became necessary for mining in the middle Mississippi Valley. De Gruy most likely carried European iron hoes, picks, shovels, and crowbars from either New Orleans or France to mine for lead ore. Iron could be sharpened to hold an edge better than the animal bones or stone that Native Americans continued to use. During this transitional period, Native Americans had adopted the European tools to dig trenches, even as the French continued to apply the Native American trench method to extract lead ore using iron tools.

[103] For a concise discussion of early North American Indian tools used to extract in the area of the Santa Fe lead mines, see Hayward, *The Los Cerrillos mines [N. M.] and their mineral resources*, 10, 26, 28; Silliman, "The Turquoise of New Mexico," 289; Bice, *Indian mining of Lead for Use in Rio Grande Glaze Paint*, Ch. 3:1-8.

Before Antoine De Gruy departed on his expedition to the mines, he stated that "We carried implements necessary for making excavations in the earth."[104] De Gruy and the Kaskaskias' wagon included an iron probe, shovel, and pick that on one side could be used as a hammer called a poll. Miners used the probe to "plunge into the ground in alternating places until a vein was struck."[105] Miners applied the probe to drive gads, a type of chisel, into the earth to loosen the lead ore from surrounding soil or rocks. The probe latter became known as a borer; it resembled a thick chisel. While one miner held the borer in the hole, another miner would strike the head with a sledgehammer.[106] A pointed shovel—spade—was the ideal mining tool to penetrate the earth, as well as coarse fragments in the trench. After locating a vein, miners used their shovel to dig a large hole and "extract all of the ore." Since the mines that the Native Americans and French worked at Mine La Motte produced lead close to the surface, it was only necessary to dig a trench no more than six feet deep. What had changed by the time of De Gruy's expedition was that the Kaskaskia now used iron tools to mine for galena.

Native Americans traversed the Americas hunting buffalo and meeting to exchange their goods, their environmental knowledge, and their technology centuries prior to European contact. Their cultural practices crisscrossed the Rocky Mountains, following routes into the Great Plains.[107] What becomes clear is that Native American

[104] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[105] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[106] Mine blasting techniques were introduced in European mines in 1615. See, Andrew Ure, *A Dictionary of Arts, Manufactures, and Mines: Containing a Clear Exposition of Their Principles and Practice* (London: Longman, Orme, Brown, Greene, & Longmans, 1839), 829-856.
[107] For early Native American mining experiences across North America, see A. Morlot, "On The Date of The Copper Age in the United States," *Proceedings of the American Philosophical Society*, 9, no. 68 (1862): 111-114; Thwaites, "Notes on Early Lead Mining in The Fever (or Galena) River Region," 271-276; Frank Hamilton Cushing, "Primitive Copper Working: An Experimental Study," *American Anthropologist*, 7, no. 1 (1894), 93-117.

prospecting and mining culture traveled these same well-worn pathways of exchange forged through centuries of experience.

In conclusion, from prehistoric time to the early eighteenth-century, Native American societies mined and traded crushed and melted galena throughout North America. The mining expeditions of Des Ursin, Renaudiere, De Gruy, and Native American guides offer us a glimpse into indigenous mining knowledge and practices in this early North American frontier. Most likely, European miners did not expect to encounter Native American prospecting methods that were similar to their own. However, as Renaudiere's observations show, Native Americans carefully observed plant, stone, and soil color before discovering metal lying just beneath the earth's surface. Because Des Ursin and Renaudiere lacked the tools to dig shafts, they were instructed by the Kaskaskia to adopt the Kaskaskia longstanding practice of trench mining using their implements to extract lead ore. The amalgams highlighted in this chapter show how these cultural groups created new alliances around lead ore for local and distant distribution, and established the beginnings of an early mining frontier. Finally, like earlier explorers, Des Ursin and Renaudiere carefully searched for the possibility of establishing a mining settlement. Their goal was to manufacture baling seals or musket balls more economically for the expanding fur trade. In subsequent chapters, the amalgams put into practice in 1723 would expand to the adoption of indigenous smelting techniques.

Chapter 2: Convergence of Smelting Techniques

Introduction

On Monday, April 15, 1743, two Kaskaskia Indians and Antoine Valentine de Gruy departed the village of Kaskaskia for Mine La Motte.[108] De Gruy and the Kaskaskia walked "along a very usable road," passing deer and other animals, before stopping to construct a bark canoe for their journey down the Meramec River.[109] After arriving at the mines De Gruy noticed a "vein of lead above the ground," and he proceeded to dig "a trench wherein he discovered pellets of lead intermingled with rocks."[110] Later that same day, the Kaskaskia Indians directed him toward a cliff, and De Gruy commented, "The numerous rocks would be a good source for the construction of forges." In the evening, De Gruy recorded his observations in a report to the marine secretary of state, Jean-Frederic Phelypeaux, Count of Maurepas.[111] De Gruy stated that the animals, the usable road, the rocks to build furnaces, and most of all the pellets of lead would make the place a promising mining settlement.

The account of the De Gruy and Kaskaskia Indians expedition to the lead mines offers a unique window into further understanding how the Native American and French amalgam continued to develop the early North American mining frontier. The expedition emphasizes the long-lasting presence of indigenous guides as skilled prospectors and

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[108] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country," 136-150.

[109] Europeans observed Native Americans building boats. Thomas Haricot, *A Brief and True Report of the New Found Land of Virginia: of the Commodities and of the Nature and Manners of the Natural Inhabitants*, http://docsouth.unc.edu/nc/hariot/hariot.html, (August 1, 2009); Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997), 9.

[110] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

[111] A branch of the Ministry of the Marine engaged in scientific recording for France. Their activities included cartography and mineralogy. Phelypeaux sponsored new letters to govern colonial commerce soon after Louis XV began his rule. See James E. McClellan, III, and Francois Regourd, "The Colonial Machine: French Science and Colonization in the Ancien Regime," *Osiris*, 2nd Series, Vol. 15, Nature and Empire: Science and the Colonial Enterprise, (2000): 31-50.

miners. De Gruy's report also reveals how miners continued to envision establishing a mining settlement in closer proximity to the lead. Moreover, unlike the Renaudiere account, De Gruy's details offer a rare view into comprehending how Native American and French miners fused their smelting practices after contact. Therefore, in addition to Native American and French miners creating a prospecting and extracting amalgam, as discussed in chapter one, De Gruy describes how miners interacted to establish a cross-cultural dialogue to smelt lead ore on the mining frontier.

Following the extraction of lead ores from the earth, miners then had to smelt it to extract the metals. Agricola believed that nature usually created metals in an impure state, mixed with earth and stones. So the refiner had to separate the ores, which contained metals from the surrounding impurities. The process of smelting ores described by Agricola was the earliest description in the literature of metallurgy.[112] Subsequent writers similarly repeated the same smelting processes used by De Gruy.

Mid-eighteenth century observers of Native American mining practices clearly show that the mining frontier began earlier than otherwise understood, and was influenced by both Native American and French experiences. Patricia Limerick suggests that Frederick Jackson Turner's frontier charting occurred at the cost of excluding Native Americans.[113] Today when historians consider frontiers, we understand them to be

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[112] Hoover, *Georgius Agricola, De Re Metallica*, Book VIII.
[113] Patricia Nelson Limerick, *The Legacy of Conquest: The Unbroken Past of the American West* (New York: W. W. Norton & Company, 1988), 20-23; John Mack Faragher, "Afterword: The Significance of the Frontier in American Historiography," *Rereading Frederick Jackson Turner: The Significance of the Frontier in American History and Other Essays* (New York, 1994), 237-241. The literature on western frontier mining is extensive. For a start see, Duane A. Smith, *Rocky Mountain Mining Camps, the Urban Frontier* (Indiana: Indiana University Press, 1967); Otis E. Young Jr. *Western Mining: An Informal Account of Precious-Metals Prospecting, Placering, Lode Mining, and Milling on the American Frontier from Spanish Times to 1893* (Norman: University of Oklahoma Press, 1970); William Cronon, "Kennecott Journey: The Paths out of Town," in *Under an Open Sky: Rethinking America's Western Past*, ed. William

meeting places of peoples where geographic and cultural borders were not clearly demarcated.[114] Equally important to studying early frontier histories that examine Native American hunting, farming, and trading customs is to also research how Native American smelting knowledge and processes aided French settlers. What we learn by examining the convergence of Native American and French smelting skills is that the formers' abilities played a significant part in supplying hunters, fur traders, and merchants with a variety of lead products.

Daniel Usner's study of Indians, French, and African slaves frontier alliances notes the changing experiences of those who created new systems of exchange. Usner scrutinizes a region where French and indigenous peoples created a hybrid of practices and alliances around natural resources.[115] Limerick and Usner are right to see the frontier as a meeting place offering a constructive model to explore the changing customs and meanings of mining and smelting. Their interpretation forces scholars to pay attention to different kinds of ecological elements to understand the relationship between early environmental knowledge and skill. However, to continue the reconstruction of the French and Native American mining amalgam in the middle ground requires more than just following their social relations in the context of ethnic and gender hierarchies or imperial motives, as Lucy Eldersveld Murphy's in-depth study of lead mining and

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Cronon, George Miles, and Jay Gitlin (New York: W.W. Norton & Company, 1992), 28-51; Andrew Isenberg, *Mining California: An Ecological History* (New York: Hill & Wang, 2005).

[114] Frederick Jackson Turner, "The Significance of Frontier in American History," *AHA Annual Report for the Year* (1893): 199-227; Ronald Trosper, "That Other Discipline: Economics and American Indian History," *New Directions in American Indian History*, ed. Colin G. Calloway (Norman: University of Oklahoma Press, 1988), 208, 219; William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: 1991). Nancy Shoemaker reviews much of this research in the introduction to her *Negotiators of Change: Historical Perspectives on Native American Women* (New York: Routledge, 1995).

[115] Daniel H. Usner Jr., *Indians, Settlers, & Slaves In A Frontier Exchange Economy: The Lower Mississippi Valley Before 1783* (North Carolina: University of North Carolina Press, 1992).

frontier exchange illuminates.[116] It necessitates discovering how Native American smelting practices influenced French settlers during the mid-eighteenth century. Just as Europeans and Native Americans formed alliances around fur extraction, as Richard White has shown, Europeans and Indians cultivated relationships in regards to smelting lead ore.[117]

The French mining engineers Renaudiere and Des Ursin, as well as Antoine de La Motte Cadillac, the governor of Louisiana, did not document how the Kaskaskia Indians melted their lead before pouring it into molds to shape various ceremonial artifacts. By combining Renaudiere's statement with much earlier French exploration narratives and archaeological evidence reveals that Native Americans possessed smelting knowledge before European contact. Furthermore, their practices would eventually converge with European smelting techniques, which further enhanced the mining amalgam.

Europeans carried their smelting skills to the North American mining frontier. Like gold, lead and copper were both used in ancient times. In spite of the wide use of metals in ancient times, the literature regarding their source and processing is practically non-existent. Evidence of smelting practices from the mounds of slag from primitive foundry furnaces of the Bronze Age are scattered over Western Europe. These mounds also show how copper was treated in shallow pits with charcoal. Over time, great skill

[116] For a discussion of the importance of wheat farming and lead mining in Ste. Genevieve see, Carl Ekberg, *Colonial Ste. Genevieve: An Adventure on the Mississippi Frontier* (Tucson: Patrice Press, 1985), 126-143; Carl Ekberg, *French Roots in the Illinois Country: The Mississippi Frontier in Colonial Times* (Illinois: University of Illinois Press, 2000), 99, 171; Carl J. Ekberg, *Francois Valle and His World: Upper Louisiana Before Lewis and Clark* (Columbia: University of Missouri, 2002), 22-41; Walter A. Schroeder, *Opening the Ozarks: A Historical Geography of Missouri's Ste. Genevieve District 1760-1830* (Columbia: University of Missouri Press, 2002), 284-339. For Indian men and women miners in the Upper Mississippi Valley and the construction of a lead mining community, see Murphy, *A Gathering of Rivers: Indians, Métis, and Mining in the Western Great Lakes, 1737–1832* (Lincoln: University of Nebraska Press, 2000).
[117] White, *The Middle Ground*, 94-96.

and experience were acquired to obtain the maximum metal from its ore so that the least amount was lost through slag and fire.

Long before the synchronization of Native American and French smelting practices on the frontier, Native Americans not only exchanged goods but also technological practices and environmental knowledge across vast networks. For example, the Pueblo Indians melted ores in semi-subterranean ovens. Theoretically, their smelting practices were later transferred and adopted by Native Americans long before encountering the first French explorers. Later the Mississippians witnessed their ceremonial lead artifacts melting on their stone or wooden altars, which suggest that they must have understood a type of lead melting process. The early Indians of the Ohio valley also annealed and melted copper into useful objects. As early as 1497, Sebastain Cabot adorned the ornaments of the Native Americans along the Atlantic Coast, and determined that close by must be veins of copper.[118]

During the mid-sixteenth century, Jacques Cartier and Samuel de Champlain documented for Europeans Native American metal working skills, which I suggest influenced Indians of the Mississippi Valley and became part of the Native American and French amalgam. In turn, the genesis of Native American smelting practices combined with French techniques reveal a type of technological middle ground where Native American and French miners' practices converged.[119] Uncovering these associations reveals a Native American presence.

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[118] Richard Hildreth, *The History of the United States of America: Colonial, 1497-1688 Volume 1* (New York: Harper, 1863), 36.

[119] James Phinney Baxter, Jean François de La Roque Roberval, Jean Alfonce, *A memoir of Jacques Cartier: sieur de Limoilou, his voyages to the St. Lawrence* (New York: Dodd, Mead & Co., 1906). http://books.google.com/books?id=Grx1AAAAMAAJ&client=firefox-a&source=gbs_navlinks_s, (March 20, 2010).

Indigenous and French miners blended their knowledge and skills not only to exchanged ideas and methods about how to extract lead ore, but also about how to smelt it in larger quantities to aid the production of musket balls for local use and distant trade.[120] The intercultural dialogue between French and Native American miners encouraged both miners to adopt each other's smelting techniques. To fully understand the phenomenon, we must first consider early Native American smelting skills. Then, we need to examine French practices to explain their convergence with Native American methods. The smelting amalgam reveals a mixture of indigenous environmental knowledge and skills, as opposed to only impositions of European techniques. Just as the fusion of ores is the process of making an alloy to create a more pliable metal, similarly, the fusion of practices represents the creation of a hybrid of smelting techniques. Decades before De Gruy's expedition, Native American and French traders and settlers learned to depend on lead to make their own musket balls.[121] The "pellets of lead intermingled with rocks" that De Gruy described were what Europeans preferred to manufacture lead into useful products.[122]

De Gruy fails to mention a particular Native American tribe or the French miner who procured the lead for frontier communities in 1741. However, he may have been watching Francois Valle who conducted seasonal mining operations at Mine La Motte.

Edmund Farwell Slafter, eds., Samuel de Champlain, *Voyages of Samuel de Champlain: 1604-1610*; *Volumes 11-13 of Publications of the Prince Society*; *Volume 2 of Voyages of Samuel de Champlain, translated by, Charles Pomeroy Otis* (Boston: The Prince Society, 1878). (March 20, 2010). http://books.google.com/books?id=Q_kWAAAAYAAJ&q=copper#v=snippet&q=copper&f=false.

[120] George R. Milner, "American Bottom Mississippian Cultures: Internal Development and External Relations," *New Perspectives on Cahokia Archaeology: Views from the Periphery*, James B. Stoltmann ed., (Madison: Prehistory Press, 1991), 29-47.

[121] Pioneers molded bullets and from a very early period pewterers mixed it with alloys for household goods. For sample inventory of a fur traders personal affects showing musket balls and musket manufacturing materials see Thwaites, "Notes on Early Lead Mining in The Fever (or Galena) River Region," 278. For a discussion of the early uses of lead and importance of metals to early societies see, Orlando C. Harn, *Lead The Precious Metal*, (New York: The Century Co., 1924), 18, 44.

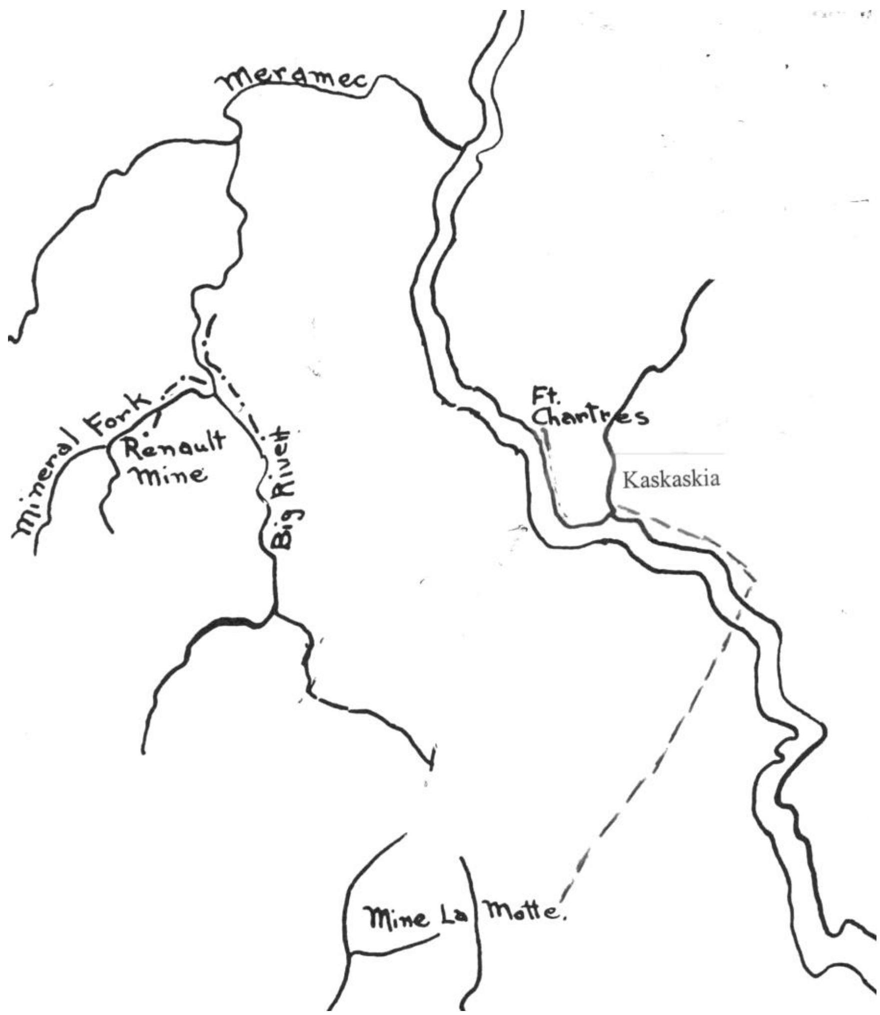
[122] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

He was a French Canadian who was born outside of Quebec City, and after migrating to the Illinois Country became involved in lead mining at Mine La Motte. Valle had made lead mining his primary income and initially fixed his operations at Kaskaskia. He often traveled across the Mississippi River from Kaskaskia to "work the diggings to extract minerals, cut wood and build furnaces to smelt lead, and transport pig lead by horse" back to Kaskaskia.[123] Valle would then depart Kaskaskia for trading expeditions in the Wabash river valley, as well as to outposts in Upper Canada and Detroit, where he supplied lead to frontier villagers that he smelted using the Native American and French-styled furnace. In all probability, Valle used a type of furnace that De Gruy observed Native American and French miners using. However, he was not the first.

After the French adopted the Native American seasonal mining and smelting custom, as had Des Ursin and Renaudiere, De Gruy wrote about his desire to firmly establish a mining settlement in closer proximity to the mines. De Gruy was eager to establish a mining community at Mine La Motte. He believed that such a place would assist miners in their attempts to extract and smelt lead ore year round. De Gruy, Valle and the Kaskaskia Indians departed for the mines during the spring and fall hunting seasons after planting their crops. To promote the creation of a settlement near the mines, De Gruy's report is replete with geographical descriptions. His account outlines significant features necessary for planting a settlement such as: (1) accessibility to the mining region by land or water; (2) flowing water to wash ores and propel machines; and (3) abundant meadows with "a great quantity of fruit trees." Finally, miners required

[123] Concerning Valle's life see Carl J. Ekberg, *Francois Valle and His World*, 22-41; Concerning travels see Contract, Kaskaskia Manuscripts 44:5:5:1; Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period," 50-85.

prairies "filled with excellent timber" as an additional quality necessary for a successful settlement.[124]



Map 7: Antoine Valentin de Gruy and Native American Route to the Lead Mines[125]

[124] Anthony Crozat emphasis on the abundant forest in the region is noteworthy. Newton D. Mereness, ed. " Journal of Diron D'Artaguiette," *Travels in the American Colonies, 1690-1783, Edited Under the Auspices of the National society of the Colonial Dames of America*, (New York: Antiquarian Press, 1961), 15-75; Moses Austin documented similar concerns. Moses Austin, *A Summary Description of the Lead Mines in Upper Louisiana. Also, An Estimated of their Produce for Three Years Past* (City of Washington: A. and G. Way Printers, 1804), 10, 21.
[125] Lucy Elizabeth Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period" (unpublished master's thesis, St. Louis University, 1942), 15.

The "mine appeared to be very rich"

After De Gruy arrived at the lead mines, he began to describe the continuation of the mixture of Native American and French practices on the mining frontier. De Gruy carefully examined how eighteen to twenty miners prospected and extracted lead ore. He does not note Native American miners as extractors; instead it is the French miners who applied their European tools to prospect for and extract lead ore using the indigenous trench mining technique. One French miner informed De Gruy that the "mine appeared to be very rich." De Gruy penned in his report:

> Everyone works by himself trying to locate a branch or a vein, for they do not have the capacity to go deeper in search of the solid body of the mine—each uses a probe four or five feet long, which is plunged into the ground in different places until a vein is struck. When one is struck, they make a large trench and extract what they can. If they run into rock or water they abandon their dig and move elsewhere.[126]

De Gruy was observing the steps miners followed to locate lead ore. He noted that miners were ignorant as to the construction of shafts, and had "no power other than that of their arms" and used the "primitive method of work" to dig their trenches to extract lead ore.[127] His comments suggest that the miners did not have the knowledge to dig shafts, when in fact what he observed were French miners who adapted the Native American trench mining practice.

Unlike Des Ursin and Renaudiere, De Gruy's description offers a clearer depiction of how the French and Native Americans fused their practices in the mid-eighteenth century. De Gruy details the depth of the trenches and how miners worked a particular vein until rock impeded their labor or water began to flood the trench. In such cases, miners would abandon the shallow trench and begin a fresh search for lead in

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[126] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[127] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

alternate locations. De Ursin also encountered the same water problems at Mine La Motte. Unlike the Mississippi Valley miners who extracted lead ore from trenches, their European counterparts installed machines over their shafts.[128] For example, when European miners encountered water, they used windlasses to raise water, soil, and ores from their mineshafts. These machines were cranks powered manually or by animals to which miners attached rope and buckets to hoist or divert water away from a shaft.[129] Since French miners needed additional capital to employ European practices to construct pumps to remove water from their shallow trenches, they continued to use Native American styled rope and buckskin baskets to extract galena.

Miners often abandoned their trenches because they lacked the "implements necessary to divert the ground water from flowing into the trenches."[130] When faced with this challenge, De Gruy considered the importance of installing water pumps, a common European practice. Because De Gruy needed to convince French officials of the challenges miners encountered to secure additional capital, it was important to include these natural obstacles in his report. To overcome these obstructions, the French still used the Native American method to extract lead ore, which required very little capital.

De Gruy also documented how miners abandoned and relocated after encountering rock.[131] In particular, limestone was a barrier to miners. As mentioned in chapter one, the French and the Kaskaskia used similar methods to remove lead ore embedded in rock. They both still practiced igniting large fires near the rock, and doused

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[128] Hoover, *Georgius Agricola, De Re Metallica*, Book VI; Barba, *A Collection of scarce and valuable treatises upon metals, mines and*, 54-56 .
[129] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[130] Hoover, *Georgius Agricola, De Re Metallica*, Book VI.
[131] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

the heated rock with cold water. Adhering to their procedure allowed miners to pry rocks apart, and extract embedded galena.

The Kaskaskia were not the only lead miners in the Mississippi valley. Jonathan Carver, who visited the lower Wisconsin River Valley, noticed numerous piles of lead ore in both the Winnebago and Fox villages near Galena, Illinois. Carver was an American explorer who traveled with Native Americans along French trade routes to the French settlements along the Fox River and eventually arrived at the Winnebago Indian's village. When Carver visited the Winnebago Indian's mines, he not only saw their mounds of galena, he also observed them using "wooden spades, buckhorn picks and iron tools" to extract lead.[132] So, similar to the miners that De Gruy visited, the Winnebago and Fox miners also created a type of middle ground where Native Americans adopted European iron tools to their mining practices. Carver's descriptions of Upper Mississippi indigenous skills reveal how Native American lead mining practices most likely traveled across great distances.

Native Americans who traversed the Americas hunting buffalo and meeting to barter their goods, exchanged their environmental knowledge and their technology centuries prior to European contact. What becomes clear is that Native American prospecting and mining culture journeyed these same well-worn pathways of exchange forged through centuries of experience. In like fashion to earlier Native Americans, the Winnebago and Fox Indians excavated the earth by following the deposits along inclined surface trenches into the sides of the hills, spending a great deal of time separating the lead ore from the soil and rock using both Native American and European tools.

[132] Jonathan Carver, *Travels through the interior parts of North America, in the years 1766, 1767, and 1768* (London: C. Dilly, 1781), 63; Murphy, *A Gathering of Rivers: Indians*, 79-100.

Skimming over cultural and material exchanges between Native Americans and French settlers, we have missed the opportunity to fully appreciate what role smelting technology played in accommodations between the Kaskaskia Indians and French miners. We have also missed the occasion to investigate how miners adjusted to each other's mining practices in the middle Mississippi Valley, a place where, like other North American frontiers, multiple exchanges occurred.

Recovering and connecting smelting practices

During the 1690s, French traders purchased smelted lead from the local Native Americans at Fort Creve Coeur. Nicolas Perrot lived in the region during the late seventeenth and early eighteenth centuries, and Perrot was one of the first settlers to make contact with the Illinois and Miami Indians.[133] One contemporary account of Perrot's interactions with several Miami, mentions how the Native American Chief asked him about building a trading post near their villages. As an inducement and to secure a trading alliance, the Miami presented Perrot with sample of galena. The exchange between Perrot and the Miami Indians highlights an early account of Native American lead mining ability. However, by the late nineteenth century scholars interpreted the exchange as Perrot instructing Native Americans how to extract and smelt galena.[134] It is not clear how between 1690 and 1890 knowledge of Native American mining and smelting practices disappeared, however, clearly, a number of French explorers witnessed

[133] Lucy Elizabeth Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period" (unpublished master's thesis, St. Louis University, 1942), 272.
[134] Garland C. Broadhead, et.al., *Report of the Geological survey of the state of Missouri, Including Field Work of 1873-1874, Missouri Geological Survey* (Regan & Carter, State Printers and Binders, 1874), 632.

not only early Native American lead smelting, but also copper smelting procedures. [135] Despite these debates, according to the late nineteenth century historian William Pulsifer, Native Americans sold lead of their own smelting to French traders at Peoria in 1690.[136]

To understand the longstanding tradition of melting ores, it is important to discuss why Native Americans smelted their ores. North American indigenous miners shaped lead in catlinite molds to manufacture goods for burial with the dead. The Kaskaskia made their molds from sand or clay to manufacture gaming pieces, pipes, ornaments, and following contact musket balls.[137] In the Ohio Valley, Native Americans also molded copper into useful objects. Their copper smelting customs were later transferred to Native Americans who encountered the first French explorers in North America. Jacques Cartier and Samuel Champlain both recorded the smelting and annealing techniques of the Algonquin Indians.[138] Cartier and Champlain describe how Indians mined, manufactured, and traded copper prior to European contact, and that they were indeed experienced smelters.[139]

When Cartier arrived in North American on the Isle Coudres, he encountered the Algonquin Indians. At his first meeting with Chief Donnacona, Cartier was presented

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[135] A number of early nineteenth century visitors to the Missouri mines have acknowledged Europeans for introducing Native Americans to their smelting technology. Thwaites, “Notes on Early Lead Mining in The Fever (or Galena) River Region,” 271-272; Henry Rowe Schoolcraft, *A View of the Lead Mines of Missouri, including some observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, population and Productions of Missouri and Arkansas, and other sections of the Western Country* (New York: Charles Wiley, 1819), Chapter. 3.

[136] William Pulsifer, *Notes for the History of Lead and an inquiry into the development of the manufacture of white lead and lead oxides*, (New York: D. Van Nostrand Co., 1888), 81. http://www.archive.org/details/notesforhistoryo00pulsrich, 82.

[137] Cushing, “Primitive Copper Working: An Experimental Study,” 93, 96.

[138] Roberval Alfonce Baxter, *A memoir of Jacques Cartier*; Samuel de Champlain, *Voyages of Samuel de Champlain: 1604-1610* ; Justin Winsor, *Cartier to Frontenac: Geographical Discovery in the Interior of North America in its Historical Relations, 1534-1700*, (New York: Cooper Square Publishers, 1894; reprinted 1970), 37, 122, 203, 218-219.

[139] For a discussion of early Native American societies extracting and smelting experiences across North America, see Morlot, “On The Date of The Copper Age in the United States,” 111-114.

with a copper knife.[140] Chief Donnacona told Cartier that many tribes of Saquenay were skilled at working with “red copper,” which they called caignetdaze. The Chief related to Cartier the location of Saquenay, which was in the west near the “Great River and a great lake.” Chief Donnacona’s geographical markers suggest he was referring to the Mississippi and Lake Superior.

Later in the sixteenth century after Samuel Champlain arrived in the St. Lawrence Gulf, he too encountered the Algonquians. In like fashion to Cartier, Champlain was introduced to Chief Yroquet, and like Chief Donnacona he too “drew from a sack a piece of copper a foot long,” and gave it to Champlain. Champlain noted that the piece “was very handsome and quite pure,” and Yroquet also told Champlain that “there were large quantities where he had taken this [copper], which was on the bank of a river, near a great lake.” Chief Yroquet then proceeded to explain to Champlain the five-step copper smelting process, which mirrored the way the Kaskaskia later, would smelt their lead ore.

First, Native American miners gathered lumps of copper ore. Next, they melted the ores. Then they proceeded to spread the melted ore on large flat stones before shaping the copper into a sheet. Finally, they polished the sheet with a stone hammer. Similar to the Kaskaskia, who molded lead, the Algonquin also shaped the melted copper in molds to cast various cultural implements. The cross-cultural dialogue between Yroquet and Champlain about Indian smelting and annealing processes provided Champlain with a sense of their copper melting, molding, and shaping techniques. What

[140] Edmund Farwell Slafter, eds., *Samuel de Champlain, Voyages of Samuel de Champlain: 1604-1610; Volumes 11-13 of Publications of the Prince Society; Volume 2 of Voyages of Samuel de Champlain, translated by, Charles Pomeroy Otis* (The Prince Society, 1878), 24-27, 234-238. (March 17, 2012). http://books.google.com/books?id=Q_kWAAAAYAAJ&q=copper#v=snippet&q=copper&f=true

Champlain failed to outline was how the Algonquians constructed their furnaces. In this way, the Kaskaskia Indians also were accustomed to melting and molding lead ore to use in manufacturing cultural implements.[141] To comprehend how Native Americans may have constructed their copper or lead furnaces, we have to examine additional evidence.

The archaeological record also provides evidence of Native Americans smelting lead and copper in subterranean furnaces. Early indigenous societies roasted the ores on an open fire by using a subterranean funnel-shaped oven-furnace to “bake or partially smelt” the ores. First, they placed a “flat-bottom pot or relatively small pocket” to collect the melted ore beneath the subterranean furnace. Next, Native Americans surrounded and covered the ore with fuel, and replenished the conical shaped furnaces with more timbers. Smelting was accomplished by introducing only a small amount of ore at a time. Once the slag had cooled, miners removed the cinders so that the melted lead could be collected from the furnace bottom—“where it occurred in buttons or irregular nodules.”[142] The Pueblo peoples prior to European contact also applied a similar technique. In fact, it may be conceived that the crude art of smelting here discussed might easily have been discovered through the earlier practice of the Pueblo peoples who also cooked food by means of stone baking in large underground ovens.[143]

[141] Cushing, “Primitive Copper Working: An Experimental Study,” 96.
[142] Brown, “The Zimmerman Site: Further Excavations at the Grand Village of Kaskaskia,” 73-79.
[143] Cushing, “Primitive Copper Working: An Experimental Study,” 93-94.

Figure 5: Native American Subterranean funnel-shaped oven-furnace.[144]

Near the Kaskaskia village, where Des Ursin and Renaudiere began their expeditions, archaeologists have unearthed burned circular areas. The discovery of a burned area of clay and dirt, six feet in diameter, suggest that the Kaskaskia also melted ore in subterranean furnaces. During the finding, archaeologists located pieces of lead ore, ashes, and melted lead across a small area that appears to be the remains of a simple small-scale smelting operation. The evidence suggests that the Kaskaskia Indian method also required them to place lead ore in conical ovens, and fired the ovens in the same way as the Pueblo peoples. Additionally, archaeologists have recovered shaping molds near the circular burned area. The molds are significant for a couple of reasons. First, the location confirms that the Kaskaskia established worksites to extract lead ore. Second, they appear to be designed to manufacture Native American circular gaming pieces, crosses for burial with the dead, and musket balls.[145]

Before examining European contributions to the smelting amalgam, someone else researching near the Mississippi valley lead mines discovered stones laid in circles about

[144] Cushing, “Primitive Copper Working: An Experimental Study,” 94.
[145] Walthall, *Galena and Aboriginal Trade in Eastern North America*, 37-41.

three feet in circumference. After excavating one of the circles, he believed he had discovered an object that was at one time used as an oven. W.Y. Woods documented how the three foot deep hole was shaped like an inverted cone, and the sides were carefully "walled up with flat stones, and around the edge was left bare, which ran around the mouth of the hole."[146] After Woods removed the earth resting in the ovens, at the bottom of one oven he found seventeen pounds of lead ore. Considering that Woods made his discovery during the 1890s, it is not clear when Native Americans used the thirty ovens he discovered. However, it does reveal that similar to the Pueblo peoples and the Kaskaskia Indians, the Winnebago, who inhabited the area where the ovens were discovered, also developed a comparable smelting art.

Smelting and molding lead was an important part of the European mining experience as well. According to Georgius Agricola, the ores of lead and copper were considered similar in class, and he notes that reduction of copper from its ores is older than human records. Agricola entered the University of Leipzig at the age of twenty, finally earning his degree in medicine. Primarily a physician, Agricola became a court historian in 1530, and a city physician in 1533. Agricola medical training, most likely helped him to become a keen observer of the nature of the mines that he investigated in the sixteenth century. By 1546, he had published a series of six works on mining, metallurgy, geology, and animals used in mining.[147]

According to Agricola, the smelting of ores of gold and silver, which were considered to be rich in metal, the smelting process was considerably shorter, whereas the smelting of lead and copper required longer periods of heat. The process described by

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[146] W.Y. Woods, "A Strange Pre-Historic Find," *The Wisconsin Naturalist*, 1, no. 1 (1890), 25.
[147] Hoover, *Georgius Agricola, De Re Metallica*, Book VIII.

Agricola was the earliest such description in the literature of metallurgy. He described and illustrated the smelting process. In Europe, copper and lead smelting times extended over three days and three nights. Agricola describes the ancient furnace used to melt copper as a simple shallow pit in the ground lined with charcoal and covered with ore. Using these pits, smelters were able to produce crude round copper cakes eight to ten inches in diameter, which settled at the bottom of the pits.[148]

In North America, early Native Americans smelted copper by first roasting the copper "in an open fire," and "then baked or partially smelted" it in "a kind of subterranean funnel-shaped oven-furnace."[149] Therefore, at contact, the French were probably introduced to the longstanding Native American smelting practice, which they recognized. What continued to develop was an amalgamation of Indian and European smelting practices, which aided early miners.

The furnaces European miners constructed in Europe appear to be similar to the type of furnaces used by Native Americans. The difference in the construction of early frontier furnaces was the stonewalls, and they were not circular either. For example, European furnaces consisted of a "main wall against which a series of furnaces were built." The wall, built of "brick or stone" was approximately fifteen feet high and had "six furnaces spaced six feet apart." Agricola suggested that stone was preferred to brick because it resisted fire longer.[150]

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[148] Hoover, *Georgius Agricola, De Re Metallica*, Book IV.
[149] Cushing, "Primitive Copper Working: An Experimental Study," 98-99.
[150] Hoover, *Georgius Agricola, De Re Metallica*, Book VIII.

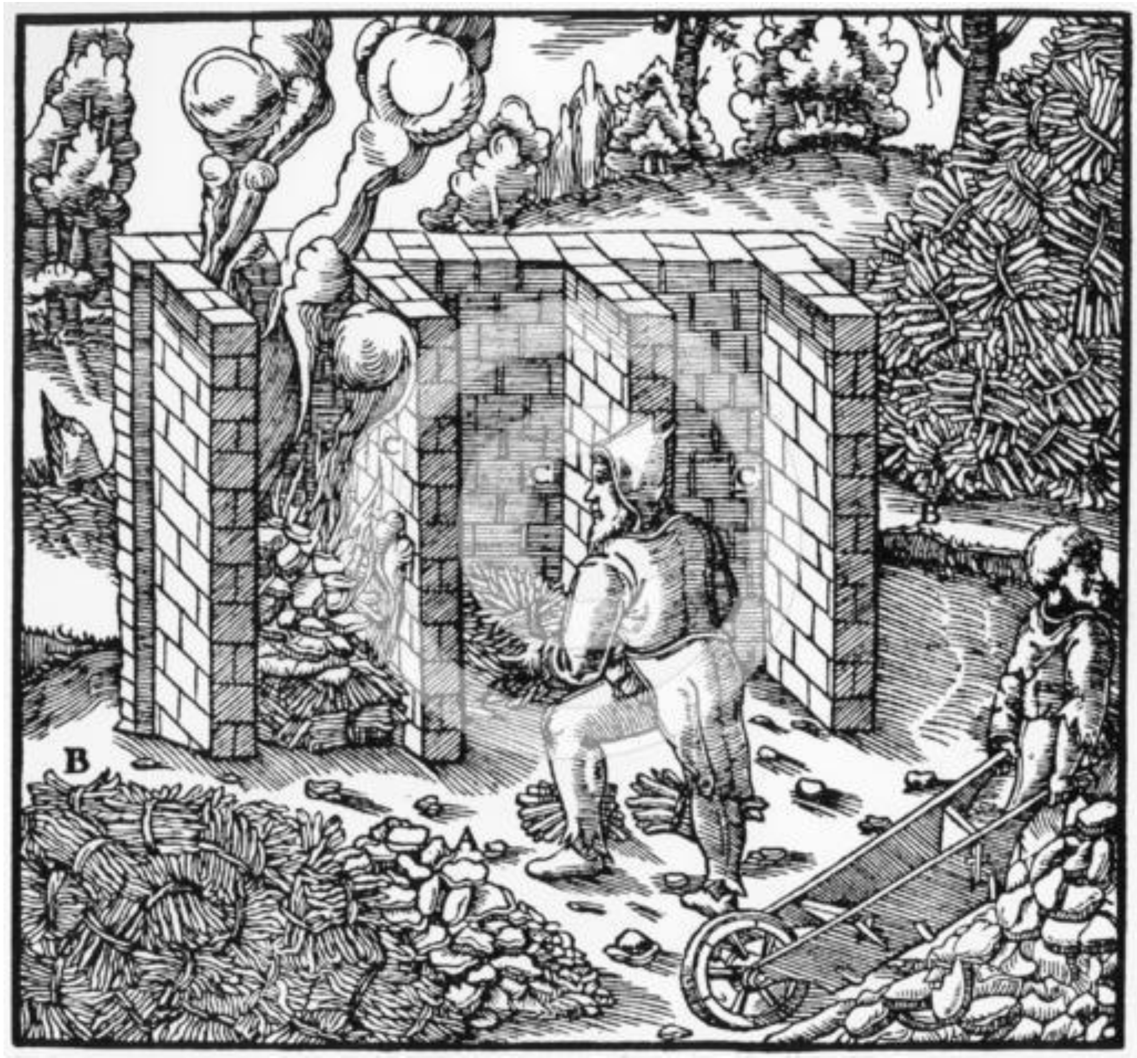

Figure 6: Agricola description of the European miner furnace with logs.

There were similarities between the ways by which Europeans constructed their masonry furnaces, and how the Kaskaskia built their subterranean conical stone furnaces. Europeans dug a hole in the earth, and "then built square walls along the sides and back to hold the heat of the fire more effectively." They also left the front of the furnace open for easy cleaning. After digging the hole and constructing the walls, "wood about twelve feet long" was "laid in the area in four layers," in alternating directions. In addition, Europeans built this particular type of furnace on the slope of a hill. Finally, like the Kaskaskia Indians who placed their lead ore under the small logs used for fuel, the European smelter also placed "pieces of ore" under the wood before igniting the fire.[151]

Recall that Renaudiere walked alongside of Native Americans who carried no tools when going to "make lead."[152] The phrase "make lead" supports the existence of Native American smelting knowledge prior to contact. Although Renaudiere fails to mention the Kaskaskia, who extracted lead from trenches, dispersing into the forest to gather fuel for their conical shaped furnaces, they made lead. Therefore, Native American ability to "make lead" refers to melting lead, and De Gruy describes eighteenth-century miners amalgamating their smelting practices to make lead for local use and distant trade. De Gruy's account methodically depicts how French miners smelted lead ore using a combination of features from the Native American subterranean oven and the above ground French-styled log furnaces. De Gruy watched miners would collect large amounts of timber to construct "log furnaces" over basins. De Gruy considered the method time consuming calling it a "primitive method" to smelt lead ores.[153]

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151 Hoover, *Georgius Agricola, De Re Metallica,* Book VIII.
152 Renaudiere "Account of the Mines of M. de la Motte." Also, see Clarence Walworth Alvord, *The Illinois Country, 1673-1818* (Illinois: Illinois Centennial Commission, 1920), 154.
153 "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

Both the Renaudiere and De Gruy accounts infer a type of early technological exchange between the Kaskaskia and the French regarding the useful art of smelting on the mining frontier.[154] De Gruy's reference to assembling furnaces shows how Native American and French miners blended more than their prospecting and extracting practices. De Gruy's observations clearly depict another significant occurrence in their cross-cultural dialogue, smelting, which continued long after the arrival of American and British miners. The De Gruy report opens a window into the manner in which "eighteen or twenty" miners designed a smelting amalgam to melt lead ore in log furnaces on this early North American frontier.[155] Most significant, the Champlain and De Gruy reports, as well as archaeological evidence, not only show how Indians invented a method to smelt and refine ores, but also how French miners further amalgamated their practices to the Kaskaskia Indians techniques. Additionally, like those who came before, De Gruy too desired to use the local limestone to construct furnaces, and establish a mining settlement according to a European plan. However, stone furnaces and settlements would not begin to replace the Native American and French amalgam until 1797, following the arrival of Moses Austin.

[154] Renault's report would surely be a fascinating document but it had never been found. There is visual evidence of Renault's brick furnace. Louis Houck, *The Spanish Regime in Missouri: a collection of papers and documents relating to upper Louisiana principally within the present limits of Missouri during the dominion of Spain, from the Archives of the Indies at Seville, etc., translated from the original Spanish into English, and including also some papers concerning the supposed grant to Col. George Morgan at the mouth of the Ohio, found in the Congressional library, Vol. 1* (Chicago: R.R. Donnelley and sons company, 1909), 372, 392.
[155] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

Convergence of smelting practices

Over one hundred and fifty years after the explorations of Cartier and Champlain, De Gruy described the Indian smelting abilities they used to produce the items they were given.[156] Although De Gruy fails to attribute the smelting knowledge and technology he observed to the Kaskaskia Indians, what he describes is a hybrid practice adopted by French miners to make lead. At the mining site, a French miner told De Gruy that after "extracting enough ore to pay a year's expenses, he ceased digging and busied himself smelting the ore in the fashion," most likely, constructing log furnaces after a full day of extracting lead.[157]

Native American and French miners began to construct their furnaces after "chopping down three big trees, and then cutting them all into three-foot lengths," and then much smaller pieces. Next, a miner proceeded to "dig a small hole like basin in the ground" before placing the logs or timbers above the hole around the edges of the excavation. The miner continued to build and shape the furnace by positioning "three additional shorter logs." He then added two additional "logs of the same length crosswise." The entire furnace resembled a "funnel-like box." Next, the miner filled the inside of the box with wood, and began to layer ore on top of the timber. And then, miners positioned three logs, shorter than the first three, in the same manner.[158] Finally, miners filled the entire box with lead ore and wood, after which the furnace heap was set afire "from below."[159]

[156] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[157] Thwaites, "Notes on Early Lead Mining in The Fever (or Galena) River Region," 276-277.
[158] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[159] Henry Rowe Schoolcraft gives a similar description of this log-type furnace. He also compares it to the mill hopper furnace used during the early nineteenth century. Schoolcraft, *A View of the Lead Mines*, 45,

Miners told De Gruy these early furnaces only smelted a part of the lead and it was often necessary to resubmit the ores to three additional firings, which required three supplementary furnaces to procure a larger yield of lead. If the mineral obtained from the veins contained a high percentage of sulfur, the ore was reheated three times over. Apparently, French miners understood that this practice served to drive away additional sulfur to yield about five percent lead. Miners then placed the slag in another log furnace for the second burning, to yield another fifteen percent lead. These first two processes were designed to drive off the sulfur, and the third heating was considered the real smelting process.[160]

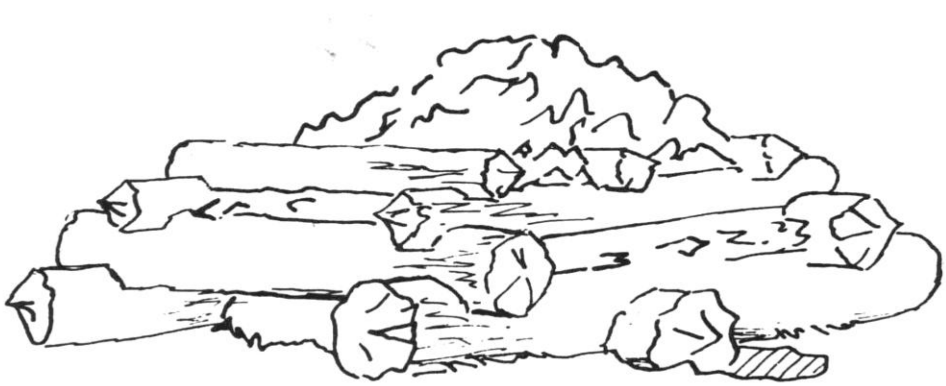

Figure 7: Native American & French Styled Log Heap Smelting Method[161]

174, 195; Also see Reuben Gold Thwaites, *How George Clark Won the Northwest and Other Essays in Western History* (Chicago: A.C. McClurg & Co., 1903), 314: a. a hole shaped like a mill hopper, two feet wide and two feet deep was cut into a slope and lined with flat rocks. Into this the ore was dropped, b. the opening at the bottom of the mill hopper was eight or nine inches wide. A crude grating of rocks was placed across the opening. The molten lead flowed a few minutes after the fire was lighted, c. a trench one foot deep and one foot wide was dug from the front of the slope to meet the narrow lower end of the mill hopper. Brush and wood were heaped in this and set afire, d. a mold into which the molten lead flowed or was dipped.

[160] The method is not described in De Gruy's account, however, later manuals discuss this process of reheating to obtain a high yield of lead. See James Woodhouse, *The young chemist's pocket companion connected with a portable laboratory; containing a philosophical apparatus, and a great number of chemical agents; by which any person may perform an endless variety of amusing and instructing experiments; and intended to promote the cultivation of the science of chemistry* (Philadelphia: J.H. Oswald, 1797). Also, see Thomas Dobson, *A Compendious System of Mineralogy & Metallurgy; Extracted from the American Edition of the Encyclopedia* (Philadelphia: Thomas Dobson, 1794).

[161] Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period," 23.

Most significant is the design of the furnace. French miners followed the Native American practice of designing a basin to collect the melted lead, and excavated a hollow earthen basin below the burning heap. The design also illustrates how after the third firing, as the molten lead flowed into the conical earthen basins, it was shaped into "small flat bars each weighing" between "sixty and eighty pounds." De Gruy also noted that the flat bars resembled "a rough oval" because of the earthen basins used to create them.[162] Most bars were two feet long, six to eight inches wide, two to four inches thick in the middle, and became thinner towards the edge. Each oval-shaped leaden mass generally weighed between thirty and forty pounds.[163] Molding the lead into bars facilitated easy transport between the mines and villages. Following contact, the French adopted the same technique to efficiently transfer their lead to Kaskaskia or Ste. Genevieve. The French used horses and carts to carry four or five of these bars each trip, a mode of transport that may have been adopted by the Native Americans. The log furnaces that produced these bars yielded about forty percent lead; the rest of the ore was reduced to lead ash and lost.[164]

[162] By 1855 *saumon* was described as leaden mass shaped as a *saumon*. These accounts are concerned with 1822 reports of Fox and Sac Indians who trade in the Galena region. James H. Lockwood, "Early Times and Events in Wisconsin," *Collections of the State Historical Society of Wisconsin, Vol. 2,* (1855): 131-132.
[163] Thwaites, *How George Clark Won the Northwest*, 300-315.
[164] Moses Meeker, "Early History of the Lead Region of Wisconsin," in *Wisconsin Historical Collections*, http://content.wisconsinhistory.org/cdm4/document.php?CISOROOT=/whc&CISOPTR=3876&CISOSHOW=3636&REC=1. 271-296.

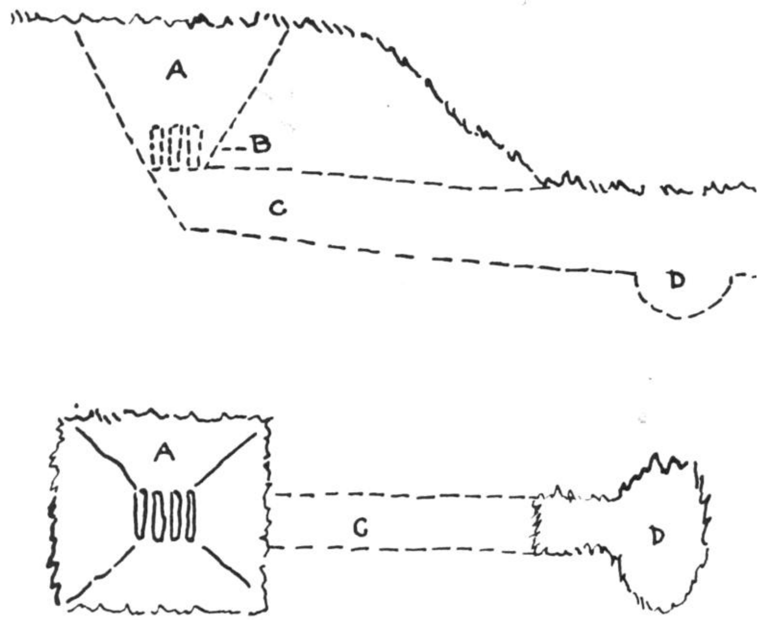

Figure 8: Native American and French Basin Mill Hopper Smelting Method. (a) hole lined with flat rocks; (b) grate opening where melted lead dropped to the subterranean level; (c) slope trench to allow lead to flow; (d) mold[165]

Although French miners were concerned over the inefficiency of the furnaces, they continued the practice throughout the eighteenth century. To acquire additional amounts of lead, Native American and French miners would occasionally search through the ashes for ore that had not succumbed to the fire. Miners understood the possibility of procuring a further yield from the lead ashes. The French had a name for lead ash, "scorie," or slag.[166] The lead ashes consisted of various sizes of lumps that fell through the logs before being touched by the fire. The experienced miner who understood this process would have used the same furnace to re-melt the lead ash into a slag. The larger pieces, consisting of ore partly desulphurated were picked out from the ashes and added

[165] Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period," 143-144.
[166] There was a colloquial designation with a variety of spellings ranging from *escourie*, *escouris*, and *recourie*. Jean-Antoine-Claude Chaptal, *Elements of Chemistry, Translated From the French, Three Volumes in One* (Philadelphia: Printed By Lang & Ustick for M. Carey, 1796), 333-334.

to the next smelting.[167] It was realized that a considerable amount of lead remained in the ash heaps, which were near each log furnace site throughout the mining landscape where De Gruy envisioned establishing a settlement.

A "very fine hunting" and mining country for settling

Recognition of mining amalgamation not only can help chart French and Native American interactions and associated hybridity, but also how their influences evolved in hopes of establishing an early mining frontier settlement. The frontier was not just a contact zone where peoples mixed their extracting and smelting traditions but also where miner's settlement traditions converged. The Kaskaskia and French amalgamated their hunting seasons with their lead mining activities. While the French looked forward to establishing mining centers, Native American communities understood the importance of exploiting the seasonal diversity of their environment by practicing mobility and following a particular cycle. The Kaskaskia lead mine was "a place with an abundance of game, and a summer forest where a variety of flowers, such as red lilies" blanketed the landscape.[168] Explorers painted a picture of turkeys running along the countryside, passenger pigeons darkening the skies, and ducks covering numerous small river systems. Wherever villagers expected to find the greatest natural food supplies, there they went. When fish were spawning, Indian families gathered there; when it was hunting season in the summer or fall, the same families might be found scattered over many square miles of land. Like the New England coastal Indians, the Kaskaskia and Osage Indians living

[167] Schoolcraft, *A View of the Lead Mines of Missouri,* Chapter. 3.
[168] Timothy Flint, *The History and Geography of the Mississippi Valley. To Which is Appended A Condensed Physical Geography of the Atlantic United States and the Whole American Continent. 2nd Ed. Vols. 1 & 2* (Cincinnati: E.H. Flint and L.R. Lincoln, 1832), 285-332.

along the rivers of the central Mississippi Valley between March and October were also free from all anxiety about their sources of food. Although De Gruy fails to mention a semi-permanent settlement near the mines, they may have built small cabins to live in during the mining seasons.

The Kaskaskia planted crops during the month of March. Between April and May, the arrival of migratory birds alerted the communities to the coming of healthy ducks laying large eggs. While the men fished and hunted, women and children gathered bird eggs. Beginning in June, Indian communities began their summer hunt, living along the plains while hunting bison, turkey, and antelope. In July, the women began to harvest their crops and gather nuts, berries, and other wild plants as they became available.[169] Similar to New England subsistence schedules, summer was a time of plenty in the central Mississippi Valley. The late summer harvest was conducted in August, and from late September through November, the fall hunt would commence. They hunted bear, rabbits, and migratory birds. From December to February, the Kaskaskia lived in small longhouses and scattered into smaller groups to hunt for bears. During each of these seasons, Native Americans intermixed extracting, smelting, and refining lead ore on seasonal timetable that coincided with Indian hunting and farming practices.

Following the Kaskaskia custom, Europeans adopted the Native American practice and carried out their mining operations in the same cyclic fashion. Miners worked at the mines during a period sometimes called "la campagne."[170] They used the expression to describe the nature of lead mining enterprise during the early eighteenth

[169] Carl H. Chapman, "Osage Village Locations and Hunting Territories to 1808," *A Preliminary Survey of Missouri Archaeology: Osage Indians IV*, (New York: Garland Publishing Inc., 1974), 17-30.
[170] Carl Ekberg, *Colonial Ste. Genevieve: An Adventure on the Mississippi Frontier* (Tucson: Patrice Press, 1985), 126-143.

century. Leaving their villages, homes, and common fields, workers penetrated the countryside to discover, extract, and smelt lead ore. Following the Kaskaskia calendar permitted the miners to return to their villages in time to assist with the first summer harvest.

Des Ursin, Renaudiere and De Gruy traveled from Kaskaskia to the lead mines, either in April or during the early summer harvest. They crossed the Mississippi River by bateaux, and then traveled on horseback along wooded trails for approximately four days. Each miner described the area around the mines as a place "where the country is very fine to establish a settlement and the land are as good as might be desired."[171] European prospectors and miners had to be knowledgeable about their surroundings when considering establishing the ideal site for the extraction of lead ore. By the mid-eighteenth century, miners began to take advantage of a second mining season. It ran from August to December, which was from the end of the second harvest until the first frost.[172] However, French miners eventually wanted to establish a settlement closer to the mines as opposed to following the seasonal mining schedule.

The accounts of Des Ursin, Renaudiere, and De Gruy were transmitted to French officials, who became increasingly anxious to receive a precise report and samples of lead ore from the Illinois country. For example, Phelypeaux needed to know from De Gruy the possibilities for constructing a mining settlement.[173] Apparently, Phelypeaux was aware that one of the significant challenges to extracting and processing lead ore

[171] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; Renaudiere "Account of the Mines of M. de la Motte"; "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[172] Margaret Kimball Brown and Lawrie Cena Dean, eds., *The Village of Chartres in Colonial Illinois 1720-1765* (New Orleans: Polyanthos, Published for La Compagnie des Amis de Fort de Chartres., 1977); Ekberg, *Colonial Ste. Genevieve*, 126-157; Ekberg, *French Roots in the Illinois Country*, 99, 171.
[173] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

year round was French miners adherence to the Native American seasonal mining schedule. Des Ursin, Renaudiere, De Gruy, and their Native American guides each prospected, extracted and smelted lead ore during the early spring, summer, or fall months.[174] Phelypeaux requested the total production of the lead mines during the previous decades. More specifically, he desired to learn the location of new mines, the method of extraction, the number of settler homes, and the number of furnaces used for smelting. Furthermore, Phelypeaux requested an accounting concerning the skill level of those currently engaged in mining activities.[175] De Gruy wanted "very much to find something worthy of attracting the attention" of Phelypeaux to encourage the creation of a mining settlement as opposed to following the Native American seasonal mining calendar.[176]

Like those explorers who came before, De Gruy also was familiar with the English mining engineer Thomas Houghton's instructions. The accounts of all three miners provided a detailed description for establishing a European style mining settlement. Houghton provided miners with explicit directions for establishing a mining settlement. He recommended that a miner keep in mind three environmental factors when considering a settlement: the ability to access the mining region, the availability of water, and the general conditions.[177] When Des Ursin set out from Kaskaskia to appraise

[174] The central government, notably the Ministry of the Marine, had a branch that engaged the scientific arm of France's colonial machine, also included the formation of the Company of India earlier. The research sent to Louisiana supported French colonization. Their activities included cartography and mineralogy discoveries. Soon after Louis XV vegan to rule, Phelypeaux sponsored new letters patent to govern colonial commerce. McCleelan and Regourd, "The Colonial Machine" 31-50.

[175] Phelypeaux to Bienville and Salmon, Versailles: Paris, Archives Nationales, Colonies, MSS. B72: 476-477, (Missouri Historical Society) Oct. 6, 1741.

[176] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

[177] Houghton, *Royal Institutions: Being proposals for…the digging and getting of lead*, 13, 15, 22.

Mine La Motte more thoroughly, he notes "The way to the mines is well-beaten."[178] A number of years later Renaudiere also traveled a similar route to the one taken by Des Ursin. Both note the way to the mines to be extremely accessible.

The De Ursin, Renaudiere, and De Gruy accounts all mention numerous small prairies in the area of the mines. The prairies, according to all three, "served as a retreat to numerous buffalo, bears, deer, skunks, and other animals." Like Renaudiere, De Gruy also portrays the area as a "very fine hunting country, where the rivers contain plenty of fish and a large number of water fowl." His account also mentions a great quantity of fruit trees, such as persimmons, plums, and pecans and grape vines. He notes the fruits and nuts as having "supplied their diets" while Native Americans extracted and smelted lead ore. Like earlier accounts, De Gruy's narrative became a vehicle for French officials to determine how much to invest in developing a mining settlement.[179]

Pleased with the surroundings, De Gruy turned to his Native American guides to learn more about the location of these rich lead deposits. They informed him that the mines were approximately twenty miles from Kaskaskia. The Kaskaskia guides told De Gruy that "numerous mines could easily be found along many of the riverine systems." In an effort to promote the Mississippi Valley lead mines and hope to encourage French miners to immigrate to the region to exploit the mineral resources, De Gruy included the guide's information in his report. De Gruy discussed the method of transportation, noting, "The route to this deposit appeared practical for pack horses."[180] Like Renaudiere, De Gruy also expressed an interest in the method of transporting smelted

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[178] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; Renaudiere "Account of the Mines of M. de la Motte."
[179] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[180] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

lead. The Kaskaskia informed him that horses should have no difficulty covering the distance in less than a day. Based on their information, De Gruy acknowledged that the "passable road" would also make it easy to negotiate "pack horses" for carting tools and smelted lead. In addition to land passage, De Gruy noted that "the mine being in an area with innumerable streams all flowing into the St. Francis River," was ideally located only two miles from a navigable river.[181]

The location of the mines, just twenty-eight miles from Kaskaskia in the "well watered area would make it possible to deliver the smelted lead to the village, and then transfer the lead throughout the Illinois country." All three miners described how "carters" could travel twelve miles by water and sixteen miles by land to reach Kaskaskia. However, upon further consideration and consultation with his Native American guides, Renaudiere decided the distance was too great to economically transport the lead over land. In addition to Des Ursin's observations, Renaudiere recommended the forming of "a settlement at the mines" to avoid "this portage."

As an economical and efficient means, Renaudiere proposed shipping the lead on one of the smaller rivers, the St. Francis, which flowed into the Mississippi near the Arkansas River. Renaudiere thought that since the "St. Francis was navigable during the rainy seasons, if miners placed their lead on pirogues near the mines, it would reach the Mississippi River in eight days." He estimated that between five and six thousand pounds of lead "may be carried in a pirogue from the mines to New Orleans by way of

[181] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

the Arkansas River." Renaudiere anticipated the route to be equal to the distance between the mines and Kaskaskia.[182]

De Gruy also depicted the mining site as well watered, making it possible to deliver the smelted lead to either Kaskaskia or Fort Chartres using the navigable rivers. Recall that according to European standards, running water also suggested that miners could easily construct mills to grind large chunks of galena into smaller more manageable pieces for the smelting. De Gruy used his report to sway French officials into believing that once a mining settlement was established, workers could then conduct the business of selling or trading their lead to the local community, or even shipping lead bars to New Orleans.[183] The numerous streams of water flowing through the mining district also suggested local river systems, mountains ranges, and other natural resources for the development of a settlement. In like fashion mining engineers who came before, De Gruy also reported how "numerous smaller rivers made it easy to construct mills here."[184] He also understood that water mills could supply water to clean lead ore before smelting.

In essence reporting the mining environments general conditions to French officials was a promotional technique that Des Ursin, Renaudiere and De Gruy, as well as others, employed to entice their readers to settle at the mines. Renaudiere clearly documents how "in the neighborhood of the mines there are many mountains of no mean height—if a settlement could be formed here—a good living could easily be made."

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[182] Des Ursin, "Relation of the Journey to the Mines in Illinois Country by des Ursin"; Renaudiere "Account of the Mines of M. de la Motte."

[183] For an example of lead trading account, see October 14, 1734. Fontainebleau. Minister to Beauharnais [Beauharnois]. The departure of the Charente for Lao delayed by lead shipment; instructions on the cargo. AC., B 60:249. N.M. Miller Surrey, trans., *Calendar of Manuscripts in Paris Archives and Libraries Relating to the History of the Mississippi Valley to 1803* (Washington: Carnegie Institution of Washington Department of Historical Research, 1926), 297; Joseph H. Schlarman, *From Quebec to New Orleans; The Story of the French in America Fort de Chartres* (Belleville: Buechler Publishing Co., 1929).

[184] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

After describing the mining landscape, Renaudiere lists multiple examples of European machines that could be constructed at the mines.

In addition, each of their reports emphasized the possibility of Europeanizing the lead mines by establishing a permanent mining settlement instead of traveling between Fort de Chartes and the mines. For example, because of numerous instances when miners encountered water obstacles, Des Ursin also noted that installing pumps to extract the water was the best solution, thereby making it possible to more easily reach the veins of lead. Des Ursin understood the necessity for pumps to drain the water from mines in order to make them operable at increasing depth. Beginning with Agricola, mining manuals illustrated mine-pumping equipment. Agricola used illustrations to show the mechanical art of mining, from the simplest European tools to the more complex water pumps. Europeans carried mining troubleshooting ideas and solutions to the North American mining site to extract the most lead ore efficiently.

To further encourage establishing a mining settlement, De Gruy painted a picture of a sufficient amount of timber. Late seventeenth-century and early eighteenth-century travelers describe the Mississippi Valley as a place "filled with excellent timber."[185] In addition to extracting lead ore from the earth's surface, the next operation at the worksite was to test the lead ore's quality, and begin gathering large quantities of timber to construct numerous open-air log furnaces for the many firings.

De Gruy considered the crude mining and smelting practices that limited the possibility of having greater success at Mine La Motte. He also saw the short mining season of only four or five months, the absence of a permanent mining settlement, and the shortage of skilled workers as hindrances to further development. Although De Gruy

[185] Mereness, ed. " Journal of Diron D'Artaguiette," *Travels in the American Colonies*, 67.

considers the Native American and French amalgam to be primitive, he recorded a significant amount of lead produced. De Gruy provided court officials with the production amounts of Mine La Motte. In 1741, he estimated that miners produced 2300 saumon bars weighing about 161,000 pounds at 70 pounds per bar.[186] In addition, the total amount that miners produced in 1742 was 2228 saumon bars weighing approximately 155,960 pounds.[187] So even though De Gruy clearly has a critical eye towards the present amalgam, since the productions amounts remained relatively satisfying to local and court officials the Native American and French techniques remained in place. However, to counter the above impediments he proposed that a mining community be established to grow the enterprise. He also suggested that the government consider sending prisoners to extract lead and cut timber for three years. He considered that such a commitment would support the year-round extraction and production of lead.

As court officials consider how to best expand the small colony near the lead mines, Phelypeaux may have thought the best course of action to make the colony profitable was to motivate the miners towards agriculture rather than towards the extraction and smelting of lead ore. Phelypeaux believed that they should be persuaded to concentrate on pursuing agriculture, as it would provide security for their families.[188] By the 1740s, life in and around the mines resembled the older towns on the other side of the Mississippi. Ste. Genevieve and parallel communities in the mid-eighteenth century

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[186] Lockwood, "Early Times and Events in Wisconsin," 131-132 does not use the word saumon but he describes a leaden mass shaped like a saumon probably was shaped. His account is concerned with 1822 reports of Indian trade in the Galena region.
[187] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."
[188] Minister of the Marine to de Bertet, Paris, Archives Nationales, Colonies, MSS. C13, 28: 245-250 vol. (Missouri Historical Society) January 1, 1744.

looked more like another colonial region: the Chesapeake. More like the Chesapeake than New England because, the settlements near the mines directed much more of their agricultural production to distant markets. Like farming, fur trading and mining provided settlers with a degree of freedom, and most settlers rebelled when presented with the prospect of farming for a living. Shipping records between New Orleans and Upper Louisiana note pig lead and other types of cargo in their manifest. Local villagers, merchants and miners were pleased with the production of the lead mines because they did not have to worry about the leakage of grain lead on the trans-Atlantic voyage, and could avoid the difficult upstream transportation of lead from New Orleans to colonial post located along the Mississippi River.[189] Another advantage was that a new commercial field would be established in the colony. As time elapsed, miners and farmers continued to extract, smelt, and manufacture shot, which became increasingly valuable to frontier fur traders and farmers needing to provide security for their homes. Miners also suggested that manufacturing lead products in the colony would save on transporting similar items across the Atlantic. However, it was incumbent for the colonists to have a skillful lead manufacturer to make shot for the local and distant villages.[190]

[189] The continuing significance of lead is noted in the Chouteau Family Papers, 1752-1946, which consist of correspondence, bills, accounts, inventories, contracts of engagement with various men, packing accounts, bills of lading, and other business papers related to the sale of lead from Auguste Chouteau, Pierre Chouteau, Sr., Pierre Chouteau, Jr., and Rene Chouteau, relating to their activities as fur traders, merchants, and financiers of Missouri. Includes 53 ledger account books of the American Fur Company's Western Division, Collection of Chouteau family papers. (Missouri Historical Society & Yale University Libraries).

[190] Settlers' manufactured shot with: a burnishing mill, arsenic, ladles, skimmers, scoops, testers, iron molds, scraper, big covered boilers, and a gun barrel used to make the shot. See Account of the sale of widow Madame Gadobert's home and shot making equipment to Francois Valle in 1774. Ste, Genevieve Archives, Mine La Motte, Mines Collection, MSS. 24. (Missouri Historical Society).

During the French and Fox wars, fighting between the French and Fox Indians caused an increase in the demand for lead. However, because the lead trade was disrupted in the Mississippi valley so severely by 1733 the Governor of Illinois reported that he was only able to safely procure enough lead for use by his own men, and had none to export to New Orleans.[191] Although the Fox and French continued their clashes, the Native Americans near the lead mines still welcomed the French traders who came to live among them. They repeated their practice of forming trade alliances with the French who desired to exchange European manufactured goods for furs, hides, and lead.[192]

In light of these developments, miners continued to ignore the indifference of the French officials. One colonist even sent his lead to the French market, as is disclosed in a letter to the Minister. Phelypeaux approved of the shipment of over thirty thousand pounds of lead belonging to Mr. Desclozeaux on the ship *La Charenete*.[193] Phelypeaux had arranged for the remission of the freight charges on his shipment. He also suggested that others might send their lead as ship ballast, but made it clear that lead could not be permitted to displace other colonial products like wheat flour.

In 1754, smelter and merchant Karpen de Lagautrai, working near Mine La Motte, wanted to manufacture enough musket balls to supply a consistent flow to the royal warehouses and the entire colony. Lagautrai described himself as "already engaged in the lead industry" and requested expert workmen be sent to the colony.[194] He required

[191] Louise Kellogg, *The French Regime in Wisconsin and the Northwest* (Madison: The State Historical Society of Wisconsin, 1925), 221, 360-363.
[192] Bernard Schockel, "Settlement and Development of Jo Daviess County" *Geography of the Galena and Elizabeth Quadrangles*, eds. Arthur Trowbridge and Eugene Shaw, no. 26, Illinois State Geological Survey, (Urbana,: State of Illinois and University of Illinois, 1916), 180.
[193] Jean Arnold Valentine Bobe Desloseaux was a successor to Joseph Buchet as guardian of the King's warehouse in Illinois sometime after 1757, since Buchet served until that year. Little else is known of Desloseaux. Alvord, *The Illinois Country*, 96.
[194] Paris, Archives Nationales, Colonies, MSS., 38: 39-40 vol. (Missouri Historical Society)

one or two workmen capable of making "grain lead and rolled lead." He asked officials to try and locate a skilled individual and send him with the necessary equipment. Lagautrai even offered to pay all the travel expenses for the workmen, their tools, and wages. Lagautrai's proposal to pay the workmen suggests his willingness to "further risk at" his "expense the working of mines," and the manufacture of a necessary commodity. Nothing is known of the response to his requests for skilled workmen. It seems safe to assume that the court was slow to act on such colonial matters. The problem of securing knowledgeable workers and manufacturers continued to hinder the growth of the French lead enterprise.[195] Although it remained a viable colonial industry for local consumption, after Spain came to possess the region in 1763, new knowledge and technology began to influence mining and smelting on the frontier.

In conclusion, Antoine De Gruy's Native American and French miners' prospecting, mining and smelting expedition represent a continuum of the amalgam of cultural contact and the creation of new alliances. His narrative uncovers a number of changing patterns in the way Native Americans and French miners applied their environmental knowledge and tools to prospect for and extract galena. Most significantly, De Gruy's travels through the "country full of mines," offers a window into a Native American longstanding smelting technology, which French miners adopted in order to manufacture lead bars for local and distant consumption. The De Gruy narrative is also useful for estimating the mining progress for the years between 1719 and 1743. Only Mine La Motte had been exploited. Even though miners worked only one season per year using "primitive methods," by 1743 the landscape had changed. De Gruy's

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[195] This was not only a problem at the mines, American colonial mines also lacked skilled workers. See Nicholas Roosevelt and Jacob Mark and Company, *Papers relative to an application to Congress for an exclusive right of searching for and working mines in the Northwest and South-West Territory* (1793).

analysis of the exploitative methods of miners, the digging of numerous trenches in the surface of the earth, and the amount of timber used for smelting must have scarred the mining district.

According to the Mine La Motte production records, miners continued to extract a large quantity of lead. Miners using Native American methods began to be viewed as mining in what De Gruy described as "a haphazard fashion."[196] Kaskaskia continued to be the lead depot. To transport the lead from the mines to Kaskaskia, Valle directed his sturdy horses to carry the lead bars. To ease the movement of lead, local miners, after the lead was sufficiently melted, placed a large stick into the molten lead before it hardened. When the lead became solid metal, the stick was removed, leaving behind a hole through which carters could thread rope for ease of carriage. These details of production note the hard but somewhat profitable early stages of a developing mining industry.

During the years of the French dominating the Mississippi Valley, the region witnessed the continuation of a thoroughly native lead enterprise. Assisted by Native Americans, De Gruy and French miners located additional lead mining sites. Independent of France and depending only upon the "strength of their arms," the settlers and the Native Americans carried the enterprise forward.[197] As a native currency, lead became increasingly significant in the form of baling seals for the fur trader and the Native American, and in the form of shot for the protection of the colony and the frontier home. All became dependent upon the little blue-gray pellets for security. Lead was traded or sold almost entirely within the confines of the Mississippi Valley.

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[196] De Gruy and Robineau to the Minister, Paris, Archives Nationales, Colonies, MSS. B 78: 443:443 vol. (Missouri Historical Society) December 6, 1744.

[197] Chouteau Family Papers, 1752-1946. American Fur Company's Western Division, (Missouri Historical Society & Yale University Libraries).

The prospecting, extracting, and smelting amalgam created by the convergence of Native American and French miners knowledge and practice allowed them to establish a small enterprise. As the enterprise grew, new villages were established. One of the villages, Old Mines Creek, situated on a branch of the Mineral Fork, became significant following the arrival of Moses Austin in 1797. Austin came to Spanish Louisiana from Virginia with a number of knowledgeable British miners and smelters. These men would import their European extracting and smelting technique, as well as establish a permanent mining settlement. The new technology would not erase the presence of the Native American and French practices. Instead, both European and Native American methods continued to develop alongside each other at two separate settlements.

Part II: Settling In: Closer Proximity to the Mines

By the 1760s, the lead mines near the Mississippi River became home to a second colonial settlement. Imperial scheming resulted in the division of the region around the mines. As conflicts between France and Britain that began in the Ohio valley, and extended across the Atlantic continued, for the most part villages near the lead mines Kaskaskia, Fort de Chartres, and Ste. Genevieve remained isolated from these frontier and global struggles. However, no one in the Illinois Country knew of negotiations between the Catholic monarchs of France and Spain. Both countries joined to discuss the exchange of the French territory west of the Mississippi to Spain. In the following year, the Treaty of Paris ended the Seven Years' War, which reordered the border along the Mississippi. England and Spain were now new neighbors. In addition, the nearby Natvie Americans had migrated from nearby Kaskaskia, because the cultivating fields around their villages began to lose some of their fertility, and they resettled southwest of the lead mines.[198] However, the accommodations established earlier continued to serve their purpose as French villagers, and newcomers that included the Shawnees, Delawares, and Americans maintained good trade relations.[199]

With the outbreak of the American Revolution, the competition for empire also continued in North America during the 1770s and 1780, which would also settle some of the political complications in Louisiana. Great Britain would no longer continuously compete for control of the Mississippi Valley, however, in the peace treaty of 1783, the English maintained their rights to navigate and trade along the entire Mississippi River.

[198] Stephen Aron, *American Confluence: The Missouri Frontier from Borderland to Border States* (Bloomington and Indianapolis: Indiana University Press, 2006), 42.
[199] Kathleen DuVal, *The Native Ground: Indians and Colonists in the Heart of the Continent*, (Philadelphia: University of Pennsylvania, 2006), 28, 198; Also, see Aron, *American Confluence*, 69-70.

Great Britain also conducted fur trading with local Native American tribes of the upper Mississippi Valley. At times during these years England threatened to attack Spanish Louisiana. However, after 1783, Great Britain was no longer a persistent contender to gain control of the colony.

Map 8: North America with the boundaries of the thirteen United States, as settled by the Treaty of 1783[200]

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[200]North Carolina Collection – (March 24, 2012).
http://dc.lib.unc.edu/cdm4/item_viewer.php?CISOROOT=/ncmaps&CISOPTR=66

Between 1783 and 1803 there were other competitors—Spain, France, and the United States—who each tried to impose their rule upon the vast Louisiana Territory, which included the important lead mines located just west of Ste. Genevieve, Missouri. By 1783, Ste. Genevieve was as large as St. Louis, and was vital to not only the trans-Mississippi West, but also it served as a depot for the storage and shipment of pig lead. Following the American Revolution, newly arriving Americans, like Moses Austin, British miners, and the local people of Ste. Genevieve desired to settle near the lead mines, but they probably did not imagine a time when the new American republic would govern the region.

Just as the lead mines on the western side of the Mississippi River had changed hands forty years earlier, by the first decade of the nineteenth century, it would change colonial hands twice. Initially, Spain sold Louisiana back to France, and then the United States purchased the territory from France. In March 1804, the American flag was raised in St. Louis, and the United States now claimed the lead mines as well as the Mississippi and Ohio Rivers, on which pig lead flowed across North America south to the Gulf of Mexico or east to the growing Atlantic cities. This remapping of the western side of the Mississippi opened the door to new visions of American scientific exploration and the desire to improve mining technologies.

During the opening years of the new century, Thomas Jefferson entered office and deployed a sense of innovative change and expansion that was not only flowing over the young republic, but also over the mining frontier. Jefferson envisioned the United States multiplying across the continent as early as 1792.[201] At that time, he proposed an

[201] Donald Dean Jackson, James P. Ronda, *Thomas Jefferson & the Stony Mountains: Exploring the West from Monticello* (Tulsa: University of Oklahoma Press, 1993), xv, 74, 93.

expedition to map the vast territories west of the Mississippi River. Although Jefferson connected exploration and growth with the pursuit of agricultural development, as a respected amateur scientist, he also was devoted in technological improvement. Yes, Jefferson still cast a distrustful eye on factory enterprises that employed large labor forces, but he was a realist. He recognized that for the new republic to establish a prosperous domestic economy it had to lessen America's dependency on foreign goods.[202] As an American ambassador to France (1784-89), he had acquired firsthand knowledge about the latest European innovations in firearms with interchangeable parts, steam engines, and geological explorations.[203]

Jefferson believed that science and the useful arts should be applied to enable people to own and develop their own farms to provide the necessities of life. Always interested in agricultural improvements, in 1788, he designed a moldboard for turning soil that improved the efficiency of the common plow.[204] Jefferson also understood the need to generate income by any innovative means possible. For example, he decided to build a nail-making factory on the grounds of Monticello after discovering his crops had failed.[205] Similar to Jefferson, miners in the middle Mississippi Valley also recognized the need to generate additional income beyond farming. To increase their mining profits, they desired to use new scientific methods to investigate the numerous veins of lead lying beneath the earth's surface at Mine a Breton and Mine La Motte. For example, Austin's personal library contained over seventy encyclopedias—evidence of his interest not only in geology, but also in early experimentation to improve lead mining and smelting. Like

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[202] Joseph J. Ellis, *American Sphinx: The Character of Thomas Jefferson* (New York: Alfred A. Knopf, 1997), 167-168.
[203] Ellis, *American Sphinx*, 97, 166.
[204] Ellis, *American Sphinx*, 162, 345.
[205] Ellis, *American Sphinx*, 166.

Jefferson, Austin had obtained direct information about the latest European innovations and technological improvements of his time. Neither Austin nor Jefferson feared new inventions. They both believed that where new innovations were supported by well-known principles it promised to be useful and therefore should be tried. Jefferson, Austin, and Northeastern merchants, aware of the escalating tensions in Europe and their potential threat to overseas trade, realized the significance of expanding mining possibilities in the United States.

Following the Embargo of 1807, Jefferson's longstanding vision of seeing the United States develop into an agrarian nation gave way to a fundamental change in the American economy. Adventurous urban and rural entrepreneurs and miners seized the advantage of the embargo. For example, with overseas commerce at a standstill, and British products cut off from American markets, Moses Austin constructed a machine based shot factory at Herculeaum, Missouri. In Philadelphia as well, Christian Wilt and Samuel Wetherill, both producers of red and white lead, made plans to either relocate their operations to St. Louis or establish business connections with the Missouri Territory's lead mine owners, respectively, in closer proximity to Mine La Motte's quality lead.

In the years leading up to the War of 1812, and thereafter, the allure of the West also created western markets as settlers directed their consuming gaze eastward for manufactured goods, and other hard to obtain supplies on the frontier. Although settlers looked to Northeastern merchants for a variety of products, they did not have to look any further than their local mining region for lead products such as shot or sheet lead. Local French miners continued to smelt lead ore on the spot at the mines by using the log-heap method. By the 1790s, miners had begun to use unique stone furnaces, even as Austin introduced the reverberatory and ash furnaces that had been used England. With the arrival of Austin at Mine a Breton in the late 1790s also came significant changes in almost every aspect of lead mining in Spanish Illinois. Austin mined the mineral from deep vertical shafts, instead of digging trenches as the French and Kaskaskia had done. He used his furnaces to extract a greater percentage of the ore's lead. He also expedited the transport of lead from the mines to the Mississippi by building a road between Mine a Breton and Herculaneum. Austin's new road not only connected the mines to the Mississippi, but also to what had become, in 1800, the best water trade route to transport manufactured shot from the American West down the Mississippi River, into the Gulf of Mexico, and up along the Atlantic coastline.

Chapter 3: The Plumb-line: Establishing a Mining Frontier Bordered-land

In December 1795, Charles De Hault Delassus completed a report highlighting the importance of establishing two mining settlements, one at Mine La Motte and the other at Mine a Breton.[206] To accomplish his goal, Delassus planned to recruit the American miner Moses Austin and a few British miners, "all skilled in mineralogy," to transfer European mining customs to the region. He wanted Austin to teach local miners how to extract lead from shafts and how to erect "an excellent foundry" to smelt lead ores and cease using the Native American and French amalgam. Delassus also wanted Austin to begin manufacturing shot, sheet lead, and zane at Mine a Breton for local and distant trade.[207] Delassus had observed local farmers leaving Ste. Genevieve for Mine La Motte "after harvest from August to December to dig for mineral" and hoped that the longtime local miner Francois Valle would establish a settlement there and smelt lead year-round.[208] By 1800, Austin had successfully constructed a settlement at Mine a Breton. However, in its shadow, Valle and other miners still traveled to and from Ste. Genevieve

[206] Delassus Report and Census of the population in the Spanish Illinois Country—1797. Archivo General des Indies, Papeles de Cuba—cited *AGI, PC legajo* 2365. Missouri Historical Society. Hereafter cited as Delassus Report and Census.

[207] Charles (Don Carlos) DeHault Delassus (1764-1846), Captain and commandant of the New Bourbon post was the second son of Pierre and Josepha, was born in Bouchaine in April 1764. By 1799, under orders from Spain, Delassus was appointed Lieutenant Governor and commander in chief of Upper Louisiana. He was at St. Louis before turning over control of the territory to the American agent Amos Stoddard when Louisiana was transferred to the United States. Trudeau was born in New Orleans, November 28, 1748. He was well educated, had a family of several sons. See, Louis Houck, *A History of Missouri from the Earliest Explorations and Settlements Until the Admission of the State into the Union, Vols.1* (Chicago: R.R. Donnelley & Sons Company, 1908), 57-59.

[208] James Woodhouse, *The young chemist's pocket companion connected with a portable laboratory; containing a philosophical apparatus, and a great number of chemical agents; by which any person may perform an endless variety of amusing and instructing experiments; and intended to promote the cultivation of the science of chemistry* (Philadelphia: J.H. Oswald, 1797).

to their semi-seasonal mining settlement, Mine La Motte, to extract and refine lead ore seasonally according to their traditional mining customs.[209]

Similar to early miners, Valle and others continued to carry out Native American and French mining techniques in the cyclic fashion. But like early French miners Delassus wanted to establish a settlement closer to the mines as opposed to following the seasonal mining schedule. He too had a vision of creating a mining community. To found a village near the mines, Delassus fashioned a plan to entice "a considerable number of industrious" Americans and Europeans by offering them liberal land grants near the places where lead was to be found.[210]

The mining frontier was not only a contact zone where peoples intermixed through trade, agriculture, and marriage but also where miners' traditions converged. From 1719 to 1763, the Kaskaskia Indians and French miners learned to barter and even work mines together using their respective environmental knowledge and practices. The middle ground they forged around lead ore was replete with syncretism and alliances.[211] This chapter examines the efforts of local miners, American, and British miners to found Mine La Motte and Mine a Breton on the early American frontier. Additionally, since the mining "cultural fusion between native and settler cultures" has been least understood by historians, I examine how the convergence of Euro-American settlement practices and

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[209] Delassus Report and Census. Also, see Anthony Crozat emphasis on the abundant forest in the region is noteworthy in Newton D. Mereness, ed. " Journal of Diron D'Artaguiette," *Travels in the American Colonies, 1690-1783, Edited Under the Auspices of the National society of the Colonial Dames of America*, (New York: Antiquarian Press, 1961), 15-94.
[210] Houck, *The Spanish Regime in Missouri*, 358-360.
[211] Richard White, *The Middle Ground: Indians, Empires and Republics in the Great Lakes Region, 1650-1815* (New York: Cambridge University Press, 1991), 94-96; James Axtell, *The Invasion Within: the Contest of Cultures in Colonial North America* (New York: Oxford University Press, 1985), 23-127.

certain mining and smelting techniques reveal how the mining frontier began to transition to a mining frontier-borderland.[212]

If the mining frontier became a meeting place where miners amalgamated their prospecting, extracting, and smelting customs, then the designation of borderland denotes the arrival of alternative mining techniques that tried to oppose preexisting practices. The emergence of the mining frontier-borderland occurred after Spanish officials, who now controlled the Louisiana Territory, encouraged American and British lead miners to transfer their mining traditions to the Territory in the 1790s. The frontier-borderland became a place where Valle and other miners continued to apply the hybrid. However, with the arrival of Moses Austin and English miners using their European technologies, the mining frontier became a frontier-borderland where the amalgam and new mining practices co-existed and formed a boundary.[213] Therefore, by the late eighteenth century, a good deal of what is now called technology transfer began as miners settled near the mines, and proceeded to create a mining frontier-borderland.

Historians have examined how American settlers changed the environment after establishing settlements in closer proximity to the lead mines beginning in the late antebellum period.[214] The value of such studies of the relationship between humans and nature is that it reminds us in the twenty first century that during the eighteenth century most people needed to live relatively close to what would later, especially, be called "nature". Miners and merchants alike clearly understood that their environment was not

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[212] Colin G. Calloway, *New Worlds for All: Indians, Europeans, and the Remaking of Early America* (Baltimore: Johns Hopkins University Press, 1997).

[213] I use technology to emphasize the frontier and borderlands transition of the lead mines during exploitation. See, "From Borderlands to Border: Empires, Nation-States, and the Peoples in Between in North American History" *The American Historical Review*, Vol. 104, No. 3 (Jun., 1999), 814-841.

[214] Hugh Davidson, "The George Cresswell Lead Plantation," in *Material Culture*, 23, no. 2 (1991): 1-23; Walter A. Schroeder, *Opening the Ozarks: A Historical Geography of Missouri's Ste. Genevieve District 1760-1830* (Columbia: University of Missouri Press, 2002), 225-266.

merely a place where action took place; environment was connected with action. Mart Stewart argues that examining how settlements changed in the past is also the study of change in nature.[215] Stewart explores how the cultivation of rice had distinct connotations for slaves and slaveholders. Stewart's evidence shows how slaves and slaveholders came together in a southern agricultural system to skillfully refashion Georgia's environment. His research into the transculturation of technology between African and European rice cultivators highlights a comparative framework for understanding the convergence of environmental knowledge and practices. Similarly, by the late eighteenth century, the methods miners used to extract and smelt lead ore at Mine La Motte and Mine a Breton reveals a meeting between different mining methods and the creation of two diverse mining villages.

Since Austin, Delassus, and English miners believed that their sense of inventiveness, organization, and working of nature would guide the establishment of Mine a Breton, their confidence shows the appearance of a single hegemonic technology. According to the Delassus plan, he not only welcomed American and English miners, but also those miners who understood the latest European excavating and smelting practices to extract and refine the region's lead ore more efficiently. For example, a few years before the United States controlled the lead mines, Austin and English miners initiated new extracting, smelting, and refining methods according to European methods at Mine a Breton, while local miners continued to use the Native American and French syncretic practices at Mine La Motte. In the face of European practices, local miners continued to

[215] Plantations or settlements organized labor, resource, and nature. The lead settlements constituted a mineral-ecological system that restructured mineral processes for industrial purposes. Mart A. Stewart, *What Nature Suffers to Groe: Life, Labor, and Landscape on the Georgia Coast* (Athens: University of Georgia Press, 1996), 90.

employ "crude methods to discover lead ore," by digging trenches and building ancient log furnaces to smelt galena.[216] Although cross-cultural mixing continued at the mining frontier-borderland, earlier syncretic techniques began to slowly disappear in the shadow of new hegemonic instruments, which accompanied American and European miners' settlement practices.

In the seventeenth century, miners heading to colonial Spanish settlements carried with them Gabriel Plattes' *A Discovery of Subterraneal Treasures*. Plattes had synthesized the old mining information to show Spanish miners how to design their mining communities after they applied their European practices to extract gold and silver. In like fashion, miners from Cornwall, Wales, and German principalities carried with them Plattes' manual to transplant the medieval mining traditions to colonial Virginia, Maryland, and Pennsylvania in an attempt to recreate Spain's wonderful discoveries.[217] Therefore, well into the late eighteenth century, miners in the United States had established a number of iron plantations that served the needs of settlers. At these mining sites, workers extracted iron ore from deep shafts before smelting it in blast furnaces that were located on large tracts of land called plantations to supply colonial farmers with horseshoes, ax blades and plowshares.[218] In 1784, when *A Discovery of Subterraneal Treasure* was reprinted in Philadelphia, Delassus and Austin now had a plan to follow in

[216] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 10.
[217] Thomas A. Richard, *A History of American Mining*, (New York: McGraw-Hill, 1932), 18; John R. Stilgoe, *Common landscape of America, 1580 to 1845* (New Haven: Yale University Press, 1982), 273-274.
[218] For significance of metals such as iron and lead Europeans and Americans, Orlando C. Harn, *Lead The Precious Metal* (New York: Century, 1924); Robert B. Gordon and Patrick M. Malone, *The Texture of Industry: An Archaeological View of the Industrialization of North America*, (New York: Oxford, 1994); John Opie, *Nature's Nation: An Environmental History of the United States* (New Jersey: New Jersey Institute of Technology, 1998), 223-225; Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997), 57-63.

their quest to recreate a late eighteenth-century mining settlement near where lead was to be discovered.[219]

Plattes' manual also outlined the importance of forming a mining association. The mining association necessitated wealthy merchants who possessed the capital needed to support exploration and digging. In addition, money was needed to build roads and furnaces, and houses for miners and their families planning to relocate to Spanish Louisiana.[220] Plattes stressed that each of these steps to form a mining settlement were necessary to ensure the miners' good humor and the success of the mine. In addition, Delassus, Austin, and Valle also needed (1) a resident labor force; (2) a location near a flowing stream to erect a waterwheel to assist miners with cleaning and grinding the lead ores before smelting; (3) acres of forest to build housing for workers and their families, as well as to provide the fuel to smelt their lead ores; (4) furnaces to smelt the ores; (5) fields in which to grow food for settlers; and (6) close proximity to their source of ore.[221] Clearly, they understood the significance of location. Mine La Motte and Mine a Breton were both adjacent to navigable rivers so that pig lead, which was very heavy, could be transported to markets east of the Mississippi at the lowest possible cost.

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[219] Gabriel Plattes, *A Discovery of Subterraneal Treasure of all manner of mines and minerals*, (Philadelphia: Printed and sold by Robert Bell, 1784), 50-52; Charles Swift Riché Hildeburn, *A century of printing: The issues of the press in Pennsylvania, 1685-1784, Volume 2 American culture series Library of American Civilization* (Philadelphia: Press of Matlack & Harvey, 1886), 445; John Stilgoe explains how Gaberill Platte's plan shaped early Spanish and English mining settlements. His analysis of the technological transfer of mining practices from Europe suggests that European expertise made possible the construction of a mining settlement. See John R. Stilgoe, *Common landscape of America*, 277-288.

[220] For a more recent study of mining settlements as places of diversity, see Donald L. Hardesty. *Mining Archaeology in the American West: A View from the Silver State* (Lincoln: University of Nebraska Press and the Society for Historical Archaeology, 2010).

[221] Thomas Houghton, *Rara avis in terris: or The compleat miner, in two books; the first containing the liberties, laws, and customs, of the leadmines, within the weapontake of Wirksworth in Derbyshire. In fifty nine articles: to which are added, some new standing laws never printed before. The second teacheth the art of dialling and leveling*, (Derby: Printed by Samuel Hodgkinson, 1729), 16.

The construction of communities at Mine La Motte and Mine a Breton was also in line with what was occurring along the United States' Atlantic coastline. Beginning in the late eighteenth century, a good deal of what is now called technology transfer began after Europeans immigrated to the east coast.[222] Austin represents one American seeking to migrate west, and induce trained lead miners to emigrate from England to help expand his lead plantation at Chisel Mines in Wythe County, Virginia, and eventually Mine a Breton. However, a similar technology transfer occurred from the east coast to the Mississippi Valley. A few years prior to the Louisiana Purchase, Spanish Louisiana, like the United States, had become a place where immigrants transferred their technological skills and their mining management style from the newly formed United States and Great Britain to the frontier.

Value of mining administration to frontier miners

Transforming the mining frontier to a mining frontier borderland involved the formation of a mining association.[223] The association was formed to unite only Euro-American and European practices. In Europe, to start production at iron plantations, land was purchased, houses, furnaces, and water wheels were constructed only after a group of entrepreneurs pooled their resources to finance their endeavors. Miners, who lacked the capital to prospect, extract, and smelt minerals joined with entrepreneurs interested in mining the earth for its minerals to make money. In the United States, merchants and miners also formed similar associations and jointly signed contracts with American and

[222] Cowan, *A Social History of American Technology*, 19.
[223] Austin's letter to Kendall and Bates, December 1797, in Eugene C. Barker, eds., *Annual Report of the American Historical Association for The Year 1919: In Two Volumes, Volume II, The Austin Papers Part I* (Washington: Government Printing Office, 1924), 32-39.

European miners. For example, in January 1797, two New York merchants, Jacob Mark and Nicholas Roosevelt, employed German and English miners and metallurgists to locate ore and begin mining and smelting production. Their plan was "to explore for metals in the Northwestern and Southwestern regions" of the United States.[224] In 1793, Jacob Mark, General Philip A. Schuyler and Nicholas J. Roosevelt formed the New Jersey Copper Mines Association with the intention of reviving the business on a larger scale. Their need for new engines and other machinery prompted members of the association, and the European miners to set up a smelting plant, machine shop, foundry, and other necessary equipment.

Organizing associations also signifies the importance of procuring "skilled persons" to manage the extraction, smelting, and manufacturing of lead products. At the lead mines all three partners considered it essential to begin mining and smelting year-round once they established their settlements. Additionally, like Mark and Roosevelt Austin also needed to hire knowledgeable miners and manufacturers to increase the flow of lead down the Mississippi River to New Orleans and other ports. While Austin and British miners planned to import new techniques, constructing European machines to extract and smelt lead, miners continued to apply longstanding Native American procedures. Thus, although the mining association is representative of a European practice, miners at La Motte continued to extract lead ore from trenches and smelt their lead in Native American and French blended furnaces. Both methods appear to have had

[224] Nicholas Roosevelt and Jacob Mark and their Associates, *Papers relative to an application to Congress for an exclusive right of searching for and working mines in the Northwest and South-West Territory* in William Langworthy, *Papers Relative to an Application to Congress for an Exclusive Right of Searching for and Working Mines in the Northwest and Southwest Territory*, (Philadelphia: Printed By Samuel H. Smith, 1796), 3-28. Also, see Collamer M. Abbott, *The William and Mary Quarterly, Third Series*, 27, no.2 (April 1970): 295-309.

similar outcomes; the extraction of significant amounts of lead ore for the production of lead articles for society.[225]

The agreement made between Delassus, Valle, and Austin called for Austin to dig the region's first shaft, erect a reverberatory furnace, hire experienced miners from Derbyshire and Cornwall, England, and manufacture shot, sheet lead, and a key component for making glass bottles, zane.[226] By 1800, because Great Britain had "annually produced the greatest quantity of lead furnishing every year 12,500 tons of lead, would be another reason Austin looked to British miners and artisans from the lead producing regions of Derbyshire and Cornwall. Therefore, beginning in the late eighteenth century experienced English miners began to immigrate to search for veins of lead. Austin also needed artisans familiar with the British inventor Josiah Watts shot patent, so that Austin could begin to build a shot tower.

Prior to Austin's arrival, many frontier homes contained musket ball making equipment, or one villager was responsible for manufacturing musket balls. This was accomplished by using a burnishing mill, arsenic, ladles, skimmers, scoops, testers, iron molds, scraper, big covered boilers, and a gun barrel to shape musket balls. Valle most likely welcomed the association and Austin's commitment to manufacture shot, as he would no longer have to travel and peddle his pig lead in frontier towns. Valle intended to deliver his pig lead to Austin, who would manufacture a considerable proportion of

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[225] Langworthy, *Papers Relative to an Application to Congress for an Exclusive Right of Searching for and Working Mines,* 9-11.

[226] See, Benjamin Henfrey, *A Plan With Proposals for Forming a Company to Work Mines in the United States; and to Smelt and Refine the Ores Whether of Copper, Lead, Tin, Silver, or Gold* (Philadelphia: Snowden & M'Corkle, 1797), 18; Zane and shot was also important settlers. For the manufacture of shot, see James Cutbush, *The American artist's manual, or Dictionary of practical knowledge in the application of philosophy to the arts and manufactures. Selected from the most complete European systems, with original improvements and appropriate engravings, adapted to the use of the manufacturers of the United States* (Philadelphia: Johnson & Warner, and R. Fisher, 1814) "lead" section, in Emporium of Arts & Sciences, August 1, 1814; 3, 2.

Upper Louisiana's shot.[227] While sheet lead was used in frontier homes primarily to make small boxes to preserve goods, in New Orleans it was used to secure the decks of shipping vessels, to cover roofs, to line cisterns, to line bathtubs, and to allow pipes to convey water underground.[228] Austin also planned to make zane from lead ashes, after he secured business connections with glassmakers in Frederick, Maryland because it was suitable material for making glass bottles.[229] For example, in 1784, when Johann Friedrich Amelung settled, he proceeded to construct a glassworks factory. Amelung produced some of the most beautiful glass ever made in America. Similar to Austin, Amelung, brought sixty-eight glass craftsmen, although of German origin, and furnace equipment to the young United States. During the following decade, Amelung built housing for approximately 400 to 500 American and German workers. Similarly, the Pittsburgh Glass Works, founded by James O'Hara in the late 18th century where Moses Austin may have hoped to sell zane for their bottle works. Although pleased that Austin would be capable of making these products, Delassus was more excited about Austin's prospects of bringing European-trained miners to change how mining and smelting was practiced.[230]

The invasion of European methods reveals how the mining frontier continued to be a zone of intercultural penetration. The willingness of miners to adapt Austin's European methods also represented the locals' appreciation of new technological exchanges. However, after seventy years of native and French amalgamation on the

[227] Barker, eds. *The Austin Papers Part I*, 9-10.
[228] Author unknown, *Proposals For Establishing an Association for Working Mines and Manufacturing Metals in the United States* (Philadelphia: Printed By Samuel H. Smith no. 118 Chestnut Street, 1796), 14-22.
[229] John Frederick Amelung, *Remarks on Manufactures, Principally on the New Established Glass-House near Frederick-Town, In the State of Maryland* (Maryland: 1787).
[230] Author unknown, *Proposals For Establishing an Association for Working Mines and Manufacturing Metals in the United States*, 5-6.

mining frontier at Mine La Motte, with the arrival of newcomers' who settled at Mine a Breton applied their mining systems and routines a mining frontier bordered-land started to develop. As this chapter highlights, as the amalgam coexisted alongside of new settlers' customs, the old respective technologies increasingly became demarcated.

Following his arrival at Mine a Breton, Moses Austin and the British and American miners who accompanied him began to apply European mining methods by digging the regions first shaft and roasting ores in the regions only reverberatory furnace. In 1799, Austin reported, "The mines on the waters of the St. Francis are capable of furnishing vast quantities of lead." He further estimated that miners could extract and smelt over 200,000 pounds and 366,666 pound of pig lead at Mine La Motte and at Mine a Breton, respectively.[231]

Luring settlers "inclined to the arts"

To begin his regional redefinition of the mining frontier, Delassus focused on increasing the population along the western bank of the Mississippi adjacent to the mines.[232] Delassus' efforts symbolize how early Europeans promoted settlement near the lead mines by distributing flyers throughout the United States and Europe hoping to induce artisans to resettle and to begin to extract and smelt lead ore to manufacture shot, sheet lead, and zane. He wanted Americans and Europeans who possessed "inventive genius" with an "inclination to the arts" as a necessary step to develop a mining

[231] Moses Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 20.
[232] For examples of Spanish concerns with entrusting the defense of Louisiana to Americans, see Georges-Henri-Victor Collot, *Journey in North America, Containing a Survey of the Countries Watered by the Mississippi, Ohio, Missouri, and Other Affluing Rivers Volumes 1 and 2* (Paris: Printed for Arthus Bertrand, 1826): pg#; online facsimile edition at www.americanjourneys.org/aj-032/, (March 30, 2012); Concerning Collot's activities in North America see Houck, *The Spanish Regime in Missouri*, 133-138; Durand Echeverria, "General Collot's plan for a Reconnaissance of the Ohio and Mississippi Valleys, 1796," *William and Mary Quarterly*, 9, (October 1952): 512-20.

settlement.[233] Delassus assumed "a great number of families could be found who would" come from America if he presented them with land.[234] He announced his plan in the United States by distributing handbills in border and distant states.[235] Almost immediately, Americans began to travel from Pennsylvania, Kentucky, Virginia, and North Carolina to the western edges of the Mississippi.[236]

As the fame of the vast lead ore deposits in Upper Louisiana, as well as the ease of mining it, quickly spread over the eastern seaboard, the news reached the ears of Moses Austin. Austin was born in Durham, Connecticut, in 1761. As a youth, he lived in Middletown near the lead mines that supplied the Continental Army with lead to make musket balls. It was there that Austin became familiar with lead mining. In 1783, Austin developed an interest in a dry goods importing company in Philadelphia, and the following year his firm sent him to Richmond, Virginia, to manage a branch of the company. Since pewter buttons were one of the items imported by his firm from England, Austin used lead and zinc to make American pewter buttons.[237] Later, Austin recommended to the Philadelphia firm that they should purchase the Chisel Mines in Wythe County, Virginia, to obtain all the lead necessary to make their own products.[238] Eventually, Austin found it necessary to hire skilled English miners to help with the expansion of the settlement, and he persuaded his brother Stephen to travel to England to

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[233] Delassus Report and Census.
[234] Delassus Report and Census.
[235] Barker, eds., *The Austin Papers Part I*, "William C. Carr to Moses Austin," 105-107; Henry Clay Thompson, II, *A History of Madison County Missouri, The Democrat-News* (Missouri: Serially Published, 1940), 27-47.
[236] For early migration history to the region, see Lawrence Kinnaird, "American Penetration of Louisiana," in George P. Hammond, ed., *New Spain and the Anglo-American West, Vol. 1* (Lancaster: Lancaster Press, 1932), 211-37; Gilbert Din, "Spain's Immigration Policy in Louisiana and the American Penetration, 1792-1803," *Southwestern Historical Quarterly* 76 (1973): 255-76.
[237] For a detailed summary of the importance of lead discovery and use by settlers, see "Account of the lead mines in Derbyshire, England with the Manner of Working The Mines," *The New York Magazine or Literary Repository*, (1790-1797): May 1797, 240.
[238] Thompson, *A History of Madison County Missouri*, 30-33.

hire experienced workers. While there, Stephen met Josiah Bell, who helped him locate skillful miners who were also familiar with smelting and manufacturing lead products. Stephen Austin and Bell returned to Virginia in early 1796, only to find Moses Austin preparing to travel to Spanish Louisiana to explore the lead mines advertised by Delassus.

On December 8, 1796, accompanied by Bell, Austin rode by horseback from Virginia to Spanish Louisiana to explore the lead mines. Following a short stay in St. Louis, Austin arrived at Ste. Genevieve on January 20, 1797. He made the acquaintance of Francois Valle, who provided him with a two-horse wagon, to ease his travels to the famed lead mines, thirty-eight miles away. After conducting a survey of the lead diggings, Austin commented that "a country with everything to make its settlers rich and happy could hardly remain unnoticed by the American people." He later returned to Ste. Genevieve, and submitted his application for a grant of land, near what would become known as Mine a Breton, to Delassus by simply stating "he desired to settle in the country."[239] In addition, prior to returning to Virginia, Austin and Valle made plans to expand lead production and grow the mining business.

Francois Valle's ancestors came to the middle Mississippi Valley from Canada. By 1750, Valle began mining at Mine La Motte where he applied the Native American and French amalgam. The Francois Valle family was early settlers in Ste. Genevieve, Missouri. Francois Valle Sr. came from Canada to Kaskaskia and then moved to Ste. Genevieve during the 1750s. He was the first commandant of Ste. Genevieve under Spain. Francois Valle Jr. and his son and John Baptiste Valle were prominent lead miners and merchants who were active in the formation of the Upper Louisiana Territory, 1804. When he was not mining or smelting lead ore, he was in Ste. Genevieve planting

[239] Barker, eds., *The Austin Papers Part I*, "Moses Austin to Lieutenant Governor Delassus," 47-53.

or harvesting his crops. He conducted both activities according to the previously established seasonal schedule. Valle would then depart for trading expeditions in the Wabash River Valley and the trading posts in Detroit and Upper Canada to sell lead to settlers.[240] Valle also hoped to expand his mining enterprise by creating a mining village in closer proximity to the mines. A few years after Austin settled Mine a Breton, Valle requested land near Mine La Motte, but he and other miners continued their seasonal mining operations by "digging to extract mineral, cutting wood to build log furnaces to smelt the lead, and transporting the lead by horse" back to Ste. Genevieve.[241]

Local farmers and miners understood very well how easily they could extract galena using the Native American trench manner. The mines offered farmers a method to supplement their yearly income. Already, many locals could be found "working the mines between August and December after the harvest" as they "depended on the mines to furnish them with lead to purchase all imported articles."[242] In 1798, Valle and thirteen families presented Delassus with their petition to found the village of St. Michael, just south of Mine La Motte. After Delassus awarded land grants to Valle and a "certain number of farmers," they planned to leave their homes in Ste. Genevieve and resettle at Mine La Motte near the "beautiful and fertile open prairies."[243] The settlers

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[240] The Valle family came from Rouen, Normandy and settled near Quebec. See the Francois Valle Papers, 1742-1846. Mines Collection, 1715-1900 and Mine La Motte activity at the Missouri Historical Society. Also, see Houck, *The Spanish Regime in Missouri*, 54; Contract, Kaskaskia Manuscripts 44:5:5; Lucy Elizabeth Hanley, "Lead Mining in the Mississippi Valley during the Colonial Period" (unpublished master's thesis, St. Louis University, 1942), 30-37; Ekberg, *Francois Valle and His World*, 22-41.

[241] Francois Valle's account books often show the exchange of lead for products not available on the frontier. See Francois Valle Papers, Missouri Historical Society, St. Louis; and Valle Mining Company Account Books, The Western Historical Manuscript Collection (WHMC), Rolla, Missouri.

[242] Moses Austin report outlines the working mines in 1797. This report also mentions the importance of trading lead products for goods made in the United States. Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 17-22.

[243] Mines Collection, Missouri Historical Society, St. Louis. Trudeau's Report Concerning the Settlements of the Spanish Illinois Country—1798. Archivo General des Indies, Papeles de Cuba—cited *AGI, PC legajo* 194. Also, see Houck, *The Spanish Regime in Missouri*, 9-11, 255, 358-360.

proceeded to construct wooden frame homes and continued to mine for lead ores by following the Native American and French amalgam to extract the galena, and then melting the lead in log furnaces.

In addition to the Delassus report outlining his vision to establish mining settlements, his report also became a tool to supplant the amalgam. Decades before improvement societies began to organize local surveys to replace Indian methods officials measured the amalgam against what they believed to be more sophisticated European technologies. While watching local miners, both Delassus and Austin observed how they worked the "lead mines with which all that country abounds." Throughout the Delassus report, which he compiled for officials, he described the miners using "primitive methods" to extract lead, which shows his dislike of the trench mining practice. He also stated "more mines have yet to be opened, [but] the habitants are contented with [digging] to three or four feet in depth." He further noted "these mines if worked with intelligence would come to be the source of great prosperity for individuals, and a national aim of the greatest importance."[244] Like Delassus, Austin too described miners as "having no strength but their arms to extract lead ore." Austin also details how miners constructed unique "furnaces to smelt their lead, which leaves much waste and spent a great deal of time re-smelting their lead ore."[245] Delassus and Austin each wanted to see local miners transition from using wasteful mining and smelting methods used at both mines by importing European techniques, and establishing a mining community.

The land grants, the arrival Austin, the labeling of the amalgam as "primitive," and the transfer of the European-styled shaft, windlass, mill, and reverberatory furnace all

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[244] Houck, *The Spanish Regime in Missouri*, 360-370.
[245] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 7-10.

pointed in the direction of transforming the frontier to borderland as Delassus envisioned. However, to realize his vision he needed well-trained American and British miners and smelters to assist him with establishing two mining neighborhoods. Austin later speculated that when the population of the country increased, miners would open and work both mines in a more profitable manner during the early years of the coming century.[246] After all, the agreement between Austin and Valle was specifically arranged so that Austin could obtain extracted lead ore, which he agreed to, smelt in his furnace and sell for a profit.

Hybridity and the Mine La Motte settlement

The mining records of Francois Valle during the late eighteenth century provide little mention of a Native American presence near Mine La Motte. A close reading of Valle's account book, however, does reveals the gradual transfer of European technologies to Mine La Motte, along with the continuance of hybrid mining habits as the mining frontier transitioned to a bordered-land. As a well-established miner and merchant of lead, Valle wanted to construct a settlement near Mine La Motte. The mine was north of Cape Girardeau in the interior of the country on the St. Francis River, which miners used to send their pig lead to the Mississippi River.[247] By the late eighteenth century, as Ste. Genevieve became the established main depot from where merchants shipped their pig lead to New Orleans, many visitors to the mines stated, "The lands—are as beautiful

[246] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 20-22.
[247] Francois Valle items are included among the bulk of the materials concerning official matters. The bills and receipts make one section of the collection. This collection contains about ten items, which include copies from the Paris Archives on Mine La Motte copies located at the Missouri Historical Society Mines Collection. The collection includes information about early mining in Missouri, including Mine a Breton and Mine LaMotte. Also account of the history and ownership status of the Mine La Motte (or Lamothe) lead mine area in Missouri. Mines Collection, Missouri Historical Society, St. Louis; WHMC also contain the Valle letter books. Also, see Houck, *The Spanish Regime in Missouri*, note on page 54.

and as fertile—and already some inhabitants are thinking of settling there." Their comments suggest the importance of seeing farmers and miners of Ste. Genevieve construct a self-sufficient mining community, similar to iron works in the eastern United States, except where lead would be the ore of choice. Valle was not alone. When offered the opportunity to obtain a land grant from Spanish officials, part-time miners and farmers Paul De Guire, Joseph La Chance, Gabriel Nicollet, Jerome Matis, Peter Chevalier, and Pierre Variat joined Valle's petition to apply for land grants just south of Mine La Motte.[248]

Unlike Austin, however, after the applicants were awarded the land, they were unable to immediately settle, build homes, farm, or mine year-round near Mine La Motte. Instead, they continued to mine seasonally as the earlier Native Americans and French did. The arrangement allowed miners to spend more time committed to their mining chores, as opposed to spending two days each week traveling between the mines and Ste. Genevieve. Their mining and smelting calendar, which started in late March and lasted until late June, coincided with harvesting crops in Ste. Genevieve. Again, they departed for the mines in August to work until December before returning to their homes.

Although De Guire, La Chance, Nicollet, Matis, Chevalier, and Variat left no known personal records, their names and their assignments appear throughout Valle's letter book. His records provide evidence that clearly supports not only their adoption of the Native American techniques, but also how they were influenced by European division of labor practices.[249] It is not clear why or when Valle adopted this method. For example, during the first mining stage, the amalgam, there were no notable divisions of

[248] Houck, *The Spanish Regime in Missouri*, 365-372; Also, see Thompson, *A History of Madison County Missouri, The Democrat-News*, 27-47.
[249] Trudeau's Report. Archivo General des Indies, Papeles de Cuba—cited *AGI, PC legajo*, 194-196.

labor among the miners. However, during the second mining stage, the borderland period, Valle assigned La Chance to supervise the mining activities at Mine La Motte, a European and American practice, clearly outlined in Gabriel Plattes' manual.[250]

In addition to miners maintaining their seasonal activities, they also required food. The name La Malice appears in Valle's letter book, and he was responsible for to hunting and gathering food. He supplied meat, biscuits, meal, salt, and oil for the miners who were busy prospecting, extracting, and smelting lead. Other than these two specified work assignments Valle's account fails to show any additional divisions of labor among the other miners. Instead, De Guire, Nicollet, Matis, Chevalier, and Variat continued the Native American practice of jointly prospecting, mining, cutting, smelting, and carting lead.[251]

Valle clearly documents the type of implements used to prospect for and extract lead ore. The tools are consistent with those described by De Gruy in 1743. The La Motte miners used the iron probe, the shovel, and the poll, which served as both a pick and a hammer.[252] Mine La Motte miners employed hybrid-extracting methods. For example, the pointed shovel, called a spade, was the ideal mining tool to penetrate the earth, as well as the coarse fragments in the trench. Miners used their shovels when they encountered "soil intermixed with stone." Since miners encountered limestone intermixed with lead ore, La Chance, similar to European supervisors, conducted nightly tool inspections to ensure their sharpness for the following day's work. Dull tools were usually given to the hunter, La Malice, who combined his hunting trips with a stop at the

[250] Plattes, *A discovery of subterraneal treasure: of all manner of mines and minerals*, 276.
[251] Mine La Motte (or Lamothe) lead mine area in Missouri. Mines Collection, Missouri Historical Society, St. Louis. The Western Historical Manuscript Collection (WHMC).
[252] "Memoir of sieur de Guis Concerning Lead Mines in the Illinois Country."

village blacksmith in Ste. Genevieve, where he would have the tools repaired or sharpened before returning to Mine La Motte. After Austin's settlement was outfitted with a blacksmith shop, La Malice was able to cut his travel time to one-half day as opposed to making the trip to Ste. Genevieve.

Evidence that the miners at La Motte still used the Native American trench extracting method is revealed in the depth of the lead ore. Austin noted that since "the mineral is found two feet below the surface of the earth, the French miners being unacquainted with the utility of machines, are able to procure plenty [of lead ore] near[er] to the surface."[253] In Europe, in order for miners "to procure minerals from a depth beyond twelve feet," they usually installed a windlass above their shafts to lower tools and to raise ore, water, or debris from their mines.[254] Since miners at La Motte still applied the Native American practice of excavating the earth by following the deposits along the surface, in lieu of installing windlasses, they hoisted the lead ore using ropes and Native American buckskin baskets called "mo-cocks".[255]

Valle also adopted the European blasting techniques to extract ores. The earliest record of miners using the blasting method at Mine La Motte was in the late eighteenth-century.[256] Replacing the fire-setting technique with the blasting technique helped miners to crack limestone and recover lead ore, which was a significant change. The Valle accounts list an expensive powder, steel, and other items translated as flame or light. When miners combined these articles, they successfully produced a fuse for blasting to

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[253] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 14-17.
[254] Plattes, *A discovery of subterraneal treasure: of all manner of mines and minerals*, 304-308.
[255] Carver, *Travels through the interior parts of North America*, 63.
[256] For a concise history of the blasting methods see, Andrew Ure, *A Dictionary of Arts, Manufactures, and Mines: Containing a Clear Exposition of Their Principles and Practice* (London: Longman, Orme, Brown, Greene, & Longmans, 1839), 835-837. Also see, how Native Americans and American miners used similar techniques in the Upper Mississippi Valley mines near Galena, Illinois. See, Millhouse, "A Chronological History of Indian Lead Mining," 6-8.

help with the extraction of ore from in between limestone.[257] Depending on whether the ground was wet or dry miners employed two methods of blasting. Miners placed the gunpowder into a powder burn or tin cartridges to protect the fuse—and then rubbed the paper with gunpowder. If miners encountered a wet area, they filled the space with clay to act as a drying agent.[258]

After they extracted the lead ore, they prepared it for smelting by cleaning it of all spar with a small, sharp pick. The desirable size for the "lump of ore was the bigness of a man's two fists and weighed about fifteen pounds." Miners crushed large lumps into smaller chunks by beating or stamping before the smelting process. They simply hammered the larger pieces into smaller chunks before beginning the smelting process. The miners at Mine La Motte continued to manually beat lead ores until more American miners constructed European stamping mills to mechanically crushed large pieces of ores.[259]

As in De Gruy's 1743 description of miners, building log furnaces to smelt lead ores was still practiced at Mine La Motte. As mentioned above, miners seasonally melted ores. During the smelting months, miners dispersed into the forest to cut enough timber to build the furnace by rolling large oak logs into place. According to Valle's records, miners alternated the "chopping of wood for the furnaces— estimated for forty furnaces," during the second mining season after they returned from the first harvest.[260] Austin further confirms seeing miners building Native American styled log furnaces to smelt

[257] Account of the expenses of Francois Valle and La Rose in exploiting Valle's half of the Castor Vein at Mine La Motte sometime during the 1790s. Ste, Genevieve Archives, Mines Collection, MSS. 29. Missouri Historical Society.
[258] Ure, *A Dictionary of Arts, Manufactures, and Mines*, 837.
[259] Schoolcraft, *A View of the Lead Mines of Missouri*, Ch. 4.
[260] Account of the expenses of Valle in exploiting Mine La Motte sometime during the 1790s. Ste, Genevieve Archives, Mines Collection, MSS. 29. Missouri Historical Society.

their lead stating "miners extracted their lead ore [and then] they dispersed into the forest to cut enough timber" for their furnaces. Austin states that miners smelted their lead by "depositing mineral in a pile of logs" and that the piles were then set on fire, consuming the entire log furnace. Delassus reported seeing two furnaces in the vicinity of Mine La Motte.[261]

Austin described the miners at La Motte and other mines constructing furnaces to smelt their lead and revealed that they spent "a great deal of time re-smelting their lead ore." Austin states, "The French inhabitants of this country have followed the mining business upwards of eighty years, yet they have not advanced in the art of smelting a step beyond their ancestors."[262] Miners spent their time building additional log furnaces to re-smelt the lead ore to obtain a higher yield of lead. The use of log furnaces was a practice that Delassus desperately wanted to change after Austin built the first reverberatory at Mine a Breton. Although the miners continued to use the Native American and French-styled-furnace, there was another furnace variation used at the Mine La Motte in 1797, which was different from earlier log furnaces. It resembled a furnace used in Europe. The construction date of these furnaces is uncertain, but it must have occurred between the periods of Austin's correspondence with Delassus. According to Austin's descriptions, these furnaces were similar to European furnaces, but were more complex than the log furnaces. The furnace was made with three log walls lined with split logs standing upright. Miners placed about five thousand pounds of ore in the furnace and

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[261] Delassus Report and Census.
[262] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 10-17.

covered the ore with additional logs. He noted that "there were twenty different French furnaces" but only one was in use at the time.[263]

Austin and other Americans commonly called these peculiar furnaces "log hearth furnaces," which further notes the penetration of European technologies and their existence alongside of the amalgam.[264] The name was similar to the Scotch hearth furnace, which originated in England where miners placed their furnaces on summits or western slopes of the highest hills. Josiah Bell would have recognized the furnace because the lead ores of Derbyshire in the north of England were smelted in "very rude furnaces, or boles, urged by the natural force of the wind."[265] The construction of the log hearth furnace was simply constructed on a hillside with an inclined hearth surrounded by walls on three sides. The wall at the base of the incline was constructed with an arch for the admission of air.[266] Usually, two furnaces were built together, making the common center wall stronger. In addition, the design was more economical, since one crew could manage and regulate the heat of two furnaces. When this furnace was constructed in the Mississippi Valley is uncertain; it may have occurred during the last decade of the eighteenth century after miners in the Upper Mississippi Valley corresponded with miners at Mine La Motte.

Most likely, the furnace was a hybrid of earlier Native American and European furnaces.[267] Following contact with European miners, Native American miners near Galena, Illinois, designed a hillside trench furnace to yield more metal. One early

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[263] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 16.
[264] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 14-17. Also, see Schoolcraft, *A View of the Lead Mines of Missouri*, 93-104. For illustrations of early European furnaces see, Hoover, *Georgius Agricola, De Re Metallica*, Book IX.
[265] Hoover, *Georgius Agricola, De Re Metallica*, Book IX; Ure, *A Dictionary of Arts, Manufactures, and Mines*, 752.
[266] Schoolcraft, *A View of the Lead Mines of Missouri*,103-106.
[267] Thwaites, *How George Clark Won the Northwest*, 314.

description of such a furnace dates back to 1804. In that year, Sergeant Nathaniel Pryor of the Lewis and Clark expedition purchased a supply of lead near Ste. Genevieve for making musket balls to be used on the western trip. Pryor described the shape of what he calls a "Native American furnace as being similar to a mill hopper."[268] Further north, in the Upper Mississippi basin, the Fox Indians also applied a very interesting method of smelting lead ore, which may account for the exchange of smelting technology between Mine La Motte and the Upper Mississippi lead mines. Henry Rowe Schoolcraft provides a very clear description of the furnace at Mine La Motte, as well as at the Upper Mississippi lead mines. While touring through both mining regions, Schoolcraft used the expression "like the roof of a house inverted" to describe the same furnace.[269]

In addition to Schoolcraft, other visitors to the mining frontier described the furnace shape as similar to a mill hopper. The Italian traveler Giacomo Beltrami made another observation of interest.[270] He was a passenger on the *Virginia*, which was the first steamboat to ascend both rapids in the Mississippi River. Stopping at the Dubuque mines, he observed how the Fox Indians "smelt the lead in holes which they dig in the rock to reduce it into pigs." Incredible as it appears, a little reflection suggests that since Native Americans smelted lead ore at both locations, this was a practical way of prolonging the life of furnaces. Most significantly, these furnaces are very similar in description to another type of furnace Austin observed miners depositing mineral into, a "furnace of stone somewhat similar to lime-kilns." These roasting ovens usually

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[268] See, Millhouse, "A Chronological History of Indian Lead Mining," 38-40.
[269] Schoolcraft, *A View of the Lead Mines of Missouri*, 94-106.
[270] Giacomo Beltrami traveled up the Mississippi in 1823 to explore, map, and interact with the local Native Americans. See Giacomo Costantino Beltrami, *A pilgrimage in Europe and America: leading to the discovery of the sources of the Mississippi and Bloody River : with a description of the whole course of the former and of the Ohio; in two volumes*, *Volume 2*, (London: Hunt and Clarke, 1828). http://books.google.com/books?id=5QEpAAAAYAAJ&dq=Giacomo+Beltrami+A+Pilgrimage+in+Europe+and+America%2C+1828&q=smelt#v=onepage&q=smelt&f=false, 161-164. (April 2011).

consisted of a square area dug out of the earth and lined on three sides with stone or brick. The masonry walls retained the heat more efficiently. Miners then layered firewood in alternating patterns, and larger pieces of ore were placed on top, followed by smaller pieces of ore placed around the sides.[271]

Another variation of the same type of smelting furnace was for Native Americans to simply dig a horizontal trench in the side of the hill, with smaller trenches running downhill to distribute the melted lead into separate holes to cool. While it is not clear if this type of furnace was used at Mine La Motte, Americans and Native Americans used the smelting method at the Galena lead mines. Miners filled the primary trench with ore and logs. It was then ignited, and the molten metal ran out the small trenches into the various holes. Sometimes a hard stick or other object was placed in the center of the flow mold so that the lead would cool around it, leaving a perforation for rawhide rope for easy transport. After the lead cooled it resembled pig bars weighing sixty to eighty pounds each. These early furnaces only yielded about forty percent lead; the rest of the ore was reduced to lead ash or was lost. When miners began to use this type of furnace is unknown; however, since Schoolcraft's illustrations were similar to sketches drawn by Agricola, the furnace design must have originated in Europe.[272] The miners at the Galena lead mines who used this particular smelting furnace also represents the regions transition to a borderland as the arrival of a new set of alternative mining techniques converged with preexisting mining rituals.

The creation of a bordered-land can be seen in how miners began to change over to using European technologies. The multiple examples of technology transfer suggest

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[271] Schoolcraft, *A View of the Lead Mines of Missouri*, 94-106.
[272] Hoover, *Georgius Agricola, De Re Metallica*, Book VIII.

the beginning of the regional redefinition of the Louisiana Territory's mining frontier and the establishment of mining settlements.[273] Austin depicted a landscape in transition as miners employed a variety of smelting methods at La Motte. He was concerned that "A continuation of smelting in this manner will exhaust the timber." Valle's account shows that smelting in the log furnaces required large quantities of timber, so much so that the forest must have been scarred with large areas of tree stumps.[274] Austin's concerns and Valle's letter book suggest that a few years prior to the 1803 Louisiana Purchase, and two decades before miners fully implemented European smelting technologies, the forest in the surrounding area was already exhausted of timber forcing miners to request additional land specifically to supply their furnaces with fuel.[275]

Sometime after miners settled at Mine La Motte, they increased their mining and smelting work to include two seasons, which "coincided with the seasonal flow of lead bars" to frontier villages and cities. Packhorses carried four lead bars per trip.[276] The activity along the Mine La Motte path to Ste. Genevieve was intense. At times, De Guire, La Chance, Nicollet, Metis, Chevalier, or Viriant along with at least two of Valle's African slaves, transported the smelted lead using ox carts. Before Austin established another village at Herculaneum, Missouri in 1809, Ste. Genevieve was the leading lead storage location and depot for both Mine La Motte and Mine a Breton. The lead was

[273] Houck, *The Spanish Regime in Missouri*, 358-360.
[274] Account of the expenses of Valle regarding the amount of timber carted. Ste, Genevieve Archives, Mines Collection, MSS. 29. Missouri Historical Society.
[275] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*,; Schoolcraft, *A View of the Lead Mines of Missouri*, 129-130.
[276] For descriptions of s*aumon* the oval shaped masses of lead that were 2 feet long, 6 to 8 inches wide, 2 to 4 inches thick, and weighing 30 to 40 pounds." See, Datchurut's petition for a survey of Mine La Motte, July 7, 1770. Ste. Genevieve Archives, Mines Collection, MSS. 23; Lockwood, "Early Times and Events in Wisconsin," 131-132.

either stored near Francois Valle's home or at another location before being shipped to New Orleans.[277]

Shipping lead bars to New Orleans from either the Mine La Motte or Mine a Breton required Valle and Austin to observe "the different stages of the water in the different seasons."[278] Travelers suggested that from about the middle of July until the beginning of October, "embarkation should be attended with considerable detention."[279] In other words, the safest time to float down river would be at the very low stages of water. Merchants and miners understood that the "spring season journey from the mines to Ste. Genevieve and onto New Orleans would be slow and safe." Autumn was another season "encouraged for navigating the inland waterways." However, merchants were cautioned to sail by "late December [before the] ice formed, [closing] rivers, [which] greatly hinder[ed] navigation."[280] Following the arrival of Moses Austin, lead shipments to New Orleans and beyond increased. Concern over the inefficiency of the furnaces and the wasted lead in the slag annoyed Delassus, and he attempted to find a solution by luring Americans and Europeans into the Louisiana Territory to help establish a "foundry and forge" similar to those used in England. Similar to merchants, miners, and scientists in the United States who desired to increase mining profits, like Jefferson, Delassus too believed that new innovations and early experimentation should be developed to efficiently smelt lead ore in stone furnaces. Delassus would have been well aware of the

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[277] Phone interview with Gwedolyn Midlo Hall by Mark M. Chambers (27 January, 2007).
[278] Early writings and travels along these water routes see, Zadok Cramer, *The Navigator: containing directions for navigating the Monongahela, Allegheny, Ohio, and Mississippi Rivers; with an ample account of these much admired waters, from the head of the former to the mouth of the latter; and a concise description of their towns, villages, harbors, settlements. With accurate maps of the Ohio and Mississippi, to which is added an appendix, containing an account of Louisiana, and of the Missouri and Columbia rivers, as discovered by the voyage under Captains Lewis and Clark. Sixth Edition – Improved and Enlarged* (Pittsburgh: Cramer & Spear, 1801), 34-40.
[279] Cramer, *The Navigator*, 18.
[280] Cramer, *The Navigator*, 34.

latest European innovations and technological improvements of the age associated with mining.

European practices and the Mine a Breton settlement

During the late eighteenth century, Americans witnessed a new scientific renaissance, as the latest technological information was transferred to the United States from Europe.[281] By 1765, the Freiberg School of Mines in Europe discovered new mining and smelting methods. Miners, metallurgist, and smelters learned new technological practices for prospecting, mining, metallurgy, and mine management. During his travels, around Europe and across the Atlantic, Delassus possibly heard or read about new European innovations in lead mining and metallurgy after the Royal Mining School in Mexico City.[282] American citizens of the new republic also hungered for knowledge and insights to found mining settlements that were purely of European origin. As a result, the resurgence in publications on natural history, chemistry, mineralogy, and new innovations occurred. Many of the mining books published in the United States after 1790, would either translated from French or German, before being in Philadelphia. Some idea of the extent of American familiarity with the progress of mineralogy and chemistry in Europe and of the obstacles confronting American aspirations in this field can be seen in multiple publications of English works. The early mining manuals used by European miners who settled in North America were reprinted

[281] Clement G. Motten, *Mexican Silver and the Enlightenment* (Philadelphia: Octagon Books, 1950). Also, see Arthur P. Whitaker, "The Elhuyar Mining Missions and the Enlightenment," *The Hispanic American Historical Review*, 31, no. 4 (1951): 557-585; Silvia Figueiroa and Clarete da Silva, "Enlightened Mineralogists: Mining Knowledge in Colonial Brazil, 1750-1825," *Osiris, 2nd Series*, Vol. 15, Nature and Empire: Science and the Colonial Enterprise (2000): 174-189.
[282] Samuel Miller, *A Brief Retrospect of the Eighteenth Century, Part First in Two Volumes Containing A Sketch of the Revolutions and Improvements In Science, Arts, and Literature During That Period* (Philadelphia: T. and J. Swords, 1803), 145-155.

in Philadelphia.   Austin planned to follow the explicit directions of Gabriel Plattes, and first-hand experiences of British miners to help him recreate a late eighteenth-century mining community where miners extracted, smelted, and refined lead in close proximity to where lead grew.

When Moses Austin and Josiah Bell relocated from the United States and Great Britain, respectively, to Spanish Louisiana's lead district they carried new ideas, practices, and apparatuses to mine and smelt lead ore. A similar transfer occurred across the Atlantic, between England and cities like Philadelphia, New York, and Boston. Samuel Slater, an English immigrant, is one example. Slater learned that some American states were paying British citizens who knew how to build cotton-spinning machinery to relocate and build the same machines in their states. Slater immigrated to New York carrying textile machine designs he committed to memory. Eventually, Slater would establish a number of mills in Rhode Island, where most American industrialization remained for many years. A few decades later, learning about new prospects in lead mining Josiah Bell immigrated to Austin's Chisel Mines in Wythe County, Virginia.[283]

In like fashion to Slater, Bell, a skilled English miner transferred his knowledge about creating a mining settlement from England to the United States and New Spain.[284] Bell was from the lead district of England, Cornwall and Derbyshire, and was partly responsible for launching Mine a Breton, as well as cultivating European mining

[283] George P. Garrison, ed. "A Memorandum of M. Austin's Journey from the Lead mines in the County of Wythe in the State of Virginia to the Lead Mines in the Province of Louisiana West of the Mississippi, 1796-1797." *American Historical Review (AHR)* 5 (1900), 518-542.
[284] Langworthy, *Papers Relative to an Application to Congress for an Exclusive Right of Searching for and Working Mines*, 12-15.
[284] Author unknown, *Proposals For Establishing an Association for Working Mines and Manufacturing Metals in the United States*, 4-6.

techniques in what was becoming the mining frontier borderland.[285] Bell came to the United States to assist Austin with his Virginia mines, before they both moved to Spanish Louisiana.[286] Austin decided Mine a Breton would be a good place to "take up such lands and lead mines and there make such establishment of the lead mine business and introduce the many improvements in mining with which he was familiar."[287] Like Mine La Motte, Mine a Breton exhibited certain geographical features conducive for a mining community. The location of Mine a Breton afforded plenty of flowing water for washing ores and for constructing water propelled machines. There were also plenty of prairies with "fruit trees and was a place filled with excellent timber."[288] Like Delassus, Austin wanted to discourage the local miners from using their "wasteful mining practices." He called them "the unskilled workers in the neighborhood of Mine a Breton."[289] Within a few months, Bell and Austin made their way back to the lead mines along the Mississippi River, carrying the knowledge and practices to introduce a European-styled settlement to the mining region.

Before Austin departed Virginia for Mine a Breton, he sent employees from his lead plantation to begin work on the Mine a Breton settlement. The initial team included his nephew, Elias Bates, workers from the Chisel Mines—Kendall, Shouse, and Nall—

[285] Henfrey, *A Plan With Proposals for Forming a Company to Work Mines in the United States*, iii-v.
[286] Garrison, ed. "A Memorandum of M. Austin's Journey from the Lead Mines" *AHR* 5 (1900), 523-524; Author unknown, *Proposals For Establishing an Association for Working Mines and Manufacturing Metals in the United States*, 5.
[287] Edward G. Mason, "Early Chicago and Illinois," *Chicago Historical Society's Collection*, IV, (Chicago: Fergus Printing Co; 1890), 36, 230-251; Barker, eds., *The Austin Papers Part I*, 2-9.
[288] Austin, *A Summary Description of the Lead Mines in Upper Louisiana,* 17-18; Cramer, *The Navigator,* 334-336.
[289] Barker, eds., *The Austin Papers Part I*, 48; An account of Moses Austin list the total slaves he owned as 16 men, 3 women, and 6 small children at the lead mines in Virginia. It is not known how many of these slaves he transported with him to Spanish Louisiana. See. Barker, eds., *The Austin Papers Part I*, 60.

and the Mathew and Timothy Mullins brothers, also from Great Britain.[290] Later, Josiah Bell, John Storts, Drury Green, and John Brickey traveled with Austin and his family back to Spanish Louisiana. Before the first group of miners departed Virginia for Mine a Breton, Austin gave them an illustration of how the settlement should be laid out. The map described the location of his home, living quarters for the miners, the furnace house, and sawmill. The map provided Mullins and Storts with "a good idea of the situation of the lead mines and marked out the place for the furnace to stand." Austin suggested that the furnace house be positioned "at the lower end of the Village," and he also outlined the specific dimensions not only "for the furnace house, but also for the saw mill," which he wanted "to be built in a good place."[291] Austin told Mullins and Storts to erect the sawmill first so that workers could begin cutting lumber to build living quarters, a shot tower, and sheet lead manufactory.[292] In addition to the American and English lead miners, Austin also transported a number of his slaves, and although it is not clear how many slaves Austin transported to Spanish Louisiana, by the early nineteenth century he had purchased more slaves for his operations.

By the time of Austin's arrival the workers had accomplished a great deal. Foremost, they finished the saw mill and started to construct the reverberatory furnace house, which was completed and put to blast in January 1799. Almost immediately, miners at La Motte began to transport their lead ashes to the furnace to make zane for

[290] In 1796 Moses Austin brother Stephen Austin traveled to Great Britain to enlist the services of two lead miners; Timothy Mullins and John Storts. See, Bankruptcy Records, United States District Court for the Eastern District of Pennsylvania, RG 21. The records of Stephen Austin's bankruptcy proceeding constitute Case #204 (Microfilm publication M-993, Roll 24). For the contract between Austin and two employees, Timothy Mullins and John Storts, October 28, 1797. Ste. Genevieve Archives, Mines Collection, MSS. 12. (Missouri Historical Society).
[291] Barker, eds., *The Austin Papers Part I*, "Moses Austin to Kendall and Bates," 38-39; Garrison, ed. "A Memorandum of M. Austin's Journey from the Lead Mines" *AHR* 5 (1900), 518.
[292] Barker, eds., *The Austin Papers Part I*, "Moses Austin to Kendall and Bates," 38; 48-51; Austin, *A Summary Description of the Lead Mines in Upper Louisiana,* 19.

bottle makers.[293] The blacksmith shop and other buildings began operating that same year. One building was designated to make "patent shot of good quality" that conformed to Josiah Watts' invention in England.[294] In addition, the sheet lead house was also placed into operation. In 1819, Henry Rowe Schoolcraft sketched the town of Mine a Breton, which at the time contained over forty wooden-frame structures.[295] Austin built his family home, which he called Durham Hall, and on a nearby hill above his quarters he built to house forty miners. In the sketch, all the homes appear to be located on hills and in valleys and arranged in geographical clusters.

Figure 9: Mine a Breton[296]

Austin and his miners prospected for lead ore by applying their longstanding European prospecting approaches, which were similar to the amalgam used by early miners. They observed other signs, such as odors, changes in the texture of the soil and in the earth's color, and small specks of ore scattered about the shaft. At times Austin noticed "grains of lead mixed in with the soil."[297] When English miners recognized these signs, they continued to sink their shafts even deeper, and then miners hoisted the ores to

[293] Barker, eds., *The Austin Papers Part I*, "Enclosure, Illinois Adventure To Stephen and Moses Austin, Dr.," 40-41; Barker, eds., *The Austin Papers Part I*, "Moses Austin to Lieutenant Governor De Lassus," 49-53; Schoolcraft, *A View of the Lead Mines of Missouri,* 104-106.
[294] Barker, eds., *The Austin Papers Part I*, 9-10; Ure, *A Dictionary of Arts, Manufactures, and Mines,* 761.
[295] Schoolcraft, *A View of the Lead Mines of Missouri,* 2.
[296] Schoolcraft, *A View of the Lead Mines of Missouri,* 2.
[297] Austin, *A Summary Description of the Lead Mines in Upper Louisiana,*8-9.

the surface by the windlass. More importantly, like those who came long before, Austin's miners shared a familiar and intimate knowledge of the environment.[298]

In similar fashion to Francois Valle's operations at Mine La Motte, Austin employed a mining manger. Josiah Bell supervised the work of the other miners who were assigned as miners, smelters, woodcutters, and carters.[299] A fuller complement of American and European miners at Mine a Breton would usher in a quicker movement away from the Native Americans mining practices than the gradual transitions taking place at Mine La Motte. In like fashion to Valle, Austin also recorded early examples of the division of labor but rarely mentions who performed mining, dressing, or smelting work except for when he wrote specific instructions to John S. Brickey on February 22, 1815. Brickey was assigned to work the reverbertory furnace built at Mine a Breton. In his letter Austin states "I give you the following memorandum by which you will fully understand, what I wish you to take under your charge."[300] Austin provided Brickey with detailed regulations regarding what was to follow after the lead ore was extracted from the shaft. Austin required Brickey and miners to restock the wood, charge the furnace, and smelt the lead ore. Additionally, Austin letter also instructed Brickey that "Negroes and Whites are to be prevented from visiting the furnace not suffered to remain about the furnace, they draw off attention of the hands."[301] These comments suggest that slaves worked in the mines or separated and cleaned the ores prior to smelting.

By 1799, Austin made plans to sink a shaft. Before doing so, Austin cleared the surrounding surface of all the alluvial soil. Since Austin describes "the first shaft

[298] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*,15-16.
[299] Garrison, ed. "A Memorandum of M. Austin's Journey from the Lead Mines," 518-542.
[300] Barker, eds., *The Austin Papers Part I*, "Moses Austin to John S. Brickey," 248.
[301] Barker, eds., *The Austin Papers Part I*, "Moses Austin to John S. Brickey," 249.

reaching a depth of eighty feet," the shaft may have been vertical. He noted "The clay at Mine a Breton was thirty or forty feet thick," and it was into this that he sank his shaft" but he, "stopped at the limestone rock." He did, however, dig tunnels into some of the "crevices that contained massive ores."[302] Once the shaft was cleared of soil, miners put in place a common windlass and bucket tied to a rope, which was an English and American practice. Then a shed was built to protect the pit and workers from rain, wind, and cold weather. The shed was also a good place to keep wheelbarrows and to store the miners' tools. One miner would dig and place the earth into the bucket, and another miner controlling the windlass from the top would raise the filled bucket to the surface.[303] There were tunnels extending in several directions from the shaft.[304] It is possible that as many as ten miners could manage one shaft.[305]

When enough lead ore accumulated around the shaft, the miners used carts to transport the ore to a nearby stream to wash it before smelting. It is probable that Austin's slave women and children washed the ore in nearby streams.[306] Miners proceeded to separate any remaining spar and rubble by breaking it into small pieces with hand-hammers called buckers. The fist-size pieces were then placed in a bundle (trough) to be sifted in water. They then underwent a second washing to separate them from the lighter foreign matter in another bundle for sorting the ores. If washing was omitted and

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[302] Barker, eds., *The Austin Papers Part I*, "Moses Austin to Kendall and Bates," 39; Austin, *A Summary Description of the Lead Mines in Upper Louisiana,* 7-10.

[303] Numerous British mining and smelting manuals were reproduced in the United States. Alvaro Alonso Barba, Gabriel Plattes, Thomas Green, *A collection of scarce and valuable treatises upon metals, mines and minerals: In four parts. Part I. and II. Containing the Art of metals, written originally in Spanish, Translated by Edward Montagu Sandwich,* (London: Printed by C. Jephson for O. Payne, 1738), 304-308. Author unknown, *Proposals For Establishing an Association for Working Mines and Manufacturing Metals in the United States*, 14-16.

[304] For descriptions of Austin's mining activity, see Henry Marie Brackenridge, "Sketches of the Territory of Louisiana" and "Lead Mines in the district of Ste. Genevieve," *Missouri Gazette*, Jun, 20, 1811.

[305] Schoolcraft, *A View of the Lead Mines of Missouri,* 90-93.

[306] Barker, eds., *The Austin Papers Part I*, "Moses Austin to John S. Brickey," 62, 249.

the ore was dirty, the resulting zane that resembled a heavy slag or dross was similar to lead ashes. To assist in the process, another dresser agitated the bundle with a hoe so that the lighter material would float away.[307] As miners repeatedly cleaned the lead ore, they were preparing it for smelting.[308]

Austin's reverberatory furnace is a matter of considerable interest, as it appears to have been used to smelt lead ore as well as lead ashes. Schoolcraft described Austin's furnace as the only one in the district. Reverberatory furnaces in Europe were built of bricks. It is not clear whether Austin was capable of making his own bricks or if he purchased them from New Orleans. Most likely, the bricks were shipped from New Orleans along with other instruments Austin purchased from Philadelphia, including a fireplace, a grate, and the ash pit. There was also a conduit for the vaporized substances to be deposited. A chimney allowed for the smoke to escape. The period for roasting of lead ashes required between six and twelve hours.[309] As mentioned earlier, the introduction of innovative furnaces made a significant contribution to the mining district by reclaiming the lead from ash heaps scattered about the old furnace sites. With care, the furnace could produce sixty thousand to ninety thousand pounds of lead.[310] When Schoolcraft visited the lead mines, he observed and documented it as "the chief of the entire lead" mines. Contemporary European mining manuals also confirm Schoolcraft's

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[307] Miners followed instructions from manuals on the various stages of prospecting, assaying, cleaning, and smelting ores. James Woodhouse, *The young chemist's pocket companion connected with a portable laboratory; containing a philosophical apparatus, and a great number of chemical agents; by which any person may perform an endless variety of amusing and instructing experiments; and intended to promote the cultivation of the science of chemistry* (Philadelphia: J.H. Oswald, 1797); Cutbush, *The American artist's manual*, "lead" section; Schoolcraft, *A View of the Lead Mines of Missouri*, 98-103.
[308] For the points of production see, Cutbush, *The American artist's manual*, "mine" section.
[309] Most of the literature refers to the ash furnace as a "blast furnace." It is hard to know why the term is interchanged. Jean-Antoine-Claude Chaptal, *Elements of Chemistry, Translated From the French, Three Volumes in One* (Philadelphia: Printed By Lang & Ustick for M. Carey, 1796), 333-334.
[310] Schoolcraft, *A View of the Lead Mines of Missouri*, 102-103.

extensive illustrations of the furnace. Schoolcraft elaborates on how the reverberatory furnace was also capable of "refining lead ashes," which were a mixture of impurities and lead that miners melted into zane.[311] Austin's furnace was twice as efficient as the log and stone furnaces that it would eventually replace. The furnace worked on the principle of an oven. It used hot air and the ores did not have direct contact with the fire. By this method Austin was able to obtain seventy-five percent of the lead from the ore.

Austin and Schoolcraft both speak of the reverberatory furnace as the primary European furnace of the entire lead district, but they fail to give a precise description or to designate the type of Austin's furnace. Austin mentioned only one furnace, which he termed a reverberatory furnace, while Schoolcraft gave an elaborate description of an ash furnace. Both speak as though there were just one efficient furnace in the district. But the ash furnace, which was a reverberatory furnace, smelted only lead ashes. Therefore, it seems that Austin introduced two improved furnace types to the colony—the reverberatory and the regular hearth furnace.[312]

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[311] Schoolcraft, *A View of the Lead Mines of Missouri,* 103-106.
[312] Schoolcraft, *A View of the Lead Mines of Missouri*, 22.

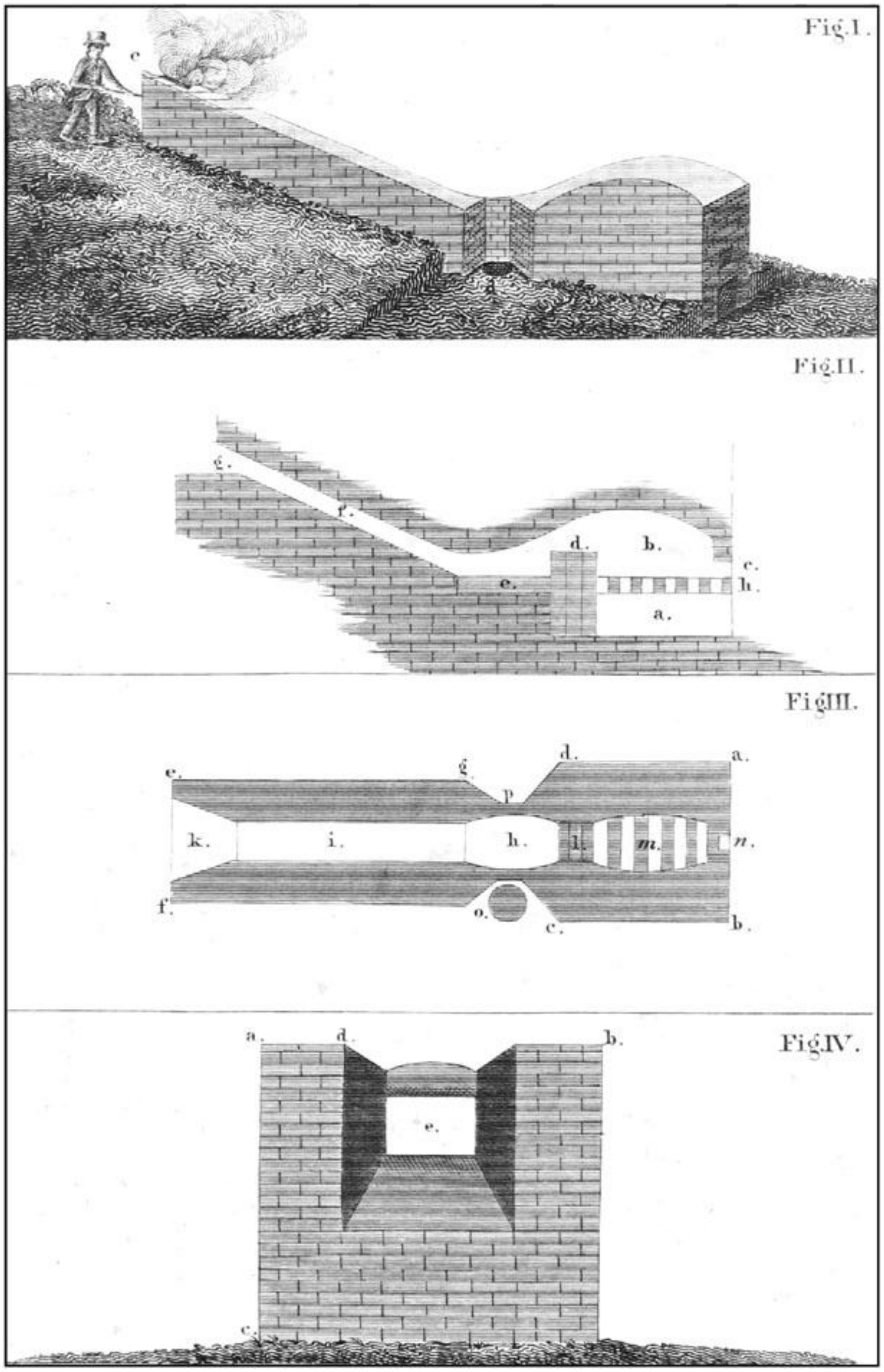

Figure 10: Reverberatory furnace as described by Henry Rowe Schoolcraft.

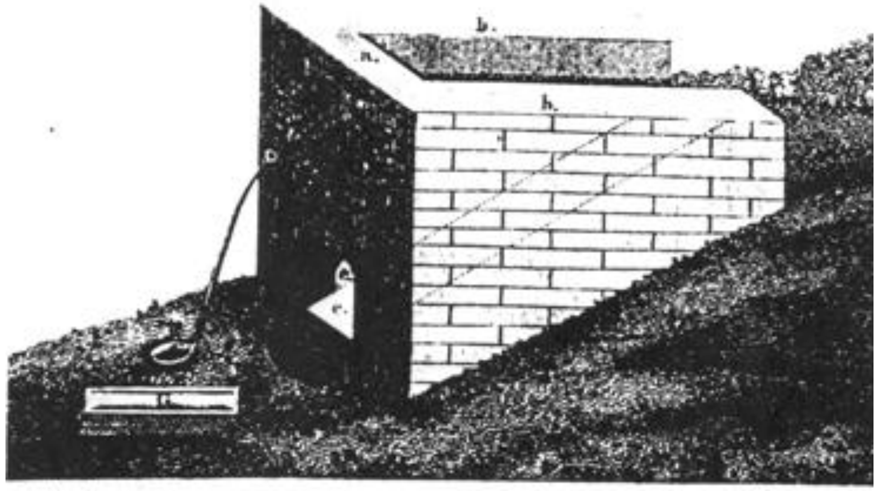

Fig II.

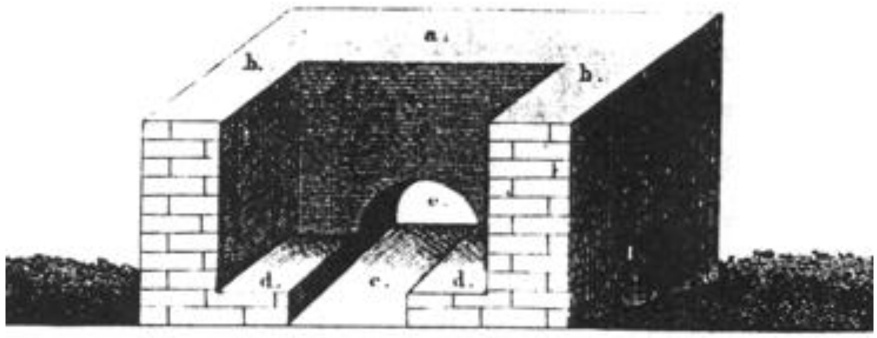

Fig III.

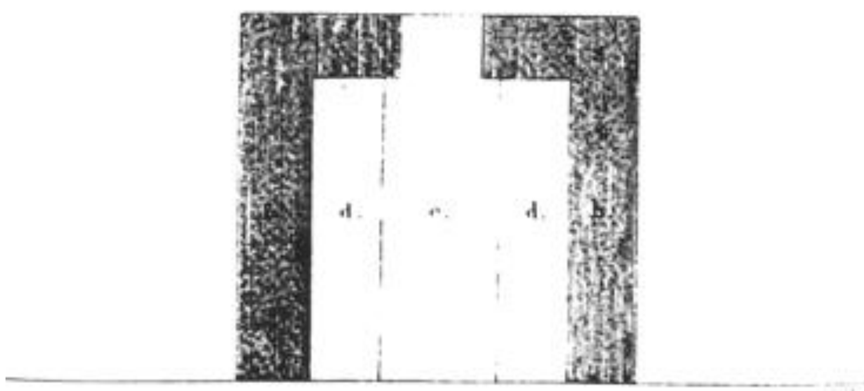

Figure 11: Ash Furnace as described by Henry Rowe Schoolcraft

Probably the introduction of the ash furnace was also a significant contribution to the colony since it made possible the reclaiming of the ash heaps laying around the old log furnace sites. Ordinarily the ash furnace was built of limestone, a very poor material for the purpose. A limestone ash furnace usually lasted only fifteen to twenty days, and with care it might be made to last a month during which time it was possible to produce 60,000 to 90,000 pounds of lead.[313]

Smelting began after the miners placed a layer of ashes and a layer of wood at the mouth of the flue. At that location the ashes were thoroughly heated before being thrust down the flue with a long, iron-handled hoe. Six hours were required for putting a full charge into a furnace. Two hours later, the furnace was ready for tapping. The tapping was accomplished by thrusting a sharp iron bar through the side of the furnace. As the molten material flowed into the iron pot, the impurities were ladled off the top. The lead was poured into molds, and the zane was taken back to the log furnace where it was easily converted into lead by another smelting.[314]

The lead yielded from the lead ashes after melting was heavy black zane.[315] Since the zane was suitable material for the manufacture of glass bottles, Austin recommended that glassmakers add a small amount of alkali and sand when melting the zane. The addition of alkali would "make it truly stronger, and able to be blown into junk bottles."[316] Zane was also used in the manufacture of lighter-colored green bottles. The zane melted at Mine La Motte was particularly useful for the variety of glass bottles produced.

As the use of lead expanded, sheet lead, was another article of lead manufactured by Austin.[317] To manufacture sheet lead, Austin and his workers poured the lead onto a

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[313] Schoolcraft, *A View of the Lead Mines of Missouri,* 102-103.
[314] Chaptal, *Elements of Chemistry*, 338; Schoolcraft, *A View of the Lead Mines of Missouri,* 103-105.
[315] For an early history of American glass manufacturing, see Pearce Davis, *The Development of the American Glass Industry*, (Cambridge: Harvard University Press, 1949), 21-34.
[316] Schoolcraft, *A View of the Lead Mines of Missouri,* 105-106.
[317] Barker, eds., *The Austin Papers Part I,* 247-249; Cutbush, *The American artist's manual*, "lead" section.

large stone table. In the mining country, there was an abundance of limestone, and Austin slaves quarried the stone and fashioned it into tables for the sheet lead factory. After the limestone was put in place, a small ledge was installed around the edges to prevent the lead from flowing onto the ground. Workers moved the liquid lead around the stone with a straight edge. While the lead was still warm, two workers, one at each end, used iron rollers to make all sections the same thickness and ensure there were no rough surfaces.[318] By 1800, Austin was beginning to ship sheet lead to St. Louis, New Orleans, and Cincinnati.

Austin manufactured a considerable portion of the lead made in Upper Louisiana into shot. Prior to Austin constructing his shot making, either frontier homes contained shot-making equipment or one villager manufactured the shot. Austin was familiar with manufacturing shot in a shot tower, and in 1791, he ordered a copy of Josiah Watts' patented instructions from England.[319] Watts' developed a method to slowly cool shot as it fell through the atmosphere. Prior to his innovation, there were numerous imperfections in the manufacture of lead shot, which was caused by the rapid cooling of the spheres being dropped into the water while still hot. As a result, the surface of the shot formed a solid crust, and the interior remained in a fluid state causing the entire shot to shrink and thereby producing irregularities on the surface. With the introduction of the shot tower, originally constructed in England, the problem was minimized by exposing the fused shot after they passed through a large colander before being dropped through

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[318] Ure, *Dictionary of Arts, Manufactures, and Mines*, 578-594.
[319] Barker, eds., *The Austin Papers Part I,* 9-10.

the air before falling into a water tub placed on the ground, or before landing in the river, as was the case with Austin's shot tower.[320]

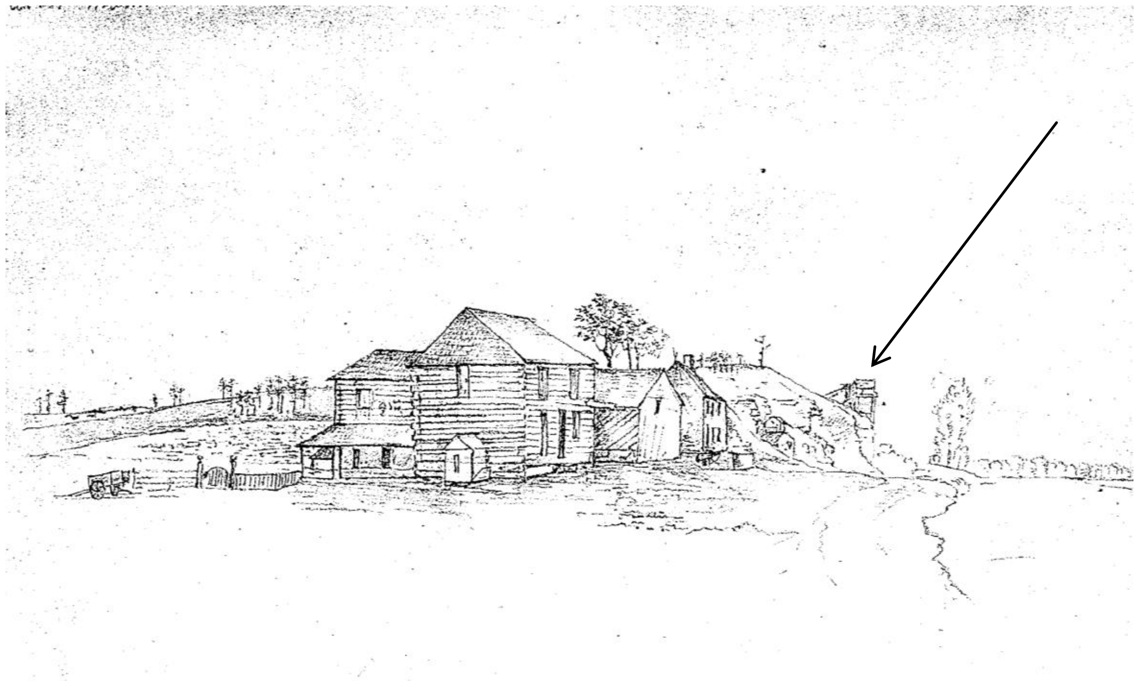

Figure 12: Charles-Alexandre Lesueur, Austin's Herculaneum Shot Tower.

After erecting his shot tower, Austin hired one worker to manage the furnace and the kettles used to smelt and cast the lead. The lead was mixed with arsenic, which made it more fluid during the casting process. Arsenic also quickened the hardening process. After the worker thoroughly mixed the lead and arsenic, he dropped the lead into water through an iron or copper frame perforated with round holes according to the required size. To make the smallest shot, the elevation had to be about ten feet above the water, and for the largest shot, about a hundred and fifty foot. Austin recommended that manufacturers note that, "a material difference of the height is required in the local

[320] Ure, *Dictionary of Arts, Manufactures, and Mines*, 761.

climate," according to the seasons of the year.[321] After the molten lead shot cooled, it was glazed and polished.[322] One artisan could cast between four and five thousand pounds a day and polish the entire batch over the course of nine days. Polishing was accomplished by placing the shot into a wooden tub with a crank that workers turned. The constant motion caused the shot to hit each other, making each piece smoother and ready for market.[323]

As an additional advantage of the association formed with Valle and Delassus, Austin gained unlimited access to navigate the Mississippi River. At the time, only residents of the Spanish Territory could trade or transport goods between Ste. Genevieve and New Orleans. Thus, Delassus provided Austin with the necessary passports for unlimited travel to and from New Orleans, which allowed Austin to ship his sheet lead and patent shot directly from Mine a Breton. Both articles flowed along navigable rivers to frontier societies. On April 12, 1801, at about ten in the morning, Moses Austin departed Ste. Genevieve for New Orleans with two small timber flat boats.[324] Each was loaded with the sheet lead and shot he and his cultivator artisans manufactured. Austin was attentive to embark on his trip at a time that coincided with "the different stages of the water in the different seasons."[325] Travelers suggested that during the month of April, before the heavy spring rains, "embarkation should be attended with considerable detention."[326] In other words, the safest time to sail would be at the very low stages of water. Merchants and miners understood that the spring season journey from Ste.

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[321] Barker, eds., *The Austin Papers Part I*, 10.
[322] Chaptal, *Elements of Chemistry*, 338.
[323] William Bingley, *Useful Knowledge of a Familiar and Explanatory Account of the Various Productions of Nature: mineral, Vegetable, and Animal* (Philadelphia: A. Small, 1818), 179.
[324] Barker, eds., *The Austin Papers Part I*, 69-74.
[325] Cramer, *The Navigator*, 34.
[326] Cramer, *The Navigator*, 18.

Genevieve to New Orleans would be slow and safe. Austin arrived at his destination twenty-three days later and made arrangements with John Merieult to have the lead articles loaded on the schooner *Nancy* bound for Philadelphia.[327]

In conclusion, numerous accounts from Mine La Motte and Mine a Breton highlight the significance of lead ore to society in the form of shot, sheet lead, and zane; and different sorts of settling that went on in the frontier. This chapter demonstrated the ability of merchants, farmers, and miners to establish Mine a Breton where they worked year-round and Mine La Motte where miners continued to employ seasonal mining practices. Like the French miners who amalgamated their mining practices to the Kaskaskia hunting seasons the French came to understand how to exploit the seasonal diversity of their environment by practicing mobility and following a particular cycle. However, at Mine a Breton, Austin went one step further to manufacture lead articles on the frontier. The task of the numerous prospectors, miners, and smelters was to construct a plan to locate, extract, and manufacture this useful metal that included both Native American and European mining traditions to increase lead production.

The evidence suggests the continuing significance of mining to a late eighteenth-century frontier society. Clearly, lead ore was an agent of change. It transformed and influenced mining, smelting, and new settlement styles after American and English settlers carried their knowledge and technology into this North American frontier. Like early eighteenth-century French engineers De Ursin, Renaudiere, and De Gruy, Delassus also envisioned a more efficient mining operation and a well-settled village in closer proximity to the lead mines.

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[327] Barker, eds., *The Austin Papers Part I,* 75-76.

Although Delassus and Austin wanted to discourage the La Motte miners from using the Native American and French amalgam Francois Valle and other miners there continued to produce over two hundred thousand pounds of pig lead between 1799 and 1803. The miners at Mine a Breton, who installed the latest European equipment, produced over three hundred thousand pounds of pig lead during the same period, a significant change from what De Gruy had produced during the 1740s.[328] When farmers, miners, and smelters crossed the Mississippi River to work in Missouri's early lead district, they carried with them new ideas on how to link the arts with commerce. They united a set of hybrid practices to form ornaments for society. Most significantly, this chapter suggests those who migrated to the mines in Spanish Louisiana promoted useful knowledge and technology in the mining environment. Local farmers and Austin encouraged by the lead prospects, settled near Mine La Motte and Mine a Breton.

At the close of the Spanish period, the United States government asked Moses Austin to compile a report on the Missouri lead mines. He reported that miners had discovered ten additional mines in the southern mineral region and that from 1802 to 1804; only twenty-five men had worked there, and for only a few months. The region remained well watered and residents described it as "pure and wholesome."[329] The next chapter focuses on the first geological survey conducted by Austin to determine the quality and quantity of the lead ores lying beneath the soil.

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[328] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 20-21.
[329] Amable Partenay, April 21, 1804, Ste. Genevieve Archives, Mines Collection, MSS.40.

CHAPTER 4: From the 1804 Early Mineralogical Report to Shot Manufactories

In 1804, Captain Meriwether Lewis arrived in St. Louis with a message from President Thomas Jefferson for the acting commandant of Upper Louisiana, Captain Amos Stoddard.[330] Jefferson requested Stoddard to compile a census and obtain knowledge of the mining region located near Ste. Genevieve. Amos Stoddard was selected by the France and the United States to represent each country during the transfer of the Louisiana Territory to the United States. He remained in command at St. Louis, acting as governor until Congress made provision for the government of the newly acquired land. Stoddard contacted Moses Austin, the owner of Mine a Breton, and asked him to provide a "memorandum of the number, extent and situation," as well as "the quality of the mineral produced," at the lead mines. Jefferson also requested information regarding "the number of hands employed," the amount "annually produced," and the primary uses of the metal. Austin agreed, and by using European prospecting and assaying methods to conduct analysis on the region's lead ore at Mine a Breton and Mine La Motte he documented his findings. Austin "found by experiments, that the mineral" in the veins was of superior quality and that "in the hands of skillful smelters" they could produce "sixty and in some veins seventy percent" metal.[331] After completing his analysis, Austin forwarded the report to Stoddard. From that report, Jefferson learned that eight hundred miles away, just west of the Mississippi, lay vast quantities of a

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[330] Stoddard to the President, June 16, 1804, in Thomas Jefferson, *Message from the President of the United States to Both Houses of Congress, 8th November, 1804,* n.p.

[331] Moses Austin obtained a Spanish land grant in 1796 and established a settlement at Mine a Breton near present day Potosi, Washington County, Missouri. Moses Austin, *A Summary Description of the Lead Mines in Upper Louisiana. Also, An Estimated of their Produce for Three Years Past* (City of Washington: A. and G. Way Printers, 1804), 10; Louis Houck, *A History of Missouri From the Earliest Explorations and Settlements Until the Admission of the State into the Union Vol. 2*, 355-370.

superior quality lead ore. On November 8, 1804, in his State of the Union Address, he noted, "The lead mines in Louisiana offer so rich a supply of that metal as to merit attention."[332]

Because Thomas Jefferson was an inventor he envisioned new technologies as essential to slowly lessen America's dependency on foreign goods to establish a dynamic domestic economy. Clearly he appreciated the value of introducing into the United States new innovations related to agriculture and other technologies being developed in England and Europe. Jefferson's viewpoint signaled a cultural sea change that had far-reaching implications for the improvement of Missouri's mining frontier borderland. Following the Embargo of 1807 and the War of 1812, Jefferson's vision of seeing the United States develop into an agrarian nation would give way to a fundamental change in the American economy. For example, as commercial exchanges with European nations came to a halt, and British products cut off from American markets, Americans experimented with constructing machine based factories and exploring the vast countryside for minerals. Austin's report was the first American mineralogical survey to outline in detail the Louisiana Territory's lead mines. Noticeably, it reveals the beginning of an abandoning of Native American techniques as more miners transitioned to European experimenting, mining and smelting practices. In like fashion to Europeans who believed their prospecting instruments to be superior to others, Austin also alleged that by precisely applying his apparatuses correctly would prove his techniques to be superior to local miners' methods.

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[332] United States Congressional Documents and Debates, 1774-1875, House of Representatives, 8th Congress, 2nd Session, Thomas Jefferson to the Senate and House of Representatives, Communicated to Congress November 8, 1804, *American State Papers, Public Lands*, I, 13.

In the opening decades of the nineteenth century, both Europeans and especially Americans coming from the east considered their way of thinking and identifying the earth as profoundly different from the ideas and practices of the peoples they encountered on the mining frontier borderland. Austin's mineralogical survey exposes his confidence in English scientific advances, which he believed had surpassed those of other civilizations. Michael Adas argues that from the 1780s in Britain there was an acceleration in the pace of new technologies to prospect for minerals.[333] Although Adas shows how numerous new practices spread within England, this chapter argues that similar techniques and instruments not only proliferated across Europe, but also penetrated the heart of the United States in the early part of the nineteenth century. With the technology transfer to the United States, American miners grew more and more sensitive to the fundamental differences between their practices and the Native American and French amalgam. Austin's report increasingly stressed the idea that Americans proclaimed their superiority over more "inexperienced" miners' practices similar to those applied by local miners.[334]

Early nineteenth-century mineralogical surveys are currently under explored territory in environmental history. Austin's accounting of the lead mines offer historians an opportunity to examine how new means of studying nature manifested before geological and mineralogical research in North America advanced into a descriptive science.[335] The Austin account conveys an American commitment to use scientific and

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[333] Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca and London: Cornell University Press, 1989), 1-6; A. Oleson and S. C. Brown, eds., *The Pursuit of Kowledge In The Early American Republic* (Baltimore and London, 1976), 39-46.

[334] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 8, 13, 15.

[335] Andrew Ellicott, who traveled through the southern United States in 1796, and Joseph Nicollet who traveled to the mining region in 1831 were both examples of how their copious notes provided geological observations and insights into the general cultural and social life of the areas he visited. Robert M. Hazen

technical means for gaining environmental knowledge. The survey conducted by Austin and his English assistants made known the complex endeavors aimed at identifying, defining, and improving prospecting and extracting methods.

By the time of the Louisiana Purchase, in 1803, Moses Austin, the experienced miner from Virginia, and a number of recent emigrant miners from England had successfully established a settlement at Mine a Breton.[336] Austin and his miners were the first in the Mississippi Valley to dig the region's first shaft and to construct a reverberatory furnace. They also employed the latest European machines to produce shot and sheet lead. All combined, their actions represent the formation of a mining frontier borderland where they transferred European technologies to Spanish Louisiana, while local miners continued to prospect and mine lead according to the amalgam they had adopted from early miners at Mine La Motte. However, during the application of their differing mining practices, what appears to have emerged was a further demarcation between mining knowledge and technology. While Austin's copious notes highlighted the quality and quantity of the region's lead ore, his mineralogical report also brought to bear a growing critique of those prospecting attempts influenced by Native Americans.

Austin prepared his survey with the assistance of Josiah Bell and Timothy and Matthew Mullins, miners who had recently immigrated to the United States from England. Austin and his English miners came to view science and especially technology as a measure of their own civilization's achievements. Together they conceived a plan to conduct experiments on lead "specimens" they collected from ten mines. While Austin

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has argued that geological research in North American developed from a few isolated inquires in the eighteenth-century. See Hazen, "The Founding of Geology in America: 1771 to 1818," 1827-1834.; James X. Corgan, ed., *Geological Sciences in the Antebellum South* (Alabama: University of Alabama Press, 1982), 9-25.

[336] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 7-8.

determined the quality and quantity of the ores in his home laboratory, Bell and the Mullins brothers conducted field observations on veins of galena. To analyze and describe lead ore, Austin, the Mullins brothers, and Bell applied European systems of mineralogy and chemistry in both types of frontier laboratories. Clearly, their application of European instruments and systematic procedures also marked the beginning of the erasure of Native American prospecting practices.

Various writers saw the role of science and technology as essential to the evolution of humanity, and the ability of people to control nature. The mastery of nature and the power of Austin and his assistants to explore the secrets of nature using European tools and experiments, simultaneously, contributed to the gradual erasure of the Native American and French prospecting practices from the mining frontier borderland. Benjamin Cohen's recent research recovers the extent to which new environmental knowledge and measuring apparatus in the form of geological surveys were connected with ideas of improvement. Cohen has argued that the Geological Survey of Virginia conducted from 1835 to 1842 helped to build interest in and acceptance of science as a valid means to describe the natural world.[337] Cohen suggests that the survey offered a view of a developing agro-science that relied on materialist notions of the soil as natural philosophers used chemistry and geology to reveal "the great wealth which lies buried in the earth." Because Austin conducted his survey three decades before the Virginia survey, his work relocates the growing importance of mineralogical surveys to an earlier time and geographic space and its benefit to early American miners and merchants.[338]

[337] Benjamin R. Cohen, "Surveying Nature: Environmental Dimensions of Virginia's First Scientific Survey, 1835-1842", *Environmental History*, 11, no. 1 (2006): 37-69.
[338] For mining technologies transfer, see Andrew C. Isenberg, *Mining California: An Ecological History* (New York: Hill and Wang, 2005), 24.

The geological surveys of the nineteenth century have received some scholarly attention, but mostly in their national form and as part of western development.[339] Donald Worster notes that "the survey demands scientific expertise; it is a project characteristic of a modern nation-state steeped in the perspective of science." Worster is referring to the postbellum surveys.[340] However, scholarly attention to the mineralogical work of early miners on the mining frontier borderland is lacking. Conducting an organized portrayal and cataloging of minerals after the Louisiana Purchase was not an easy task on the mining frontier borderland. To precisely conduct chemical and physical tests on minerals, Austin had to rely on Europeans' manuals, procedures and tools to effectively classify, analyze, and record exact measurements on galena.[341] Austin's early nineteenth-century analysis reveals how miners used small-scale laboratories to conduct field experiments, and communicate their scientific knowledge about nature to American naturalists.

Austin conducted his survey during America's era of early industrialization, a period when American leaders considered that independence would depend on cultivating the nation's natural resources.[342] Decades before the Revolution, colonists mined iron,

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[339] Hazen, "The Founding of Geology in America: 1771 to 1818," 1828-1829; Corgan, ed., *Geological Sciences in the Antebellum South*, 9-25.

[340] Donald Worster, *A River Running West: The Life of John Wesley Powell* (*New* York: Oxford University Press, 2001), 203.

[341] For a historical description of the scientific scene in the early American Republic and development of mineralogical studies in the United States, see John C. Greene, John G. Burke, "The Science of Minerals in the Age of Jefferson," in *Transactions of the American Philosophical Society, New Series*, Vol. 68, no. 4 (1978): 1-113; Rachel Laudan, *From Mineralogy to Geology: The Foundations of a Science, 1650-1830* (Chicago: University of Chicago Press, 1987), 88-87.

[342] Similar reports of rich minerals deposits in the American Midwest by explorers Peter Kalm in 1753, Major Robert Rogers in 1765, and Thomas Hutchins in 1778 stimulated interest in the growing nation's mineral wealth. The science of mineralogy acquired a solid footing in the United States only gradually, remaining on the descriptive level well into the nineteenth century. See, Samuel Miller, *A Brief Retrospect of the Eighteenth Century, Part First in Two Volumes Containing A Sketch of the Revolutions and Improvements In Science, Arts, and Literature During That Period* (Philadelphia: T. and J. Swords, 1803), 145-155.

copper, lead, zinc, and salt. At the turn of the century, frontier miners and urban merchants well understood the natural relationship between the newly acquired lead mines and manufacturing. Austin and other miners examined the properties and changes in the composition of minerals, which enabled them to make a contribution to the young United States' growth.

By the late eighteenth century, United States metals were being employed in a multitude of products. Iron hollow ware—pots, pans, and kettles—was cast directly from blast furnaces, as were anchors, fireplace andirons, and pokers. In addition, blacksmiths fashioned iron into horseshoes, scythes, sickles, hay rakes, knives, razors, shears, axes, chains, and plow irons. Coppersmiths sold kettles, boilers, and roofing cooper as well as stills for the manufacture of beer and whiskey. Tin was alloyed with copper to produce bronze statues and bells.[343] Lead was employed to make ribs for windowpanes, sheet lead for roofing and sheathing ships, and shot. Following the publication of Austin's survey, red and white lead manufacturers seeking quality ores in great quantities began to purchase Missouri's pig lead. More than twenty first century peoples give early Americans credit; Austin's survey reveals that the constant need for minerals was responsible for the active study of these substances by the early American scientific community. These mineralogical reports were common. Each projected the idea that nature was a resource and commodity, a set of products that could be classified, mined, and sold.

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[343] Robert Boyle, *The Works of the Honorable Robert Boyle in Five Volumes* (London: Thomas Birch, 1772), ii, 32; Henry Rowe Schoolcraft Papers, Manuscript Division, Library of Congress, Washington, D.C., Container 82; Also see, Miriam Hussey, *The Wetherill papers, 1762-1899; being the collection of business records of the store and white lead works founded by Samuel Wetherill in the late eighteenth century ... held by the Trustees of the University of Pennsylvania for the Industrial research department* (Philadelphia: Industrial research dept., Wharton school of finance and commerce, University of Pennsylvania, 1942), 1-11; Cowan, *A Social History of American Technology*, 45-46.

Making the case for improving prospecting methods

During the early eighteenth century, Native Americans had guided French explorers to their lead mines, and filled document the regions mineralogical information. While touring the mining district, the French documented the region's natural features in categories such as rivers, mountains, vegetables, animals, and minerals to further the expansion of the empire. As discussed in early chapters, the Kaskaskia Indians and their French counterparts had created a middle ground, forming their prospecting and extracting methods into an amalgam of mining practices. A little less than a hundred years later, Austin would embark on a mining and scientific project that would begin the erasure of the Indian and French amalgam. As the broad title suggests, the 1804 mineralogical survey was notable for its emphasis on the region's lead mines. Offering a more systematic scientific study of the mining district, Austin hoped it would provide an accurate appraisal of mineral availability. However, his analysis required the use of European methods, which stemmed instead from an era of high-Enlightenment civic pursuits into the knowledge of nature.

Austin's mineralogical interpretations became a tool to supplant longstanding Native American prospecting and extracting practices. Before the 1830s, when improvement societies began to organize local surveys to replace Indian methods; miners measured the amalgam against, what they believed to be more, sophisticated European technologies. The survey reveals that American miners believed the amalgamated prospecting methods needed to be replaced with up-to-date scientific assessments of natural resources. As mentioned earlier, Austin's report started a critique of those practices influenced by Native Americans. Austin was surprised to see local miners discovering lead ore as they did. For example, when miners went to "discover ores," they used the amalgam established during the early eighteenth century to follow environmental markings. Miners also examined "the soil, the slope of the hills, and trees," and in some cases they would determine if lead ore was "attached to these natural markers."[344] Following the amalgam, miners would check the color of plants to see if they could detect the presence of a vein running beneath the soil's surface.[345] Embracing European practices to master nature as manifested in scientific discovery and technological advancement, Austin wanted to learn if a vein of ore was a branch or a main lode. Therefore, he distained the way these particular miners' haphazardly worked their trenches.

Austin believed that local miners were unable to efficiently exploit the resources because they not only lacked the proper European environmental knowledge, but also lacked the European tools to successfully determine the quality or quantity of lead veins. Primarily, when visiting Mine La Motte, Austin and his staff observed how many miners worked. He surmises, "Skilled miners would most likely have been astonished to see miners" in the Missouri Territory applying such "crude methods to discover lead ore."[346] Local miners used the fusion to prospect for lead ore by digging numerous "scattered pits" or trenches "four to five feet deep until a good vein was found." Along these veins, they worked until their mining progress "was impeded by rock" or by water flowing into the trench. Whenever these obstacles emerged, miners abandoned their trench and began to search in another location. When the miner was ten or twelve feet below the earth's

[344] Austin, *Summary Description of the Lead Mines in Upper Louisiana*, 8, 11,17-19.
[345] For early nineteenth century immigrant prospecting, mining, and smelting methods, Charlotte Erickson, *Invisible Immigrants: The Adaptation of English and Scottish Immigrants in Nineteenth-Century America* (Florida: University of Miami Press, 1972), 411-420.
[346] Austin, *Summary Description of the Lead Mines in Upper Louisiana*, 8, 10, 13, 15.

surface, “he usually quit and began digging a new pit.”[347] Austin’s comments proved the best expression of an emerging American disdain for these practices. Again, after visiting one of the mines and observing miners prospecting methods, he referred to their actions as “inefficient,” as their only tools for discovering ore were a “pick and wooden shovel,” and he stated that they clearly had a need for European mining instruments.[348] Furthermore, he reported “that miners “seldom dig deeper than ten feet.” making it “impossible to determine whether the mineral terminates in regular veins or not; for when the miner finds himself ten or twelve feet below the surface, his inexperience obliges him to quit his digging and begin anew” at an alternate location.[349]

Compared with De Gruy critical comments about miners’ methods in the 1740s, by far the most extensive critique of the Native American and French amalgam was contained in Austin’s *A Summary Description of the Lead Mines* from 1804. Based on his observations and knowledge of European techniques, Austin recommended improving practices after witnessing miners abandoning their trenches after only “scratch[ing]” the surface. Most crucially, they possessed none of the tools or machines essential for mining ore from the rich veins deep in the earth. No matter how much lead ore miners discovered using their techniques, Austin felt that they wasted time, noting that “one half of the miners time is taken up in sinking new holes or pits.” He assumed that with correct supervision and training, a European practice, American miners would resort to using instruments specifically designed to guide their searches for ores. He wanted to see miners carrying iron hoes, picks, shovels, and crowbars to prospect for lead ore. Austin

[347] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 8.
[348] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 8.
[349] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 19; Schoolcraft, *A View of the Lead Mines of Missouri,* 90-92.

believed that the adopted methods hindered them from clearly observing the true nature, length, and depth of the veins. For approximately three years, Austin noted that miners had no instruments for determining where the riches veins were located, and they lacked the correct prospecting tools need to gauge the quantity and quality of the lead ores waiting to be extracted.

Before Austin and his staff departed on their multiple expeditions to the multiple mines now being worked, they most likely packed a cart with an iron probe, shovel, and poll (pick on one side, hammer on the other), which was similar to what English miners would have used when prospecting the lead mines of Derbyshire.[350] In England, miners used the four-to-five-foot long probe to "plunge into the ground in alternating places until a vein was struck."[351] After locating veins of lead ore, miners also breached into the earth using a pointed shovel (a—spade).[352] English miners at Moses Austin's mining settlement applied these same practices as they search for lead ore and Austin felt that more miners should incorporate similar standards. Austin's account reveals the acceleration of new European tools and practices to characterize veins of lead.

Austin was the first miner in the Missouri Territory to describe numerous lead veins according to traditional European nomenclature, which eventually informed lead manufacturers back east of the district's immense value. Naming and describing veins

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[350] Langworthy, *Papers Relative to an Application to Congress for an Exclusive Right of Searching for and Working Mines*, 17-18; Cutbush, *The American artist's manual*, "ores" section.

[351] For comprehensive use of European terms and mining techniques, see W. Pryce, *Mineralogia Cornubiensis: A Treatise on Minerals, Mines, and Mining: Containing the Theory and Natural History of Strata, Fissures, and Lodes, with the Methods of Discovering and Working of Tin, Copper, and Lead Mines, and of Cleansing and Metalizing their Products; Showing Each Particular Process For Dressing, Assaying, and Smelting of Ores. To Which is Added, An Explanation of the Terms and Idioms of Miners* (London: Printed and Sold For the Author By James Phillips, 1778), 112, 127-128; Cutbush, *The American artist's manual*, "mine" section.

[352] Mines Collection, Missouri Historical Society, St. Louis. Also, see Jean-Antoine-Claude Chaptal, *Elements of Chemistry, Translated From the French, Three Volumes in One* (Philadelphia: Printed By Lang & Ustick for M. Carey, 1796), 330-339.

was a longstanding European organized practice.[353] While traveling through the mining region, whenever Austin spotted miners digging trenches to expose the lead ore, he had difficulty evaluating the character or termination of the numerous veins.[354] Hindered by their practices Austin found it difficult to effectively apply European terminology to describe the lead veins.

Naming and describing veins was also a longstanding practice of local miners.[355] For example local miners referred to lead ore that was attached to rock as *blossom of lead*. Another term that local miners used was *tiff*, which was called *cawk* by English miners. *Tiff* and *cawk* was a very white and very heavy piece of lead ore. "It was useful as a chemical re-agent or test, and is recommended as one of the best fluxes for iron ores in smelting."[356] Each of the above terms, however, did not describe any of the lead veins located throughout the mining region.

To effectively distinguish veins, Austin depended on European mineralogists and their encyclopedias. Using the tools and books republished in Philadelphia to help him to redefine and promote the regions environment, Austin was acquainted with the methods of Abraham G. Werner, a professor of mineralogy at Freiberg.[357] Werner used a descriptive approach to study and examine the external characteristics, of minerals to

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[353] William Maclure and others wrote essays on the mineral productions of the United States, "Observations on the Geology of the United States, Explanatory of a Geological Map" *Transactions of the American Philosophical Society, Vol. 6*, (1809), 411-428; Benjamin De Witt and Sylvain Godon each wrote essays on the mineral productions of New York and Maryland respectively. Benjamin De Witt, "Mineral Productions of the State of New York," *Memoirs of the American Academy of Arts and Sciences,* 2, 2, (1804): 73-81: Sylvain Godon, "Observations to Serve for the Mineralogical Map of the State of Maryland, *American Philosophical Society Transactions, 6*, (1809), 319-323.

[354] Austin, *A Summary Description of the Lead Mines in Upper Louisiana,* 18-19.

[355] Martin J. S. Rudwick, "The Emergence of a Visual Language for Geological Science, 1760-1840," in *History of Science* 14 (1976), 149-195.

[356] Schoolcraft, *A View of the Lead Mines of Missouri,* 69-72.

[357] Abraham G. Werner determined mineral species by examining their external characters. See Abraham G. Werner, *On the External Characters of Minerals*, trans. Albert V. Carozzi (Urbana: University of Illinois Press), 962; William Maclure made a number of references to Werner's processes in "Observations on the Geology of the United States," 415-417;

determine the quality of lead ore.[358] According to Werner, minerals' external characters such as color, smell and taste, needed to be correctly classified. He described eight principal colors: white, gray, black, blue, green, yellow, red, and brown. Richard Kirwan of Ireland, whose works were well known in the United States published Werner's system of mineralogy in 1794. Kirwan's manuals would have been carried in the knapsacks of many miners venturing into the North American frontier.[359] Samuel Miller suggested that many American mineralogists applied Abraham Werner's practice, which they learned from the work of Richard Kirwan. Miller also made mention of Kirwan's collection of minerals as "the best collection on earth."[360] Although Austin may have considered his practices superior to the Native American and French fusion, at contact, the Kaskaskia and French prospectors also used soil color and taste to characterize lead ore.

European techniques through the lens of the early mineralogical survey

In like fashion to Europeans, Americans carried to the early frontier meaning of the superiority of scientific thought and technological innovation.[361] Moses Austin and his English miners' possessed a sense of their preeminence in inventiveness and organization. They believed their practices and tools to be superior, and their understanding of nature to be justified as they proceeded to control the mining frontier

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[358] Early mineralogists and chemist included mining instructions and methods to construct furnaces to conduct test, and melting lead ore. See Pryce, *Mineralogia Cornubiensis*, 131-141; Jean-Antoine-Claude Chaptal, *Elements of Chemistry*, 333.

[359] Richard Kirwan published Werner's system of mineralogy in 1794. See Richard Kirwan, *Elements of Mineralogy in Two Volumes* (London : Printed by J. Nichols, for P. Elmsly, 1794-96).

[360] Miller, *A Brief Retrospect of the Eighteenth Century Vol. 1*, 145-155.

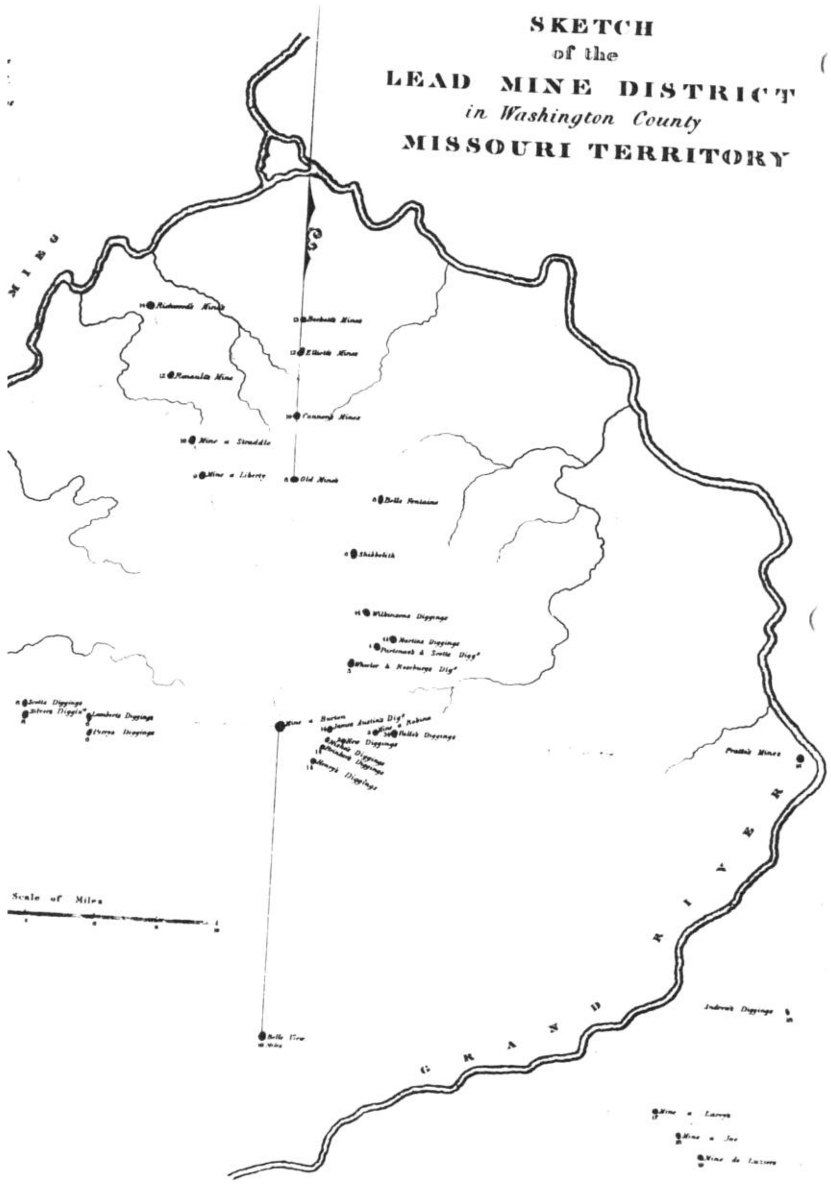
[361] Moses Austin's assets lists "70 VI Cyclopedia and cost" on October 7, 1820. On October 20, 2008, I spoke with Evan Hocker, archivist at the Barker Texas History Center at University of Texas at Austin. Mr. Hocker advised that no list of Austin's Cyclopedias have been located. See, Barker, eds., *The Austin Papers Part I*, 360-362.

borderland's lead, by improving how miners located, defined, and assayed lead ore. Carrying their portable European styled laboratories to conduct their chemical analyses Josiah Bell and Matthew and Timothy Mullins conducted numerous field trips between Mine a Breton and other mining sites to assist Austin.[362] At the conclusion of the month-long field surveys, Austin compiled their information into one report. In line with contemporary European scientific analysis, his mineralogical survey outlines the general layout of the mining frontier borderland, the names of lead veins, and the quantity and quality of lead ores for the president, Congress, naturalists, and merchants.

Austin and his assistants began their survey in January, and it was complete by February of 1804. The timeframe coincided with the phase when most miners ceased their extracting and smelting activities, and remained close to home preparing their tools for the spring planting and mining season.[363] The short amount of time required Austin and his staff to work long days traveling between locations. Their plan was to combine the breadth of observations and chemical analyses of the lead ores in the mining district, as well as provide a short history of each mine. The organization of the report is also telling. Instead of Austin beginning with the oldest, Mine La Motte, he chose to begin with his recently established mining settlement—Mine a Breton—revealing pride of place. Since Austin desired to promote the significance of his settlement to lead manufacturers and miners back east, he needed to communicate to others that the European-like mineshaft, the masonry smelting furnace, and the lead manufactory where he produced sheet lead and shot only existed at Mine a Breton. In addition, although Austin's staff conducted "a few experiments" at nearby mines, "because of the strong

[362] Partnership agreement between Austin, Valle, Delassus, January 26, 1797. Barker, eds., *The Austin Papers Part I*, 29-31.
[363] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 10, 17.

appearances" of quality lead ore at Mine La Motte, he explained the benefits of that mine as well.[364]



Map 9: Lead Mine locations in 1804[365]

There is perhaps no more striking illustration of the central position that science and technology took in shaping Austin's interaction with nature than the utensils he

[364] For the importance of lead and the trade of pig lead to early frontier societies, see Schoolcraft, *A View of the Lead Mines of Missouri,* 38-40 & Ch. 7;
[365] Map obtained from Walter A. Schroeder, Columbia, Missouri.

applied to measure lead ore. Clearly, the procedures to prospect or assay minerals outlined in European manuals also improved Austin, Bell and the Mullins understanding of the quality of Missouri's lead. To remain well versed in mineral classification Austin and his staff depended on the continuous flow of reprinted British publications in the United States. To conduct experiments, Austin relied on other American's mineralogical reports. For example, in 1804, Benjamin De Witt produced an essay entitled "Mineral Productions of the State of New York," and Sylvain Godon examined and described Boston minerals. In 1818, James and Samuel Dana would expand on Godon's Boston survey in their detailed "Outline of the Mineralogy and Geology of Boston."[366] Together, the reports suggest that Americans were eager to control and redefine the natural environment. Similarly to De Witt and Godon, Austin too recognized that economic benefits would come from a systematic charting as focused miners used their skills to create a clearer picture of nature and "the number, extent and situation of the lead mines in Upper Louisiana."[367]

Austin explained how the mining region "may be said to extend over two thousand acres of land." In each entry on a mine in the survey, Austin first described how miners "[worked] using a method that renders it impossible to determine whether the mineral terminates in regular veins or not." Thus, it appears that one of his primary goals was to define the lead veins at each mine. Austin and his assistants had to estimate the length and depth of each vein to determine how and where miners would construct shafts

[366] De Witt, "Mineral Productions of the State of New York," 73-81; Godon, "Observations to serve for the mineralogical map of the State of Maryland" 319-323; James F. Dana and Samuel L. Dana, "Outlines of the mineralogy and geology of Boston and its vicinity," *American Academy of Arts and Science Memorial*, 4, 129-223.
[367] Austin, *A Summary Description of the Lead Mines in Upper Louisiana,* 18-20.

or European-like galleries, and then erect “machinery” to further aid the recovery of larger quantities of lead.

Although Austin had built a laboratory at Mine a Breton, to guide his assaying activities he also had to acquire a number of pocket-size manuals and portable laboratories from England. To help them quickly conclude the amount and purity of each mine’s lead ore, English miners used these miniature manuals and laboratories to prospect and assay minerals when away from the main laboratory. What we are unable to gather from the survey is how Bell and the Mullins brothers corresponded with Austin, who remained at Mine a Breton, from the field. Since the surveys were conducted during the winter, there must have been traveling difficulties, such as falling snow and cold air. At times it must have been difficult to pass over certain roads because of snow or mud, and these obstacles may have even damaged their equipment.[368] There is also no way of telling if any of the assistants experienced poor health or problems with their horses. Because the work had to be completed quickly, the miners must have endured some level of exhaustion. However difficult the process of collecting and analyzing samples may have been, they each understood that it was necessary to acquire information from the local mines so that Austin could incorporate their analysis into the report.

The European method of classifying the Louisiana lead mines served the president, Congress, and natural philosophers well. Clearly, the survey’s outline of soil, lead veins, and rock descriptions helped solidify geological ideas about the quantity of lead ore. The mineralogical report provided Americans with an analysis detailing the “strong appearance of mineral—to render the mining business generally advantageous” to

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[368] For travel difficulties, see Barker, eds., “Journal of Voyage Down the Mississippi,” *The Austin Papers Part I*, 69-75; Lewis C. Beck, *A Gazetteer of the State of Illinois and Missouri* (Albany, Charles R. and George Webster, 1823), 252.

both the miner and farmer.[369] Another central element to the report's success was the use of instruments and equipment in the lab or in the field to meticulously represent the quality of lead ore.

With Austin's staff in place and the tools and organization completed they were prepared to look at the mining environment and organize it according to European inventiveness. Amos Stoddard recognized Austin as a miner and, more importantly, as a chemist who understood geology. Most likely, Bell and the Mullins brothers carried with them to the United States similar skills and also understood that because of the extent and situation of the lead mines in Upper Louisiana, an accurate survey and estimate of the average quality of mineral produced along with the probable quantity which may be annually produced would benefit lead production in the mining frontier borderland.[370]

Replacing old prospecting practices in low and flat prairies

Austin wanted to provide Jefferson, merchants, and naturalists back east with an assessment of the region's natural features by categorizing waterways, mountains, vegetables, and animals. Since Austin and the accompanying English miners had created an orderly way to work nature at Mine a Breton, they wanted to implement similar European prospecting practices at each mine. Francois Azau Breton was the first French settlers to work Mine a Breton 1780. Mine a Breton was originally designated as the mine on the forks of the Meramec River. The mine was situated where the town of Potosi, Missouri, now stands. Mine a Breton was the chief mine of the Mississippi Valley from

[369] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 10.
[370] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*. 7, 17.

the late 1790s through the early nineteenth century.[371] The mine was approximately forty-five miles northwest of Ste. Genevieve. It was situated on a fork of the Grand River, twenty-five miles west of the Mississippi River. The Grand River was navigable during the spring season, which made it the ideal location for shipping lead down to the port of New Orleans. Austin characterized the mines as "the greatest part—in an open prairie which rises nearly an hundred feet above the creek. The mine extends over two thousand acres of land; but the principal workings are within the limits of one hundred sixty acres."[372] Similar to those explorers who came before, Austin proceeded to organize his survey with mineralogical information to bolster the need for expanding the mines.

Austin's appraisal of Mine La Motte showed it to be more extensive than Mine a Breton. Considered the oldest of all the mines in the district, Mine La Motte differed in every way from Mine a Breton. Situated on the St. Francis River, Mine La Motte was six miles from the main river. The closest town, Ste. Genevieve, was thirty miles to the southwest. The ground was "low and flat," and Austin reported that "miners penetrated the ground to a depth of twenty-five feet"; however, "water seepage often prevented additional mining except during the dry season beyond that depth."[373] He also noted that miners still applied the Native American amalgam at Mine La Motte.

Austin's descriptions of miners' techniques at Mine La Motte are by far the most extensive critique in the survey. He noted that "when the miner finds himself ten or twelve feet below the surface, his inexperience obliges him to quit his digging and begin

[371] Hunt's Minutes, Recorder's Office, St. Louis, Missouri, 1825, Typed. Schoolcraft, *View of the Lead mines of Missouri*, 18; Houck, *The Spanish Regime in Missouri* 74, 283; Thomas Maitland Marshall, *The Life and Papers of Frederick Bates, Vol. I* (St. Louis: Missouri Historical Society, 1926), 188, 275.
[372] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 7.
[373] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 18, 19.

anew" without understanding or viewing a vein's character or shape.[374] Similar to Europeans who questioned African and Asian miners' techniques during the early days of exploration, Austin and other travelers may have praised the final amounts of lead produced, but they also noted that Native American and French amalgam produced a small amount of lead.[375] Because miners had adopted the amalgam, Austin became motivated to apply European prospecting practices to more clearly describe and study the lead ore veins. For example, most of the mineral at both mines was found in what Austin termed "regular veins" of varying sizes.[376]

Closely adhering to the instructions of Europe's natural philosophers found in their manuals, Austin decided to describe the underground patterns of *regular* veins at Mine a Breton and Mine La Motte. He uses these terms to distinguish between two types of veins of deposits of lead ore: rake-veins and flat-veins. Europeans considered rake-veins to be true veins because they were "narrow, and often mixed in with limestone." As mentioned earlier, De Gruy reported how he usually observed lead ore enclosed in limestone. Austin did see the same features when he and his assistants described local rake-veins near limestone as having "a thickness of at least a foot." He further observed how the veins widened "three to four feet in width" in most pits or shafts' and how at greater depth the veins at both mines contained an abundance of lead ores.[377] Like English miners in Great Britain, Austin assumed flat-veins to hold small beds of ores connected to rake-veins and were only productive to a certain distance from the body of a

[374] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 8.
[375] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 20. For the nature of European descriptions of native practices in the African and Asian context see, Adas, *Machines as the Measure of Men*, 1-3.
[376] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 8, 15.
[377] The English word vein corresponds to the French term *filon*, which indicates all the deposits of this ore. Kirwan follows Werner's methods to describe the variety of veins, see Kirwan, *Elements of Mineralogy*, 202-223.

vein. In the flat veins, Austin observed the lumps of ore "to have been rounded into common gravel." After the miners removed three or four feet of earth, they would reach gravel lead ore intermixed with "sand rock," which could be easily broken using their picks.[378]

Austin's survey highlighted "regular vein" more than any other vein structure, which not only confirms his understanding of European terminology, but also his ability to apply their methods to prospect deeper into the earth. He could clearly view where mineral veins terminated. Austin's use of the term *regular veins* most likely means rake-veins, since both appeared near limestone. At both mining sites where Austin prospected, he noted that rake-veins were the most common form in which lead ore occurred at the mines he observed. Additionally, his reference to "quartz and pyrites" also notes that galena was nearby.[379]

Since the time of Agricola, Europeans had borrowed the term *vein* from its use to describe animals. Beginning in 1546 with the publication of Georgius Agricola's prospecting, mining, and smelting manual, it remained the leading textbook for miners and metallurgists for nearly two centuries. At a time when families, guilds, or towns held most industrial processes secret, Agricola thought it important to publish every practice and improvement that he considered of value. He believed that when associated with geology, mineral veins indicated canals in the earth or channels of ore. Just as animals' veins are distributed through all parts of the body, allowing blood to flow from the liver throughout the whole body, so too the mineral veins traverse the whole globe. More

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[378] Pryce, *Mineralogia Cornubiensis*, 179.
[379] Pryce, *Mineralogia Cornubiensis*, 92-94.

particularly, it was believed that these veins were present in the mountainous and hilly regions, where water runs and flows through the veins.[380]

The classification of minerals also included a description of lead ores' external characteristics. At Mine La Motte, Austin noticed three distinct qualities of ore: gravel, gold-colored fossil mineral, and "fine steel grain" mineral. The gravel ore could be seen immediately under the soil and was intermixed with "lumps" of lead "the size of a fist weighing from one to fifty pounds."[381] One hundred years earlier, the French explorers Des Ursin, Renaudiere, and De Gruy also described the galena as "rounded pebbles or gravel ore" that they discovered in small, detached lumps "buried beneath three to ten feet of the earth's soil." Gold fossil, yet another type of mineral, was a term that had applied to rocks and minerals since the medieval period. The meaning stemmed from the Latin word *fossilis*, which referred to anything dug out of the earth. The metallic luster of gold fossil was pale to normal with a "brass yellow hue," which often caused miners to confuse it with gold.[382]

Believing they had the scientific instruments needed to determine where the riches veins were located, Austin and his assistants became excited when he first recognized the dark blue "fine steel grain" mineral at Mine La Motte. Known as galena, or potter's lead ore, it was the most common of all the lead ores and appeared as grains shaped like moderate-sized cubes. Recall, this was the same galena was the same lead that the Native Americans prized for local use and distant trade. Native Americans cherished this type of galena because it could be easily broken with the blow of a

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[380] Hoover, *Georgius Agricola, De Re Metallica*, Book I.
[381] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*,15.
[382] Hoover, *Georgius Agricola, De Re Metallica*, Book I; Ure, *Dictionary of Arts, Manufactures, and Mines*, 745-748.

hammer. On account of galena's richness, the Kaskaskia Indians used it with very little preparation as a glaze for coarse pottery, and exchanged it with other Native American tribes for products not available in the Mississippi Valley.[383] Native Americans traveled over land and river networks to deliver their crushed galena to tribes located along the Mississippi and Ohio Rivers. Europeans classified this galena "as soft unless it was mixed with iron making it harder."[384] Because the lead appeared like colorless glass and had a refracting quality, Austin, Bell, and the Mullins brothers recorded as carbonate of lead.[385] With the discovery of deep veins where carbonate of lead lay hidden, Austin outlined in his report the need to improve prospecting and mining techniques. He presented to Jefferson a call for local miners to abandon their trenches, and start digging deep mine shafts using European contraptions.

At Mine La Motte, Austin noted that the greatest portion of lead ore could be found imbedded in a thick stratum of marl clay adjacent to limestone.[386] Since the carbonate of lead was free of contaminates, glass manufacturers craved it as it was a key ingredient for making quality red lead to fabricate glass. In certain lighting it appeared colorless, transparent, and glass-like in appearance, all natural qualities for producing flint glass. After experimenting on the particular galena type from Mine La Motte, Austin discovered the amount of lead registered between forty-five and eighty-three percent.[387] Austin's experiments prompted him to write in his report that Mine La Motte was a "gold mine descriptive of its wealth" and capable of furnishing vast quantities of

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383 Walthall, *Galena and Aboriginal Trade in Eastern North America*, 37-41.
384 Kirwan, *Elements of Mineralogy*, 49, 179.
385 Chaptal, *Elements of Chemistry*, 331; Schoolcraft, *A View of the Lead Mines of Missouri,* 77-80,103-106.
386 Similar to Mine La Motte, miners found lead next to limestone at the Derbyshire, England lead mines. See Cutbush, *The American artist's manual*, "lead" section; Ure, *Dictionary of Arts, Manufactures*, 837.
387 Schoolcraft makes reference to many European encyclopedias and experiments. Schoolcraft also he conducted experiments while traveling through the lead district in 1818. Schoolcraft Papers, Container 82.

lead. Most significantly, Austin and his staff understood the galena to be useful for commerce.[388]

As early nineteenth-century miners, Austin and his staff after applying their various European skills they would alert the president, Congress, and other natural philosophers of the significance of the dark blue “fine steel grain” galena found at Mine La Motte. Most likely, all as well as lead manufacturers understood this type of lead would be useful primarily for manufacturing red and white lead.[389] A decade later, when the glassmaker and geologists, Henry Rowe Schoolcraft toured the lead district, he would state that “when this ore is piled near mines, the reflection of the light makes it appear white, and the unfamiliar workers unacquainted with this ore might readily mistake it for silver.”[390] Schoolcraft’s description of the vein structures and the various character traits of galena were similar to Austin’s: “the external luster of this type of galena was found to be resplendent and specula to glimmering” and refracted like glass.   In like fashion to Austin, Schoolcraft also came to believe that if local miners possessed the tools and machines to prospect correctly they would be able to extract carbonated of lead from the rich veins. Both described it as a pinhead to chestnut-size gravel mineral intermixed with the soil. Long after Austin had completed and published his survey of the mines, his analysis would alert both merchants in frontier and urban spaces of the type of galena discovered, and they would continue to purchase and use this lead to manufacture a variety of items.

[388] Schoolcraft discusses types of galena used to manufacture flint glass. Schoolcraft Papers, Container 82.
[389] Jean-Antoine-Claude Chaptal, *Elements of Chemistry*, 335.
[390] Ure, *Dictionary of Arts, Manufactures, and Mines*, 541; Schoolcraft, *A View of the Lead Mines of Missouri*, 77-80.

Austin's mineralogical report added to the landscape not only European terminology that classified galena and carbonate of lead, but also a laboratory "fitted up with furnaces, instruments and apparatus" to help them characterized lead ore.[391] They used European chemist tools such as furnaces, cisterns, pots, and utensils for examining features of the natural landscape to identify veins and lead formations and also to determine their ore's quality.[392] Another central element of the report's success, explored next, was the use of instrumental and analytical equipment in the lab and field to produce quantified and qualified representations of lead ore.

Early American frontier experiments

Austin's acceptance of the superiority of his precision, tools, and instruments clearly was connected to his way of thinking and perceiving the natural world. He published that his utensils and methods were fundamentally different from the tools and practices he encountered on the mining frontier-borderland. Most significantly, many Europeans and Americans were confident that because of advances in the sciences they had surpassed all other civilizations. In such an environment, by the early nineteenth century, Austin and other miners desired to more fully comprehend and control the natural world. To do so, they believed that the best means of redefining the mining region was not only to characterize nature, but also to use the latest European apparatuses to conduct experiments on lead to measure its quality.

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[391] Chaptal, *Elements of Chemistry*, 1-3.

[392] The scientific or experimental chemist required a place as well as specific tools for conducting their operations, which were deigned to discover how to effectively smelt and manufacture minerals effectively. Cutbush, *The American Artist's Manual*, "Laboratory" section.

The descriptive and technical dimensions of the report were all part of recreating environmental knowledge that had been originally characterized by the amalgam. While the Native American and French practices to test the quality of lead ores was closely associated with human taste and touch, the European method appears to have been more distant, requiring tools. Most likely, to test the quality of the galena gathered from the field, Austin and his assistants constructed a laboratory. The chemical analysis performed by Austin and his staff represents a critical moment on the mining frontier borderland, signaling the further disappearance of the Native American and French amalgam.

Armed with new technologies, Austin and English miners began the informal process of transferring European assaying practices to the frontier. The laboratory at Mine a Breton may have been in the same building as the reverberatory furnace near the shot and sheet lead factory.[393] In addition, Austin and his staff carried portable or pocket laboratories when traveling between the various mines throughout the district.[394] Both the stationary and pocket laboratory included a variety of European instruments to test minerals.[395] For example, James Woodhouse, who was devoted to mineralogical science in Philadelphia was trained in chemistry at the medical school in that city. A number of years after Woodhouse earned his M.D. in 1792, he organized his *Young Chemist's Pocket Companion: Connected with a Portable Laboratory* in 1797.[396] Woodhouse also

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[393] Austin's letter to Kendall and Bates, December 1797, Barker, eds., *The Austin Papers Part I*, 32-39.
[394] Anonymous Author, *A Compendious System of Mineralogy & Metallurgy; extracted from the American edition of the Encyclopedia* (Thomas Dobson: Stone-House, no 41, 1794), 30-40.
[395] Early mineralogists and chemist included mining instructions and methods to construct furnaces. They carried pocket size instruction books instructing them in the various stages of prospecting, assaying, and smelting metals. Chaptal, *Elements of Chemistry*, 2-8; 330-339.
[396] James Woodhouse, *The young chemist's pocket companion: connected with a portable laboratory, containing a philosophical apparatus, and a great number of chemical agents, by which any person may perform an endless variety of amusing and instructing experiments: intended to promote the cultivation of*

spent the opening years of the nineteenth century conducting analysis on lead ores at the Perkiomen Creek mines near Philadelphia. With these instruments and manuals in their hands, Woodhouse, Austin, Bell, and the Mullins brothers produced new knowledge about their environment with technical specificity.[397]

Across the Atlantic as well as on the mining frontier, natural philosophers and miners used a number of tools to assay their minerals. Most would have followed the chemical analysis techniques outlined by James Woodhouse and others.[398] Closely adhering to the Woodhouse model, Austin conducted experiments with great care and skill. Any error made during the assaying process would have been multiplied when the bulk ore was worked at a later time, and resulted in losses to the owners. Since most encyclopedias were cumbersome and difficult to carry between mining sites, Austin provided his field assistants with the Woodhouse pocketbook-sized manual, instruments, and a field laboratory to conduct their investigations. The pocket laboratory was not intended for "a person who always resides at one and the same place."[399] Because of time constraints and obstacles on the frontier, the miners used both systems to assay ores.

In addition to European manuals, miners depended on various instruments to help them conduct assay lead ore at the mining site. Packed in a "small oak box, the size of a book, the field laboratory was designed for the miner who travels from one mine to another." The design of the portable laboratory reveals the care by which miners conducted their experiments and also provides insight into the topography of the mining

the science of chemistry (Philadelphia: Printed by J.H. Oswald, 1797); Woodhouse also authored Woodhouse, *The Young Chemist's pocket Companion*; *Compendious System of Mineralogy & Metallurgy* (Philadelphia: Printed by J.H. Oswald, 1798), 420-423.

397 Miller, *Brief Retrospect of the Eighteenth Century*, 145-155.

398 Thomas Thomson, *A System of Chemistry: Volume 1 of a System of Chemistry: In Four Volumes* (London: Bell & Bradfute; sold by J. Murray, London, 1802), 150-160.

399 Woodhouse, *The Young Chemist's pocket Companion*, 24.

area where they traveled. Manufacturers designed the boxes to protect the instruments by "lining the compartments with green velvet," and they also "covered it with leather" so that the boxes would not become damaged in the wagons that passed over the mining region's rugged topography. The inside of the boxes were divided into multiple compartments to further protect the iron blowpipe, the glass triple magnifier, and the lamp furnace.[400] The blowpipe was made of ivory to eliminate the sensation of having a piece of metal "between the teeth and lips" for a long time. This simple blowpipe with a tapering iron tub at the end and a small opening allowed the artisan to blow air "under relativity high pressure."[401] Miners used the blowpipe, which acted as a portable bellow, and replaced the large furnace at Mine a Breton, to perform chemical tests. The *Compendious System of Mineralogy & Metallurgy* states that "when the blowpipe was applied to compact or common galena," it melted and gave off a "sulphureous odor" and produced a button-size piece of metal at the bottom of the crucible.[402]

By the late eighteenth century, advances in optics aided miners. A triple magnifier able to produce "seven magnifying powers," and one lamp furnace were both stored in separate compartments of the pocket laboratory. The magnifier enabled Austin to enhance his observations. With the triple magnifier miners could view small and middle-sized "crystals with specula, splendent or sometimes rough surfaces that appeared uneven and splintery."[403] Miners used optics to detect if foreign matter was attached to the minerals. In these cases the miner would have to take extra care when cleaning the mineral in preparation for assaying. The mineralogist could clearly distinguish the

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[400] Woodhouse, *The Young Chemist's pocket Companion*, 26-27.
[401] Woodhouse, *The Young Chemist's pocket Companion*, 24-25.
[402] Dobson, *Compendious System of Mineralogy*, 30-40.
[403] Schoolcraft, *A View of the Lead Mines of Missouri*, 90-94.

structure and metallic parts of lead ores. The blowpipe and lamp furnace sufficiently perform in a few minutes and "with very little expense the assay, which otherwise would require large vessels like a reverberatory furnace," for the miner when the mobile iron or clay furnace was not available. Traveling along the rough trail, field assistants seldom had an opportunity to carry portable iron or clay furnaces. They may very well have been content with the portable laboratory and apparatus, "which are sufficient for the most part of such experiments as can be made on a journey," to the local mines.[404] With the blowpipe, the triple magnifier, and the lamp furnace, Bell and the Mullins brothers could supply Austin with the analytical results of all ten mines. The eighteen-page report included approximately seven pages devoted to just the mineral analysis that Austin collected from his assistants.

Two more brief examples of the types of instruments miners armed themselves with to survey the lead mines reveal the use of hidden knowledge on the frontier. Field assistants carried a separate portable laboratory that contained a washing trough to rinse water over mineral ores to separate the ore from "adherent rock" before the conducting of chemical assays on the minerals. Troughs came in multiple sizes and were very common in laboratories. Woodhouse recommended that miners use "one of a moderate size for field use." He provided instructions for building troughs according to the following dimensions: a trough should be twelve inches and a half inches long by three inches wide at the one end, and one a half inches at the other end and should slope down from the sides and the broad end to the bottom, where it is three quarters of an inch deep.

Troughs were commonly made of smooth, hard, and compact wood containing no pores where minute grains of the pounded ores "may conceal themselves." Finally, there

[404] Woodhouse, *The Young Chemist's pocket Companion*, 26.

was also a separate laboratory box to house different acids to test the mineral bodies. The most common were niter of vitriol, vinegar, borax, and common salt.[405] All combined the tools Austin and his assistants carried represent how they came to view science and especially technology as a measure of their own civilizations past achievements. Just a few years prior to Austin conducting his survey of the mines more patents were issued in Great Britain than had ever been grants for new inventories in all the preceding years of the century combined.

Most important to any miner was to correctly assay ores. Early mineralogists had an intimate knowledge of many chemical substances.[406] Similar to Renaudiere and Des Ursin, who conducted an assay of the lead ore at Mine La Motte, Austin and his field assistants understood the importance of determining the amount of metal contained in a sample of ore. To analyze these samples, Austin combined fieldwork with lab work. Testing metals required a set of tools, such as the cupola, a very absorbent, shallow vessel. After acquiring a small sample from each mine, they proceeded to carefully assay the ores. Any error made was multiplied many times over when the bulk ore was smelted. For example, losses of several thousand pounds of ore might incur for the owners if the assaying process was not correctly performed.[407] If overheated, the metal could be lost in fumes; if under heated, the metal would be lost with the slag and furnace accretions.

A broader significance of the report is an acknowledgment that more than the sensory observations of miners, Austin used more distant European instruments and measurements to achieve his goal of redefining and controlling the region's most precious natural resource. While these tools and practices appeared useful and beneficial,

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[405] Woodhouse, *The Young Chemist's pocket Companion*, 14-20.
[406] Hoover, *Georgius Agricola, De Re Metallica*, Book VII.
[407] Ure, *Dictionary of Arts, Manufactures, and Mines*, 837.

in the hands of Austin and his associates, they instigated the erasure of the Native American and French amalgam. For example, Native Americans had a method to wash and analyze lead ore prior to smelting. If the ores were covered with clay, they would need washing. If gangue minerals adhered to the galena, Native Americans would have hand-cobbed the ores with a small pointed hammer know as a pickwee. Finally, if the galena was heavily coated with white carbonate, miners understood that the smelting process would be slowed. Although Native American smelters may have done some preliminary washing and cobbing, it is unclear how long Native Americans were aware of these practices. However, because Indian smelting was labor intensive, there is no doubt that prospecting, assaying, and smelting required considerable judgment. Perhaps explaining why after observing Native American smelters, a visitor believed them to be better smelters than the white miners.

The analysis conducted on lead ore at Mine La Motte proved that the lead ores were of a superior quality to the ones at Mine a Breton. Austin tested the ores to determine the true percentage of metal. In 1818, glass manufacturer Henry Rowe Schoolcraft also conducted an analysis on Mine La Motte's galena. Schoolcraft "found by experiments that the mineral in the hands of skillful smelters" would produce 60 or 70 percent metal. Austin also believed that if "fifty men under a proper manager" worked "with a good smelting furnace," the mine "might produce five or six hundred thousand pounds of weight of lead per [year]."[408] As mentioned earlier, Schoolcraft also confirmed what Austin had already discovered—that Mine La Motte appeared to be like a gold mine.[409] According to Schoolcraft the amount of sulphur associated with lead ore

[408] Austin, *A Summary Description of the Lead Mines in Upper Louisiana,*16.
[409] Schoolcraft, *A View of the Lead Mines of Missouri,* 80.

was important to miners. Although, Austin fails to mention veins of sulphur or the amount of sulphur contained in the lead, Schoolcraft noted that "the ores of La Motte contain an unusual portion of sulphur…I draw this inference from its refractory nature." Schoolcraft's experimenting experiences taught him that when the ore was heated and "the more sulphur there is driven off, the brighter it grows."[410] In effect, the analyses of Austin and Schoolcraft agreed that with proper management and the transfer of skilled smelters to Mine La Motte, the gross production of the mine would increase.

Austin's report produced new and more scientific descriptions of the lead region's features. By the beginning of the nineteenth century, American and English miners began to specify their understanding of European environmental knowledge, which most likely further influenced changes to the mining district. They took up all manner of questions, including topics we would now assign to medicine, engineering, travel writing, or even ethnography. Science was welcomed in both urban and frontier spaces. Everyone who could do so read about the sciences.[411] Notably, near the lead mines of Missouri, experiments and demonstrations were public events. Newspapers regularly published accounts of experiments, new technologies, and medical news.

Like Austin, the eighteenth-and early nineteenth-century men of science did not specialize in science. They had other occupations or careers. They were presidents, like Thomas Jefferson, clergymen, members of Parliament, farmers, tax administrators, ship captains, noblewomen, printers, and even miners or smelters.[412] On the early North American mining frontier, Austin and his field workers connected European instruments with the landscape that had originally been defined according to Native American and

[410] Schoolcraft, *A View of the Lead Mines of Missouri*, 81.
[411] Oleson and Brown, *Pursuit of Knowledge*, 39-46.
[412] Greene and Burke, "The Science of Minerals in the Age of Jefferson," 21-22.

French practices. The report centers on the development of science in these spaces. By producing new kinds of environmental knowledge, the survey would become a tool for improvement predicated on the importance of applying enlightened views to resolve extracting and smelting problems.

On November 8, 1804, Thomas Jefferson provided Congress with copies of Austin's report on Louisiana's rich lead mines. During the next five years, the Missouri Territory's lead industry was one of slow but substantial growth.[413] The European techniques of prospecting, naming of veins, and conducting assays enabled Austin to determine with certainty the percentage of lead contained in the ores. As word spread in the form of his mineralogical survey, others were encouraged, which prompted additional explorations and experiments on newly discovered deposits; new towns were settled, and the manufacture of lead on an important scale began. By 1809, Joseph Brown and John A. Storch both migrated from Philadelphia to St. Genevieve, Missouri. Brown was a surveyor of lands and treaty lines for the government. He surveyed the state line between Missouri and Arkansas. Although there is no information related to their assaying activities, Brown and Storch decided to erect a permanent laboratory to assay minerals. Their plan was to establish a business for "analyzing ores of every description." Brown and Storch subscribed to the idea of anyone possessing all kinds of ores to have them "ascertained for five dollars per experiment," on the precondition that they send no more than one pound per visit.[414] As the Missouri Territory became more populated with miners, they would discover new deposits of mineral that needed to be assayed.

[413] Message of Thomas Jefferson, 8 November 1804, *American State Papers: Foreign Relations I*: 63.
[414] Joseph Charless, "The Subscribers having erected at the New Diggings district at St. Genevieve, and Assay Furnace," *Missouri Gazette*, April 12, 1809, (St. Louis: Printed by Joseph Charless, Printer to the Territory and of the Laws of the United States, Term Subscription to the Missouri Gazette).

Following the publication of Austin's analysis, news of the region's mineral wealth spread from the frontier to eastern manufacturers already engaged in the production of shot and red and white lead.[415]

Reconstructing the use of galena according to its quality

There is a close link between the timing of Austin's report and the industrial development of the eastern United States. In 1794, Tench Coxe listed over fifty classes of assembled goods. He cataloged "many articles indeed" as being "manufactured in the city of Philadelphia, in the boroughs, and in the counties of Pennsylvania."[416] Local officials as well as politicians encouraged development in and beyond Philadelphia. For example, shot, sheet lead, red lead, and white lead were useful products to both frontier and urban places. There was also a growing desire to discontinue importing both products and glass from London into the United States. The increasing friction between the old and new countries during the early 1800s provided added impetus to commercial independence for the younger one. As tensions continued to rise, Congress passed the 1806 Act, which forbid the acceptance of any commodity in glass bottles restricted importations. The Act was not enforced until the Embargo Act of 1807, so merchants continued to accept large orders of white and red lead, litharge, paints drugs, and chemicals from London, as Great Britain gladly continued to flood American markets with these products.

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415 Reviewing the amount of Missouri pig lead received by the Wetherill's for the buying agent in New Orleans between 1810 and 1826, they had increased the production of red and white lead. Wetherill Production Records, Item 17, 18, and 25; Also, see Walter Renton Ingalls, *Lead and zinc in the United States: Comprising an economic history of the mining and smelting of the metals and the conditions, which have affected the development of the industries* (New York: Hill, 1908).

416 Tench Coxe was appointed by President George Washington Commissioner of the Revenue of the United States, to oversee the "Report on Manufactures." See *A View of the United States of America, In a Series of Papers Written at Various Times, between 1787 and 1794* (Philadelphia: 1794), viii.

On March 8, 1809, the *Missouri Gazette* announced that Moses Austin had established at Herculaneum a "shot manufactory," saying that "the situation is especially adapted for the purpose of having a natural tower or stupendous rock, forming a precipice about 130 feet." The village of Herculaneum was located on the west bank of the Mississippi, about thirty miles below St. Louis. Frederic Billon noted,

> After the transfer of the country [west of the Mississippi River] to the United States, and the extensive development of lead mineral throughout all this region back from the river, two enterprising Americans, Colonel Samuel Hammond of St. Louis, and Moses Austin of Ste. Genevieve, perceiving the advantages of this point for an extensive lead business from its nearer proximity to the mines than Ste. Genevieve, then the only point of shipment on the river, purchased from Jonathan Kendall, on January 9, 1809, a tract of land at the mouth of Joachim Creek and immediately laid off their plat of the town.[417]

The *Gazette* noted that because of the nearby lead mines and the accessible harbor, the Missouri Territory would be able to "supply the Atlantic states on such terms as will defeat the competition."[418] In addition to the closeness of the mines, Herculaneum provided a good landing for boats in the nearby Joachim Creek, which afforded an excellent harbor.[419] Neither Austin nor Kendall feared new inventions or establishing new frontier manufactories. Like their counterpart Northeastern merchants, they were also aware of the escalating tensions in Europe and their potential threat to overseas trade. And they began to explore expansion possibilities with western outposts from Lake Erie to St. Louis and beyond to sell their shot and sheet lead.

Rising almost two hundred feet from the river banks were perpendicular cliffs. The natural elevation allowed shot-makers to drop the molten lead, and meant they did

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[417] Federic Louis Billon, *Annals of St. Louis in Its Territorial Days, from 1804 to 1821: Being a Continuation of the Author's Previous Work, the Annals of the French and Spanish Period* (St. Louis: Printer for the Author, 1888), 19, 115, 229.
[418] Charless, "At Herculaneum a Shot Manufactory is now erecting by an active enterprising citizen of our territory," *Missouri Gazette*, March 8, 1809.
[419] Cramer, *The Navigator,* 87-90.

not have to invest substantial capital in the construction of shot towers. Still, John Macklot erected a tower to manufacture patent shot at Herculaneum, and the *Gazette* reported that he had "begun to cast shot equal to the best English patent."[420] Macklot planned to manufacture ten thousand pounds of shot. A visitor to the region noted how the energy with which capital turned to this form of production at this early date on the frontier was remarkable.[421]

On June 20, 1811, the *Gazette* reported that the lead mines in the "district of St. Genevieve promoted a spirit of industry and everyday manifesting itself among the people of this territory." The fur trader William Ashley began to experience a decrease in the value of peltry, and increasingly turned his attention to lead mining.[422] It was also reported that captains of several large boats no longer left Ste. Genevieve but instead departed from Herculaneum, "the larger mineral establishment." These boats carried more laborers to supply a quantity of lead "sufficient for at least one half of the consumption of the United States." Local citizens hoped that if the trade in lead became successful, it would lessen "the imports of this article into the United States from foreign countries, and decrease our dependence on them, as well as give activity and life to the trade of this territory." Now they needed artisans with scientific knowledge to turn their attention to quality galena in the Missouri Territory in order to begin the production of red and white lead locally.[423]

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[420] Charless, "The Erection of a Patent Shot Manufactory At Herculaneum," *Missouri Gazette*, November 16, 1809.

[421] Henry Marie Brackenridge, "Sketches of the Territory of Louisiana," *Missouri Gazette*, June 20, 1811.

[422] Thompson, *A History of Madison County Missouri*, 20.

[423] Charless, "Shipment Received at the General Store of Aaron Elliot & Son," *Missouri Gazette*, November 7, 1810.

The Austin report encouraged manufacturers of red and white lead in Philadelphia to search for domestic natural resources instead of imported ones. As will be covered in the next chapter, by 1804, the Wetherill Brothers of Philadelphia, "learning that this country [would] furnish lead sufficient for the United States consumption," would begin to slowly decrease their flow of white lead and red lead from Great Britain, and begin to manufacture similar products using galena from the Missouri Territory.[424] The Wetherill Brothers had a long established association with the London shipping and warehousing firm Brandram, Templeman, & Jacques. The association with this firm endured over many years. Now the Wetherill's were considering a way to make glass, dry white and red lead to sell from their Philadelphia store. To manufacture similar products, they made plans to secure from Mine La Motte the best quality of pig lead, for their Philadelphia red and white lead factory.[425]

Five years after the publication of Austin's report in 1809, frontier towns also began to change as there was a widening usage of lead. Merchants and artisans erected factories to produce white and red lead in Cincinnati, and glass was being manufactured in the town of Pittsburgh. Additionally, the report encouraged Christian Wilt and Joseph Hertzog, two Philadelphia merchants, to consider establishing a white and red lead factory in the frontier borderland town of St. Louis. The pigment white lead was prepared by casting the lead into sheets, rolling it up in a spiral form, and setting it to corrode in clay pots partly filled with vinegar.[426] Following its complete preparation, white lead was used for painting wood and to plaster interior walls. It was applied alone or in conjunction with other pigments to serve as a base, and give paint body. To

[424] Wetherill Collection, Letter book, Item #1, July 8, 1812 to Benjamin Morgan, New Orleans.
[425] Wetherill Collection, Letter book, Item #1, June 3, 1789 to Brandram, Templeman, & Jacques, London.
[426] Ure, *A Dictionary of Arts, Manufactures*, 744-746; Henry Rowe Schoolcraft Papers, Container 82.

manufacture white lead correctly, artisans needed the purest galena, free from any contaminates.[427]

Painters and glassmakers depended on manufacturers who understood Austin's assays. Manufacturers had to acquire the highest quality of galena for the production of white lead for paint and red lead for glass.[428] Red lead was produced by moderately heating metallic lead in a reverberatory furnace. Following hours of heating, workers witnessed metallic lead transition to a vivid red-orange colored almost—soft powder that crumbled between their fingers. Red lead flowed into society as an ingredient used to prepare enamels for potters' glazing. However, a greater quantity of red lead was used to manufacture glass, "which increased its luster, weight and strength." With the correct amount of "lead combined with other raw materials, glass became more pliable to work and easy to mold into a variety of ornamental forms."[429] Similar to Austin building shot and sheet lead factories and applying new scientific knowledge on the frontier, factory owners and their workers who manufactured glass, red lead, and white lead were required to have a level of scientific acumen to correctly measure and control the process.[430]

On October 26, 1811, Christian Wilt, the Philadelphia merchant who had recently migrated to St. Louis, published an article in the *Missouri Gazette* stating, "This is the proper country for the establishment of manufactures of lead such as shot, red lead, and white lead, which in the vicinity of the mines can be carried on better than any other location. Persons have been sent on this summer to erect buildings and commerce the

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[427] Henry Rowe Schoolcraft Papers, Container 82; Cutbush, *American Artist's Manual*, "lead" section.
[428] Ure, *A Dictionary of Arts, Manufactures*, 747-748, 572; Henry Rowe Schoolcraft Papers, Container 82.
[429] Ure, *A Dictionary of Arts, Manufactures*, 573; Henry Rowe Schoolcraft Papers, Container 82.
[430] William Nicholson, *A Dictionary of Chemistry, Exhibiting the present State of the Theory and Practice of that Science, its Application to Natural Philosophy, the Processes of Manufactures, Metallurgy, and numerous others Arts dependent on the Properties and Habitudes of Bodies, in the Mineral, Vegetable, and Animal Kingdoms, Vol. 1, 2* (London: G.G. and J. Robinson, 1795), 616-633.

manufacture of red and white lead."[431] In the same edition, the paper outlined an estimate of lead shipped from the region at two billion pounds, for total revenue of $200,000. Soon, Wilt would establish the first red and white lead factory on the edge of the frontier in St. Louis.

During the early nineteenth century, as the eastern markets became flooded with British shot, the Philadelphia shot factories suspended operations. As a result, Joseph Hertzog, Wilt's uncle in Philadelphia, decided it was a good time to begin manufacturing red lead in St. Louis to supply nearby frontier towns. In addition, he visualized possibly selling red lead to potters located along the Ohio River. Wilt and Hertzog also hoped to extend their sales to Pittsburgh where five glass factories had recently been erected, all using red lead.[432] Austin's chemical analysis of the Mine La Motte lead ores encouraged cultivators of science in Philadelphia to produce red lead, a key ingredient for manufacturing glass.

Wilt and Hertzog made plans to manufacture red lead, and sell it to factories in Pittsburgh and Cincinnati.[433] Both merchants were aware that in addition to glassmakers, there was also a growing number of pottery artisans located along the Ohio River who they could supply with quality red and white lead.[434] Both men apparently lacked the experience required to manufacture either product; therefore, to help construct and operate the factory, Hertzog hired two Philadelphian artisans.[435] Joseph Henderson was employed to color the lead since he had some chemical expertise. The factory also

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[431] Charless, "The Proper Country to Establish Manufactures of Red Lead, White Lead," *Missouri Gazette*, October 26, 1811.
[432] Hertzog to Wilt, April 30, 1811. For a detail review of the number of glass factories and potters located along the Ohio River, see Cramer, *The Navigator*, 18.
[433] Hertzog to Wilt, May 13, 1811.
[434] In Pittsburgh, Bakewell & Company manufactured red lead from lead acquired from Wilt. Hertzog to Z. Musiana, June 10, 1811; Benjamin G. Bakewell, *The Family Book of Bakewell* (Pittsburgh: 1896), 70.
[435] Hertzog to Wilt, May 13, 1811; and May 23, 1811.

needed as skilled smelter, and John Sparke, a former employee of Samuel Wetherill, the owner of the largest lead factory on the east coast, was hired as the grand smelter charged with the job of preparing the bar lead to manufacture red and white lead.[436]

Joseph Henderson fits the image of an early nineteenth-century American worker who applied the European sciences to manufacture red and white lead. During Henderson's leisure time, he studied Aiken's *Dictionary of Chemistry* and Nicholson's *Dictionary of Chemistry*. Using both works, Henderson conducted experiments to work out a formula to manufacture over four tons of red lead a week. He hoped to "discover some valuable processes for making sundry profitable articles," and he worked out a new system to manufacture red lead through the use of heat alone. Henderson believed that if his chemical tests were successful, his invention would make it unnecessary to pound, grind, and wash the lead, thereby saving time, and that he could manufacture red lead according to the demands of the market. He also assumed that with his new discovery, the weekly output should not be limited to four tons of red lead but that the quantity of manufactured lead could be regulated according to the demand of both the urban and frontier markets. Although following several attempts, Henderson's experiment was unsuccessful; his attempts represent the importance of scientific experimentation on the frontier.[437] The ability of Henderson to conduct research by applying European systems according to Aiken and Nicholson's chemical methods during the early nineteenth century on the frontier tells of the growing importance of red and white lead to society. Merchants in St. Louis, Ste. Genevieve, and Herculaneum sent their products east along

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[436] Hertzog to Wilt, May 25, 1811; and see the discussion between Sparke and Hertzog. Apparently Hertzog was considering hiring a Mr. Donahue a former employee of the Wetherill's, and Hertzog wanted a reference from Sparke, Hertzog to Wilt, September 26, 1811.

[437] From the letters it is difficult to know the precise time when they realized Henderson's experiment would not produce what he suggested. Wilt to Hertzog, December 3, 1814.

the Ohio River or down the Mississippi River to New Orleans, where they were loaded on ocean vessels bound for Philadelphia, New York and Boston.[438]

As word of the Missouri Territory's mineral-rich region spread east, the *Missouri Gazette* announced the arrival of Henry Marie Brackenridge, a gifted mineralogist, and requested that he "be protected and given guidance during his two-year residence," in the territory.[439] When Brackenridge finally made his way to the lead mining district, he observed the methods miners employed to extract and smelt lead ore. He asserted that although "the principal employment of the inhabitants is agriculture, the greater part are, also, more or less engaged in the lead business. This is a career of industry," he continued, "which is open to all, and the young in setting out to do something for themselves usually make their first assay in this business."[440] Brackenridge estimated "from the best information he could gather," the annual production of lead by the number of workers at each site, reporting that fifteen workers at Mine a Breton produced 50,000 pounds, and forty workers at Mine La Motte produced 100,000 pounds of lead.

The estimated output of lead from the Missouri Territory from 1800 to 1829 was 73,000 tons of metal valued at $4,188,000. The amount of shot manufactured during the same period probably approximated an annual average of $50,000. The lead product sent from Herculaneum alone during the eighteen months ending in June 1818 was 668,350 pounds. The value was $46,784, and the exports of bar lead during the same period were valued at $126,294. In 1819, Schoolcraft estimated that 1,130 persons including miners,

[438] Joseph Hertzog to Christian Wilt, June 27, 1811.
[439] Charless, "Arrival of Individual Gifted in the Two Sciences," *Missouri Gazette*, February 22, 1810.
[440] Henry Marie Brackenridge, *Views of Louisiana: Containing Geographical, Statistical and Historical Notices of that Vast and Important Portion of America* (Philadelphia: Printed by Schaeffer & Maund, 1817), 154.

blacksmiths, smelters, woodcutters, and carters were engaged in the lead business for a portion of the year.[441]

In conclusion, at the time that Lewis and Stoddard presented President Jefferson's request for additional information about the lead mining district to Austin, the natural philosophers and businessmen alike desired to understand the mineralogical and chemical properties of lead ore for national development. Austin and his British miners' knowledge and skills were regarded as valuable and indeed a necessary to medicine and a large portion of manufacturers that supplied the comforts and luxuries of nineteenth-century life. The miners' experiences with chemistry and mineralogy would encourage the flow of lead from Mine a Breton and Mine La Motte to frontier and urban spaces.

Austin's analysis highlights an example of the convergence of early nineteenth century environmental knowledge with technology. By using European experiments to describe and assay lead ore he promoted the regions lead ore's quality, which aided in the development of lead manufactories between 1801 and 1813. The primary mining sites were Mine a Breton and Mine La Motte. Failing to notice the Native American influence on mining, Austin observed one hundred and fifty miners extracting mineral using "primitive methods" by digging shallow pits and trenches. When Schoolcraft traveled through the same district in 1818, he recorded that over one thousand workers were employed in mining by "digging trenches." He also listed the primary methods miners used to smelt lead ores as being "in the common log hearth furnace, and the British reverberatory furnace at Mine a Breton," a significant change from local miners who used

[441] Austin, *Summary Description of the Lead Mines,* 10; Austin Report 1816, *American State Papers, Public Lands, Vol 3,* 609-613; Brackenridge, *Views of Louisiana,* 154; Schoolcraft, *View of the Lead mines,* 126-127.

the Native American log furnace method as describe earlier.[442] Therefore, a mix of methods continued into the early republic.

Additionally, the first mineralogical survey performed by Austin and his associates made a significant contribution to the young United States, as the volume of lead that flowed from the mining district to frontier and urban factories increased. The vast frontier of minerals would continue to be examined, exploited, and manufactured for the next several decades. Austin's observations and experiments would eventually be refined for Philadelphia's merchants, who desired additional mineralogical and chemical data about Missouri's lead. The environmental knowledge produced by Austin and his associates was transferred to glass manufactures who coveted quality lead ore for the manufacture of red lead.

Samuel Miller who published *A Brief Retrospect of the Eighteenth Century*, in 1803, sketched out the "revolutions and improvements in science." In his discussion on mineralogy, he believed that Americans were handicapped by the newness of the country, and that it was necessary to conduct more field examinations to discover the county's vast mineral wealth. Austin too was fully convinced that mineralogical science influenced the development of the United States economies and industries. Regarding Austin's galena report, Miller stated that "a larger proportion of the growing wealth of our country will hereafter be devoted to the improvements of knowledge and especially to the furtherance of all the means by which scientific discoveries are brought within popular reach." Miller believed Moses Austin and John Henderson represented future prospects of American science. Certainly, Austin, Bell, the Mullins brothers, and Henderson all implemented European instruments and analytical techniques that can be

[442] Schoolcraft, *View of the Lead mines,* 90-93.

seen as the impetus of the erasure of the Native American amalgam that American miners practiced.[443]

This chapter examined how these cultural and technological transformations began to reshape the environment from a mining frontier borderland into a bordered mining district as European scientific text, tools, and methods to describe the mining district's wealth pushed out the earlier techniques. Combined, the invasion of new European mining cultural practices would seal the fate of the French and Kaskaskia amalgamation of mining methods created during their eighteenth-century encounters.

[443] Miller, *A Brief Retrospect of the Eighteenth Century,* 145-155.

Part III: Improvement and Missouri's Mining District

The War of 1812 brought with it far-reaching cultural and technological changes to the United States and the Missouri Territory. As the west became more diversified after the War of 1812, the economy of the Northeast became more specialized. As the Northeast developed toward manufacturing, east coast lead manufactures would look to the lead mining and smelting region west of the Mississippi River for their supply of quality pig lead from Mine La Motte. The introduction of steamboats, red and white lead factories, and regional specialization in the New Republic—like lead mining—were all examples of how new technological innovations indicated that Jefferson's vision of America as a nation of farmers was breaking down.[444] The United States was experiencing the early stages of an industrial revolution that was not confined to the Northeastern cities. As the spirit of innovation flowed towards the Missouri Territory, miners continued to apply new methods to extract, smelt, and produce lead for growing markets back east.

By the end of the war, Americans in urban centers as well as on the frontier desired to move forward with a number of technological and cultural changes, which miners, geologists, and boosters hoped would transform the mining region into a mining district. They all began to call for a cultural sea change in the way that lead was extracted, smelted, and produced to increase the varying ways lead could be knit with the growing national market. Altogether these changes signaled the importance of lead products to a new market revolution. During these early American Republic years, as

[444] John Lauritz Larson, *Internal Improvement: National Public Works and the Promise of Popular Government in the Early United States* (Chapel Hill: University of North Carolina Press. 2001).

farmers, hunters, miners made a choice to buy factory made shot; to use pewter cups or fashioned glassware; to paint their wood walls they each became linked to industrial revolution that had an environmental impact on a local, national, and global scale.[445]

Settlers in the mining bordered district were also well aware of federal and state government policies that were put in place to construct roads and canal systems. Miners and merchants envisioned the possibly of quickly transporting lead across these new byways to markets in Pittsburgh, New Orleans and Philadelphia. Announcing a new era of river transportation, on August 2, 1817, the steamboat *Zebulon M. Pike* emerged at the St. Louis docks. It was the first and certainly not the last steam powered vessel to climb the Mississippi.[446] As steamboats like the *Pike* would regularly float up and down the inland waterways of the Ohio, Illinois, and Mississippi Rivers, it not only carried settlers, miners and boosters looking for profit, but it also deposited manufactured goods from the east in villages, in exchange for transporting pig lead from the mines to New Orleans and beyond. Eventually, like those displaced by new steam powered vessels, new steam technologies associated with mining would replace the Native American and French amalgam at the lead minesl, which represented the Americanization of the region.[447]

Progress in the mechanical arts associated with mining lead ore also paralleled developments in society as Americans' began to search for progress in a culture of improvement. During the postwar years as reform groups tried to create a total Christian environment that would purify America, visitors to the mining region also saw a need to

[445] Charles Sellers, *The Market Revolution: Jacksonian America, 1815-1846* (Oxford University Press, 1994), 58, 195, 80.
[446] William E. Foley, *The Genesis of Missouri: From Wilderness Outpost to Statehood* (Columbia: University of Missouri Press, 1989), 244-45.
[447] Stephen Aron, *American Confluence: The Missouri Frontier from Borderland to Border States* (Bloomington and Indianapolis: Indiana University Press, 2006), 170.

once and for all purge from the mining frontier-borderland the Native American and French amalgam. To incorporate a culture of progress meant to transfer new mining and smelting techniques to Mine La Motte. Just as Samuel Slater carried to the United States British textile plans, Americans also wanted to see highly skilled miners from Europe settle near Mine La Motte, and construct mills to crush and stamp lead ores in to manageable pieces, and to build the latest model of lead furnaces to smelt lead ores.

During this era of technological transfer, Americans' criteria for extracting and smelting lead ores meant importing and using sophisticated knowledge and complex machines. Their hope was to create a bordered mining district by imposing applying their new mining methods and machines over nature. These modifications did not just come in how Americans viewed the landscape; their vision included a revolution in technological attempts to transform the mining frontier borderland. With new steam powered instruments miners could work year-round instead of following a seasonal schedule. Additionally, the way that pig lead was shipped down the Mississippi River, across the Gulf of Mexico and north to eastern cities by steamboats, also increased the frequency of pig lead's arrival to the Wetherill Lead Factory in Philadelphia. Most significantly, more miners using improved techniques became a way to supply east coast red and white lead manufacturers with larger amounts of pig lead.

In the midst of all the technological changes to increase the transfer of pig lead across the United States, a crisis would fragment the nation. In the later part of 1819, the territory of Missouri applied for admission to the Union as a slave state. This move kindled a debate over the expansion of slavery and Missouri's admission to the Union in both houses of Congress from December 1819 to March 1820. In 1820, the United States consisted of twenty-two states, evenly divided between free and slave. Missouri also represented the first state other than Louisiana (1812) to be carved out of the Louisiana Purchase, and was viewed as setting a standard concerning the future of slavery in newly admitted states. Eventually, following the lead of Henry Clay, Congress worked out a compromise to admit Missouri into the Union as a slave state; Maine was admitted as a free state; and slavery was prohibited in all territories north of the latitude 36'0-30', Missouri's southern boundary line.[448]

Before Missouri became the twenty-fourth state, as a slave state, a small number of slaves worked at the lead mines. When Austin began mining at Mine a Breton, he used a number of black slaves who lived year round in cabins located near the mines, and who helped to implement his shaft mining techniques. Curiously, thus far, none of the official documents that list men by occupation contains a single individual designated as a lead miner. In like fashion, documents did not specifically refer to miners as slave or free. Instead, most were listed as day laborers who, most likely, not only worked at the lead mines but were also involved in cultivating crops. Still, it is difficult to determine what percentage of the pick and shovel labor at the mines was made up of slaves. In many cases slaves were often rented out by their owners and therefore, also appear on lead mining accounts as day laborers.

[448] Aron, *American Confluence,* 180-181.

Chapter 5: "Improving" Missouri's Lead Mining District; Forgetting Native American Influences; and Relative Consequences

Introduction

In 1819, the year that Henry Rowe Schoolcraft published his observations and illustrations of Mine La Motte, marked the one-hundredth anniversary of the Kaskaskia Indian miners and the European miners Marc Antoine Des Ursin and Renaudiere joining their methods to create their amalgam. During his visit to the same lead mines, Schoolcraft watched the transition of the mining frontier-borderland to a bordered mining district. He observed miners using hybrid methods and newly settled Americans using European mining systems. After closely describing each technique, he stated that the European mining technology was "superior to those in use under the French and Spanish governments." He also noted that there was still "ample room for improvement." He portrays the mines as places where "the population had increased, and the progress of settlement have made advances in civil refinement, mechanical arts, and useful inventions." Schoolcraft watched how mines "worked in a more improved manner by [employing] a greater number of miners." He believed that to satisfy red and white lead manufacturers back east more "improvement was needed in raising ore and smelting it." According to Schoolcraft the rapid settlement of Americans in the region also changed the character of the mining frontier-borderland from a space of "barbarism to refinement."[449] In addition, as Alexis de Tocqueville crossed the countryside he too observed how the invasion of American settlement practices caused the gradual

[449] Henry Rowe Schoolcraft, *A View of the Lead Mines of Missouri, including some observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, population and Productions of Missouri and Arkansas, and other sections of the Western Country* (New York: Charles Wiley, 1819), 4-7, 26-27.

diminishing presence of Native American tribes, stating "their huts were replaced with the civilized man's house."[450] Tocqueville's observations also provide a lens into how American settlers desired to replace the Native American and French mining amalgams with their new prospecting, extracting, and smelting methods. The invasion of Americans carrying new mining technologies, about which Schoolcraft wrote caused the gradual diminishing presence of the Native American and French habits.

The opening decades of the nineteenth century mark a time when Americans searched for scientific information. Schoolcraft, boosters, and naturalists believed that the "mine country" was in need of miners possessing "scientific knowledge, practical skill, and industry, which characterized the best [worked] European mines."[451] To fully explain this phenomenon, this chapter shows the result of Americans who used European technologies to extract lead ore and produce pig lead. Chapter three described changes at the first mining settlement Mine a Breton, in the late 1790s; by the 1820s, Mine La Motte experienced similar evolutions. The earlier modifications at Mine a Breton and the alterations in extracting practices at Mine La Motte reveal how the conversion from indigenous to European customs occurred more slowly than Richard Grove suggests. Grove argues that early on European Colonizers dismissed native environmental knowledge and technical skills. He asserts that naturalists and merchants thought the prudent way to unearth a region's resource potential was to import skilled workers and

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[450] See Alexis de Tocqueville, "A fortnight in the Wilds," George Lawrence ed. J. P. Mayer, *Journey to America* (New Haven: Yale University Press, 1959) http://www.iwu.edu/~matthews/journey1.html Also, see David Nye, *America as Second Creation: Technology and Narratives of New Beginnings* (Cambridge: MIT Press, 2003), 9.
[451] Schoolcraft, *A View of the Lead Mines of Missouri.* 4, 113-133.

install European mining machines.[452] However, at the Missouri lead mines, because longstanding Native American manners intermingled for decades with longstanding European habits, the transition was gradual. My argument is more consistent with Richard White's theories in that, at least in the case of mining, there was a relatively longer period in the frontier's history when Native American knowledge, influence, and actual work in North America was comparatively easy to see and widely acknowledged.[453]

Guided by enlightenment confidence, travelers, geologists, and miners who made their way west in the early nineteenth century to survey the Missouri lead mines wanted to promote the region's resource potential. Acting like American boosters and improvers, visitors to the mines believed the mining frontier-borderland to be incomplete and only expected it to become complete by introducing more advanced mechanical interventions. Before Americans installed their machines, they envisioned the possibility for progress and began to rename the lead mining amalgam as "primitive, uncivilized, simple" or "inefficient."[454] Michael Adas argues that Europeans assumptions of material advantage in modernization caused them to question the knowledge and expertise of their colonial subjects.[455] Adas' argument can also be applied to America's *civilizing* project because naturalists viewed the French and Native American mining and smelting techniques as *primitive*. Visitors like Henry Marie Brackenridge, Henry Rowe Schoolcraft, and Dr.

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452 Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600-1860* Studies in Environment and History, eds. Donald Worster and Alfred W. Crosby, (Cambridge: Cambridge University Press, 1995), 3.

453 Richard White, *The Middle Ground: Indians, Empires and Republics in the Great Lakes Region, 1650-1815* (New York: Cambridge University Press, 1991), ix-xv.

454 Moses Austin, *A Summary Description of the Lead Mines in Upper Louisiana. Also, An Estimated of their Produce for Three Years Past* (City of Washington: A. and G. Way Printers, 1804), 8, 15; Schoolcraft, *A View of the Lead Mines of Missouri*, 4-7.

455 Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca and London: Cornell University Press, 1989), 4.

Lewis Linn similarly endorsed the American desire to "civilize" the mining frontier.[456] They wrote not simply as a botanist, geologist, or doctor but as the region's admirers who desired to see migrants settle and install new techniques.

To be sure, Americans confidence in improvement has received a good deal of scholarly attention, but mostly as part of the story of agricultural development or western expansion, and mostly for the later nineteenth-century. For example, Elliott West notes that "the government's policy had always been to demand that Indians surrender their vision and adopt that of settlers and abandon hunting, gathering, and trading for a life as sturdy farmers."[457] West views the Native American "civilizing" project through the lens of Americans who cultivated the landscape for agricultural purposes. West's argument also offers an alternative way to understand how the ideology of improvement can be applied to the mining frontier borderland as Americans transferred new technology to the region. According to historian of technology David Nye, one way that nineteenth-century Americans developed stories about their technological superiority was by writing geological reports and travel narratives to showcase the need for new expertise.[458] In the case of mining, Brackenridge and Schoolcraft both supported progress by explaining how altering settlement procedures and adopting European mining devices could increase the scale of what lead miners produced. In addition, by the 1830s, two geologists, George W. Featherstonhaugh and Thomas Clemson, confirmed earlier prophetic voices by noting

[456] Henry Marie Brackenridge, *Views of Louisiana: Containing Geographical, Statistical and Historical Notices of that Vast and Important Portion of America* (Philadelphia: Printed by Schaeffer & Maund, 1817), 125, 256.
[457] Elliott West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University Press of Kansas, 1998), 260-261; Lynn Morrow's excellent article, "New Madrid and Its Hinterland: 1783-1826," *The Bulletin of the Missouri Historical Society*, 34, no. 4, Part II (1980): 241-250.
[458] For early nineteenth century improvement societies, see Steven Stoll, *Larding the Lean Earth: Soil and Society in Nineteenth-Century American* (New York: Hill and Wang, 2002).

how new mining shafts and machines and a steam furnace had increased the amount of lead that flowed from the ground into society.

Accompanying the conversion from the Native American and French hybrid to American systems resulted in material changes. There was a growth in the number of villages and towns populated by Americans located near the mines where doctors could ply their services among miners. By 1816, doctors began examining miners, diagnosing miners with lead poison, and documenting early accounts of the region's unhealthiness in connection with new production techniques. While doctors' medical observations framed the mining settlement as unhealthy and dangerous, visitors and geologists continued to promote the region as healthy, which signaled a reinterpretation of the meaning of improvement.[459]

During the opening decades of the nineteenth-century, doctors' medical observations and treatment practices, as well as miners' health reports testify to the high incidence of unhealthy settlements associated with new extracting methods. Together these reports raised new questions about land healthiness as lead production increased in scale. Conevery Valencius argues that early nineteenth century settlers considered the healthiness, salubrity, or unhealthiness of landscapes for settlement.[460] Essentially early settlers found a way of deciphering whether or not frontier lands were good for agricultural development. My argument is consistent with Valencius' theories, except

[459] Linda Nash notes how Americans understood new landscapes not only in terms of impending resource possibility, but also in terms of health. Linda Nash, "Finishing Nature: Harmonizing Bodies and Environments in Late-Nineteenth-Century California," *Environmental History* 8 (2003): 25-52. http://www.historycooperative.org/journals/eh/8.1/nash.html.

[460] Conevery Bolton-Valencius reveals a new attentiveness to kinds of "healthy" and "unhealthy" places to connect disease and land during a similar period. Conevery Bolton-Valencius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York, Basic Books, 2002), 96. Also see, Gregg Mitman, "In Search of Health: Landscape and Disease in American Environmental History," *Environmental History* 10 (2005): 184-209.

that in the final section of this chapter I examine the unhealthiness of the mining environment. Americans' efforts to "civilize" the mining frontier, which meant digging deeper shafts, blasting with dynamite, working with lead particles in underground tunnels, and furnaces spilling fumes into the air, collectively made settlers and doctors recognize and define the environment as unhealthy for settlement.[461]

Lead Mines through the "primitive" lens, and European-derived progress

In 1811 and 1819, the travel account of both Henry Marie Brackenridge and the report of Henry Rowe Schoolcraft critiqued the mining practices influenced by Native Americans. When Brackenridge, the botanist and mineralogist, traveled through the Missouri Territory's mining district, he wrote his concerns after seeing miners discovering lead ore as they did. Brackenridge stated that "if mining were carried on in a proper manner," other than by "scratching the surface of the earth," mining profits "might increase."[462] When Schoolcraft, the glassmaker and mineralogist, traveled to the same mines, he also surmised that more "skilled miners would most likely have been astonished to see miners" applying such "crude methods to discover lead ore."[463] The language of Schoolcraft and Brackenridge reflected an emerging American disdain for what appear to be unsophisticated manners. For example, when Schoolcraft observed the manner in which miners at Mine La Motte discovered ore using a pick and wooden shovel, he labeled it as primitive and inefficient. When it came to resource extraction and

[461] Recently environmental historians have begun to examine the scale and material flows between various landscapes to understand more fully how the past has shaped modern environments. See, Gregg Mitman, Michelle Murphy, and Christopher Sellers, eds., *Landscapes of Exposure: Knowledge and Illness in Modern Environments, Osiris, Second Series*, 19, (2004).
[462] Brackenridge, *Views of Louisiana*, 125, 256.
[463] Schoolcraft, *A View of the Lead Mines of Missouri.* 4, 90-112.

production, references to miners using "crude tools" also meant they lacked any superior knowledge and skill.[464] Like those who came earlier, Brackenridge and Schoolcraft desired to see miners apply superior devices, which eventually would lead to the forgetting of Native American traditions.

American visitors to the mines assumed that miners lacked the ability to fully exploit the region's resources. They also lacked the proper equipment and knowledge. In similar fashion to European colonizers, Americans believed that the agility required for digging trenches was no substitute for excavating deep shafts with more advance equipment to access richer veins of lead ore. Improvers no longer wanted to see miners using Native American woven baskets to haul ore. Instead, Brackenridge, Schoolcraft, and others envisioned miners transporting lead ore in iron buckets and wheelbarrows, and installing windlasses to raise ore hidden beneath the soil. Brackenridge, Schoolcraft, and other improvers thought American techniques should represent the most progressive equipment and "advances made to the useful arts," as was the practice in England.[465] The ultimate proof in their assumptions about achievement was their dependence on Europe.[466]

The transition from old practices to new European traditions was a gradual one. Although Brackenridge witnessed miners to some degree using European equipment to dig their trenches, he remarked that miners built "primitive" log furnaces to smelt galena. Like previous observers, Brackenridge observed and explained to his readers how miners

[464] For example, Nathan Haley an English immigrant described in letters to his parents how he could easily apply a "pick and wooden shovel to discovered ore," like earlier miners. See Charlotte Erickson, *Invisible Immigrants: The Adaptation of English and Scottish Immigrants in Nineteenth-Century America* (Florida: University of Miami Press, 1972), 411-420.
[465] Schoolcraft, *A View of the Lead Mines of Missouri,* 4.
[466] Miller, *A Brief Retrospect of the Eighteenth Century,* vii-ivx.

reduce the mineral by throwing it on top of large fires. As a substitute, he envisioned seeing multiple masonry furnaces, similar to Moses Austin's reverberatory furnace at Mine a Breton. By 1819, there was progress. Eventually, as more European immigrants and Americans made their way to the mining frontier borderland, they transferred their skills to Mine La Motte. Schoolcraft reported that more miners employed European mechanical apparatus such as windlasses to hoist ore. Schoolcraft also commented that miners depended on English smelters to help build their stone furnaces.

Improvers suggested that local miners did not have enough technological acumen or intelligence to effectively operate machines; therefore, the evidence suggest that miners continued to block change by abiding to the amalgam. Schoolcraft believed that importing additional miners from England, who could dig deeper shafts, conduct experiments to determine the quality of the ore, and build furnaces' production would expand. Promoters of the "civilizing project" perceived the current approaches to mining as slowing progress, and the ultimate creation of a bordered mining district. They alleged that it was incumbent on new miners to seize the opportunity to extract the region's mineral assets more efficiently. Like improvers who promoted the acculturation of Native Americans, Brackenridge and Schoolcraft extended the same ideology beyond lead production to considering how to change miners' behaviors.

In addition to criticizing miners' methods, Brackenridge and Schoolcraft disparaged their manners. Brackenridge likened miners' behavior to that of "savages."[467] He noted that the "manners of the miners and the persons engaged in the mining business are barbarous."[468] He continued, "a few years ago there was a collection of worthless and

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[467] Brackenridge, *Views of Louisiana*, 20.
[468] Brackenridge, *Views of Louisiana*, 4, 268.

abandoned characters, the different mines were scenes of broils and savage ferocity."[469] The language suggested that miners, who improvers viewed as too lazy to exploit the resources, needed to be transformed as well. Cultivating the mining frontier borderland also applied to "civilizing" the "wild behaviors and work habits" of miners.[470]

To overcome what improvers considered miners' indolence required supervision and training. Since local miners were "unacquainted with the utility of machinery," according to Schoolcraft miners needed to be well informed to correctly operate European machines.[471] This was a change from earlier managerial procedures. During the late eighteenth century, mine owners appointed one miner to supervise the mining activities at Mine La Motte. The supervisor monitored extracting lead ore, ensured log furnaces were constructed properly and well supplied with fuel, and assigned miners to transport ore to the furnaces. Schoolcraft understood these European ways, which he connected to production, stating, "It was evident that miners under a proper manager in this country will furnish lead sufficient for the consumption of the United States."[472] In addition to the mine manager supervising these activities, Schoolcraft also implied that the overseer should be held responsible for educating all miners according to the latest procedures. In the end, Schoolcraft recommended that if English miners with managerial skills immigrated to Missouri's mining district they could install and direct miners, and thereby increase the flow of lead from the ground into society.

During the eighteenth-century, European and American miners had envisioned bringing trained miners from Europe to replace the Native American and French

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[469] Brackenridge, *Views of Louisiana*, 269.
[470] Brackenridge, *Views of Louisiana*, 236.
[471] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 10.
[472] Schoolcraft, *A View of the Lead Mines of Missouri*, 133; Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 16, 19.

methods. Similarly, in the 1830s, Lewis Fields Linn, the physician in Ste. Genevieve, Missouri, tried to incorporate new techniques rather than just calling for change.[473] Linn had always been interested in medicine and had completed some of his studies in Louisville, Kentucky. However, following the War of 1812 he joined his brother as a surgeon of the Missouri Militia, and after the war he went to Philadelphia for further medical training before returning to Ste. Genevieve in 1816.[474] Dr. Linn recognized that the mining and smelting methods used were "crude, out of date, and highly wasteful of the lead content." According to Linn, the methods in use were inferior to the latest developments in Europe. Linn devised a plan with "great hopes of bringing back some highly skilled workmen" from England and France after making an investigation of their latest mining methods to remake Mine La Motte into a bordered mining district.[475]

In London, Linn searched for "at least one hundred lead miners," by publishing two pamphlets "extolling the virtues of" the district. He stressed how the region needed workers possessing the latest knowledge. He planned to have samples of the ores sent to chemists for careful analysis; and anticipated installing "crushing and stamping mills so miners could pursue their work for more than half time they had been able to work because their ores could not be processed" into manageable pieces. Dr. Linn also expressed hopes of building "lead furnaces of the most approved kind."[476] There is no record to suggest whether Dr. Linn's promotional tour attracted European miners to Missouri; however, there was a notable increase in the number of American, English, and French settlers who made their way to Mine La Motte.

[473] Lewis Fields Linn Papers, Box 2, Folder 4, Missouri Historical Society, St. Louis.
[474] Thompson, *A History of Madison County Missouri*, 40.
[475] Thompson, *A History of Madison County Missouri*, 77.
[476] Thompson, *A History of Madison County Missouri*, 78-79.

In just months after Linn returned to the Missouri mines from Europe, a cultural and material sea change from the Native American practices to more European methods, as improvers wanted to see, began in earnest. Two miners, Henry Henriod and Ferdinand Rozier, arrived from France. Their short but informative journal describes a number of gradual alterations to mining work, as well as to settlement style. Both miners crossed the Atlantic, and arrived at Philadelphia before boarding a steamer to New Orleans. Henriod and Rozier departed New Orleans on a steam-powered riverboat that carried them up the Mississippi River to Ste. Genevieve, Missouri. Eventually, they settled twenty-five miles west of Ste. Genevieve in the newly established village named St. Michael adjacent to Mine La Motte.[477] Henriod and Rozier were among many settlers who migrated to the mining bordered district after the construction of roads and canal systems over which the traveled quickly from Philadelphia to New Orleans by steam powered boats, most likely the same boats that transported increasing amounts of lead to the growing national markets.[478]

Daily, from Monday to Saturday, Henriod and Rozier departed the village of St. Michael for Mine La Motte to extract lead ore. Their ritual marks a transition from early practice. Before settlements were established near the mines, miners planted their crops, and then traveled two days to the lead mines where they extracted lead for two months before returning to Ste. Genevieve to harvest their crops.[479] After the harvest, miners returned to the mines to either extract more lead or to smelt the ores they previously recovered. Now that a new settlement surrounded Mine La Motte, Henriod and Rozier

[477] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal No. 8, begun June 28, 1832 up to July 20, 1838: Missouri Historical Society.
[478] For personal travel and lead shipments between New Orleans and Ste. Geneive, see Henry Rozier Ledger.
[479] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 1.

could quickly travel to their shaft to continue "burrowing further into the east-west hole in search of lead ore" by clearing away what Henriod called "pretty yellow and red earth." They applied their iron tools to "bore through the lengthy cold and wet shaft and tunnel," encountering rock and the continuous flow of water.[480] Like most early miners, Henriod and Rozier prepared for these obstructions "by loading into their cart necessary utensils" such as iron shovels, pickaxes, sledgehammers, and gads.[481]

By the 1830s, miners added other utensils to their array of tools. Henriod and Rozier included a "compass, ladder, and cord."[482] Like European miners, they used the compass to guide their search for lead here in Missouri. Miners used the compass to prospect, locate, and map numerous veins of lead.[483] Henriod and Rozier were also trained to dig deeper European-styled shafts, which they could easily descend and ascend using their ladder. Daily, Henriod wrote in his journal how "the first line of attack when using" new extracting devices "was to climb down their thirty-foot homemade ladder into their shaft."[484] Additionally, since miners no longer constructed trenches, Henriod or Rozier installed a windlass above their shaft's opening.

The windlass enabled Henriod and Rozier to more easily remove ore, dirt, or water from the depths of the earth. During this period, windlasses hauled a small amount of material; therefore, the use of windlasses was limited to prospecting, sinking, beginning shafts, and raising ores. To assemble the windlass, first miners cut timber, and then attached a cord purchased in Ste. Genevieve. Once in the shaft or a connecting

[480] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 3.
[481] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 17.
[482] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal. 10.
[483] Andrew Ure, *A Dictionary of Arts, Manufactures, and Mines: Containing a Clear Exposition of Their Principles and Practice* (London: Longman, Orme, Brown, Greene, & Longmans, 1839), 830-831.
[484] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 14.

tunnel, Henriod and Rozier tried to "straggle between stones to the linking reservoir, to cross a small fissure to continue their search for lead ores."[485] When Henriod discovered lead ore, he would return to the opening of the shaft to obtain the tools Rozier had lowered in the iron basin connected to the windlass. Clutching the sledgehammer, pick, and gad, Henriod began to separate rock, earth, and lead ore from the tunnel's sidewalls. At times miners screamed to their partners, as when Rozier yelled, "I see an opening which seems to go under the rock." To which Rozier replied, "Clear away as much as you can and I will descend later to clean the rubble away." After Henroid ascended to the surface, Rozier descended into the shaft, and continued working the tunnel. Rozier noted how he "filled five to seven iron basins of rubble, opened an additional cave, and began to load another four basins of rock, earth, and lead ore" to be raised to the surface.[486] Daily Henriod and Rozier worked in this fashion, unless they were sick or injured.

The daily experiences of Henriod and Rozier reinforced Schoolcraft's call for improvement, and Dr. Linn's efforts to transfer new techniques from Europe to the Missouri mines. Henriod and Rozier's daily work represents the change from trench mining to excavating "shafts in imitation of some practical miners" from Europe, who were "rewarded with the most perfect success." Henriod and Rozier's skills and equipment provided them with the ability to dig multiple shafts to a "depth of about sixty feet and locate sulphuret of lead vein" before discovering additional "horizontal veins upwards of one foot thick."[487] The steps outlined show Henriod and Rozier's abilities with European tools, but their actions also continued the burial of Native American and French amalgam as the mines started to resemble a bordered mining district. In addition,

[485] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 17.
[486] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 22.
[487] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 23.

largely shaped by the demands for quality and quantity of pig lead by Americans back east, the United States planned to conduct more environmental and scientific investigations into Missouri's galena.

After Moses Austin and Henry Schoolcraft wrote their geological reports, in 1804 and 1819 respectively, no other geologist ventured to Missouri to conduct a survey before the 1830s. As miners started to employ their new equipment to open numerous shafts, geologists and merchants back east wanted a clearer assessment of the district's geological structure. In 1834 and 1838, George W. Featherstonhaugh, the leading English geologist, and Thomas Clemson, the American mineralogist and geologist, respectively, completed their evaluation of the district.[488] On July 12, 1834 Lieut. Col. J.J. Albert of the U.S. Topographical Engineers instructed geologist Featherstonhaugh to repair some point on the northern boundary of the Territory of Arkansas, and inspect the minerals, water sheds between the Missouri and Red Rivers. While touring the region he visited not only Mine La Motte. The Featherstonhaugh Geological survey helped to build interest in science as a valid means to describe the environment.[489] During the same period, the Geological Survey of Virginia was conducted. The Virginia survey offered an analysis on minerals and soils for further agricultural development. In similar fashion, improvers suggested that natural philosophers apply chemistry and geology to reveal "the great wealth which lies buried in the earth" in Missouri.[490] Featherstonhaugh and

[488] G.W. Featherstonhaugh, *Geological Report of An Examination Made in 1834 of The Elevated Country Between the Missouri and Red Rivers* (Washington: Printed by Order of the House of Representatives, Gales and Seaton, 1835), 5-51. Missouri Department of Natural Resources, Lynn Morrow Personal Collection.

[489] James X. Corgan, ed., *Geological Sciences in the Antebellum South* (Alabama: University of Alabama Press, 1982), 9-25. For a more recent discussion, see Benjamin R. Cohen, "Surveying Nature: Environmental Dimensions of Virginia's First Scientific Survey, 1835-1842", *Environmental History*, 11, no. 1 (2006): 37-69.

[490] Featherstonhaugh, *Geological Report*, 47-51.

Clemson used their environmental knowledge and experiments to confirm Austin and Schoolcraft's tests, and confirmed the quality and quantity of Mine La Motte's lead for commercial production.[491] Their reports, as well as a description of the mining district, by Charles Gregoire, the agent to the mines, provided readers with a detailed description of the geological features of the mining district in *Observations of the La Motte Mines,* published to promote the recent improvements completed at the mines in 1839.[492] Widely read, this account acted as a scientific text that resembled a travel narrative about landscape of abundant and quality galena, as well as advertising settlement opportunities.

In 1838, when Clemson visited Mine La Motte, Henriod and Rozier offered him the opportunity to work together in their shaft. His experience with Henriod and Rozier confirm the critique of old-versus-new mining and the installation of new smelting furnaces. Observing Henriod and Rozier, Clemson stated, "a reform in the whole system of mining is taking place and I believe the changes would henceforward be conducted upon acknowledged principles which will enable them to contribute powerfully to the national resources."[493] Henriod and Rozier, Clemson noted, "sunk [their] shaft to a depth of about one hundred and ten feet, when I was there, and very obligingly let me down into it, and gave me every aid and facility in examining their works, which enabled me to observe the very curious [underground] structures they built."[494] In addition, Clemson

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[491] Thomas G. Clemson, "From a Discourse delivered before the citizens of Fredericktown…Governing Mine La Motte," in *Observations of the La Motte Mines and Domain in the State of Missouri with some Accounts of the Advantages and Inducements there promised to Capitalists and Individuals desirous of engaging in Mining, Manufacturing, of Farming operations* (Baltimore: Royston & Brown, 1839), 22-32. Missouri Department of Natural Resources, Lynn Morrow Personal Collection.
[492] Charles Gregoire, *Observations of the La Motte Mines*, 4-6.
[493] Featherstonhaugh, *Geological Report*, 45-46.
[494] Clemson, *Observations of the La Motte Mines*, 27.

was not only impressed with the depth of the shaft but also impressed with the European-styled galleries Henriod and Rozier constructed.[495]

Clemson carefully watched how Henriod and Rozier prospected for the origins of "subterranean structures."[496] They created underground tunnels, which further represented how miners applied their skills and were "observant and experienced in both the arts and sciences."[497] Miners employed their compasses to guide them to valuable mineral veins, and to manage tunnels successfully. In like fashion to European miners, Rozier and Henriod combined their knowledge of surveying and arithmetic to sink shafts and to construct underground tunnels in Missouri. Clemson was satisfied with the lead veins he studied alongside of Rozier and Henriod, and decided to turn his attention to watch how miners cleaned and crushed their lead ores before the smelting process. Rozier and Henriod, and others, harnessed the force of nearby rivers and streams by installing water-powered mills.[498]

Recall how the Native Americans and French also managed water to clean lead ore before hammering large chunks of galena into smaller pieces with their stone and iron hammers before smelting. Now, Henriod and Rozier gathered stones and controlled the rivers and streams located throughout Mine La Motte to power machinery. The abundance of limestone and sandstone on the property made it suitable for miners to manufacture millstones large enough to grind and crush lead ore. Mills at Mine La Motte were small and included a waterwheel on the lower floor to access the water's edge. Most significantly, all of these major changes helped Mine La Motte to become what

[495] Clemson, *Observations of the La Motte Mines*, 29.
[496] Clemson, *Observations of the La Motte Mines*, 28-30.
[497] Featherstonhaugh, *Geological Report*, 48-49.
[498] Featherstonhaugh, *Geological Report*, 42-51.

improvers predicted, a landscape where settlers ploughed their farms and mined the earth. By the 1830s, Mine La Motte expanded into a twenty-four thousand acre property consisting of mines, farms, and smelting furnaces.[499]

During Clemson's visit, Charles Gregoire invited him to see the region's first steam furnace. Gregoire, Mine La Motte's manager, published a pamphlet to attract more migrants stating, "For smelting of this lead a steam furnace has been erected."[500] This was another major evolution at Mine La Motte: miners who once smelted their lead ores using three types of furnaces—log, ash, and reverberatory—were now powering a steam furnace. With the steam furnace in place, miners could obtain a higher percentage of lead without reintroducing lead ores to the furnace a second or third time. Rozier stated, "I fired the furnace today but I cannot say now with what success."[501] However, he most likely did not do so badly, for Charles Gregoire stated, "I shipped on board the steamboat *Jubelle* 1428 pigs of lead weighing 85, 016 pounds, being lead taken from Rozier's" furnace.[502] Before Clemson completed his report, he wrote that "to render these mines more productive" and improve the mining frontier, "it would be necessary to bring in at least one hundred lead miners and smelters from Europe for five or ten years."[503] The American geologist witnessed and promoted how new miners after installing new machines adjacent to their village transformed the mining frontier borderland to a bordered mining district according to improver's specifications.[504]

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[499] For a visual of Mine La Motte furnaces and machines, see 1839 "Map of the La Motte Copper & Lead Mines, Containing 24,010 acres," in *Observations of the La Motte Mines and Domain in the State of Missouri*, 1-6.
[500] Gregoire, *Observations of the La Motte Mines*, 5-6.
[501] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 18.
[502] Gregoire, *Observations of the La Motte Mines*, 4-5; For lead shipments between New Orleans and Ste. Genevieve and Herculaneum, see Henry Rozier Ledger.
[503] Clemson, *Observations of the La Motte Mines*, 30-32.
[504] Featherstonhaugh, *Geological Report*, 48-49.

After Moses Austin settled Mine a Breton, it had become the first village to be located in the district. Prior to 1820 the combined populations of the counties surrounding the lead mines was 11,613; in 1830 the population was recorded as 18,648. The majority of settlers who came to Missouri migrated from Kentucky, Tennessee, and Virginia. Steamboats now plied upriver more frequently carrying settlers interested in lead mining.[505] As the scale of lead production increased, and the population grew, new villages and towns were established.[506]

During the 1830s, Ste. Genevieve and Herculaneum continued to be the two primary towns where miners shipped their pig lead to New Orleans and eastern cities. Both towns were between twenty-five and thirty-five miles away from Mine La Motte. Desiring to establish a settlement in closer proximity to the mines and to begin year-round operations, settlers organized the village of St. Michael. The village contained "fifty houses, several stores, and a post office all located at the center of the richest farming district" where miners worked individual farms.[507] Since Mine La Motte was only two miles north of the village, miners devoted their time to farming, mining, and smelting. In conjunction with the new rituals, the village enabled miners to work year-round instead of following the earlier seasonal schedule.

Besides their periodic discoveries of thousands of pounds of lead ore, Henriod and Rozier symbolize miners who maintained a farm. Prior to departing for the mines, Rozier and Henriod spent their early morning hours "cleaning orchards and calf-pens,

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[505] For personal travel between New Orleans and Ste. Genevieve and Herculaneum, see Henry Rozier Ledger.
[506] Ruby Swartzlow, "The Early History of Lead Mining in Missouri," *Missouri Historical Review*, 29 Part 4 (January, 1935): 109-114; Part 5 (April, 1935): 195-205; Thompson, *A History of Madison County Missouri*, 74-75.
[507] Gregoire, *Observations of the La Motte Mines,* 20-22

organizing the tobacco and vegetable gardens, making hay in the nearby forest, or repairing tools." By the late morning, they made their way "across the small patches of farmland, through the adjacent forests, up the hillside path, and across the Mine Creek" to their mineshaft.[508] In conjunction with the changes to mining systems and equipment, Henriod, Rozier, and the community of miners now practiced completing their daily "household, animal care and farming chores" before and after mining, which satisfied America's growing need for lead products.[509]

In 1839, Thomas Clemson summarized the changes that followed the incursion of European techniques at Mine La Motte. Clemson observed how the inhabitants spent time as "both farmers and miners who were either directly or indirectly engaged in the mines year round." He further noted how miners took advantage of numerous agricultural benefits, "but that those mines are regarded as the principal object of prosperity to the surrounding country." Clemson echoed what early travelers and miners previously envisioned, "the extraction and reduction of lead ore to supply the nations' growing demands would depend on year round operations."[510] The year-round dangerous extraction of lead ores from the earth, washing and crushing the ores in nearby water-powered mills, and long hours of smelting conducted by Henriod and Rozier generated the material flow of pig lead into society, the memory of Native American and French fusion of techniques was washed away.

[508] The report included a map of Mine La Motte, which truly depicts the mines growing into a frontier industrial complex. See, *Observations of the La Motte Mines*.
[509] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 1-4.
[510] Clemson, *Observations of the La Motte Mines*, 32.

Visually confirming the disappearance of the lead amalgam

The changes called for by Brackenridge and Schoolcraft, and the systems employed by Henriod, Rozier and Gregoire, contributed to the increase in lead production at Mine La Motte. In addition to Featherstonhaugh and Clemson witnessing and reporting on the numerous cultural and material changes that occurred during the 1830s, the French naturalist and painter Charles-Alexander Lesueur illustrated how the mining frontier borderland had been transformed to a bordered mining district. After leaving Philadelphia, Lesueur traveled west along the inland rivers to Ste. Genevieve, Missouri. When he arrived at the mines, Lesueur started to draw vivid images to capture where miners lived and where miners worked. His catalogue is depicted in his *Drawings and Sketches*.[511] Lesueur's leisurely journey along the Ohio and Mississippi rivers to the early nineteenth century La Motte' mines allowed him the opportunity to record the transformation of a once idyllic landscape to a landscape of artifice.

In Lesueur's first sketch, the Mine La Motte homes are centrally located.[512] Lesueur carefully penciled the contours of the landscape reshaped by miners according to their needs. Directly behind the village, Lesueur united the hills and the sky, which draws the viewer's attention to the abundant trees lining the hilltops in the background; however, the settlements' foreground appears to be practically devoid of trees, an indication of the amount of timber settlers used to construct their homes, build their windlasses, and fuel their furnaces. The barren forest, scattered trees along the hillside,

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[511] Charles-Alexandre Lesueur, *Drawings and sketches of the places we passed on the way from Philadelphia to Pittsburgh and from Pittsburgh to New Harmony during our voyage on the keelboat while descending the Ohio from November 27, 1825 to January 26, 1826* in Adrien Loir, "Charles-Alexandre Lesueur Artiste Et Savant Francais; En Amerique De 1816 a 1839 (PhD diss., Universite De Caen, 1920), 1-72.

[512] Lesueur, *Drawings and Sketches*, Plate XVII.

and miners' dwellings are clustered together just beyond the fence. Signs of domestication are evident; smoke filled chimneys and a clothesline are symbols of care.

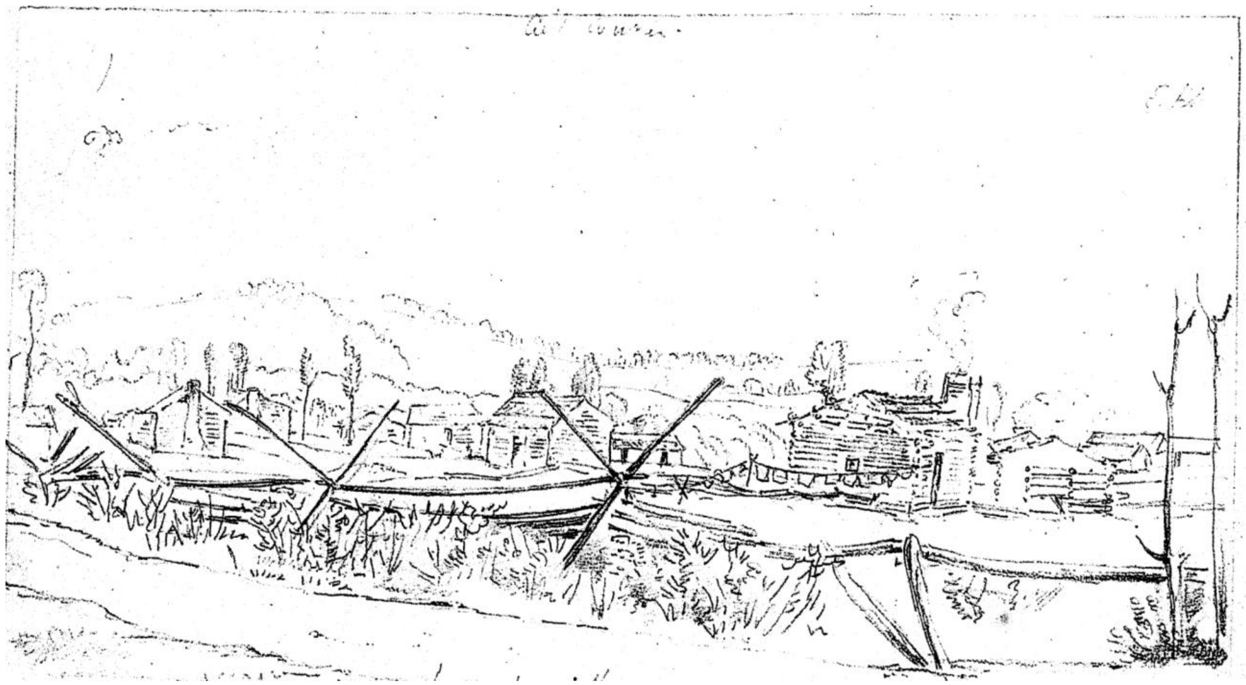

Figure 13: Charles Alexandre Lesueur - Mine La Motte Village, 1826

Lesueur illustrated the only known drawing of early nineteenth-century American miners, their equipment, in his second sketch.[513] He commented, "When I approached the mines there was opened to my view a large space of cleared ground" where "three miners [were] surveying and working the mines."[514] Included in this sketch are more than seventeen windlasses blanketing Mine La Motte. As one of the three miners clutches an iron pick.

Figure 14: Charles Alexandre Lesueur - Mine La Motte, 1826

[513] Lesueur, *Drawings and Sketches,* Plate XIX
[514] Lesueur, *Drawings and Sketches*, 17.

Lesueur captures the silencing of Mine La Motte's Native American and French hybrid, and the eventual fate of Native American and French practices. He reveals over seventeen Euro-American styled windlasses, which emphasizes the arrival of new technologies and practices. His images reiterate the material implications as Native Americans determined to control their own future and decided to voluntarily leave the mining region. As more American settlers arrived on the mining frontier borderland, Native Americans chose to relocate one hundred miles west to the Ozark region. In effect what improvers hoped for came to pass. They believed that "civilizing" the area required the separation of American and Native American mining behaviors.[515] Discarding any obligation to the assimilation policy of earlier times, in like fashion to European colonizers, Americans also disparaged native environmental knowledge and technical skills to increased lead production. Their actions and language represented a desire to control the mining frontier borderland by installing sophisticated and complex machines. Similar to the travelers who carried the improvement ideology to the mines, American settlers viewed the Native American and French amalgam as having no place in the bordered mining district. The expulsion of the Native Americans west of the Mississippi began in earnest with the *Indian Removal Act of 1830*, however, many Native Americans living near the lead mines were offered land in southwestern Missouri over a decade earlier. By the 1820s, the Native American and French methods had disappeared from Mine La Motte. The discourse was about superiority and inferiority, and the need to import new mining labor, equipment, and skills to grow the American lead industry being established back east.

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[515] Andrew Jackson, Fifth Annual Message, December 3, 1833, in James D. Richardson, comp., *A Compilation of Message and Papers of the President* (10 vols., New York, 1896-99), III, 1021-22.

The changing value of lead back east

Before Missouri miners began shipping their pig lead to the east coast, they made numerous lead products for both rural and urban consumers. As discussed in chapter three, Moses Austin and his English miners not only extracted lead ore but also produced shot, sheet lead, and a key component for making glass bottles, zane.[516] After establishing settlements at Mine a Breton and Herculaneum, Austin manufactured a considerable amount of shot, which he sold throughout the Mississippi and Ohio valleys. Austin went on to build a special room to house large limestone tables to mold sheet lead, which he shipped to New Orleans where workers used sheet lead for sealing shipping vessels, covering roofs, lining cisterns and bathtubs, and molding pipes for the conveyance of water. Settlers and city dwellers also used sheet lead to make small boxes to preserve food items. Finally, Austin utilized lead ashes to make zane, which glass makers in Pittsburgh coveted to make bottles.[517] The changes to mining and settling habits made it possible to extract, produce and ship shot, sheet lead and zane to merchants all year-round. The nineteenth-century transfer of technologies to Missouri's frontier-borderland not only made it a bordered mining district, but these changes also were connected to where lead products would eventually be made.

Noticeably, a correlation existed between the arrival of miners carrying new apparatus to the Missouri mines and the early beginnings of the Wetherill lead factory in Philadelphia. By the opening decade of the nineteenth-century, Samuel Wetherill learned about the abundance of quality lead at the Missouri mines through Austin's 1804

[516] Austin, *A Summary Description of the Lead Mines in Upper Louisiana*, 17-22.
[517] Schoolcraft, *A View of the Lead Mines of Missouri.* 134-149.

geological survey.[518] With this new knowledge Wetherill hoped to stop importing lead products from England, and to begin making the same goods in the United States. Most important, there was an emerging market for white lead to produce paints and for red lead as a key ingredient in flint glass.

Before merchants endeavored to build a laboratory, most would make trips, while others, like Samuel Wetherill, sent weekly correspondences across the Atlantic to England to purchase lead and glass products from the shipping firm of Brandram & Templeman in London. The Wetherills maintained detailed letter books from 1789, and note numerous requests for not only various products and raw materials but also they often requested information regarding the latest innovation regarding the manufacture of lead products.[519] However, in one letter, Wetherill placed an order for instruction manuals before he planned to produce his own red and white lead.[520] To outfit a laboratory to make products in the United States, first Wetherill needed to understand how to design a laboratory with the appropriate apparatus; and second, he needed to access the quality pig lead from the mining frontier to maintain consistent production.[521] Finally, by the early nineteenth-century, Samuel Wetherill and his sons began to build his red and white lead factory in Philadelphia.[522] Eventually, he made contact with a mine owner and a lead agent to secure a steady flow of pig lead. Thereafter, Wetherill began to decrease the number of lead products he purchased, and turned his commercial gaze on establishing deep connections with Mine La Motte's agent.

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518 Wetherill Collection, Letter book, Item #1, June 3, 1789, Letter Dated April 16 & 18, 1818.

519 Wetherill Collection, Letter book, Item #1 October 29, 1789 to Dr. Young Eagle; Letter book, Item #1, Letter Dated January 10, 1810 to Brandram, Templeman & Co., London.

520 One example listed in the letters is William Nicholson spent a great deal of time outlining the correct procedure to manufacture red lead, see Nicholson, *A Dictionary of Chemistry*.

521 Wetherill Collection, Letter book, Item #1, June 3, 1798. Letter to Brandram, Templeman, & Jacques, London. This letter confirms the interest of the Wetherill Brothers to manufacture lead products.

522 Hussey, *The Wetherill papers, 1762-1899*, 12-23.

Similar to the way miners adopted English techniques, the Wetherills adopted their processes to make red and white lead.[523] Like Samuel Slater, who transferred fresh ideas about factory operations to America, the Wetherills followed the English plan to design, build, and operate their lead laboratory.[524] The Wetherills intended the rooms to be "fitted up with furnaces, instruments, and apparatus."[525] These tools as well as knowledge of science and art were necessary to reintroduce pig lead to millstones, tools, furnaces, and cisterns once it arrived in Philadelphia.[526] By grinding, raking, melting, and washing the warmed lead, they carefully observed the yellow, brown, and white dusty substance transform to either white or red lead constituted for commerce.[527]

The Wetherills prepared white lead by casting the lead into sheets, rolling it up in a spiral form, and setting it to corrode in clay pots partly filled with vinegar. To produce red lead the Wetherills moderately heated lead in a reverberatory furnace, until the lead turned a vivid red-orange soft powdery substance.[528] Similar to the Missouri miners applying new European tools to discover, extract, and smelt lead ore in their workscapes, the Wetherills fitted their workspaces with European furnaces, cisterns, pots, and utensils

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[523] Wetherill Collection, Letter book, Item #1, July 8, 1808.
[524] September 19, 1809, Daybook 21, p. 30. The only James Lyle listed in the city directories of 1809 and 1810 is a merchant. A description of the early nineteenth century factory appears on June 14, 1845 billhead. Ten sheds were on the property at 12th and Cherry Street in the 1820s. Sheds contained logwood, straw, linseed oil, set white lead bed, vinegar cistern, white lead barrels, and bricks: there were also horse stables. Wetherill Daybook, #70, June 14, 1845.
[525] Cutbush, *American Artist's Manual*, "laboratory" section.
[526] Hussey, *From Merchants to Colour Men,* 76-78.
[527] Cutbush, *American Artist's Manual*, "lead" section.
[528] Ure, *A Dictionary of Arts, Manufactures*, 572, 573, 744-745; Henry R. Schoolcraft documented and researched the manufacture of white and red lead, and glass. See, Henry Rowe Schoolcraft Papers, Manuscript Division, Library of Congress, Washington, D.C., Container 82.

to convert pig lead to red and white lead.[529] Changes on the bordered mining district converged with changes in the production of American lead products back east.

To successfully produce quality products, the Wetherills required a superior grade of pig lead year-round. Therefore, it was May 26, 1812, when Samuel Wetherill wrote a letter to Benjamin Morgan, a New Orleans' lead agent, stating: "Having learned of the quality lead being extracted and produced I would like to request two separate shipments of 100 and 200 tons of Mississippi Valley pig lead."[530] Satisfied with the quality of pig lead Wetherill received from Morgan, in January 1813, he then turned to Henry Thompson of Baltimore, another customer of Morgan, "to provide him with fifty tons of Missouri pig lead" from Mine La Motte.[531] Within a few days Samuel Wetherill requested that his Baltimore agent John Kipp also send fifty tons of pig lead "as soon as navigation opens as we are out of lead."[532] Again, in June of 1815, Wetherill secured from Benjamin Morgan another fifty tons of pig lead.[533]

In addition to creating business alliances with Morgan and others, the Wetherill brothers also corresponded directly with mine owners to arrange multiple shipments of pig lead. And after several attempts, Samuel Wetherill finally made a trip to the lead mines to arrange for a steady flow of pig lead. For example, in 1835 and again in 1839, while Wetherill was on a trip to Galena, Illinois, his brother in Philadelphia reminded him by letter "not to fail to visit Mine La Motte and acquire all the information you can

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[529] Cutbush, *American Artist's Manual*, "lead" section; Also Thomas Andrew used the term "workscapes" for the interplay between human labor and the environment. See, Thomas G. Andrews, *Killing for Coal: America's Deadliest Labor War* (Cambridge: Harvard University Press, 2008), 125.
[530] Wetherill Collection, Letter book, Item #1, Letter Dated July 8, 1812 to Benjamin Morgan, New Orleans.
[531] Wetherill Collection, Letter book, Item #1, Letter Dated January 26, 1813.
[532] Wetherill Collection, Letter book, Item #1, Letter Dated February 12, 1813.
[533] Wetherill Collection, Letter book, Item #1, Letter Dated June 13, 1815.

connected with its advantages."[534] The Wetherills ongoing communications and one venture to Mine La Motte not only emphasize the quality and quantity of Missouri's pig lead to make red and white lead, but also emphasize how miners were now capable of conducting year-round operations. Back east Wetherill learned to depend on the flow of pig lead from the mining and smelting frontier to New Orleans and Philadelphia and into his urban laboratory. During the early nineteenth-century, miners used wagons to transport pig lead from their furnaces to two primary shipping points on the Mississippi River—Ste. Genevieve and Herculaneum, Missouri. At both depots, they hoisted pig lead onto keelboats or steamers bound north to St. Louis or east to Philadelphia.[535]

Moving pig lead around the country was connected to changes in shipping patterns and newly constructed internal improvements between Philadelphia and Missouri. Scarcely 100 miles of canals existed in the United States in 1816, and roads in most parts of the country were uneven wagon paths that became impassable during wet weather; if the wagons made it, customers often received their glass products broken. The construction of canals made shipping easier and more secure. Canals connected the Missouri mines with Philadelphia by way of the Mississippi, Ohio, and Monongahela Rivers—primary inland waterways.[536] These extensive channels of water provided an alternative means over which quantities of pig lead traveled from the region "abounding with mines" to Philadelphia's harbor. Skilled navigators guided their barges, keelboats, and steamers loaded with pig lead, wheat, hemp, and tobacco to eastern depots.

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[534] Wetherill Collection, Letter book, Item #4, Letter Dated March 30, 1835; Wetherill Collection, Letter book, Item #5, Letter Dated April 4, 1835.
[535] Beck, *A Gazetteer of the State of Illinois and Missouri,* 256-258.
[536] Gregoire, *Observations of the La Motte Mines,* 5-6.

From the mines pig lead also journeyed down the Mississippi River for ten-days to New Orleans. There it remained for another ten-day detention before being placed "aboard a good vessel bound for Gulf of Mexico."[537] After leaving the Gulf, pig lead rounded the Florida Peninsula, and arrived in Philadelphia eighteen days later. When the pig lead arrived in Philadelphia, porters hoisted it onto horse-drawn wagons and delivered it to the Wetherill factory.[538] While the Wetherills made their own red and white lead according to English specifications, miners mastered new production machinery, and navigators embraced new forms of transportation. These multiple changes eventually erased the mining frontier-borderland as a principal production site for most lead products. The mines and laboratory workscapes became part of a larger productive system where pig lead traveled east and new commodities made from lead traveled west. Finally, as larger amounts of lead moved from the earth into society, the new techniques miners employed also increased the amount of particles and fumes that flowed over the district.[539]

Unhealthy ecological consequences of lead mining:

Changes to mining and smelting production also altered the way visitors, mine agents, and mineralogists defined the health of the region. They each wrote about how new machineries increased the amount of pig lead shipped back east, not simply as specialists but also as advocates proud of the region's resource potential. Brackenridge, Schoolcraft, and Clemson's text was calculated. They did much to highlight the benefits

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[537] Wetherill outlines the water route in Wetherill Production Records, Item # 25, Routing of Pig Lead, July 10, 1835.
[538] Wetherill Miscellaneous, Item 22, "Factory Hauling" – 1838.
[539] Wetherill Letter book, Item 1, January 2, 1813.

of the new equipment, but also they diminished how unhealthy the region had become for settlers. At the same time, though, doctors and miners began to draw attention to the unhealthiness of the settlements near the mines.

During the early decades of the nineteenth-century, Brackenridge, Schoolcraft, and Clemson combined improvement with civic booterism to promote Mine La Motte. Their inquiry was of deep interest to the country regarding business advantages. In a speech to the townspeople at Fredericktown, Clemson expressed his hopes to see miners and settlers experience the immediate development of the mineral capital of the region. The three early observers did not hesitate to promote improvement, which they believed would produce results favorable to national industry. They wrote to describe the region as healthy, and planned to convince skilled miners and smelters to migrate to Missouri.

Brackenridge and Schoolcraft also described Mine La Motte and its twenty-four thousand acre property as healthy, but also minimized how producing lead affected the environment and its inhabitants. For example, although Brackenridge noted how "the business of smelting is considered unhealthy."[540] He only notices how "animals raised near the furnaces are frequently poisoned by licking the ore or even the stones. Schoolcraft also failed to call attention to how vapors, fumes, and lead particles emanating from the furnaces affected the local crops or miners health. Instead, like Brackenridge, he also reported how "the tract is well watered by several springs of the purest water…and is decidedly admitted to be the healthiest of Missouri."[541] Since production increased in scale, and because the Missouri mines were capable of supplying the nation with abundant amounts of lead, they chose to promote only the positive aspects

[540] Brackenridge, *Views of Louisiana*, 262-263.
[541] Brackenridge, *Views of Louisiana*, 207.

of improvement. By the nineteenth century it was a well-established fact that lead colic, or miners' sickness, was produced by the deleterious action of lead on the animal system, and men and animals often died of the same disease. Brackenridge and Schoolcraft, both men of science, and miners all understood the effects of lead poisoning from the first monograph on occupational diseases.[542]

Although miners and farmers were not informed by early promoters about the possible dangers of living near furnaces at Mine a Breton, Brackenridge did hint that a poisonous haze coated the landscape. Although there was only one brick furnace at Mine a Breton, he observed a considerable number of oxides spilling into the atmosphere. Brackenridge commented how "unhealthiness arises from the fumes of the furnace in which are quantities of arsenic and sulphur."[543] He also "perceived a peculiar taste in the air as vapors emanated over the landscape."[544] Austin told Brackenridge that "none of the miners experienced attacks" of lead poisoning. This is extraordinary since miners working the reverberatory furnace, would have been exposed to the vapors that would have caused injury to their health. Additionally, Brackenridge and Austin would have been aware of the effect of lead oxides on workers.[545]

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[542] See, Bernardino Ramazzini, *A treatise of the diseases of tradesmen, shewing the various influence of particular trades upon the state of health; with Reuben*
the best methods to avoid or correct it, and useful hints proper to be minded in regulating the cure of all diseases incident to tradesmen (London: 1705). Also see, Thomas Percival, *Observations and Experiments on the Poison of Lead* (London: Printed for Andrew Bell, Ralph Smith, Daniel Midwinter, Will Hawes, Will Davis [and 4 others in London], (1774).
[543] Brackenridge, *Views of Louisiana*, 262.
[544] Brackenridge, *Views of Louisiana*, 73.
[545] Dr. Anthony Fothergill, "General Effects of the Poison of Lead," *Cautions to the Heads of Families, In Three Essays, Bath* (Printed by R. Cruttwell, Bath, London: 1790). (March 30, 2011).
http://books.google.com/books?id=vT4HFtF6HZMC&pg=PA33&dq=Dr.+A+Fothergill,+%E2%80%9CGeneral+Effects+of+the+Poison+of+Lead,%E2%80%9D+Cautions+to+the+Heads+of+Families,+In+Three+Essays,+Bath&hl=en&sa=X&ei=hd95T5O1H4bq0gGQktm3DQ&ved=0CEsQ6AEwAA#v=onepage&q&f=false

During Schoolcraft's visit, he also failed to write about how handlers and smelters were affected by lead ores. To boost the need to attract skilled workers, Schoolcraft only informed his readers about how the fumes affected animals. Schoolcraft attributed "mine sickness wholly to the quadrupeds." He observed cats and dogs experiencing "violent fits [which] never fail in a short time to kill them." And he also watched cattle "licking about the old furnaces and falling down." Schoolcraft's medical observation attributed the cause of animal deaths to the inhaling of "sulphur, which is so abundantly driven off in smelting lead."[546]

Defining the region required boosters to highlight the landscapes resource potential. However, they also reported the number of tributaries of clean water, which meant healthy land. Schoolcraft noticed these springs, but also distinguished how a small number of rivers became unwholesome. Still he did not associate this unhealthiness with the increase in lead production, or its effects on settlers. He outlined how the vapors originating from the furnaces flowed over the landscape, and impregnated the drinking water with lead particles, which only animals absorbed into their systems. Schoolcraft's account suggests that, as technology evolved there was an ecological impact affecting both animals and vegetation. Schoolcraft's medical observation called attention to the unhealthiness of the water supply, but he did not report cases of miners getting sick. His goal was to promote the populating of the "healthy" country with skilled miners and farmers, but in doing so he played down the potential unhealthiness of the district.

During the early nineteenth-century, settlers frequently used the healthiness of land as a guide to settlement practices; therefore, visitors to the mines chose to minimize the use of the term unhealthy in their reports. By 1839, in *Observations on the La Motte*

[546] Schoolcraft, *A View of the Lead Mines of Missouri,* 30-31.

Mines, Clemson would also combine straightforward civic boosterism with improvement and land cultivation. Like Brackenridge and Schoolcraft, he not only promoted the region's supply of galena, but also published that "about one-third of the [land] is first rate farming land."[547] He linked the significance of mining and farming to the development of Mine La Motte, stating "to the greatest extent…and to invited miners, and those engaged in kindred operations, to make it the theatre of their future exertions."[548] Clemson underscored the numerous tributaries that he believed would not only "afford ample power to create and power" mills to stamp and crush lead ores into manageable pieces for smelting, but also provide water for crops.[549] Clemson also understood that early nineteenth-century migrants, miners and farmers, searched for new lands in the midst of a "healthy country."[550] Although Brackenridge, Schoolcraft, and Clemson failed to connect the impact of the new devices on miners and smelters, their observations did begin to change the perception of the mining settlement's healthiness among settlers and doctors.

An excellent example of the growing unhealthiness of the mining district as a result of the growing use of new machines occurred in the early nineteenth-century. As more settlers migrated to settlements near the mines, physicians migrated to the region to ply their services among miners and smelters affected by the lead particles or vapors. In 1816, Dr. Hardage Lane of St. Louis treated a miner with lead poisoning.[551] Lane also had experience with the 1849 cholera epidemic, and told patients to wear tourniquets on

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[547] Clemson, *Observations of the La Motte Mines*, 24.
[548] Clemson, *Observations of the La Motte Mines*, 26.
[549] Clemson, *Observations of the La Motte Mines*, 30.
[550] Clemson, *Observations of the La Motte Mines*, 11.
[551] Dr. Hardage Lane, in Hardage Lane Scrapbook, Missouri Historical Society, St. Louis.

both the arms and legs.[552] In 1843, Lane published the first medical report of lead poisoning while he was president of the Medical Society of Missouri. He published his account in *St. Louis Medical and Surgical Journal*. Lane stated "he was called to see a thirty year-old man at the lead mines, who seemed to be laboring under all the usual symptoms of *colica pictonum*."[553] Lane wrote that the Mine La Motte miner was "vomiting," and experiencing "pain and discharge of blood from the bowels, which continued for 2-3 days." Following the miner's death, Lane performed an autopsy and described the man's "entire alimentary canal as highly inflamed condition, and necessarily engorged and thickened." Lane noted that the man's appendix contained a large amount of "ashes, cinders, and slag."[554] Dr. Lane continued, "This discovery at once accounted for the symptoms of lead colic, and the fatal termination of the miner."[555] Lane uncovered what boosters tried to hide. He revealed how changes to lead production methods and scale affected humans, which may have alerted settlers who considered migrating to these settlements.

By this time there was already an understanding that lead in all forms was "poisonous when taken in any quantity."[556] In England after smelters became increasingly exposed to lead oxides from inhaling or handling galena, they had "bowl complaints, paralytic symptoms, and other maladies."[557] The excessive fumes and animal sickness observed by Brackenridge and Schoolcraft, and the ill health of the miner treated by Dr. Lane distinguish when this unhealthiness was linked to lead smelting at the

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552 Lane, in Hardage Lane Scrapbook, Missouri Historical Society, St. Louis
553 Lane, "Case of Poison From Lead," *St. Louis Medical and Surgical Journal* l, 2, May 15, 1843, 32.
554 Lane, "Case of Poison From Lead," 33.
555 Dr. Hardage Lane, in Hardage Lane Scrapbook, Missouri Historical Society, St. Louis.
556 Fothergill, "General Effects of the Poisson of Lead," 73.
557 Fothergill, "General Effects of the Poisson of Lead," 61.

Missouri mines. Ultimately, these occurrences suggest that the perceptions of settlers, miners and physicians about the unhealthiness of mining and smelting area were examples of early environmental consequences due to the increase manufacture of lead.

As miners and agents expanded their activities, more miners did become stricken with lead poisoning, and doctors continued to service the community. Dr. Stephen Skeel migrated and settled in the middle of the lead region while Clemson was compiling his report. In Skeels' medical observation he recorded smelters as being severely attacked with lead poisoning, and also noticed a high incidence of lead poisoning among miners between 1838 and 1840.[558] Skeel recorded over 100 cases of the disease. He treated "miners and cleaners of the mineral who handled [lead ore] or inhaled the flying particles that mingled with the saliva."[559] One evening Skeel "was called to visit the 45 year old E.B. Harris, who had been three days sick, pulse slow and full, tongue white, pain in the stomach, belly, back and collar bones; no vomiting and but little sick stomach, obstinate constipation, great thirst, but drinks but little." After examining the miner, Skeel wrote, "It is mine sickness, has had the disease before, two years ago." Skeel not only diagnosed the disease but also prescribed a plan of treatment for his patients, stating, "We have taken great pains to ascertain its nature, and the best plan of treatment, adapted to particular cases."[560]

Skeel also treated John Perkins who "had been troubled with bowel complaints while working in the neighborhood of the Perry Mines," a short distance from Mine La

[558] Dr. S. Skeel, "Lead Colic, or Mine Sickness," *St. Louis Medical and Surgical Journal* 6, no. 2, (1848): 125-129. Copies located as The New York Academy of Medicine Library, NY. Also, see Carey P. McCord, "Lead and Lead Poisoning in Early America: Lead Mines and Lead Poisoning," *Industrial Medicine and Surgery*, 22, no. 11, (1953): 534-539.
[559] Fothergill, "General Effects of the Poisson of Lead," 46.
[560] Skeel, "Lead Colic, or Mine Sickness," 126-127.

Motte.[561] After staying with Perkins for some time, Skeel concluded "that the disease must be caused by mineral; that the action on the bowels was, probably, kept up by the particles of mineral acting mechanically on the alimentary canal." Skeel developed a plan of action beginning with opium, "which relieved the pain and procured rest." The following morning Skeel "gave him two drops of croton, and one ounce of castor oil" and left Perkins' side to allow the medicine to take its course.[562] Following the treatments Skeel was happy to report "my patient was relieved when Mr. Perkins discharges were completely filled with particles of mineral." Skeel also reported that the bowls of Mr. Perkins contained two handfuls of lead particles. The fact that the excrement contained such visible quantities of lead apparently shows that miners were exposed to a high level of galena.

The increase in the number of miners and smelters who suffered from lead poisoning during the early nineteenth-century coincided with the increase in lead production as new procedures and machines continued to arrive. Dr. Skeel, who lived in the lead country, documented a high incidence of lead poisoning among the Missouri miners, at the same time that Clemson was reporting the healthiness of the country. Skeel's observations, diagnosis, and treatments also represent how settlers began to redefine the locality in terms of unhealthiness associated with lead production. While boosters wrote pamphlets to feature the bordered mining district's galena resources and praised the discovery of additional veins of lead, Skeel outlined in his medical report how the landscape was a dangerous place for settlement.

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[561] Skeel, "Lead Colic, or Mine Sickness," 127-128.
[562] Skeel, "Lead Colic, or Mine Sickness," 128.

Dr. Skeel also treated miners who faced the danger of working in thirty-five feet deep shafts. In February 1838, Rozier wrote in his journal about how he became incapacitated for a number of months after a mining accident that occurred in his twenty-six foot deep shaft. In the process of filling his basin, Rozier stated that "with the velocity of a bomb, the rock, earth, and lead ore laden basin weighing from 150 to 200 pounds fell on top of my body, knocking me to the floor of the shaft."[563] Rozier wrote that he sustained broken bones explaining, "in my right arm with such violence [I fell that the bones] penetrates the flesh causing a three-inch opening and my fingers shut from the pain coming from the nerves, muscles, and tendons."[564] After Rozier returned home, Henroid went to search for Dr. Skeel, who diagnosed Rozier as having a "great number of bruises and contusions as far as the marrow."[565] Rozier's accident represents the growing need for medical doctors in the community to help guard workmen against occupational hazards associated with new methods. In addition to blasting accidents, miners often slipped from damp ladders in the mines and emerged with broken arms, legs, or even necks. If mines were not properly drained, some fell into the water and were drowned, and others were crushed by cave-ins.

Skilled miners recorded their medical observations as they redefined their own workscapes not only in terms of prospective resource capital but also in terms of danger. In like fashion to physicians' diagnoses, miners assessed the environment in terms of healthiness and unhealthiness. Although Rozier's journal shows how mining and smelting production became integral to the settlement and development of the frontier, his account also reveals how the incursion of new European technologies increased the

[563] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 25.
[564] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 26.
[565] Rozier Family Papers, Box 3, Folder 2, Unpublished Journal, 27.

dangers of mining in deep shafts. The excessive fumes and animal sickness observed by Brackenridge and Schoolcraft, and the miner's ill health treated by Dr. Skeel distinguish when this unhealthiness was linked to lead smelting. These changes were examples of early environmental consequences due to the increased production of lead ore, and would also alert doctors to study how workers in other trades were affected by changes in technology.

As miners expanded their lead work to supply the expanding markets for lead products back east, urban doctors began to research and published their medical observations of various trades. In 1837, Dr. Benjamin W. McCready, of New York, conducted a study on occupational diseases among New York City's manufacturers. McCready examined the health problems of agricultural workers, laborers, seamen, factory operatives, professionals, and literary men. He also discussed housing and the "general conditions of life" stemming from poverty and unhealthy cities. McCready fails to report on the health of miners or smelters in America, but he does connect Missouri's lead production with the health of painters who handled white lead. He states, "Painters are in the habit of constantly employing the mineral which has long been known for its poisonous qualities, and it is to this that the peculiarities of their complaints they are unhealthy in their appearance." McCready instructed painters to do their work more quickly so that they would not breathe in the lead oxides spilling into an enclosed atmosphere. McCready explained how painters would be "affected with dizziness and head-ache, and often with nausea and vomiting."[566] McCready's observations were also

[566] The New York State Medical Society, proposed as a subject, "The influences of trades and occupations in the United States in the production of Disease. Benjamin W. McCready, M.D., *On the Influence of Trades, Professions, and Occupations in the United States, in the Production of Disease*, 1837, Introductory essay by Genevieve Miller (Baltimore: Johns Hopkins Press, 1943). The topic was most likely

similar to comments of how lead distressed miners and smelters in the Missouri mining district. It is unclear why McCready chose not to the frontier and visit the lead mines to report on the dangers of lead mining and smelting. McCready may have ignored these frontier aliments because Americans were becoming regular users of lead products, and commercial ambition erased concerns about miner's health.

In conclusion, by the early nineteenth-century, guided by enlightenment confidence, boosters and improvers desired to complete the frontier by adopting more advanced mechanical interventions. As travelers, geologists, and miners made their way west to inspect the lead mines, they combined regional definition and regional promotion as a way to recognize regional resource potential. Most significantly, in the mining district, after Americans installed their structures, settlers began to assess the healthiness and unhealthiness of their farms and settlements.

Prior to Cincinnati physician Daniel Drake publishing his atlas of health and place that shaped agricultural settlement practice, Missouri doctors and miners gave greater attention to a region's "healthiness" or "unhealthiness" in both agricultural and mining landscapes.[567] Early observers and doctors understood that animals suffered with the disease, but Drs. Lane and Skeel diagnosed settlers who suffered with the disease. In both instances, the change in settlement practices, and miners living closer to the mines, resulted in a high incidence of lead poisoning among the Missouri miners. As advocates praised the region by spreading glowing reports about vegetation, soil type, and quality

influenced by a book on occupational diseases. See, C. Turner Thackrah, *The Effects of Arts, Trades, and professions and of Civic States and Habits of Living on Health and Longevity: with Suggestions for the Removal of Many of the Agents which produce disease, and shorten the duration of life* (London: Longman, 1832).

[567] This two-volume survey includes information of diseases, geography, climate, and mineral resources. Daniel Drake, *A Systematic Treatise, Historical, Etiological, and Practical, on the Principal Diseases of the Interior Valley of North America* (Cincinnati: Winthrop B. Smith, 1850).

galena, doctors dispatched observations about the region as dangerous and unhealthy. Although boosters' civic responsibility was to promote improvement, hidden within their positive assertions, they wrote about the effects of lead on the surroundings and population.

As medical examinations revealed the harmful effects of lead at the Missouri mines, they spurred more thought and reflection about the healthiness of the district and urban trades. The attentiveness to bordered mining district workplaces seems to be consistent with a tendency to connect disease with rural workplaces. However, even as travelers and physicians alike often described the frontier as a "healthy country," the area surrounding Mine La Motte became more "unhealthy" with the transition to European technologies. Miners and animals were sometimes sick, and were sometimes in good health. But Henriod and Rozier persisted in documenting their very surroundings as also being "healthy" or "unhealthy."

When the miner, the digger, and the cleaner each handled lead, they inhaled flying particles that mingled with their saliva. Swallowing a considerable portion of lead consequently affected many villagers and workers.[568] Some miners escaped related sicknesses, but those engaged in the smelting of lead ores were often attacked. With the erasure of the Native American smelting customs and the invasion of European furnaces, humans in the neighborhood of the mines suffered from the disease. It appears that Drs. Lane and Skeel assumed that lead poisoning from mining and smelting only came after the Europeanizing of the procedures. Their experiences with sick miners provided another way of burying the Native American influences on America's early mining history.

[568] Brackenridge, *Views of Louisiana*, 150; Skeel, "Lead Colic, or Mine Sickness," 125-129.

Conclusion

What we have gained by examining the convergence of Indian, European, and American mining practices is to highlight Native American knowledge and technological experiences that are most often ignored. Without Native American influence European style mining development would have unrolled far more slowly. Scholars have written important tribal histories, as well as essays about western Native Americans. However, most authors of the frontier have failed to integrate Native American, European, and Euro-American mining practices' into early American history. Currently, for the most part, Indian history remains a preliminary chapter or introductory lecture, which is followed by the invasion of European and American cultural practices and ideas that significantly contributed to changes to Indian people's lifestyle and to the physical environment.

As European and American miners, entrepreneurs, and geologists promoted and applied new innovations to get lead out of the ground to manufacture a variety of products, not only did American consumers become increasingly dependent on them but also the local and more distant ecosystems changed. During the early years of the American Republic, every time a person made a choice to purchase a box of factory made shot or continue to make musket balls; to use pewter cups or newly fashioned glassware manufactured using red lead; to admire the natural wood walls of their home or paint over them using white lead based paints; to take a job in anyone of the factories that produced shot or red and white lead that person became linked to innovations of the industrial revolution that had an environmental impact on local, national, and global scale.

A number of years ago Ruth Schwartz Cowan referenced the sorcerer's apprentice to make a point about how resourceful people made innovative industrial structures to solve problems, but in the end each improvement fashioned additional problems—pollution and environmentally dreadful conditions. These predicaments were not unique to the twentieth century. The story of the sorcerer's apprentice can also be applied to the opening decades of the nineteenth century and beyond.[569] Following the arrival of Moses Austin and British miners in 1796, they proceeded to create shafts to extract lead ore, and they immediately installed a reverberatory furnace, all combined the amount of lead smelting increased.

Since ancient times, metallurgy added new pollutants that wafted across the seas and continents. In like fashion, the poisons from lead smelting also flowed over local vegetation, early frontier towns, and even over cities where red and white lead was being manufactured. According to J. R. McNeill, "Greenland ice cores reveal significant lead deposition from Roman times."[570] Greenland ice shows that discharges of metal particles into the atmosphere streamed after the manufacture of coins long before the Industrial Revolution. Researchers have also discovered that Greenland air bubbles trapped in ice had large amounts of lead in them after 1820.[571]

The smelting of lead ores in the middle Mississippi Valley during the onset of industrialization, in the opening decades of the nineteenth century, must have significantly contributed to transforming the earth's earlier atmospheric history. Early smelting would have produced impurities that are driven off as explosive gases that

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[569] Cowan, *A Social History of American Technology*, 224-225.
[570] J. R. McNeill, *Something New Under The Sun: An Environmental History of the Twentieth-Century World* (New York: W.W. Norton & Company, 2000), 56.
[571] McNeill, *Something New Under The Sun*, 63.

created not only a flame, but also a copious amount of sulfur dioxide, which blanketed the rural pastoral landscape. McNeill documents that the emission of lead into the atmosphere on a worldwide scale was recorded for the years between 1850 and 1900 to be 22,000 tons each year.[572] Since my current study ends in 1839, I suggest the need for more research into ecological hazards that had long-term effects on the atmosphere as a result of the increase in smelting activity during the impending market revolution. For example, the accumulation of sulfur dioxide, the main ingredient in acid rain, would have had damaged forest and river life. Recently, McNeill reported that we do not know the concentration of sulfur dioxide prior to 1900. However, the increase in lead smelting in a concentrated area would have certainly put more gases into the atmosphere. Metal smelting releases toxic metals into the air as dust. Some of the dust surely worked its way into crops and water systems near Mine La Motte to the misfortune of wildlife and humans as observed by Brackenridge and Schoolcraft.

By the 1830s, with the unleashing of clouds of lead fumes pollution flowed over both Mine a Breton and Mine La Motte infecting foodstuff, animals, and settlers. The geography of both mining sites reminds me of the landscape of cities like present day Dae Gu, South Korea, which is surrounded by mountains that contributes to multiple layers of haze that blanket that city. Because both Mine a Breton and Mine La Motte were similarly located in areas that resembled the bowl shaped Dae Gu, the emission of pollutants from numerous furnaces would have been unable to disperse. In 1839, at Mine La Motte there was one coal-fed steam engine in use and four wood or coal-fed reverbertory furnaces each spewing into the atmosphere a blend of sulphur dioxide and

[572] J. R. McNeill, *Something New Under The Sun*, 67-68.

lead particles. The haze hovering over the mining district damaged plants, caused eye irritation, and lung problems for local doctors to treat.

I hope to have outlined for us moderns a sense of the world we have lost. We are extremely alienated from the lifestyle of people not so many generations ago. They lived and worked in environments we now consider ours. The preceding chapters have outlined a set of practices, and ways of understanding nature that linked culture, people, environment, and technology. This dissertation has sketched imaginative spaces worked by Indians, Europeans, and Euro-Americans who encountered each other and the land. By examining the convergence of Indian, European, and American mining practices highlights a new Native American presence that most of modern Americans remain unaware.

Nearly every era and region of American history provides similar examples of Native American communities embracing mining opportunities. Whether the Pueblo in New Mexico, the Mississippian in Missouri, the Huron in Canada, the Winnebago near Lake Superior, or the Cherokee in Georgia, Indian communities forged or adopted unique mining systems. We have much to learn from their motives, but many of the cases suggest they were seeking metals for exchange with one another or with Euro-Americans. By moving outside of well-established frameworks, historians can go beyond the longstanding separation of the American historical landscape to recognize where Native Americans and Europeans or Euro-Americans often engaged in lengthy and complicated convergences that connects them with the emergence of modern America. I hope that this study will challenge American historians to look for and recognize additional stories about other cultural and material exchanges between Native Americans, Europeans, and

Americans. To appreciate fully the significance of the intercultural dialogue that shapes America's past; I believe we must demand to listen for Native American points of view. Only then will we be able to more fully integrate Native American experiences into the broader story of early American history.

Bibliography

Primary Source Collections & Papers

Library of Congress, Washington, D.C.
Schoolcraft, Henry Rowe, Papers

Missouri Department of Natural Resources - Missouri State Archives, Jefferson City, Mo.
Lynn Morrow Personal Collection.
Hunt, Theodore, complier. Testimony Before the Recorder of Land Titles.
St. Louis, 1825. 3 vols.

Missouri Historical Society, St. Louis, Mo.
Alexander Craighead Papers
Amoureux-Bolduc Papers
Bates Family Papers
Billon Papers
Bissell, Daniel Papers
Blow Family Papers
Chouteau Collections
Chouteau, Pierre, Letterbook
Delassus-St. Vrain Family Collection
Francois Valle Papers
George Oliver Carpenter Papers
Gratiot, Charles, Letterbook
Henry Rozier Ledger
John James Audubon Collection
Joseph Desloge Collection
Journals and Diaries Collection
Kennett Family Papers
Lewis Fields Linn Papers
Lewis Vital Bogy Family Papers
Mines Collection
Moses Austin Collection
Rose Mary Bogy Collection
Rozier Family Papers
Ste. Genevieve Papers
Stoddard, Amos, Papers
Valle Mining Company Account Books
Wilt, Christian, Letterbook

National Archives, New York City
Letters Received by the Secretary of War Relative to Indian Affairs
Letters Sent by the Secretary of War Relative to Indian Affairs

Newberry Library Cartographic Collection

New York Public Library
Print Collection
Rare Books

The State Historical Society of Missouri
Western Historical Manuscripts
Lead Mining Co., Washington County, Missouri, Records, 1809-1954
Mine La Motte Estate, Madison County, Missouri, Records, 1875-1897
Missouri, Ste. Genevieve. Archives, 1756-1930

University of Pennsylvania Rare Books
Wetherill Collection

Washington University Bernard Becker Medical Library

Yale University Library
Papers of the St. Louis Fur Trade, 1725-1925
Chouteau Collection
Fur Company Ledgers & Account Books, 1802-1871

Interviews and Communication

Brown, Margaret. March 23, 2005.

Newspapers

The New York Magazine
Literary Repository
St. Louis Missouri Gazette
St. Louis Enquirer

United States Government Documents

American State Papers: Finance, Foreign Relations, Indian Affairs, Military Affairs, Public Lands, and Miscellaneous. 38 vols. Washington, D.C.: Gales & Seaton, 1832-1861

Carter, Clarence E., ed. *The Territorial Papers of the United States. Vol. 13, Louisiana-Missouri, 1803-1806* (1948); vol. 14, *Louisiana-Missouri, 1806-1814* (1949); vol. 15, *Louisiana-Missouri, 1815-1821* (1954). Washington, D.C.: U.S. Government Printing Office, 1934-1962

Laws for the Territory of Louisiana. St. Louis, 1808

Fay, Albert Hill. *A Glossary of the Mining and Mineral Industry* (Washington, DC: GPO, 1920).

Primary Sources

Amelung, John Frederick. *Remarks on Manufactures, Principally on the New Established Glass-House near Frederick-Town, In the State of Maryland*. Maryland: 1787.

Austin, Moses. *A Summary Description of the Lead Mines in Upper Louisiana. Also, An Estimate of their Produce for Three Years Past*. City of Washington: A. and G. Way Printers, 1804.

Author unknown, *Proposals For Establishing an Association for Working Mines and Manufacturing Metals in the United States*. Philadelphia: Printed By Samuel H. Smith, no. 118 Chestnut Street, 1796.

Barba, Alvaro Alonso. *A Collection of scarce and valuable treatises upon metals, mines and minerals…Being a translation from the learned Alvaro Alonso Barba and the observations of several persons of our own country, founded on many years experience*. London: Printed for J. Hodges, 1684.

Barker, Eugene C., eds. *Annual Report of the American Historical Association for The Year 1919: In Two Volumes, Volume II, The Austin Papers Part I*. Washington: Government Printing Office, 1924.

Baxter, James Phinney. Roberval, Jean François de La Roque, and Alfonce, Jean. *A memoir of Jacques Cartier: Sieur de Limoilou, His Voyages to the St. Lawrence*. New York: Dodd, Mead & Co., 1906.

Beck, Lewis C. *A Gazetteer of the State of Illinois and Missouri*. Albany: Charles R. and George Webster, 1823.

Beltrami, Giacomo Costantino. *A pilgrimage in Europe and America: leading to the discovery of the sources of the Mississippi and Bloody River: with a description of the whole course of the former and of the Ohio; in two volumes, Volume 2*. London: Hunt and Clarke, 1828.

Bingley, William. *Useful Knowledge of a Familiar and Explanatory Account of the Various Productions of Nature: mineral, Vegetable, and Animal*. Philadelphia: A. Small, 1818.

Boyle, Robert. *The Works of the Honorable Robert Boyle in Five Volumes*. London: Thomas Birch, 1772.

Broadhead, Garland C. *Report of the Geological survey of the state of Missouri, Including Field Work of 1873-1874, Missouri Geological Survey*. Jefferson City: Regan & Carter, State Printers and Binders, 1874.

Carver, Jonathan. *Travels through the interior parts of North America, in the years 1766, 1767, and 1768*. London: C. Dilly, 1781.

Champlain, Samuel de. *Voyages of Samuel de Champlain: 1604-1610*; *Volumes 11-13 of Publications of the Prince Society*; *Volume 2 of Voyages of Samuel de Champlain, translated by, Charles Pomeroy Otis*. Boston: The Prince Society, 1878.

Chaptal, Jean-Antoine-Claude. *Elements of Chemistry, Translated From the French, Three Volumes in One*. Philadelphia: Printed By Lang & Ustick for M. Carey, 1796.

Clemson, Thomas G. "From a Discourse delivered before the citizens of Fredericktown…Governing Mine La Motte," in *Observations of the La Motte Mines and Domain in the State of Missouri with some Accounts of the Advantages and Inducements there promised to Capitalists and Individuals desirous of engaging in Mining, Manufacturing, of Farming operations*. Baltimore: Royston & Brown, 1839.

Collot, Georges-Henri-Victor. *Journey in North America, Containing a Survey of the Countries Watered by the Mississippi, Ohio, Missouri, and Other Affluing Rivers Volumes 1 and 2*. Paris: Printed for Arthur Bertrand, 1826.

Cramer, Zadok. *The Navigator: containing directions for navigating the Monongahela, Allegheny, Ohio, and Mississippi Rivers; with an ample account of these much admired waters, from the head of the former to the mouth of the latter; and a concise description of their towns, villages, harbors, settlements. With accurate maps of the Ohio and Mississippi, to which is added an appendix, containing an account of Louisiana, and of the Missouri and Columbia rivers, as discovered by the voyage under Captains Lewis and Clark. Sixth Edition – Improved and Enlarged*. Pittsburgh: Cramer & Spear, 1801.

Cutbush, James. *The American artist's manual: Dictionary of practical knowledge in the application of philosophy to the arts and manufactures. Selected from the most complete European systems, with original improvements and appropriate engravings, adapted to the use of the manufacturers of the United States*. Philadelphia: Johnson & Warner, and R. Fisher, 1814.

De Witt, Benjamin. "Mineral Productions of the State of New York," *Memoirs of the American Academy of Arts and Sciences,* Vol. 2, No. 2. (1804): 73-81.

Dobson, Thomas. *A Compendious System of Mineralogy & Metallurgy; Extracted from the American Edition of the Encyclopedia*. Philadelphia: Thomas Dobson, 1794.

Drake, Daniel. *A Systematic Treatise, Historical, Etiological, and Practical, on the Principal Diseases of the Interior Valley of North America*. Cincinnati: Winthrop B. Smith, 1850.

Eissler, M. *The Metallurgy of Silver, A Practical Treatise on the Amalgamation, Roasting, and Lixiviation of Silver Ores: Including the Assaying, Melting, and Refining of Silver Bullion*. London: Crosby Lockwood and Son, 1889.

Featherstonhaugh, G.W. *Geological Report of An Examination Made in 1834 of The Elevated Country Between the Missouri and Red Rivers*. Washington: Printed by Order of the House of Representatives, Gales and Seaton, 1835.

Flint, Timothy. *The History and Geography of the Mississippi Valley. To Which is Appended A Condensed Physical Geography of the Atlantic United States and the Whole American Continent,* 2nd Ed. Vols. 1 & 2. Cincinnati: E.H. Flint and L.R. Lincoln, 1832.

Fothergill, Anthony. "General Effects of the Poison of Lead," *Cautions to the Heads of Families, In Three Essays,* Bath, London: Printed by R. Cruttwell, 1790.

Godon, Sylvain. "Observations to Serve for the Mineralogical Map of the State of Maryland, *American Philosophical Society Transactions,* Vol. 6. (1809): 319-323.

Haricot, Thomas. *A Brief and True Report of the New Found Land of Virginia: of the Commodities and of the Nature and Manners of the Natural Inhabitants*. http://docsouth.unc.edu/nc/hariot/hariot.html;

Henfrey, Benjamin. *A Plan With Proposals for Forming a Company to Work Mines in the United States; and to Smelt and Refine the Ores Whether of Copper, Lead, Tin, Silver, or Gold*. Philadelphia: Snowden & M'Corkle, 1797.

Houghton, Thomas. *Royal Institutions: Being proposals for articles to establish and confirm laws, liberties, & customs of sliver & gold mines, to all the king's subjects, in such parts of Africa, and America, which are now (or shall be) annexed to, and dependent on the crown of England. With rules, laws, and methods of mining, and getting precious stones; the working and making of salt-petre; and also, the digging and getting of lead, tin, copper, and quick-silver-oars, in any or either of those countries; whereby navigation, and trade, with the subjects interest and riches, together with the Crown's Revenues, would be greatly Increased, in a little Time. Most humbly offered to the consideration of the King's most excellent Majesty, & this present Parliament*. London: Printed for Author, 1694.

_____. *Rara avis in terris: or The compleat miner, in two books; the first containing the liberties, laws, and customs, of the leadmines, within the weapontake of Wirksworth in Derbyshire. In fifty nine articles: to which are added, some new standing laws never printed before. The second teacheth the art of dialling and leveling*. Derby: Printed by Samuel Hodgkinson, 1729.

Kirwan, Richard. *Elements of Mineralogy in Two Volumes*. London: Printed by J. Nichols, for P. Elmsly, 1794-96.

Lahontan, Louis Armand Baron. *New Voyages to North America Containing an Account of the several Nations of that Vast Continent; their Customs, Commerce, and the Way of Navigation upon Lakes and Rivers; the several Attempts of the English and French to dispossess one another; with reasons of the miscarriage of the former; and the various Adventures between the French and the Iroquois Confederates of England, from 1683 to 1694; A Geographical description of Canada, and a Natural History of the Country, with Remarks upon their Government, and the Interest of the English and French in their Commerce.* Vols. 1 & 2. London: Printed for H. Bonwicke in St. Paul's Church-Yard; T. Goodwin, M. Wotton, B. Tooke, in Fleetstreet; and S. Manship in Cornhil, 1703.

Langworthy, William. *Papers Relative to an Application to Congress for an Exclusive Right of Searching for and Working Mines in the Northwest and Southwest Territory*. Philadelphia: Printed By Samuel H. Smith, 1796.

Lesueur, Charles-Alexandre. *Drawings and sketches of the places we passed on the way from Philadelphia to Pittsburgh and from Pittsburgh to New Harmony during our voyage on the keelboat while descending the Ohio from November 27, 1825 to January 26, 1826*. The Natural History Museum of Havre in France.

Lockwood, James H. "Early Times and Events in Wisconsin," *Collections of the State Historical Society of Wisconsin*, Vol 2, (1855).

Maclure, William. "Observations on the Geology of the United States, Explanatory of a Geological Map" *Transactions of the American Philosophical Society*, Vol. 6. (1809): 411-428.

Miller, Samuel. *A Brief Retrospect of the Eighteenth Century, Part First in Two Volumes Containing A Sketch of the Revolutions and Improvements In Science, Arts, and Literature During That Period*. Philadelphia: T. and J. Swords, 1803.

Nicholson, William. *A Dictionary of Chemistry, Exhibiting the present State of the Theory and Practice of that Science, its Application to Natural Philosophy, the Processes of Manufactures, Metallurgy, and numerous others Arts dependent on the Properties and Habitudes of Bodies, in the Mineral, Vegetable, and Animal Kingdoms, Vol. 1, 2*. London: G.G. and J. Robinson, 1795.

Percival, Thomas. *Observations and Experiments on the Poison of Lead*. London: Printed for J. Johnson, 1774.

Plattes, Gabriel. *A discovery of subterraneal treasure: of all manner of mines and minerals, from the gold to the coal; with plain directions and rules for the finding of them in all kingdoms and countries. And also, the art of melting, refining, and assaying of them is plainly declared, so that every man that is indifferently capacious, may with small charge presently try the value of such oares an shall be found either by rule, or by accident. Also a perfect way to try what colour any berry, leaf, flower, stalk, root, fruit, seed, bark, or wood will give: with a perfect way to make colours that they shall not stain, nor fade like ordinary colours*. London: Printed for J.E. and are to be sold by Humphrey Moseley at the Prince's Arms in Saint Paul's Church-yard, 1653.

Pryce, W. *Mineralogia Cornubiensis: A Treatise on Minerals, Mines, and Mining: Containing the Theory and Natural History of Strata, Fissures, and Lodes, with the Methods of Discovering and Working of Tin, Copper, and Lead Mines, and of Cleansing and Metalizing their Products; Showing Each Particular Process For Dressing, Assaying, and Smelting of Ores. To Which is Added, An Explanation of the Terms and Idioms of Miners*. London: Printed and Sold For the Author By James Phillips, 1778.

Ramazzini, Bernardino. *A treatise of the diseases of tradesmen, shewing the various influence of particular trades upon the state of health; with the best methods to avoid or correct it, and useful hints proper to be minded in regulating the cure of all diseases incident to tradesmen*. London: Printed for Andrew Bell, Ralph Smith, Daniel Midwinter, Will. Hawes, Will. Davis [and 4 others in London], 1705.

Roosevelt, Nicholas and Mark, Jacob and Company. *Papers relative to an application to Congress for an exclusive right of searching for and working mines in the Northwest and South-West Territory*. Philadelphia: Printed by Samuel Harrison Smith, 1793.

Schoolcraft, Henry Rowe. *A View of the Lead Mines of Missouri, including some observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, population and Productions of Missouri and Arkansas, and other sections of the Western Country*. New York: Charles Wiley, 1819.

Thackrah, C. Turner. *The Effects of Arts, Trades, and professions and of Civic States and Habits of Living on Health and Longevity: with Suggestions for the Removal of Many of the Agents which produce disease, and shorten the duration of life*. London: Longman, 1832.

Thomson, Thomas. *A System of Chemistry: Volume 1 of a System of Chemistry: In Four Volumes*. London: Bell & Bradfute; sold by J. Murray, London, 1802.

Thwaites, Reuben Gold. “Notes on Early Lead Mining in The Fever (or Galena) River Region,” *Collections of the State Historical Society of Wisconsin*, Vol. 13 (1895): 271-292.

Ure, Andrew. *A Dictionary of Arts, Manufactures, and Mines: Containing a Clear Exposition of Their Principles and Practice*. London: Longman, Orme, Brown, Greene, & Longmans, 1839.

Woodhouse, James. *The young chemist's pocket companion connected with a portable laboratory; containing a philosophical apparatus, and a great number of chemical agents; by which any person may perform an endless variety of amusing and instructing experiments; and intended to promote the cultivation of the science of chemistry*. Philadelphia: J.H. Oswald, 1797.

_____. Woodhouse, James. *The Young Chemist’s pocket Companion*; *Compendious System of Mineralogy & Metallurgy*. Philadelphia: Printed by J.H. Oswald, 1798.

Secondary Source Material

Abbott, Collamer M. “Colonial Copper Mines.” *The William and Mary Quarterly, Third Series,* Vol. 27, No. 2 (April 1970): 295-309.

Adams, Sean P. *Old Dominion, Industrial Commonwealth: Coal Politics, and Economy in Antebellum America*. Baltimore: Johns Hopkins University Press, 2004.

Adas, Michael. *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance*. Ithaca and London: Cornell University Press, 1989.

Adelman, Jeremy and Aron, Stephen. “From Borderlands to Borders: Empires, Nation-States, and the Peoples in Between in North American History,” *The American Historical Review,* Vol.104 No. 3 (June 1999): 814-841.

Agricola, Georgius. *De Re Metallica, Translated from the First Latin Edition of 1556, with Biographical Introduction, Annotations and Appendices upon the Development of Mining Methods, Metallurgical Processes, Geology, Mineralogy & Mining Law from the Earliest Times to the 16th Century*, trans. Herbert Clark Hoover and Lou Henry Hoover. Maryland: Dover Publications, Inc., 1950.

Aitchison, Leslie. *A History of Metals*. London: MacDonald & Evans, Ltd., 1960.

Alanen, Arnold R. "Documenting the Physical and Social Characteristics of Mining and Resource-Based Communities," *APT Bulletin*, Vol. 11 (1979): 49-68.

Ali, Saleem H. *Mining, the Environment, and Indigenous Development Conflicts*. Tucson: University of Arizona Press, 2003.

Allen, Michael. “The Lower Mississippi in 1803: The Travelers’ View.” *Missouri Historical Review*, Vol. 77 (1983): 253-271.

Allgor, Catherine. *Parlor Politics: In Which the Ladies of Washington Help to Build a City and a Government*. Charlotte: University Press of Virginia, 2000.

Alvord, Clarence Walworth. *The Illinois Country, 1673-1818*. Illinois: Illinois Centennial Commission, 1920.

Anderson, Hattie M. “Missouri, 1804-1828: Peopling a Frontier State.” *Missouri Historical Review*, Vol. 31 (1937): 150-180.

Andrews, Thomas G. *Killing for Coal: America’s Deadliest Labor War*. Cambridge: Harvard University Press, 2008.

Appadurai, Arjun, eds. *The Social Life of Things: Commodities in cultural perspective*. New York: Cambridge University Press, 1986.

Appleby, Joyce. *Capitalism and a New Social Order: The Republican Vision of the 1790s*. New York: New York University Press, 1984.

Appleby, Joyce. *Inheriting the Revolution: The First Generation of Americans*. Cambridge: Belknap Press of Harvard University Press, 2000.

Armitage, David, and Braddick, Michael J., eds. *The British Atlantic World, 1500-1800*. New York: Palgrave Macmillan, 2002.

Aron, Stephen. *American Confluence: The Missouri Frontier from Borderland to Border States*. Bloomington and Indianapolis: Indiana University Press, 2006.

Arthur, Stanley trans. *M. Le Page Du Pratz, The History of Louisiana, or of the Western Parts of Virginia and Carolina: containing a description of the countries that lie on both sides of the river Mississippi: with an account of the settlements, inhabitants, soil, climate, and products*. London, 1764.

Ashby, Leroy. *With Amusement for All: A History of American Popular Culture Since 1830*. Lexington: The University Press of Kentucky, 2006.

Axtell, James. *The Invasion Within: the Contest of Cultures in Colonial North America*. New York: Oxford University Press, 1985.

Baird, Robert. *View of the Valley of the Mississippi, or the Emigrant’s and Traveller’s Guide to the West…*2nd ed. Philadelphia: H.S. Tanner, 1834.

Bancroft, Hubert Howe. *The Native Races of the Pacific States Vol. IV*. New York: A.L. Bancroft & Co., 1875.

Barger, Harold. *The Mining Industries, 1899-1939: A Study of Output, Employment, and Productivity*. 1944, Reprint; Arno Press, 1975.

Bauxar, Joe J. "The Historic Period," *Illinois Archaeology,* Vol. 1, (1973): 40-58.

Beesley, David. *Crow's Range: An Environmental History of the Sierra Nevada*. Reno: University of Nevada Press, 2004.

Bek, William G. "George Engelman, Man of Science." Parts 104. *Missouri Historical Review* Vol. 23 (1929): 167-206, 427-46, 514-35; Vol. 24 (1929): 66-86.

Belting, Natalia Maree. *Kaskaskia under the French Regime*. Urbana: University of Illinois Press, 1948.

Berkeley, Edmund, and Berkeley, Dorothy Smith. *George William Featherstonhaugh: The First U.S. Government Geologist.* History of American Science and Technology Series, ed. Lester D. Stephens. Tuscaloosa and London: University of Alabama Press, 1988.

Berlin, Ira. *Many Thousands Gone: The First Two Centuries of Slavery in North America*. Cambridge: Harvard University Press, 1998.

Bice, Richard A., Davis, Phyllis S., and Sundt, William M. *Indian Mining of Lead for Use in Rio Grande Glaze Paint: Report of the AS-5 Bethsheba Project Near Cerrillos, New Mexico.* Albuquerque: Archaeological Society, 2003.

Billon, Federic Louis. *Annals of St. Louis in Its Territorial Days, from 1804 to 1821: Being a Continuation of the Author's Previous Work, the Annals of the French and Spanish Period*. St. Louis: Printer for the Author, 1888.

Bining, Arthur C. *Pennsylvania Iron Manufacture in the Eighteenth Century*. Harrisburg: Pennsylvania Historical and Museum Commission, 1973.

Birk, Charles R. "Shortest Route to the Galena Lead Mines: The Lewistown Road." *Journal of the Illinois State Historical* Society, Vol. 66, No. 2 (1973): 187-197.

Blumin, Stuart M. *The Emergence of the Middle Class: Social Experience in the American City, 1760-1900*. Cambridge: Cambridge University Press, 1989.

Boydston, Jeanne. *Home & Work: Housework, Wages, and the Ideology of Labor in the Early Republic*. New York: Oxford University Press, 1990.

Brackenridge, Henry Marie. *Views of Louisiana, Together With a Journal of a Voyage up the Missouri River, in 1811.* Pittsburgh, 1814. Facsimile ed., Chicago: Quadrangle Books, 1962.

Brooks, James F. *Captives and Cousins: Slavery, Kinship, and Community in the Southwest Borderlands.* Chapel Hill: University of North Carolina Press, 2002.

Brosnan, Kathleen. *Uniting Mountain and Plain: Cities, Law and Environmental Change Along the Front Range*. Albuquerque: University of New Mexico Press, 2002.

Brown, Margaret B. "The Zimmerman Site: Further Excavations at the Grand Village of Kaskaskia," *Illinois State Museum Reports of Investigations*, No. 9 (1975), 116-120.

Brown, Margaret Kimball, and Dean, Lawrie Cena, eds. *The Village of Chartres in Colonial Illinois 1720-1765*. New Orleans: Polyanthos, Published for La Compagnie des Amis de Fort de Chartres, 1977.

Brown, Ronald C. *Hard Rock Miners: The Intermountain West, 1860-1920*. College Station: Texas A&M University Press, 1979.

Browner, Tara. *Heartbeat of the People: Music and Dance of the Northern Pow-Wow*. Urbana and Chicago: University of Illinois Press, 2002.

Buechler, Jeff, ed. *Proceedings of the Workshop on Historic Mining Resources, Defining the Research Questions for Evaluation and Preservation*. Vermillion, South Dakota: State Historic Preservation Center, 1988.

Burkett, Paul. *Marx and Nature: A Red and Green Perspective*. New York: St. Martin's Press, 1999.

Bushman, Richard. *The Refinement of America: Persons, Houses, Cities*. Vintage Books, 1993.

_____. "Markets and Composite Farms in Early America" *William and Mary Quarterly*, 3rd Ser., Vol. 55 (July 1998), 351-374.

Cadigan, Sean. "The moral Economy of the Commons: Ecology and Equity in the Newfoundland Cod Fishery, 1815-1855." *Labour/Le Travial*, Vol. 43 (1999): 9-42.

Calloway, Colin G. *New Worlds for All: Indians, Europeans, and the Remaking of Early America*. Baltimore: Johns Hopkins University Press, 1997.

Canny, Nicholas, and Pagden, Anthony, eds. *Colonial Identity in the Atlantic World, 1500-1800*. Princeton: Princeton University Press, 1987.

Carney, Judith. *Black Rice: The Origins of Rice Cultivation in the Americas*. Cambridge: Harvard University Press, 2001.

Carr, Lois Green, Menard, Russell R., and Walsh, Lorena S. *Robert Cole's World: Agriculture and Society in Early Maryland.* Chapel Hill: Published for the Institute of Early American History and Culture by the University of North Carolina Press, 1991.

Chandler, Alfred D., Jr. *The Visible Hand: The Managerial Revolution in American Business*. Cambridge: Belknap Press, 1977.

Chapman, Carl. "The Little Osage and Missouri Indian Village Sites," *Missouri Archaeologist*, Vol. 21, (1959): 1-67.

Chapman, Carl H. *A Preliminary Survey of Missouri Archaeology: Osage Indians IV*. New York: Garland Publishing Inc., 1974.

Clark, Claudia. *Radium Girls: Women and Industrial Health Reform, 1910-1935*. Chapel Hill: University of North Carolina Press, 1997.

Cleary, Patricia. "Contested Terrain: Environmental Agendas and Settlement Choices in Colonial St. Louis." *Common Fields: An Environmental History of St. Louis*, ed. Andrew Hurley, 58-72. St. Louis: Missouri Historical Society Press, 1997.

Cochra, Thomas C. *Frontiers of Change: Early Industrial in America*. Oxford: Oxford University Press, 1981.

Cohen, Benjamin R. "Surveying Nature: Environmental Dimensions of Virginia's First Scientific Survey, 1835-1842." *Environmental History*, Vol. 11, No. 1 (2006): 37-69.

Corgan, James X., ed. *Geological Sciences in the Antebellum South*. Alabama: University of Alabama Press, 1982.

Cornell, Saul. *The Other Founders: Anti-Federalism and the Dissenting Tradition in America, 1788-1828*. Published for the Omohundro Institute of Early American History and Culture, Williamsburg, Virginia Series. Chapel Hill: University of North Carolina Press, 1999.

Cowan, Ruth Schwartz. *A Social History of American Technology*. New York: Oxford University Press, 1997.

Cowie, Jefferson. *Capital Moves: RCA's Seventy-Year Quest for Cheap Labor*. New York: New Press, 1999.

Cronon, William. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. New York: Hill and Wang, 1983.

Cronon, William. “Modes of Prophecy and Production: Placing Nature in History,” *Journal of American History* Vol. 76 (March 1990), 1122-1131.

_____. *Nature’s Metropolis: Chicago and the Great West*. London: W.W. Norton & Company, 1991.

_____. "Kennecott Journey: The Paths out of Town," in *Under an Open Sky: Rethinking America's Western Past*, ed. William Cronon, George Miles, and Jay Gitlin. New York: W. W. Norton & Company, 1993.

_____. “A Place for Stories: Nature, History, and Narrative,” *Journal of American History* Vol. 78 (March 1992): 1347-76.

Cronon, William, ed. *Uncommon Ground: Rethinking the Human Place in Nature*. New York and London: W.W. Norton and Company, 1996.

Crosby, Alfred W. “The Past and Present of Environmental History,” *American Historical Review*, Vol. 100, No. 4 (Oct. 1995): 1177-1189.

Cumbler, John T. *Reasonable Use: The People, the Environment, and the State in New England, 1790-1930*. New York: Oxford University Press, 2001.

Curtis, Kent. "Greening Anaconda: EPA, ARCO, and the Politics of Space in Postindustrial Montana," in *Beyond the Ruins: The Meanings of Deindustrialization*, edited by Jefferson Cowie and Joseph Heathcott. Ithaca: Cornell University Press, 2003.

Cushing, Frank Hamilton. “Primitive Copper Working: An Experimental Study,” *American Anthropologist*, Vol. 7, No. 1 (1894): 93-117.

Dalzell, Robert. *Enterprising Elite: The Boston Associates and the World They Made*. Cambridge: Harvard University Press, 1987.

Daniels, C., and Kennedy, M. eds. *Negotiated Empires: Centers and Peripheries in the Americas, 1500-1820*. New York: Routledge, 2002.

Dann, Kevin, and Mitman, Gregg. “Essay Review: Exploring The Borders of Environmental History and the History of Ecology,” *Journal of the History of Biology*, Vol. 30 (1997): 291-302.

Davidson, Hugh. “The George Cresswell Lead Plantation,” *Material Culture*, Vol. 23, No. 2 (1991): 1-23.

Davis, Pearce. *The Development of the American Glass Industry*. Cambridge: Harvard University Press, 1949.

Dawley, Alan. *Class and Community: The Industrial Revolution in Lynn.* Cambridge: Harvard University Press, 1976.

Del Mar, Alexander. *A History of the Precious Metals: From the Earliest Times to the Present*. New York: Cambridge Encyclopedia Company, 1902.

Deutsch, Sarah. *No Separate Refuge: Culture, Class, and Gender on an Anglo-Hispanic Frontier in the American Southwest, 1880-1940*. New York: Oxford University Press, 1987.

Dew, Charles B. *Bond of Iron: Master and Slave at Buffalo Forge*. New York: W. W. Norton, 1994.

Dickason, Olive Patricia. *Canada's First Nations: A History of Founding Peoples from Earliest Times*. Norman: University of Oklahoma Press, 1992.

Din, Gilbert. "Spain's Immigration Policy in Louisiana and the American Penetration, 1792-1803," *Southwestern Historical Quarterly* 76 (1973), 255-76.

Doerflinger, Thomas. *A Vigorous Spirit of Enterprise: Merchants and Economic Development in Revolutionary Philadelphia*. Chapel Hill: University of North Carolina Press, 2001.

Dublin, Thomas. *Women at Work: The Transformation of Work and Community in Lowell, Massachusetts, 1826-1860*. New York: Columbia University Press, 1979.

Dupree, A. Hunter. "Comment: The Role of Technology in Society and the Need for Historical Perspective," *Technology and Culture,* Vol. 10 (October 1969): 528-534.

Du Val, Kathleen. *The Native Ground: Indians and Colonists in the Heart of the Continent*. Philadelphia: University of Pennsylvania, 2006.

Echeverria, Durand. "General Collot's plan for a Reconnaissance of the Ohio and Mississippi Valleys, 1796." *William and Mary Quarterly,* Vol. 9 (October 1952): 512-520.

Edelson, S. Max, Hall, Gwendolyn Midlo, Hawthorne, Walter, Eltis, David, Morgan, Philip, and Richardson, David. "AHR Exchange: The Question of "Black Rice" *American Historical Review,* Vol. 115, No. 1 (February 2010): 123-171.

Ekberg, Carl J. "Antoine Valentin de Gruy: Early Missouri Explorer," *Missouri Historical Review* Vol. 76 (January 1982): 136-150.

_____. *Colonial Ste. Genevieve: An Adventure on the Mississippi Frontier*. Tucson: Patrice Press, 1985.

Ekberg, Carl J. *French Roots in the Illinois Country: The Mississippi Frontier in Colonial Times*. Illinois: University of Illinois Press, 2000.

_____. *Francois Valle and His World: Upper Louisiana Before Lewis and Clark*. Columbia: University of Missouri Press, 2002.

Eldersveld Murphy, Lucy. *A Gathering of Rivers: Indians, Métis, and Mining in the Western Great Lakes, 1737–1832*. Lincoln: University of Nebraska Press, 2000.

Ellis, Joseph J. *American Sphinx: The Character of Thomas Jefferson*. New York: Alfred A. Knopf, 1997.

Eltis, David. *The Rise of African slavery in the Americas*. Cambridge: Cambridge University Press, 2000.

Emerson, Ralph Waldo. "Nature" in *Works by Ralph Waldo Emerson: Volume One, Nature, Addresses, and Lectures*. Boston: Phillips, Sampson & Co., 1909.

Emerson, Thomas E., and Lewis, R. Barry, eds. *Cahokia and the Hinterlands: Middle Mississippian Cultures of the Midwest*. Urbana: University of Illinois Press, 1991.

English, Peter. *Old Paint: A Medical History of Childhood Lead-Paint Poisoning in the United States to 1980*. New Brunswick, NJ: Rutgers University Press, 2001.

Erickson, Charlotte. *Invisible Immigrants: The Adaptation of English and Scottish Immigrants in Nineteenth-Century America*. Florida: University of Miami Press, 1972.

Faragher, John Mack. *Sugar Creek: Life on the Illinois Prairie.* New Haven: Yale University Press, 1986.

Faragher, John Mack, ed. *Rereading Frederick Jackson Turner: The Significance of the Frontier in American History and Other Essays*. New York: Henry Holt, 1994.

Faue, Elizabeth. "Retooling the Class Factory," *Labour History*, No. 82 (May 2002): 109 119

Fay, George E. "Lead-Silver Molds of the Osage Indians." *Transactions of the Kansas Academy of Science*, Vol. 52, No. 2 (1949): 205-208.

Figueiroa, Silvia, and Silva, Clarete. "Enlightened Mineralogists: Mining Knowledge in Colonial Brazil, 1750-1825," *Osiris, 2nd Series*, Vol. 15, Nature and Empire: Science and the Colonial Enterprise (2000): 174-189.

Fisher, Marvin. *Workshops in the Wilderness: The European Response to American Industrialization, 1830-1860*. New York: Oxford University Press, 1967.

Fishkin, Shelley Fisher. “Crossroads of Cultures: The Transnational Turn in American Studies—Presidential Address to the American Studies Association, November 12, 2004.” *American Quarterly* Vol. 57, No. 1. (March 2005): 17-57.

Foley, William E. *The Genesis of Missouri: From Wilderness Outpost to Statehood*. Columbia: University of Missouri Press, 1989.

Forbes, Jack D. “Frontiers in American History and the Role of the Frontier Historian,” *Ethnohistory* Vol. 15, (Spring 1968): 203-235.

Foster, John Bellamy. *Marx’s Ecology: Materialism and Nature*. New York: Monthly Review Press, 2000.

Fox-Genovese, Elizabeth. *Within the Plantation Household: Black and White Women of the Old South*. Chapel Hill: University of North Carolina Press Books, 1988.

Francaviglia, Richard V. *Hard Places: Reading the Landscapes of America's Historic Mining Districts*. Iowa City: University of Iowa Press, 1992.

Gallay, Alan. *The Indian Slave Trade: The Rise of the English Empire in the American South, 1670-1717*. New Haven: Yale University Press, 2001.

Garrison, George P. ed. “A Memorandum of M. Austin’s Journey from the Lead mines in the County of Wythe in the State of Virginia to the Lead Mines in the Province of Louisiana West of the Mississippi, 1796-1797.” *American Historical Review (AHR)*, Vol. 5 (1900): 518-542.

Gilje, Paul A., ed. *Wages of Independence: Capitalism in the Early American Republic*. Madison: Madison House, 1997.

Gilroy, Paul. *The Black Atlantic: Modernity and Double Consciousness*. Cambridge: Harvard University Press, 1993.

Glacken, Clarence. *Traces on the Rhodian Shore: Nature and Culture in Western Thought From Ancient Times to the End of the Nineteenth Century*. Berkeley: University of California Press, 1967.

Gordon, Robert B. and Malone, Patrick M. *The Texture of Industry: An Archaeological View of the Industrialization of North America*. New York: Oxford University Press, 1994.

Green, Michael D. “The Expansion of European Colonization to the Mississippi Valley, 1780-1880.” *The Cambridge History of the Native Peoples of North America,* eds. Bruce G. Trigger and Wilcomb E. Washburn, Vol. 1, *North America: Part 1.* Cambridge: Cambridge University Press, 1996.

Gregory, Cedric Errol. *A Concise History of Mining*. Oxford: Pergamon Press, 1980.

Griffiths, Tom and Robin, Libby. eds. *Ecology and Empire: The Environmental History of Settler Societies*. Edinburgh: Edinburgh University Press, 1998.

Grove, Richard H. *Green Imperialism: Colonial Expansion, Tropical Islands Edens and the Origins of Environmentalism, 1600-1860*, Studies in Environment and History, eds. Donald Worster and Alfred W. Crosby. Cambridge: Cambridge University Press, 1995.

Gruesz, Kristen Silba. *Ambassadors of Culture: The Transamerica Origins of Latino Writing,* Princeton: Princeton University Press, 2002.

Gutman, Herbert. *Power and Culture: Essays on the American Working Class*, eds. Ira Berlin. New York: Pantheon Books, 1987.

_____. *The Black Family in Slavery and Freedom* 1750-1925, New York: Pantheon Books, 1976.

Habakkuk, H. J. *American and British Technology in the Nineteenth Century*. Cambridge: Cambridge University Press, 1962.

Hall, Jacquelyn Dowd, et al. *Like A Family: The Making of a Southern Mill World*. Chapel Hill: University of North Carolina Press, 1987.

Halttunen, Karen. *Confidence Men and Painted Women: A Study of Middle-Class Culture in America, 1830-1870*. New Haven: Yale University Press, 1982.

Hammond, George P., and Rey, Agapito. *Narratives of the Coronado expedition, 1540-1542, Don Hernando Alvarado, An Account of Don Hernando Alvarado's travels among the Pueblos in 1540*. New York: AMS Press, 1977.

Handlin, Oscar, and Handlin, Mary Flug. *Commonwealth; a Study of the Role of Government in the American Economy: Massachusetts, 1774-1861*. Cambridge: Belknap Press of Harvard University Press, 1969.

Hanley, Lucy Elizabeth. "Lead Mining in the Mississippi Valley during the Colonial Period." Master's Thesis, St. Louis University, 1942.

Hardesty, Donald L. *The Archeology of Mining and Miners: A View from the Silver State* Special Publication Series, No. 6. Ann Arbor: The Society for Historical Archeology, 1988.

_____. *Mining Archaeology in the American West: A View from the Silver State* (Lincoln:University of Nebraska Press and the Society for Historical Archaeology, 2010).

Hardin, Garrett. “The Tragedy of the Commons,” *Science,* Vol. 162 (1968): 1243-1248.

Harley, J.B. *The New Nature of Maps: Essays in the History of Cartography*. Baltimore: John Hopkins University Press, 2002.

_____. “Rereading the Maps of the Columbian Encounter.” *Annals of the Association of American Geographers,* Vol. 82, No. 3 (1992): 522-536.

Harn, Orlando C. *Lead The Precious Metal*. New York: The Century Co., 1924.

Hartley, E.N. *Iron Works on The Saugus: The Lynn and Braintree Ventures of the Company of Undertakers of the Ironworks in New England*. Tulsa: University of Oklahoma Press, 1957.

Haskell, Thomas, and Teichgraeber, Richard F. eds. *The Culture of the Market: Historical Essays.* Cambridge: Cambridge University Press, 1993.

Havighurst, Walter. *Wilderness for Sale: The Story of the First Western Land Rush*. New York: Hastings House, 1956.

Hays, Samuel P. with Hays, Barbara D. *Beauty, Health, and Permanence: Environmental Politics in the United States, 1955-1985*. Cambridge: Cambridge University Press, 1987.

Hayward, J. Lyman. *The Los Cerrillos Mines [N. M.] and their Mineral Resources: A description of the mines in the Los Cerrillos and Galisteo mining districts, accompanied by a map of the same, drawn from actual surveys*. South Framingham, MA: C. Clark Printing Co., 1880.

Hazen, Robert M. “The Founding of Geology in America: 1771 to 1818,” *Geological Society of American Bulletin* Vol. 85 (1974): 1827-1834.

Heidenreich, Conrad E. and Dahl, Edward H. “The French Mapping of North America, 1700-1760.” *Map Collecto*r Vol. 19 (June, 1982): 2-7.

Heidenreich, Conrad E. “Mapping the Great Lakes: The Period of Imperial Rivalries, 1700-1760.” *Cartographica* Vol. 18, No. 3 (1981), 74-109.

Herod, Andrew. *Labor Geographies*. New York: Guilford Press, 2001.

Heyl, A.V. “Isotopic Study of Galena from the Upper Mississippi Valley, the Illinois Kentucky, and Some Appalachian Valley Mineral Districts.” *Economic Geology,* Vol. 60: 693-714.

Hildreth, Richard. *The History of the United States of America: Colonial, 1497-1688 Volume 1*. New York: Harper, 1863.

Hill, Christopher V. *South Asia: An Environmental History: Nature And Human Societies*. Santa Barbara: ABC-CLIO, 2008.

Hodge, Frederick W., ed. *Handbook of American Indians North of Mexico, Vol. 2*. New York: Pageant Books, 1960.

Hodges, Henry. *Technology in the Ancient World*. New York: Barnes & Noble Books, 1992.

Hogan, Richard. *Class and Community in Frontier Colorado*. Lawrence: University Press of Kansas, 1990.

Horn, James, Lewis, Jan and Onuf, Peter, eds. *The Revolution of 1800: Democracy, Race, and the New Republic*. Charlottesville: University of Virginia, 2002.

Hornbeck Tanner, Helen, ed. *Atlas of Great Lakes Indian History*. Norman: University of Oklahoma Press, 1987.

Horwitz, Morton J. *The Transformation of American Law 1780-1860*. Cambridge: Harvard University Press, 1977.

Houck, Louis. *A History of Missouri from the Earliest Explorations and Settlements Until the Admission of the State into the Union, Vols.1, II, & III*. Chicago: R.R. Donnelley & Sons Company, 1908.

_____. *The Spanish Regime in Missouri: a collection of papers and documents relating to upper Louisiana principally within the present limits of Missouri during the dominion of Spain, from the Archives of the Indies at Seville, etc., translated from the original Spanish into English, and including also some papers concerning the supposed grant to Col. George Morgan at the mouth of the Ohio, found in the Congressional library, Vol. 2*. Chicago: R.R. Donnelley and Sons Company, 1909.

Hounshell, David A. *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States*. Baltimore: Johns Hopkins University Press, 1984.

Hughes, Donald J. *Pan's Travail: Environmental Problems of the Ancient Greeks and Romans*. Baltimore: The Johns Hopkins Press, 1994.

Hurley, Andrew. *Environmental Inequalities: Class, Race, and Industrial Pollution in Gary, Indiana, 1945-1980*. Chapel Hill: University of North Carolina Press, 1995.

Hussey, Miriam. *The Wetherill Papers, 1762-1899; being the collection of business records of the store and white lead works founded by Samuel Wetherill in the late eighteenth century ... held by the Trustees of the University of Pennsylvania for the Industrial research department*. Philadelphia: Industrial research dept., Wharton school of finance and commerce, University of Pennsylvania, 1942.

Igler, David. *Industrial Cowboys: Miller and Lux and the Transformation of the Far West, 1850-1920*. Berkeley: University of California Press, 2005.

Ingalls, Walter Renton. *Lead and Zinc in the United States: Comprising an economic history of the mining and smelting of the metals and the conditions, which have affected the development of the industries*. New York: Hill, 1908.

Ingham, John N. *Making Iron and Steel: Independent Mills in Pittsburgh, 1820-1920*. Columbus: Ohio State University Press, 1991.

Innes, Stephen. *Labor in a New Land: Economy and Society in Seventeenth-Century Springfield*. Princeton: Princeton University Press, 1983.

Iseminger, William R. "Culture and Environment in the American Bottom: The Rise and Fall of Cahokia Mounds." *Common Fields: An Environmental History of St. Louis*, ed. Andrew Hurley, 38-57. St. Louis: Missouri Historical Society Press, 1997.

Isenberg, Andrew. *Mining California: An Ecological History*. New York: Hill & Wang, 2005.

Jackson, Donald Dean, and Ronda, James P. *Thomas Jefferson & the Stony Mountains: Exploring the West from Monticello.* Tulsa: University of Oklahoma Press, 1993.

Jacobs, Nancy. *Environment, Power, and Injustice: A South African History*. *Studies in Environment and History*. Cambridge: Cambridge University Press, 2003.

Jacoby, Karl. *Crimes Against Nature: Squatters, Poachers, Thieves, and the Hidden History of American Conservation*. Berkeley: University of California Press, 2001.

Jaffee, David. "Peddlers of Progress and the Transformation of the Rural North, 1760 1850," *Journal of American History* Vol. 78 (September 1991): 511-535.

Jamieson, Duncan R. "American Environmental History," *Choice*, Vol. 32 (Sept 1994): 49-61.

Jefferson, Thomas. *Notes on the State of Virginia*, ed. Frank Shuffelton. New York: Penguin Books, 1999.

Jefferson, Thomas, and Dunbar, William. *Documents Relating to the Purchase and Exploration f Louisiana.* New York: Houghton Mifflin, 1904

Jennings, Francis. *The Invasion of America: Indians, empires, and republics in the Great Lakes region, 1650-1815*. Chapel Hill: University of North Carolina Press, 1991.

Jeremy, David. *Transatlantic Industrial Revolution: The Diffusion of Textile Technologies Between Britain and America, 1790 - 1830s*. Cambridge: MIT Press, 1981.

Johnson, Walter. *Soul by Soul: Life Inside the Antebellum Slave Market.* Cambridge and London: Harvard University Press, 1999.

Jones, Gareth Steadman. *Languages of Class: Studies in English Working Class History, 1832-1982*. Cambridge: Cambridge University Press, 1983.

Jones, Jacqueline. *Labor of Love, Labor of Sorrow: Black Women, Work, and the Family from Slavery to the Present*. New York: Basic Books, 1986.

Jordan, Winthrop D. *White Over Black: American Attitudes Toward the Negro, 1550 1812*. Chapel Hill: University of North Carolina Press, 1968.

Joyce, Patrick. *Visions of the People: Industrial England and the Question of Class, 1848-1914*. New York: Cambridge University Press, 1991.

Karrow, Robert W., and Buisseret, David. *Gardens of Delight: Maps and Travel Accounts of Illinois and the Great Lakes from the Collection of Hermon Dunlap Smith, An Exhibition at The Newberry Library 29 Oct – 31 January 1985*. Chicago: Newberry Library, 1984.

Kasson, John F. *Civilizing the Machine: Technology and Republican Values in America, 1776-1900*. New York: Macmillan, 1976.

Kelley, Robert L. *Gold vs. Grain: The Hydraulic Mining Controversy in California's Sacramento Valley*. Glendale: Arthur H. Clark Company, 1959.

Kellogg, Louise. *The French Regime in Wisconsin and the Northwest*. Madison: The State Historical Society of Wisconsin, 1925.

Kelman, Ari. *A River and Its City: The Nature of Landscape in New Orleans*. Berkeley: University of California Press, 2003.

Kinnaird, Lawrence. “American Penetration of Louisiana,” in George P. Hammond, ed., *New Spain and the Anglo-American West, Vol. 1*. Lancaster: Lancaster Press, 1932.

Knoblauch, Frieda. *The Culture of Wilderness: Agriculture as Colonization in the American West*. Chapel Hill: University of North Carolina Press, 1996.

Kolodny, Annette. *The Land Before Her: Fantasy and Experience of the American Frontiers, 1630-1860*. Chapel Hill: University of North Carolina Press, 1984.

Kulikoff, Allan. “The Transition to Capitalism in Rural America” *William and Mary Quarterly*, 3rd Ser., Vol. 46 (January 1989): 121-144.

Kupperman, Karen Ordahl. *Providence Island: The Other Puritan Colony, 1630-1641*. Cambridge: Harvard University Press, 1993.

_____. *America in European Consciousness.* Chapel Hill: University of North Carolina, 1995.

_____. *Indians and English: Facing Off in Early America.* New York: Cornell University Press, 2000.

LaDow, Beth. *The Medicine Line: Life and Death on the North American Borderland*. New York: Routledge, 2001.

Lamar, Howard, and Thompson, Leonard. “Comparative Frontier History,” in Limerick, Milner, and Rankin, eds., *The Frontier in History: North America and Southern Africa Compared*. New Haven: Yale University Press, 1981.

Lamborn, Robert H. *A Rudimentary Treatise on the Metallurgy of Silver and Lead*. London: J. Weale, 1861.

Landau, Ralph, and Rosenberg, Nathan. "Successful Commercialization in the Chemical Process Industries," *Technology and the Wealth of Nations*, eds. Nathan Rosenberg, Ralph Landau, and David C. Mowery. Stanford: Stanford University Press, 1992.

Lander, Ernest M., Jr. *The Textile Industry in Antebellum South Carolina*. Baton Rouge: Louisiana State University Press, 1969.

Langston, Nancy. *Where Land and Water Meet: A Western Landscape Transformed*. Seattle: University of Washington Press, 2003.

Lankton, Larry D. *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines*. New York: Oxford University Press, 1991.

Lapp, Rudolph M. *Blacks in Gold Rush California*. New Haven: Yale University Press, 1977.

Larson, Brooke. *Cochabamba: 1550-1900, Colonialism and Agrarian Transformation in Bolivia*. Durham: Duke University Press, 1998.

Larson, John L. *Internal Improvement: National Public Works and the Promise of Popular Government in the Early United States*. Chapel Hill: University of North Carolina Press, 2001.

Laudan, Rachel. *From Mineralogy to Geology: The Foundations of a Science, 1650 1830*. Chicago: University of Chicago Press, 1987.

Laurie, Bruce. *Working People of Philadelphia, 1800-1850*. Philadelphia: Temple University Press, 1980.

_____. *Artisans into Workers: Labor in Nineteenth-Century America*. Urbana: University of Illinois Press, 1997.

Layton, Edwin. "Mirror-Image Twins: The Communities of Science and Technology in 19th-Century America," *Technology and Culture*, Vol. 12, No. 4 (1971): 562-80.

LeCain, Timothy J. "Moving Mountains: Technology and the Environment in Western Copper Mining," Ph.D. diss., University of Delaware, 1998.

Lepore, Jill. *The Name of War: King Philip's War and the Origins of American Identity*. New York: Vintage, 1998.

Limerick, Patricia Nelson. *The Legacy of Conquest: The Unbroken Past of the American West*. New York: W. W. Norton & Company, 1988.

Long, Priscilla. *Where the Sun Never Shines, A History of America's Bloody Coal Industry*. New York: Paragon House, 1989.

Lewis, W. David. *Sloss Furnaces and the Rise of the Birmingham District: an Industrial Epic*. Tuscaloosa: University of Alabama Press, 1994.

Lewis, Ronald L. *Coal. Iron, and Slaves: Industrial Slavery in Maryland and Virginia, 1715-1865*. Contributions in Labor History Series. Westport: Greenwood Press, 1979.

Licht, Walter. *Industrializing America: The Nineteenth Century*. Baltimore: Johns Hopkins University Press, 1995.

Lingenfelter, Richard. *The Hardrock Miners: A History of the Mining Labor Movement in the American West, 1863-1893*. Berkeley: University of California Press, 1974.

Long, Priscilla. *Where the Sun Never Shines, A History of America's Bloody Coal Industry*. New York: Paragon House, 1989.

Lykins, William H.R. “On the Mound-Builders’ Knowledge of Metals.” *Kansas City Review of Science and Industry,* (1882): 535.

Malcolm, Lewis, G., ed. *Cartographic Encounters: Perspectives on Native American Mapmaking and Map Use*. Chicago: University of Chicago Press, 1998.

Mancall, Peter C., and Merrell, James H., eds. *American Encounters: Natives and New Comers from European Contact to Indian Removal, 1500-1850*. New York: Routledge, 2000.

Markowitz, Gerald, and Rosner, David. *Deceit and Denial: The Deadly Politics of Industrial Pollution*. Berkeley: University of California Press, 2002.

Marks, Paula Mitchell. *Precious Dust: The American Gold Rush Era, 1848-1900*. William Morrow and Company, Inc., 1994.

Marsh, George Perkins. *Man and Nature*, ed. Lowenthal, David. Cambridge: Belknap Press of Harvard University Press, 1965.

Marshall, Thomas Maitland. *The Life and Papers of Frederick Bates, Vol. I*. St. Louis: Missouri Historical Society, 1926.

Martin, Calvin. *Keepers of the Game: Indian-Animal Relations and the Fur Trade*. Berkley: University of California Press, 1978.

Marx, Jennifer. *The Magic of Gold*. New York: Doubleday & Company, Inc., 1978.

Marx, Leo. *The Machine in the Garden: Technology and the Pastoral Ideal in America*. New York: Oxford University Press, 2000.

Massey, Doreen. *Spatial Divisions of Labor: Social Structures and the Geography of Production*. London: Macmillan, 1984.

Matson, Cathy. *The Economy of Early America: Historical Perspectives & New Directions*, University Park: The Pennsylvania State University Press, 2006.

McClellan, James E., III., and Regourd, Francois. “The Colonial Machine: French Science and Colonization in the Ancien Regime,” *Osiris*, 2nd Series, Vol. 15, Nature and Empire: Science and the Colonial Enterprise, (2000): 31-50.

McCord, Carey P. “Lead and Lead Poisoning in Early America: Lead Mines and Lead Poisoning,” *Industrial Medicine and Surgery*, Vol. 22, No. 11 (1953): 534-539.

McCoy, Drew R. *The Elusive Republic: Political Economy in Jeffersonian America*. Chapel Hill: University of North Carolina Press, 1980.

McCready, Benjamin W. *On the Influence of Trades, Professions, and Occupations in the United States, in the Production of Disease*, 1837, Introductory essay by Genevieve Miller. Baltimore: Johns Hopkins Press, 1943.

McEvoy, Arthur F. "Working Environments: An Ecological Approach to Industrial Health and Safety," *Technology and Culture*, supplement to Vol. 36, No. 2 (April 1995): 145-173.

_____. *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850 1980*. New York: Cambridge University Press, 1986.

McGaw, Judith. *Early American Technology: Making and Doing Things from the Colonial Era to 1850*. Chapel Hill: Published for the Institute of Early American History and Culture, Williamsburg, Virginia by the University of North Carolina Press, 1994.

_____. *Most Wonderful Machine: Mechanization and Social Change in Berkshire Paper Making, 1801-1885*. Princeton: Princeton University Press, 1987.

McNeil, John. *Something New Under The Sun: An Environmental History of The Twentieth-Century World.* New York: W.W. Norton & Company, 2000.

McNeill, J. R. "The Nature of Environmental History: Observations on the Nature and Culture of Environmental History," *History and Theory, Theme Issue* 42 (2003): 5-43.

Meinig, D. W. *The Shaping of America: A Geographical Perspective on 500 Years of History, Vol. 2, Continental America, 1800-1867*. New Haven: Yale University Press, 1993.

Merchant, Carolyn. *Ecological Revolutions: Nature, Gender, and Science in New England*. Chapel Hill: University of North Carolina Press, 1989.

_____. "Gender and Environmental History." *Journal of American History* Vol. 76 March 1990): 1117-1121.

Mereness, Newton D., ed. *Travels in the American Colonies, 1690-1783, Edited Under the Auspices of the National society of the Colonial Dames of America*. New York: Antiquarian Press, 1961.

Mihesuah, Devon A. *Natives and Academics: Researching and Writing about American Indians*. Lincoln: University of Nebraska Press, 1998.

Miller, Randall M. *The Cotton Mill Movement in Antebellum Alabama*. New York: Arno Press, 1978.

Miller, Char, ed. *American Forests: Nature, Culture, Politics*. Lawrence: University Press of Kansas, 1997.

Misa, Thomas J. *A Nation of Steel: The Making of Modern America, 1865-1925*. Baltimore and London: Johns Hopkins University Press, 1995.

Mitman, Gregg "In Search of Health: Landscape and Disease in American Environmental History." *Environmental History* Vol. 10 (2005): 184-209.

Mitman, Gregg, Murphy, Michelle, and Sellers, Christopher. *Landscapes of Exposure: Knowledge and Illness in Modern Environments, Osiris* Vol. 19: A Research Journal Devoted to the History of Science and Its Cultural Influences, Distributed for University of Chicago Press Journals, 2004.

Molloy, Peter M. *The History of Metal Mining and Metallurgy: An Annotated Bibliography*. New York: Garland, 1986.

Montgomery, David. *Fall of the House of Labor: The Workplace, the State, and American Labor Activism, 1865-1925*. Cambridge: Cambridge University Press, 1987.

_____. *Workers in Control of America: Studies in the History of Work, Technology, and Labor Struggles*. Cambridge: New York: Cambridge University Press, 1979.

Morgan, Edmund S. *American Slavery, American Freedom: the Ordeal of Colonial Virginia*. New York: W. W. Norton & Company, 1975.

Morgan, Philip D. *Slave Counterpoint: Black Culture in the Eighteenth-Century Chesapeake and Lowcountry*. Chapel Hill and London: University of North Carolina Press, 1998.

Morlot, A. "On The Date of The Copper Age in the United States," *Proceedings of the American Philosophical Society,* Vol. 9, No. 68 (1862): 111-114.

Morrissey, Katherine. *Mental Territories: Mapping the Inland Empire*. Ithaca: Cornell University Press, 1997.

Morrow, Lynn. "New Madrid and Its Hinterland: 1783-1826," *The Bulletin of the Missouri Historical Society*, Vol. 34, No. 4, Part II (1980): 241-250.

Morse, Kathryn. *The Nature of Gold: An Environmental history of the Klondike Gold Rush*. Seattle: University of Washington Press, 2003.

Motten, Clement G. *Mexican Silver and the Enlightenment*. Philadelphia: Octagon Books, 1950.

Mouat, Jeremy. *Metal Mining in Canada, 1840-1950*. Ottawa: National Museum of Science and Technology, 2000.

Mouat, Jeremy. *Roaring days: Rossland's Mines and the History of British Columbia*. Vancouver: UBC Press, 1995.

Mulholland, James A. *A History of Metals in Colonial America*. Alabama: University of Alabama Press, 1981.

Murphy, Lucy Eldersveld. "To Live Among Us: Accommodation, Gender, and Conflicts in the Western Great Lakes Region, 1760-1832," in Andrew R.L. Cayton and Fredrika J. Teute eds., *Contact Points: American Frontiers from the Mohawk Valley to the Mississippi, 1750-1830*. Chapel Hill: University of North Carolina Press, 1998.

Murphy, Michelle. "The Elsewhere within Here" and Environmental Illness; of, How to Build Yourself a Body in a Safe Space," *Configurations*, Vol. 8 (2000): 87-120.

Nash, Gary. *The Urban Crucible: The northern Seaports and the Origins of the American Revolution*. Cambridge: Harvard University Press, 1979.

Nash, Linda. "Finishing Nature: Harmonizing Bodies and Environments in Late Nineteenth-Century California," *Environmental History,* Vol. 8 (2003): 25-52.

Nelson, Daniel. *Farm and Factory: Workers in the Midwest, 1880-1990*. Bloomington: Indiana University Press, 1995.

_____. *Managers and Workers: Origins of the Twentieth-century Factory System in the United States, 1880-1920*. Madison: University of Wisconsin Press, 1995.

Noble, David F. *America by Design: Science, Technology, and the Rise of Corporate Capitalism*. New York: Knopf, 1977.

_____. *Forces of Production: a Social History of Industrial Automation*. New York: Knopf, 1984.

Norwood, Vera. *Made from This Earth: American Women and Nature*. Chapel Hill: University of North Carolina Press, 1993.

Nye, David. *America as Second Creation: Technology and Narratives of New Beginnings*. Cambridge: MIT Press, 2003.

Opie, John. *Nature's Nation: An Environmental History of the United States*. Fort Worth: Harcourt Brace College Publishers, 1998.

Pascoe, Peggy. “Western Women at the Cultural Crossroads,” Patricia Nelson Limerick, et. al., *Trails: Towards a New Western History*. Lawrence: University Press of Kansas, 1991.

Paul, Rodman. *Mining Frontiers of the Far West, 1848-1880*, A Revised, Expanded Edition by Elliott West. Albuquerque: University of New Mexico Press, 2001.

Peck, Gunther. *Reinventing Free Labor: Padrones and Immigrant Workers in the North American West, 1880-1930*. New York: Cambridge University Press, 2000.

Perino, Gregory. “The Krueger Site, Monroe County, Illinois,” *In Mississippian Site Archaeology: Illinois Archaeological Survey Bulletins*, Vol. 8 (1971): 1-148.

Peskin, Lawrence. *Manufacturing Revolution: the Intellectual Origins of Early American Industry*. Baltimore: Johns Hopkins University Press, 2003.

Petrik, Paula. *No Step Backward: Women and Family on the Rocky Mountain Mining Frontier, Helena, Montana, 1865-1900*. Helena, Montana Historical Society Press, 1987.

Phillips, W.A. “Aboriginal Quarries and Shops at Mill Creek, Illinois*,” American Anthropologist, New Series*, Vol. 2, No. 1 (1900): 37-52.

Prude, Jonathan, *The Coming of Industrial Order: Town and Factory Life in Rural Massachusetts, 1810-1860*. Cambridge: Cambridge University Press, 1983.

Pulsifer, William. *Notes for the History of Lead and an inquiry into the development of the manufacture of white lead and lead oxides*. New York: D. Van Nostrand Co., 1888.

Pyne, Stephen J, “Firestick History.” *Journal of American History*, Vol. 76 (March1990): 1132-1141.

Quimby, George I., Jr. “Indian Trade Objects in Michigan and Louisiana,” *Michigan Academy of Science, Arts, and Letters* Vol. 27 (1941): 543-551.

Quinn, M. L. "Industry and Environment in the Appalachian Copper Basin, 1890-1930." *Technology and Culture* Vol. 34 (1993): 575-612.

Quivik, Fredric L., "The Historic Landscape of Butte and Anaconda, Montana," *Images of an American Land: Vernacular Architecture in the Western United States*, ed. Thomas Carter. Albuquerque: University of New Mexico, 1997).

_____. "Smoke and Tailings: An Environmental History of Copper Smelting Technologies in Montana, 1880-1930," Ph.D. diss., University of Pennsylvania, 1998.

Raymond, Robert. *Out of the Fiery Furnace: The Impact of Metals on the History of Mankind*. University Park: Pennsylvania State University Press, 1986.

Rice, Stephen. *Minding the Machine: Languages of Class in Early Industrial America*. Berkeley: University of California, 2004.

Richter, Daniel. *The Ordeal of the Longhouse: the Peoples of the Iroquois League in the Era of European Colonization*: Chapel Hill: University of North Carolina Press, 1993.

_____. *Facing East From Indian Country: A Native History of Early America.* Cambridge: Harvard University Press, 2001.

Rickard, T. A. *Man and Metals: A History of Mining in Relation to the Development of Civilization*. 1932, Reprint; Arno Press, 1974.

Rilling, Donna. *Making Houses/Crafting Capitalism: Builders in Philadelphia, 1790 1850*. Philadelphia: University of Pennsylvania Press, 2001.

Rock, Howard B. *Artisans of the New Republic: The Tradesmen of New York City*. New York: New York University Press, 1979.

Roediger, David R. *The Wages of Whiteness: Race and the Making of the American Working Class*. Revised Edition. London and New York: Verso, 1999.

Rome, Adam. *The Bulldozer in the Countryside: Suburban Sprawl and the Rise of American Environmentalism*. Cambridge: Cambridge University Press, 2001.

Rosenberg, Nathan. "Technology and the Environment," *Technology and Culture* Vol. 12 (October 1971), 543-61.

Rothensteiner, John E. "Earliest History of Mine La Motte," *Missouri Historical Review*, Vol. 20, No. 2 (Jan 1926): 199-213.

Rowland, Dunbar, and Sanders, A.G. *Mississippi Provincial Archives, 1702-1729 Vol. 2*. Jackson: Press of Mississippi Department of Archives and History, 1927.

Rudwick, Martin J. S. "The Emergence of a Visual Language for Geological Science, 1760-1840." *History of Science* 14 (1976), 149-195.

Salisbury, Neal. *Manitou and Providence: Indians, Europeans, and the Making of New England, 1500-1643*. New York: Oxford University Press, 1984.

Schama, Simon. *Landscape and Memory.* New York: A.A. Knopf, 1995.

Schlarman, Joseph H. *From Quebec to New Orleans; The Story of the French in America Fort de Chartres*. Belleville: Buechler Publishing Co., 1929.

Schockel, Bernard. "Settlement and Development of Jo Daviess County" *Geography of the Galena and Elizabeth Quadrangles*, eds. Arthur Trowbridge and Eugene Shaw, No. 26, Illinois State Geological Survey. Urbana: State of Illinois and University of Illinois, 1916.

Schroeder, Walter A. *Opening the Ozarks: A Historical Geography of Missouri's Ste. Genevieve District 1760-1830*. Columbia: University of Missouri Press, 2002.

Scott, James. *Seeing Like A State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven: Yale University Press, 1998.

Scranton, Philip. *Proprietary Capitalism: The Textile Manufacture at Philadelphia, 1800- 1885*. New York: Cambridge University Press, 1983.

_____. *Endless Novelty: Specialty Production and American Industrialization, 1865-1925*. Princeton: Princeton University Press, 1997.

Seed, Patricia. *Ceremonies of Possession in Europe's Conquest of the New World, 1492 1640*. Cambridge: Cambridge University Press, 1995.

Sellers, Charles G. *The Market Revolution: Jacksonian America, 1815-1848*. Oxford and New York: Oxford University Press, 1991.

Sellers, Christopher C. *Hazards of the Job: From Industrial Disease to Environmental Health Science,* Chapel Hill and London: University of North Carolina Press, 1997.

Shelton, Cynthia J. *The Mills of Manayunk: Industrialization and Social Conflict in the Philadelphia Region, 1787-1837*. Baltimore: Johns Hopkins University Press, 1986.

Shoemaker, Nancy, *Negotiators of Change: Historical Perspectives on Native American Women*. New York: Routledge, 1995.

Shy, John. *A People Numerous and Armed: Reflections on the Military Struggle for American Independence*: Ann Arbor: University of Michigan Press, 1990.

Sigstad, John S. "A Field Test for Catlinite" *American Antiquity* Vol. 35. No. 3 (1970): 377-382.

Silliman, Benjamin. "The Turquoise of New Mexico," *American Journal of Science,* Vol. 22 (July 1881): 67-71.

Silver, Beverly J. *Forces of Labor: Workers' Movements and Globalization since 1870*. Cambridge: Cambridge University Press, 2003.

Slaughter, Thomas P. *The Whiskey Rebellion: Frontier Epilogue to the American Revolution.* New York and Oxford: Oxford University Press, 1986.

Slotkin, Richard. *The Fatal Environment: The Myth of the Frontier in the Age of Industrialization, 1800-1890*. New York: Athenaeum, 1985.

Smith, Duane A. *Rocky Mountain Mining Camps: The Urban Frontier*. Indiana: Indiana University Press, 1967.

_____. *Mining America: the Industry and the environment, 1800-1980*. Boulder: University of Colorado Press, 1993.

Smith, Henry Nash. *Virgin Land: The American West as Symbol and Myth*. Cambridge: Harvard University Press, 1971.

Smith, Merritt Roe. *Harpers Ferry Armory and the New Technology: The Challenge of Change*. Ithaca: Cornell University Press, 1977.

Sobel, Mechal. *The World They Made Together: Black and White Values in Eighteenth Century Virginia*. Princeton: Princeton University Press, 1987.

Squier, Ephriam G., and Davis, Edwin G. *Ancient Monuments of the Mississippi Valley*. Washington: Smithsonian Institution, 1848.

Starobin, Robert. *Industrial Slavery in the Old South*. New York: Oxford University Press, 1970.

Steinberg, Theodore. *Nature Incorporated: Industrialization and the Waters of New England*. Cambridge: Cambridge University Press, 1991.

Stewart, Mart A. *What Nature Suffers to Groe: Life, Labor, and Landscape on the Georgia Coast*. Athens: University of Georgia Press, 1996.

Stilgoe, John R. *Common landscape of America, 1580 to 1845*. New Haven: Yale University Press, 1982.

Stiller, David. *Wounding the West: Montana, Mining, and the Environment*. Lincoln: University of Nebraska Press, 2000.

Stokes, Melvyn. and Stephen Conway. eds. *The Market Revolution in America: Social, Political, and Religious Expressions, 1800-1880*. University of Virginia, 1996.

Stoll, Steven. *Larding the Lean Earth: Soil and Society in Nineteenth-Century American*. New York: Hill and Wang, 2002.

Stoltman, James B, ed. *New Perspectives on Cahokia: Views from the Periphery*. Madison: University of Wisconsin, 1991.

Stott, Richard B. *Workers in the Metropolis: Class, Ethnicity, and Youth in Antebellum*. Ithaca: Cornell University Press, 1990.

Sullivan, William A. *The Industrial Worker in Pennsylvania, 1800-1840*. Harrisburg: Pennsylvania Historical and Museum Commission, 1955.

Surrey, N.M. Miller. *Calendar of Manuscripts in Paris Archives and Libraries Relating to the History of the Mississippi Valley to 1803*. Washington: Carnegie I Institution of Washington Department of Historical Research, 1926.

Swartzlow, Ruby. "The Early History of Lead Mining in Missouri, Part I" *Missouri Historical Review*, Vol. 28, No. 3 (April 1934): 184-194.

_____. "The Early History of Lead Mining in Missouri, Part II" *Missouri Historical Review*, Vol. 28, No. 4 (July 1934): 287-295.

_____. "The Early History of Lead Mining in Missouri, Part III" *Missouri Historical Review*, Vol. 29, No. 1 (October 1934): 27-34.

_____. " The Early History of Lead Mining in Missouri, Part IV" *Missouri Historical Review*, Vol. 29, No. 2 (January 1935): 109-114.

_____. " The Early History of Lead Mining in Missouri, Part IV" *Missouri Historical Review*, Vol. 29, No. 3 (April 1935): 195-205.

Stine, Jeffrey K., and Tarr, Joel A. "At the Intersection of Histories: Technology and the Environment." *Technology and Culture* Vol. 39, No. 4 (Oct., 1998): 601-640.

Taylor, Alan. *Liberty Men and Great Proprietors.* Chapel Hill: University of North Carolina Press, 1990.

_____. "Unnatural Inequalities: Social and Environmental Histories," *Environmental History*, Vol. 1 (1996): 6-19.

_____. 'Wasty Ways': Stories of American Settlement," *Environmental History* Vol. 3 (July 1998): 291-310.

Taylor, George Rogers. *The Transportation Revolution, 1815-1865. Volume 4 of the Economic History of the United States*. New York: Rinehart and Company, 1951.

Thomas, Cyrus. *Report On The Mound Explorations of the Bureau of American Ethnology, Bureau of American Ethnology Twelfth Annual Report*. Washington, D.C., 1894.

Thompson, E.P. *The Making of the English Working Class*. New York: Vintage, 1966.

Thompson, Henry Clay, II. *A History of Madison County Missouri, The Democrat-News*. Missouri: Serially Published, 1940.

Thornton, John. *Africa and Africans in the Making of the Modern World, 1400-1680*. Cambridge: Cambridge University Press, 1998.

Thwaites, Reuben Gold. *How George Clark Won the Northwest and Other Essays in Western History*. Chicago: A.C. McClurg & Co., 1903.

Todorov, Tzevtan. *The Conquest of America: the Question of the Other*, Trans. From the French by Richard Howard. Harper Perennial Publishers, 1984.

Tomlins, Christopher. *Labor, Law and Ideology in Nineteenth-Century America*, Cambridge: Harvard University Press, 1993.

Tomlins, Christopher L., and Bruce H. Mann, eds. *The Many Legalities of Early America,* Omohundro Institute of Early America History and Culture. Chapel Hill: University of North Carolina Press, 2001.

Trawick, Paul. *The Struggle for Water in Peru: Comedy and Tragedy in the Andean Commons*: Stanford University Press, 2003.

Trosper, Ronald. "That Other Discipline: Economics and American Indian History," *New Directions in American Indian History*, ed. Colin G. Calloway. Norman: University of Oklahoma Press, 1988.

Tucker, Barbara M. *Samuel Slater and the Origins of the American Textile Industry, 1790-1860*. Ithaca: Cornell University Press, 1984. Turner, Frederick Jackson. "The Significance of Frontier in American History," *American Historical Association Annual Report for the Year* (1893): 199-227.

Usner, Daniel H., Jr. "An American Indian Gateway: Some Thoughts on the Migration and Settlement of Eastern Indians Around Early St. Louis," *Gateway Heritage*, Vol. 11, No. 3 (Winter 1990-91): 42-51.

_____. *Indians, Settlers, and Slaves in a Frontier Exchange Economy: The Lower Mississippi Valley Before 1783*. Chapel Hill: Published for the Institute of Early American History and Culture, Williamsburg, Virginia, by the University of North Carolina Press, 1992.

Valencius, Conevery Bolton. *The Health of the Country: How American Settlers Understood Themselves and Their Land*. New York: Basic Books, 2001.

Vickers, Daniel. *Farmers and Fishermen: Two Centuries of Work in Essex County, Massachusetts, 1630-1850*. Chapel Hill: Published for the Omohundro Institute of Early American History and Culture, Williamsburg, Virginia by the University of North Carolina Press, 1994.

Wallace, Anthony, and Rockdale Anthony F. C. *The Growth of an American Village in the Early Industrial Revolution.* New York: Alfred A. Knopf, 1978.

Walthall, John A. *Galena and Aboriginal Trade in Eastern North America*. Springfield: Illinois State Museum, 1981.

Warren, Christian. *Brush with Death: A Social History of Lead Poisoning*. Baltimore: The Johns Hopkins University Press, 2000.

Warren, Karen J., ed. *Ecofeminism: Women, Culture, Nature*. Bloomington: Indiana University Press, 1997.

Warren, Louis S. *The Hunter's Game: Poachers and Conservations in Twentieth-Century America*. New Haven: Yale University Press, 1997.

Watson, Harry. *Liberty and Power: The Politics of Jacksonian America*. Oxford: Oxford University Press, 1981.

Way, Peter. *Common Labour: Workers and the Digging of North American Canals, 1780-1860*. Cambridge: Cambridge University Press, 1993.

Weaver, John E. *North American Prairie*. Lincoln: Johnsen Publishing Co., 1954.

Weber, David J. "Turner, the Boltonians, and the Borderlands," *AHR* Vol. 91(February1986): 66-81.

Weber, David J., and Rauch, Jane M., eds. *Where Cultures Meet: Frontiers in Latin American History*. Wilmington: Scholarly Resources Inc.,1994.

West, Elliott. *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado*. Lawrence: University Press of Kansas, 1998.

Whitaker, Arthur P. "The Elhuyar Mining Missions and the Enlightenment." *The Hispanic American Historical Review*, Vol. 31, No. 4 (1951): 557-585.

White, Richard. "American Environmental History: The Development of a New Historical Field." *Pacific Historical Review*, Vol. 54 (1985): 297-335.

_____. “Environmental History, Ecology, and Meaning.” *Journal of American History*, Vol. 76 (March 1990): 1111-1116.

_____. *The Middle Ground: Indians, Empires, and Republics in the Great Lakes Region, 1650-1815*. Cambridge: Cambridge University Press, 1991.

_____. “*It’s Your Misfortune and None of My Own”: A History of the American West.* Norman and London: University of Oklahoma Press, 1991.

_____. *Land Use, Environment, and Social Change: The Shaping of Island County, Washington*. Seattle: University of Washington Press, 1992.

_____. *The Organic Machine: The Remaking of the Columbia River.* New York: Hill and Wang, 1995.

White, Richard, and William Cronon. “Ecological Change and Indian-White Relations.” *Handbook of North American Indians*, ed. Wilcomb E. Washburn, Vol. 4 *History of Indian-White Relations,* 417-429. Washington, D.C.: Smithsonian Institution, 1988.

Whitman, Stephen T. *The Price of Freedom: Slavery and Manumission in Baltimore and Early National Maryland*. Louisville: University of Kentucky Press, 1997.

Wilentz, Sean. *Chants Democratic: New York City and the Rise of the American Working Class, 1788-1850*. New York and Oxford: Oxford University Press, 1984.

Wilkinson, Richard G. "The English Industrial Revolution," in *The Ends of the Earth: Perspectives on Modern Environmental History*, ed. Donald Worster, New York: Cambridge University Press, 1988.

Williams, Carol J. *Framing the West: Race, Gender, and the Photographic Frontier in the Pacific Northwest*. New York: Oxford University Press, 2003.

Williams, Michael. *Deforesting the Earth: From Prehistory to Global Crisis*. Chicago: University of Chicago Press, 2003.

_____. *Americans and Their Forests: A Historical Geography*. New York, 1989.

Winslow, A. “Lead and Zinc Deposits,” *Missouri Geological Survey*, Vol. 7 (1894): 477 487.

Winsor, Justin. *Cartier to Frontenac: Geographical Discovery in the Interior of North America in its Historical Relations, 1534-1700*. New York: Cooper Square Publishers, 1894; reprinted 1970.

Wirth, John D. "The Trail Smelter Dispute: Canadians and Americans Confront Transboundary Pollution, 1927-41." *Environmental History,* Vol. 1 (1996): 34-51.

Woods, W.Y. “A Strange Pre-Historic Find,” *The Wisconsin Naturalist,* Vol. 1, No. 1 (1890).

Worster, Donald. *Dust Bowl: The Southern Plains in the 1930s*. Oxford: Oxford University Press, 1979.

_____. *Rivers of Empire: Water, Aridity, and the Growth of the American West*. New York and Oxford: Oxford University Press, 1992 [1985].

_____. “Transformations of the Earth: Toward and Agroecological Perspective in History.” *Journal of American History,* Vol. 76 (March 1990): 1087-1106

_____. “Seeing Beyond Culture,” *Journal of American History* Vol. 76 (March 1990): 1142-1147.

_____. *The Wealth of Nature: Environmental History and the Ecological Imagination*. New York: Oxford University Press, 1993.

_____. *Nature’s Economy: A History of Ecological* Ideas. 2 Ed., Cambridge: Cambridge University Press, 1994.

Wyman, Mark. *Hard Rock Epic: Western Miners and the Industrial Revolution, 1860-1910*. Berkeley: University of California Press, 1979.

York, Neil L. *Mechanical Metamorphosis: Technological Change in Revolutionary America, Contributions in American Studies,* Vol. 78. Westport: Greenwood Press, 1985.

Young, Otis E. Jr. *Western Mining: An Informal Account of Precious-Metals Prospecting, Placering, Lode Mining, and Milling on the American Frontier from Spanish Times to 1893*. Norman: University of Oklahoma Press, 1970.

Zakim, Michael. *Ready-made Democracy: A History of Men’s Dress in the American Republic, 1760-1860*. Chicago: University of Chicago Press, 2003.