SUPPLY, TRADE AND CONFLICT ON THE COLONIAL FRONTIER. A LEAD ISOTOPE ANALYSIS OF ARTIFACTS FROM MISSION SANTA CRUZ DE SAN SABÁ AND EIGHT OTHER EIGHTEENTH-CENTURY COLONIAL-ERA SITES WITHIN TEXAS AND OKLAHOMA

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To my parents, Jamie and Jerri, for all
their love and support

and

Laura Nightengale, without whose
assistance and persistent encouragement this
thesis would not have been possible

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The production of this thesis hit some snags and bumps along the way, not the least of which were seven moves and nearly as many job changes in the course of three years. In the end, though, I hope the effort lives up to the message delivered to me in a fortune cookie received in the final days of my writing: "People forget how fast you did a job, but they remember how well you did it."

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CHAPTER 1

INTRODUCTION

This thesis will present the results of lead isotope analyses undertaken on 110 artifacts from nine different colonial-era sites in Texas and Oklahoma. Based on historic and archaeological evidence, these sites date quite securely to the first three quarters of the eighteenth century. During the 1700s France and Spain both vied for control of overlapping portions of the North American continent, setting the stage for an ongoing race to win the loyalties of the Native groups they encountered. The two European powers employed vastly different economic models in their treatment of Native Americans, with the French mostly eager to establish commercial trade alliances while the Spanish aimed more directly for the subjugation and conversion of Native souls. In accordance with these differing values, many Indian groups were equipped with firearms procured through trade with the French, whereas the Spanish disallowed and discouraged such trade. I hypothesize that along with firearms, lead for ammunition would have also been differentially acquired by the opposing factions.

One of the primary aims of this study is to determine whether French sources of lead can be reliably distinguished from Spanish sources. Utilizing the unique elemental properties of lead, whereby a comparative ratio of the four existing natural isotopes can help to pinpoint a particular geologic source, it should be possible to differentiate French and Spanish lead sources on at least a continent-wide scale. Historic evidence will be presented to show that the French relied to a great degree on lead and ammunition imported directly from Europe, although lead mines within modern-day southeastern Missouri also provided a New World source that the French had begun to exploit by about 1720. In the case of the Spanish, evidence will be presented to demonstrate that lead produced as a by-product of silver mining in Mexico served as their primary source of lead. For the purposes of this study, then, exact determination of precise, specific metallurgical sources, though ideal, will not be essential. Presuming that the Spanish and French would have exploited widely separated lead resources (with separation at a continental level), a gross characterization of lead sources at a broad regional level should prove sufficient to distinguish any existing distinct patterns. Thus, with lead sources being exploited from three widely divergent geographical regions, the prospects for successfully distinguishing different sources are rather high.

Such an analysis of lead objects should help clarify several questions relating to the topics of supply, trade, and conflict among colonial-era polities. Specifically, it should be possible at Native sites that show evidence of direct European involvement to more accurately ascertain the nature of trade relations. The technique also holds much promise for those sites with an overlap of both Spanish and French-derived materials. In these cases, testing lead artifacts could potentially demonstrate the presence or absence of Spanish and French materials, and the preponderance of one source over another could reveal greater degrees of influence at either a local or regional level. The method could also help to recognize colonial sites with intermixed components, where French and Spanish zones of occupation might be clarified.

Additionally, what might initially be perceived as situations involving the simple interaction of only two groups may turn out to be decidedly more complex. Evidence will be presented to demonstrate the great complexity of colonial trade, whereby patterns of rampant illicit trade, the intricate movements of goods, and disruptions caused by warfare all serve as complicating factors preventing overly easy interpretations from being made. Still, by incorporating a suite of complementary historical, archaeological, and geological data, it will be shown that many of these difficulties can be overcome.

Lead isotope analyses have been successfully applied for decades now to studies involving issues of Old World antiquity. It is only rather recently, though, that lead isotope analysis has been brought to bear on a number of North American concerns. It has now been used to link the lead content found in artifacts with lead in the bone tissue of historic-period Native Americans (Reinhard and Ghazi 1992); to demonstrate the influence of French colonial mining in southeast Missouri (Farquhar et al. 1995); to demonstrate matters of cultural affinity based on lead deposits in bone tissue (Carlson 1996); to trace the source of lead used in ceramic glazes in prehistoric New Mexico (Habicht-Mauche et al. 2000); to track the migration patterns of early Anglo settlers in Illinois (Augustine 2002), to show the effects of pollution from historic lead smelters (Rabinowitz 2005); to unravel the mystery of the first European metallurgical efforts in the New World (Thibodeau et al. 2007); and to demonstrate patterns within assemblages of bullets on Texas battlefields (Michael Ketterer, personal communication 2007; Bonine et al. 2009).

In evaluating the lead isotope signatures presented by colonial-era artifacts at nine sites, this study will attempt to expand the prospects in North America of this as-yet underutilized technique. In a particularly interesting case, I will apply the technique of lead isotope analysis to a rather singular event within Texas history. An interesting convergence of French versus Spanish-derived lead should be observable among lead balls recovered from the Spanish colonial Mission Santa Cruz de San Sabá. This mission, located near the small present-day town of Menard, was established in 1757 for the religious conversion of Lipan Apaches. It was attacked and destroyed the following year by a coalition of tribes hostile to the Lipan and wary of their seeming alliance to the Spanish. The skirmish involved the exchange of considerable gunfire between Indian aggressors, defenders within the mission, and Spanish military forces from the nearby Presidio San Luis de las Amarillas. Excavations conducted in 1994 and 1997 recovered a total of approximately 47 pieces of colonial ammunition from the site.

By building upon the data obtained from the other eight sites with more purely French or Spanish-influenced contexts, it will be shown that it is possible to distinguish which bullets were likely fired by which side in the conflict that destroyed Mission San Sabá. These data will then be correlated with the provenience information recorded for each item, thereby shedding light on new details regarding the skirmish. The attack on Mission San Sabá provides a particularly ideal scenario for applying lead isotopic studies in this fashion, since it involves lead artifacts from likely highly divergent sources that entered the archaeological record as the result of a single violent conflict. Further, the fact that the event is precisely confined in time and space (a singular event played out within a small area and of short duration) offers an unparalleled opportunity to assess the potential for lead isotope analyses at other similar historic period sites.

In broad terms, then, this project has the potential to shed light on certain patterns of supply, trade, and conflict for the Spanish, French, and Natives in colonial-era Texas and neighboring regions. By focusing on the origins and distributions of a particular resource (i.e., lead), new levels of complexity in the interaction between colonial-era European and Native groups will be revealed. In particular, trade networks, exchange systems, and intergroup political associations have special potential to be revealed. These studies will thereby shed light not only on broad-scale patterns of inter-group interaction, but can also be used to refine our understanding of specific historic events at a rather unprecedented level of analytical detail.

CHAPTER 2

THE THEORETICAL BASIS OF LEAD ISOTOPE ANALYSIS

The element lead occurs naturally in the form of four stable isotopes of varying atomic mass; these are ^{204}Pb, ^{206}Pb, ^{207}Pb, and ^{208}Pb. Of these, the first is natural or primeval lead and represents the isotopic variety of lead present at the initial formation of the Earth. It accounts for only a very small proportion of all the lead on the planet, making up only one to two percent of the world's stockpile. Consequently, it is also generally the most sensitive indicator isotope used in lead isotope analyses. The remainder, comprising the great majority of all lead, derives from the radioactive decay of uranium and thorium, both of which exhibit extremely long half-lives. The stable lead end products of these decay processes are thus known as radiogenic lead. Specifically, ^{206}Pb derives from the breakdown of ^{238}U, which has a half-life of 4.49 billion years; ^{207}Pb derives from ^{235}U with a half-life of 713 million years; and ^{208}Pb derives from ^{232}Th with a half-life of 13.9 billion years (Russell and Farquhar 1960:2-9; Gale and Stos-Gale 2000:505-508).

Each of these radioactive elements actually undergoes a rather more complicated decay process involving numerous intermediate steps before eventually resulting in a stable lead end product. The half-lives of these middle stages range from only fractions of a second to a quarter million years, but all are overwhelmed by the extreme duration of the parent materials uranium and thorium. Over the vast geologic history of the Earth, these radioactive elements, contained in abundance in the Earth's mantle and crust, have undergone a slow and inexorable transformation into stable lead end products. The genesis of lead from its radioactive progenitors continues to be an ongoing process (Russell and Farquhar 1960:2-9; Gale and Stos-Gale 2000:508-516).

The existence of lead isotopes and the extreme longevity of the U-Th decay cycles is in fact the basis upon which estimates of the age of the Earth are formed. However, the geologic history of our planet is simply too dynamic, and truly ancient rocks dating to the formation of the Earth no longer exist. Further, the ongoing decay and complex intermixing of uranium and thorium within the Earth's heaving crust precludes actual Earth-bound rocks from being used to make accurate determinations of planetary age. For this reason meteorites that are nearly devoid of uranium and thorium have been used as our best indicators of the primordial state of the solar system. Using these radioactively uncontaminated meteoric specimens as approximations of the Earth's primeval state, the age of the Earth has been established at approximately 4.55 billion years (Russell and Farquhar 1960:25-43). This figure, first calculated in the mid-1950s, has been little altered or improved upon since. This feat illustrates the power inherent in lead isotopic studies and grounds the technique in its historical applications. Starting in the 1960s, attention would turn to the potential for lead isotope analyses to illuminate matters of archaeological proveniencing.

Archaeological Proveniencing Using Lead Isotope Data

The same geological complexities which prevent actual terrestrial rocks from being used to determine the age of the Earth also happen to be extremely useful in tracing the sources of human-extracted and modified lead. Each locality where lead occurs has a distinct geologic history, with materials frequently mixed, churned, and chemically and physically altered over time to form a complex array of regional differences. This study will not address the intricate geological processes involved at any great length, but suffice to say that the actions which form metal-bearing ores tend to be especially complicated. The differential movement and mixture of crustal materials and the concentration of metallic deposits through involved hydrothermal processes leaves quite a puzzle for geologists to untangle. Fortunately for provenience studies, this complexity also means that the four isotopes of lead tend to be found in varying and distinctive concentrations according to an area's particular geological history.

Based on the ratios of the four isotopes to one another within a given sample, it is possible to compare lead-bearing archaeological samples to known ore sources and make fairly definitive conclusions regarding the origin of the lead. This method serves as a sort of fingerprint for lead sources, although a given lead isotope signature should not be misconstrued as a unique and infallible identifier. Rather, the possibility remains that different lead sources may be geologically similar and thus exhibit strikingly similar lead isotope balances. However, in archaeological applications there is also the matter of cultural context to consider. One would logically expect most lead-bearing artifacts to contain lead derived from well within the spheres of influence of the people creating them. It would make no sense, for instance, to suggest that eighteenth-century French colonists in North America were acquiring lead from Australian sources based simply on closely matching isotope values. On the other hand, lead isotope analyses do provide an effective means of subtractively discounting sources. If samples do not match certain ore sources reasonably well, or at all, those sources can be definitively ruled out as possibilities (Gale and Stos-Gale 2000). In other situations, it may be helpful to simply distinguish whether single or multiple sources of lead were being used in a particular cultural context, and such differentiation can usually be accomplished without requiring matching to specific physical sources on the landscape.

Robert Brill and J. M. Wampler (1967) receive the credit for first recognizing the archaeometric potential of lead isotope studies. Beginning in 1962 and throughout that decade and the next, they initiated a series of analyses on lead objects from various Old World contexts. These studies helped to scientifically establish fundamental patterns of ancient mining activity and trade that had previously been, essentially, the subject of educated guesses. Although initially restricted for the most part to Old World materials, including especially the Mediterranean region and the Middle East, Brill and his colleagues applied the new technique to a wide variety of materials such as glass, glazes, and residual quantities of lead present in ancient bronze, silver and gold objects (Gale and Stos-Gale 2000:504-505). The limited accuracy of the testing procedures available at that time now makes these earliest results somewhat unreliable, but such early studies nonetheless served to firmly establish the utility of lead isotope analyses in archaeological applications. A sizeable body of archaeometric lead isotope data has been accumulating ever since. The great bulk of emphasis has been placed on Old World lead sources, which makes sense in light of the ancient metallurgical traditions of Old World civilizations. However, this present study will hopefully provide a little more balance and help to illustrate the usefulness of lead isotope studies in New World contexts as well.

Gale and Stos-Gale (2000) provide one of the most comprehensive and up-to-date summaries of lead isotope archaeometry available, providing historical background in addition to theoretical and practical considerations. A number of different methods have been used over the last several decades to obtain lead isotope data, and while the actual process of separating isotopes requires a rather technical understanding of physics and highly sophisticated instrumentation, the analysis of the data itself is a fairly straightforward process. As a given sample of lead is broken down into its constituent parts, measurements are taken which record the abundance of each of the four isotopes. These are expressed as simple percentages or proportions, with the sum of the four isotope abundances accounting for 100% of the sample. Simple ratios are then calculated between pairs of isotope abundances, and pairs of these ratios are plotted against each other graphically in bivariate plots. The data points thus generated will cluster together, or separate, depending on their affinity to one another based on their isotopic similarities.

Given that four stable isotopes of lead exist, these can be expressed in a total of 16 separate ratios involving a maximum of six different pairings of two ratios. Each of these ratios and pairings can be useful in pinpointing sources of lead (Gale and Stos-Gale 2000:507), but with steady improvements in instrumentation a suite of three ratios has emerged as the generally favored basis for comparison:

$$\frac{^{206}Pb}{^{204}Pb} \qquad \frac{^{207}Pb}{^{204}Pb} \qquad \frac{^{208}Pb}{^{204}Pb}$$

This set of ratios thus makes extensive use of the low-abundance ^{204}Pb isotope, by comparing abundances of the more common radiogenic lead isotopes against the much smaller quantities of primeval lead present in any sample. These ratios thus provide correspondingly high values, since the radiogenic components are always present in much greater quantities than ^{204}Pb. Early lead isotope studies eschewed comparisons to ^{204}Pb, since the limited accuracy of available instrumentation and processes made it difficult to precisely measure the relatively minute quantities of natural, non-radiogenic lead. However, with the advent of exceedingly accurate instrumentation and methods in the last several years, comparisons to ^{204}Pb are now regarded as generally the most sensitive indicators available for lead isotope studies (Todd Housh, personal communication 2006). However, any combination of isotope ratios that helps elucidate the provenience of lead materials can be used, and many earlier archaeometric analyses would emphasize comparisons of the more abundant radiogenic isotopes against one other. Many archaeological reports thus initially adopted as their standards for comparison the ratios $^{208Pb}/^{206}Pb$, $^{207}Pb/^{206}Pb$, and $^{206}Pb/^{204}Pb$ (Baxter 1999:117).

An important consideration in lead isotope analyses is the multivariate nature of the data. With four inter-relating variables to contend with, the complexity of lead isotope data does not lend itself especially well to interpretation using standard statistical approaches. Baxter and Beardah (1997), Baxter (1999) and Baxter et al. (2000) have pointed out the inherent non-normality of lead isotope data, and have suggested the need for advanced non-parametric statistical procedures such as kernel density estimates to arrive at truly representative statistical characterizations. Traditionally, though, lead isotope analysis is conducted through graphical plotting of the data using paired isotope ratios. Such plotting makes clustering of data points readily apparent and allows for quick visual recognition of patterns.

This study will make use of a dual approach in its analyses, utilizing both multivariate statistical methods (in the form of a predictive discriminant function analysis) as well as the more traditional bi-variate plottings. Notwithstanding Baxter's (1999:123) methodological reservations to the non-statistical approach of recognizing visual patterns in plotted data, he has noted that for many applications this graphical plotting technique actually remains entirely sufficient. Combined, the two techniques provide a powerful means of accurately determining provenience at both large continent-level scales and at scales of finer geographical distinction. By bringing in details provided by historical background material and fully considering an object's cultural context, one can arrive at additional useful conclusions regarding provenience. The details of the statistical methodology, as well as the results of the statistical and graphical analyses for 110 archaeological samples, will be provided within Chapters 7 and 8; additional details regarding statistical findings and graphical projections of selected data can be found in Appendices B and E.

Additional Considerations in Lead Isotope Analyses

To make even somewhat definitive statements linking specific archaeological samples to a particular mineralogical source, data involving the abundances of all four stable lead isotopes must be used. This requirement applies whether a statistical or graphical approach is taken; at times different publishing formats for raw data mean that some grooming of the data must be undertaken before it can be utilized in a consistent fashion, as will be described further below.

As noted, in the case of graphical comparison, two inter-related graphs are typically prepared that integrate data from all four isotopes into three separate ratios. Again, the most commonly utilized set of ratios among recent studies involves values for

$^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$. In graphical comparisons, the resulting twin bi-variate plots thus provide a visual representation for a dual set of paired ratios. Reasonably positive identification of an association with a particular ore source can be made only if the combined data cluster reliably well within both isotope diagrams (Gale and Stos-Gale 2000:522-523). For a group of artifacts, a tight clustering within one diagram combined with a more random distribution in the other diagram likely indicates poor association and would preclude definitive statements of provenience from being made.

Instead of using two separate two-dimensional diagrams, one could conceivably use a three-dimensional graph to the same effect. Plotting the values of the three selected ratio sets onto the x, y, and z axes would allow data points to form a data cloud within three-dimensional space. In order to make reliable provenience statements, the data cloud for analyzed artifacts would have to fit within the data cloud generated by the range of variation exhibited by an ore deposit (Sayre et al. 1992; Baxter 1999:117). Such a projection would likely assist in visualizing the range of variation within a data set, but for matters of ease and display the standard two-diagram system will be used in this project.

Lead isotope data have been used primarily in geological, archaeological, and environmental studies, and depending on the research approach or age of a particular data set, the raw isotope values may be presented in a number of ways. Non-standard ratios may be employed in some works, although ideally data utilizing all four stable lead isotopes will be presented. This allows for easy mathematical conversion from the given data into preferred ratio sets, allowing for direct comparisons to be made between disparate studies. This is not always the case, however, with values sometimes reported for only three of the four stable isotopes. Alfonso et al. (2001), for example, provide values only for $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ in their study of historic lead contaminants in stratified marsh deposits of southern France. Data for ^{204}Pb are entirely left out, rendering the data set of this particular environmental study of limited utility to researchers working with the increasingly more typical ^{204}Pb-based ratios. Additionally, some reports, to save space, dispense with presenting raw data at all (e.g., Miranda-Gasca et al. 1993; Wedepohl and Baumann 1997), providing instead only graphs showing plotted fields of isotope values. In these cases direct numerical comparison is made rather difficult, and simple visual comparisons must be relied upon to a great extent.

For this thesis numerous reports incorporating lead isotope data for Europe, Mexico, and North America were consulted, and in most cases data from the reports could be incorporated into spreadsheets and adjusted as needed to arrive at desired ratio sets. For instance, if a paper presented $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{204}Pb$ values, these could be simply multiplied to yield the unreported $^{207}Pb/^{204}Pb$ values. In this way direct comparisons of data can be made across many reports that do not always present their information in the same format. Recently, many researchers are doing a much more conscientious job of providing full or close to full data sets (see Sangster et al. [2000] for an example, with six different isotope ratios reported).

Another of the challenges faced in applying lead isotope analysis to archaeological materials stems from the general scarcity of isotopic evidence from strictly archaeological contexts. Archaeometric studies, while increasingly profuse, remain an offshoot of the primary geologic motivations of most lead isotope studies. The journal *Archaeometry* in particular has become a standard venue for the publication of new archaeological lead isotope data, though the subject matter is typically directed towards issues of Old World antiquity.

The principle use of lead isotope studies still lies within the geologic realm, where lead isotope data can be used to untangle the convoluted processes of ore formation and petrogenesis. Such studies are also often conducted in order to identify economically recoverable mineral deposits (Gale and Stos-Gale 2000:504). Despite their entirely different focus and approach, one is often compelled to rely on geologically derived data when suitable archaeometric data are lacking. It must be kept in mind, though, that lead isotope data derived from geological studies may not be entirely appropriate in evaluating the composition of historical artifacts. Many modernly exploited mineral resources are simply too deeply buried, or rely on advanced extractive technologies that would have rendered them inaccessible or undiscoverable prior to the era of modern industrialization. As such, it is essential to consider the cultural context and other relevant details (such as available mining and metallurgical technologies of a given time period) that relate to how a lead-bearing artifact was created (Zalduegui et al. 2004:625-626). For these reasons, some researchers consider data generated from geological studies to be "mostly inadequate for the purpose of provenance studies" (Stos-Gale et al. 1995:407), while others "stress the convenience of making joint use of data obtained by geologists and archaeologists" (Zalduegui et al. 2004:631). Unfortunately, nothing along the lines of a cumulative worldwide lead isotope data bank exists; the geological world remains entirely devoid of any systematic method for cataloguing new data (Todd Housh, personal communication 2006). As such, a great deal of geologically-derived data are widely scattered in journals and in formats that are frequently obscure to archaeologists.

For this study, data derived from modern geological applications have been consulted extensively, owing particularly to the scarcity of archaeometric lead isotope data for North America and Mexico. This condition obviously results from the general lack of a highly developed metallurgical tradition on the North American continent prior to European colonization. In order to provide greater coverage of Old World sources, several geologically-oriented studies of European deposits have been consulted as well, to complement the pertinent archaeometric data available for France, Spain, Britain, and Germany.

An effort will not be made here to provide a general characterization of the overall geologic compositions and histories of lead-bearing zones in the three major geographic regions that will come into play in this study (i.e., Europe, Mexico, and the Mississippi Valley). Such specialized treatments are beyond the intended scope of this thesis. However, the peculiar nature of lead from the Mississippi Valley does bear some note here, as it has special implications for the results generated by this study. Lead deposits all along the Mississippi are notable for being anomalously radiogenic, having unusually high concentrations of the lead isotopes ^{206}Pb, ^{207}Pb, and ^{208}Pb. These deposits are so remarkable in their makeup that the term Mississippi Valley Type (MVT) is now applied to unusually radiogenic deposits throughout the world (Heyl 1983).

In many localities lead ores tend to be essentially free of uranium and thorium, with these elements having already been chemically and physically separated from lead through geologic processes. As such, most lead normally receives relatively little additional contribution from further radioactive decay, and thus remains isotopically frozen. In the Mississippi Valley, though, especially complex geological processes have caused unusually high concentrations of uranium and thorium to accumulate in the Earth's upper crust. Intermixed lead ores in this region thus continue to evolve in a much more complex manner than typically encountered (Gale and Stos-Gale 2000:506, 512-515). The net effect of this phenomenon on this study is that Mississippi Valley leads present rather distinctive and unmistakable radiogenic lead isotope signatures. These lead sources were actively mined by the French in the eighteenth century (as will be covered in the next chapter), and so the aberrantly high MVT ratios serve to readily identify certain artifacts as having originated from Mississippi Valley lead.

Technological Aspects of Lead Isotope Analysis

The actual instrumentation and processes used to determine lead isotope values have changed dramatically over the years, with rapid and impressive improvements in accuracy, speed, and cost. Some of the earlier archaeometric studies of lead relied upon such techniques as thermal-emission mass spectrometry (Brill and Wampler 1967), atomic absorption spectrophotometry (Walthall et al. 1980; Walthall 1981) and conventional magnetic sector mass spectrometry (Farquhar and Fletcher 1980, 1984).

Until very recently thermal ionization mass spectrometry (TIMS) had provided the most accurate means known for establishing lead isotope values, although at considerable cost and with a relatively high investment of time and effort in sample preparation. Using TIMS, specimens require fairly extensive purification with isolation of lead from other substances to maintain sufficiently sensitive measurements (Gale and

Stos-Gale 2000:518-519). The development of inductively coupled plasma mass spectrometry (ICP-MS) allowed for much quicker and cheaper processing of samples, although early units that employed a quadropole mass spectrometer in association with a single ion-beam collector could not provide the same levels of precision as TIMS. However, recent developments in ICP-MS technology have now overcome some of these deficiencies, and the technique is now capable of producing results comparable to and even better than TIMS (Gale and Stos-Gale 2000:520-522). Through the use of ICP-MS systems paired with magnetic sector mass analysis units and multiple ion beam collectors (known as multi-collector, magnetic sector inductively coupled plasma mass spectrometry, or MC-ICPMS), results equivalent to and better than TIMS-level precision are now possible; replicative tests using MC-ICPMS have achieved very close reproduction of previously generated TIMS data (Baker et al. 2006). MC-ICPMS instrumentation is currently regarded as the standard for lead isotope analyses, and is the method used in this study.

Other studies have also been conducted recently to determine the most precise methodologies for obtaining lead isotope values. Samples can either be analyzed using an aqueous process involving dissolution in concentrated nitric acid, or can be subjected directly to ablation with a laser source. Both of these methods have the distinct advantage over TIMS of requiring minimal sample preparation. Laser ablation also has the further advantage of requiring no direct sample extraction; instead, a laser burns a crater measuring only tens of micrometers wide from the surface of the object being tested (Young and Pollard 2000:23).

However, sampling by laser ablation tends to be less accurate and produces more variable results than can be obtained by the acid dissolution technique (see Habicht-Mauche et al. [2002:1053] for an example). Baker et al. (2006) notes that when using MC-ICPMS with high-concentration lead samples (greater than 500 parts per million, which certainly includes all of the artifacts sampled in this study), both laser ablation and acid dissolution techniques provide results comparable to or better than TIMS. However, the acid dissolution method also provides a means for correcting for the effect of mass fractionation during testing. By spiking the diluted lead solution with a small amount of thallium, the fractionation of the $^{205}Tl/^{203}Tl$ ratio can be measured, with this measure used in turn as a corrective factor for the resulting lead isotope data. The net result of this operation is that it imparts a much greater degree of accuracy on the results. Additionally, laser ablation is generally used for samples with relatively low lead concentrations, and introducing nearly pure metallic lead into ablation systems actually has the potential to compromise the instrumentation (Todd Housh, personal communication 2006). Overall, then, acid dissolution provides for greater systematic consistency and greater interpretive confidence, and is more appropriate for the study of artifacts that are made of almost pure lead. Consequently, the present study has made exclusive use of the acid dissolution method; the nearly pure lead nature of the artifacts also meant that no further purification of samples was required.

Regardless of the system of analysis used, it remains possible to meaningfully compare data generated by different laboratories at different times. This is because during the process of running samples, instrumentation worldwide is occasionally calibrated to either of a pair of standard lead substances of known isotopic value. These Standard

Reference Materials are known as SRM 981 and SRM 982, established by the United States National Institute of Standards and Technology (NIST). Both SRM 981 and SRM 982 come from lead stock of greater than 99.9% purity which has been drawn into fine circular wire and is sold by the NIST to research institutions worldwide by the gram. SRM 981 derives from a common batch of natural homogenous lead processed on a single occasion. SRM 982 consists of a standardized mix of commercial and radiogenic leads intended to incorporate as nearly as possible equal-atom abundances of ^{206}Pb and ^{208}Pb. The NIST has established to great accuracy the percentages of the four lead isotopes in these standard materials, with the following values and tolerances:

	SRM 981		SRM982
^{204}Pb	1.4255 ± 0.0012	^{204}Pb	1.0912 ± 0.0012
^{206}Pb	24.1442 ± 0.0057	^{206}Pb	40.0890 ± 0.0072
^{207}Pb	22.0833 ± 0.0027	^{207}Pb	18.7244 ± 0.0023
^{208}Pb	52.3470 ± 0.0086	^{208}Pb	40.0954 ± 0.0077

(NIST 1991; NIST 2004; Todd Housh, personal communication 2006). By periodically checking against these known values, laboratories around the world can ensure the consistency of their results within margins of error often less than 0.1% to 0.01% (Gale and Stos-Gale 2000:518; Baker et al. 2006:50).

Methodology Employed in This Study

Sampling Technique

Lead isotope analysis requires only very small samples of lead, with a single milligram of metallic lead more than sufficient for MC-ICPMS. As a result, samples can be taken with only minimal damage to artifacts. For this study it was decided to extract samples by drilling. Since all the selected objects were recovered from archaeological contexts, all had well developed but surprisingly thin surface patinas of lead oxide. Lead in small concentrations is actually rather ubiquitous in the environment, and alarming levels of lead have been introduced into the general environment over the last century from industrial processes (Sangster et al. 2000; Rabinowitz 2005). It is possible that the rind of lead oxide coating an artifact may have absorbed some of the ambient lead from the surrounding environment, perhaps to a degree sufficient to skew the results of a lead isotope analysis. The MC-ICPMS instrumentation is exceedingly precise and sensitive, and for these reasons it is important to obtain samples as free from contamination as possible.

For each artifact tested, a fresh X-acto knife blade and 1/16 inch steel drill bit were used, and the blade and bit were both cleaned of oily coatings using a fresh cotton ball soaked in standard household isopropyl rubbing alcohol. Additionally, each individual extraction was carried out over a fresh sheet of regular white copy paper, with each sheet carefully crumpled and discarded after use to minimize lead residues in the work area. For each artifact a location was selected on which to perform the sample extraction, with a conscious effort made to avoid blemishing potentially informative surface characteristics (such as mold lines on lead balls). This sampling location was often determined by finding a spot that provided an especially good angle or vantage point for making a clean nick to the surface. A tiny patch of thin corrosion was thus removed from the surface using a freshly cleaned X-acto knife blade, with each blade added to a discard pile after each extraction. An area of fresh, gleaming lead was thereby exposed just large enough (about 2-3 mm wide) to comfortably seat a 1/16 inch drill bit atop the fresh exposure.

For this study, a Black and Decker 9.6 volt cordless drill was used in combination with 1/16 inch Black and Decker high speed steel drill bits. Using fresh wooden clothespins to help immobilize small lead objects and to assist in handling, it was usually sufficient to run the drill at very low speed with light pressure. By sinking the drill bit only about 2 mm deep into the soft lead, the helical, spiraled design of the bit typically produced two small, spiraled slivers of lead a few millimeters in length. Reversing the rotation of the drill, these slivers would either come free of their own accord or were easily removed with the unused tip of the X-acto blade. Each drill bit was then placed in a discard pile after each extraction. The resulting surface blemish inflicted on artifacts was thus rather negligible, consisting of a small pit a couple of millimeters wide and deep.

The production of twin lead slivers served as a handy by-product of the drilling process, as one sliver could be submitted for acid dissolution and analysis via MC-ICPMS while the other was kept as a reference sample. Each sliver was then placed into its own archival-quality 2 mil plastic bag with appropriate labeling, with one set forwarded for laboratory analysis. It is my intention to eventually curate the entire collection of reference samples generated by this study at the Texas Archeological Research Laboratory (TARL), which is administered under the auspices of the University of Texas at Austin.

Statistical Procedures: Discriminant Function Analysis

Using lead isotope data extracted from the geological and archaeological literature as information of known geographical source and isotopic value, project data (110 total samples) were subjected to a predictive discriminant function analysis in order to statistically determine the most probable group membership of each given sample. This statistical method uses a body of data of known group affiliation as a means of predicting group membership for data values of unknown or uncertain affiliation. Within the known values, a set of predictor values (also known as discriminator variables) serve as dependent variables to assess affiliation to a particular group, with the groups themselves serving as the independent variables. Depending on the power of different discriminator variables to distinguish among groups, weighted scores known as discriminant coefficients are mathematically derived for each of the variables, with those variables that provide the most separation among groups weighted more heavily than those providing less separation. In this way, distinctions among different groups are mathematically maximized (Tabachnick and Fidell 1996; Brown and Wicker 2000).

Using these variables and coefficients, equations known as discriminant functions are generated which also serve as classification rules for separating individual cases into defined groups based on the combined contributions of all variables. Group centroids represent the mean discriminant scores for each group, with closeness of an individual value to the group centroid indicating a greater probability that the value belongs to that group (Tabachnick and Fidell 1996; Brown and Wicker 2000:209-235).

In this analysis, three groups were defined: lead sources known to be from either Europe, Mexico, or the Mississippi Valley. In all, slightly over 2,000 lead isotope examples of known provenience were culled from the literature and entered into a database, and ratios of measured isotope values ($^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{206}Pb/^{204}Pb$) from these samples were used to calculate the dependent discriminator or predicting variables. In performing discriminant function analysis, the number of discriminator variables should not exceed the number of groups (Brown and Wicker 2000:213); in this case, then, the number of both predictor variables and groups under consideration is equal (3), allowing for legitimate use of the technique.

The number of discriminant function equations to be used is equal in number to either the lesser of the quantity of predictor variables used (in this case, 3) or to the degrees of freedom for the groups (here, 2). Hence, two discriminant functions are used in the present analysis. In most cases, a maximum of two discriminant functions can be used to reliably distinguish between groups, with successive functions typically contributing little meaningful information to the attribution of group membership. The first discriminant function provides for the greatest separation among groups, while the second, orthogonal (uncorrelated) to the first, provides further separation among groups based on associations not used in the first function. For each of the two functions, a canonical correlation is calculated and squared that provides the proportion of variance shared by that function's groups and predictors. Essentially, the discriminant functions themselves are canonical variates computed to determine correlation between group membership and predictor values (Tabachnick and Fidell 1996:509-10, 516-517).

By utilizing the value of each predictor variable and an associated classification coefficient, classification equations are derived for each group under consideration; these equations are distinct from the discriminant functions previously generated. A separate classification equation is derived for each group into which classification is sought. Thus, in this study, three separate classification calculations were conducted for each sample. For each individual case, data are inputted into each classification equation, in order to arrive at a classification score. The sample is then attributed to whichever group provides the highest classification score, with attendant probabilities noted (Tabachnick and Fidell 1996:517-520; Brown and Wicker 2000:230-232).

For this study, a stepwise discriminant function analysis was conducted, a method most often employed when no particular reason can be perceived for assigning one predictor a greater importance than another. In this study, none of the three separate predicting lead isotope values used were thought to have any greater significance than another. By employing the stepwise method, this analysis also made use of the squared Mahalanobis distance to centroid criteria, which uses both discriminant functions to evaluate values based on distances between pairs of group centroids. This D^2 criteria attains its largest value when separation among groups is greatest, and serves as a means of evaluating the reliability of a set of predictors to accurately predict for group membership (Tabachnick and Fidell 1996:532-533).

Material pertaining to special problems encountered in performing standard statistical analyses on lead isotope data was presented earlier in this chapter; in large part, these problems stem from the non-normal structure of this particular type of multivariate data. However, according to Brown and Wicker (2000:215), "current evidence suggests that discriminant analysis is robust with respect to violation of assumptions of multivariate normality." Tabachnick and Fidell (1996:512-513), offer that discriminant function analysis is "robust to failures of normality if violation is caused by skewness rather than outliers", with equal sample sizes being one factor in helping to maintain that robustness. They warn, though, that with increasingly large differences in sample sizes, greater overall sample sizes will be needed to assure the integrity of results. A minimum sample size of at least 20 is recommended for the smallest group in cases where five or fewer predicting variables are used. In this particular study, greatly divergent sample sizes are utilized based upon the availability of raw data, with European samples far outweighing either Mexican or Mississippi Valley samples. However, only three predictor variables are being used, and the smallest sample size (Mississippi Valley, n=224) is well above the recommended threshold. As a result, this statistical analysis should maintain the desired viability in its findings.

Using the SPSS program (Statistical Package for Social Scientists), the 2000-plus data points derived from the literature were subjected to a descriptive discriminant function analysis; the overall results of this analysis are shown in Table 1 and Figure 1. Despite the general heterogeneity of lead isotope data and the inclusion of lead isotope values from widely divergent sources, a very high success rate was achieved in correctly classifying these samples into their known groups. Of the European samples, fully 93.6% of samples were correctly classified as European. Among Mexican samples 88.1% were assigned to the proper group, and 92.0% of Mississippi Valley samples were correctly identified. Taking into account the unequal samples sizes, an overall weighted average accuracy of 92.4% was achieved. This lends a considerable degree of confidence to the classifications assigned to the 110 archaeological samples of unknown group affiliation. Additional data pertaining to the probability of individual artifacts falling within their assigned groups are presented in Appendix B. In the results sections of Chapters 7 and 8, these data will be considered on a site-by-site and occasionally on a per-artifact basis in developing an analysis of provenience and archaeological interpretations.

In addition to using this statistical procedure which divides artifacts into distinct groupings at a continental-level scale, additional evidence derived from bi-variate plottings and historical background material will be evaluated. This additional information has the potential to further refine provenience results more specifically within the three major geographic regions considered statistically.

Table 1: Classification Analysis for Geographic Region

		Predicted Group Membership		
Actual Group Membership	n	Europe	Mexico	Mississippi Valley
Europe	1433			
n		1341	91	1
%		93.6	6.4	0.1
Mexico	396			
n		47	349	0
%		11.9	88.1	0.0
Mississippi Valley	224			
n		3	15	206
%		1.3	6.7	92.0
Archaeological samples (this study)	110			
n		60	32	18
%		54.5	29.1	16.4

Overall percentage of correctly classified cases for non-archaeological samples = 92.4%

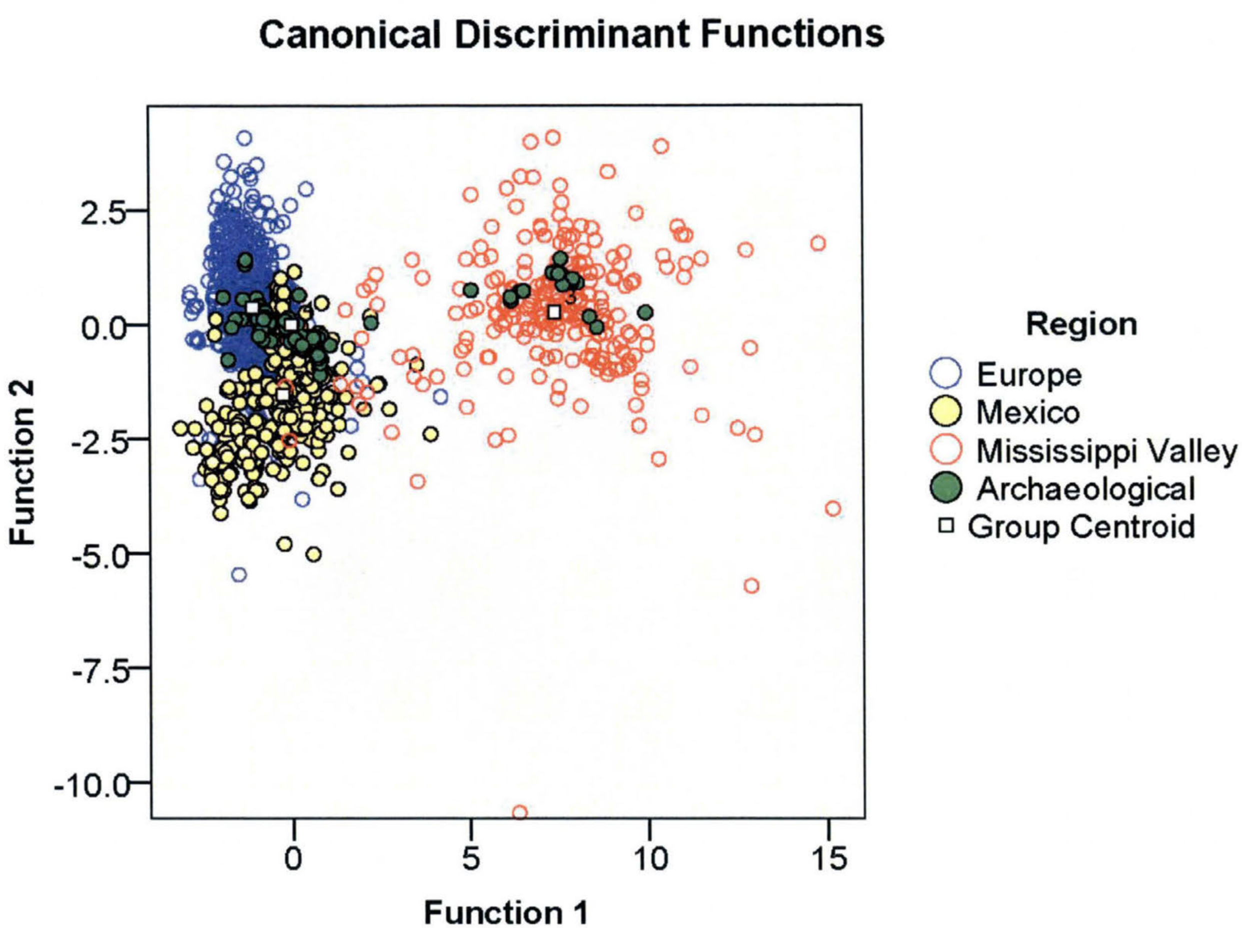

Figure 1: Overall Results of Discriminant Function Analysis

Technical Specifications

All samples were delivered to Dr. Todd Housh of the University of Texas Department of Geological Sciences for processing. The following summation of the technical procedures employed was provided directly by Dr. Housh.

Samples were dissolved in 2 mL 10M HNO_3. Following dissolution a small aliquot of each sample was taken and measured to determine the dilution needed to prepare a 100 ppb solution of Pb in 2% HNO_3. After each 100 ppb Pb solution was prepared the solution was spiked with thallium (Inorganic Ventures, lot: T-TL01075) to achieve a concentration of 20 ppb Tl.

The samples were analyzed on an IsoProbe, magnetic-sector, multi-collector ICPMS in static acquisition mode using an Aridus microconcentric desolvating nebulizer for sample introduction. Sample measurements consisted of 50 scans at 10 seconds each and were corrected for blanks and baselines. ^{204}Pb was corrected for the isobaric interference of ^{204}Hg using the measured ^{202}Hg intensity and $^{204}Hg/^{202}Hg = 0.230074$. Mass fractionation was corrected using $^{203}Tl/^{205}Tl = 0.4186$ and an exponential mass bias model. As a systematic bias is present in the data for NBS 981 if it is assumed that $\beta_{Pb} = \beta_{Tl}$, the data were corrected using $\beta_{Pb} = k \times \beta_{Tl}$, where k is determined each day to give the lowest residual for the deviations in the isotopic composition of NBS 981 from nominal values. The value of k was found to vary between 0.957 and 0.984; these differences are believed to be related to differences in the tuning conditions (Todd Housh, personal communication 2009; University of Texas Department of Geological Sciences 2009).

Illustration 1: Mural of Early Lead Mining, Missouri State Capitol Building, Jefferson City.

CHAPTER 3

FRENCH AND NATIVE LEAD PRODUCTION IN THE MISSISSIPPI VALLEY

Although numerous deposits of lead are today known throughout the United States and Canada, the French colonists of the Mississippi Valley knew of and exploited only two major sources: outcrops in the Upper Mississippi Valley, and outcrops in the region of present-day southeastern Missouri (Hanley 1942:197). The first lead-bearing region (under the jurisdiction of Canada in colonial times) is located on both sides of the Mississippi River in the area where the borders of modern-day southwestern Wisconsin, northwestern Illinois, and Iowa converge. The topography here is rather hilly with bluffs adjacent the river, and with significant waterways being the Wisconsin, Rock, and Fever (or Galena) Rivers (Thwaites 1895). It was the first area of lead ore deposits to be discovered by the French, but one which played a considerably lesser role during the colonial period than the prodigious ore outcrops to the south.

The other lead-bearing region of the Mississippi Valley occurs in the Ozarks of present-day southeastern Missouri. This region west of the Mississippi formed an extension to what was known as the Illinois Country in the French colonial period, and after 1717 officially fell under the jurisdiction of Louisiana rather than Canada (Ekberg 1998:34, 216). The topography of the area is very broken and hilly, and as such generally unfit for agriculture. The numerous drainages, however, provided natural pathways for early exploration by foot or canoe (James 1957:6-7; Schroeder 2000:84-85). The principal rivers of the mining region include the Meramec and Big Rivers, which drain generally north and east into the Mississippi below the Missouri River. The St. Francis River drains southward into the Mississippi above the Arkansas River, and another historically significant waterway, Saline Creek, drains directly into the Mississippi.

A general overview and synthesis of Native and French colonial mining history along the Mississippi will be useful here, as it puts into context the timeframe and manner in which colonial lead production occurred. From the standpoint of historical archaeology, any analysis which aims to source lead artifacts can benefit greatly from a keen understanding of a particular source's production history over time. Some historic and protohistoric sites have relatively narrowly defined timeframes, and having access to production data of a pertinent time period can assist profoundly with interpretation. Given the complex trade patterns and alliances in French Louisiana (which will be elaborated upon in a subsequent chapter), seemingly trifling details of production and distribution can radically alter the conclusions drawn. In this light, the following synopsis attempts to assimilate thoroughly but succinctly the kind of information that could prove useful to interpretations of colonial-era lead artifacts manufactured of Mississippi Valley-origin lead. To this end, since the historic records for French lead production and distribution are relatively abundant (particularly for southeast Missouri), much additional information is also presented in Appendix D in a chronological table. Also, in terms of this study, it should be kept in mind (as mentioned in the opening chapter) that most lead deposits along the Mississippi show a very distinctive but highly variable radiogenic isotope signature. Farquhar et al. (1995) has shown that lead from the Upper Mississippi Valley (UMV) can be reasonably differentiated from southeastern Missouri (SEM) lead.

In the case of southeast Missouri, two main mining localities were exploited during the early to mid 1700s; in considering these, it should be kept in mind that these areas are separated by only about 40 air miles, and that each was formed as a result of the same general geological processes. As a result, it can be expected that lead from either of these sources, or from the general vicinity, will produce rather similar isotope ratios.

This chapter will consider first the role of Native lead mining efforts in the Mississippi Valley, examining first activities in the upper reaches of the river, followed by the area of present-day southeastern Missouri. The role of French colonial mining activities in each of these areas will then be considered to about 1765, at which point France turned over control of her territories along the Mississippi to Spain and Britain.

Native Lead Mining and Processing in the Mississippi Valley

Although the greater part of this chapter will focus on the lead mining activities of the French in the early to middle 1700s, the existence of an appreciable level of Native mining, ore trading, and even smelting must be acknowledged. Historic Native American metallurgy is an aspect of culture not even realized by many North American archaeologists, but in certain areas Native groups actually controlled lead mining regions and dominated production activities for decades. While French manufacture probably still accounts for the bulk of lead produced in the Mississippi Valley in the 1700s, any study attempting to trace the origins of colonial-era lead artifacts can not discount the possible input of Native production.

Various Native groups along the Mississippi had known of and utilized the lead sulphide ore deposits in their midsts for thousands of years. There is no indication of actual, deliberate smelting prior to the arrival of Europeans, but galena has been recovered from Woodland and Mississippian period contexts in the form of raw chunks, finished ground items (such as earspools, beads, and polished cubes), and powdered for use as a pigment base. Such materials are first encountered archaeologically in the Late Archaic and Early Woodland periods, found in both mortuary and domestic contexts. During the Middle Woodland period galena begins to appear much more widely, and prior trace element and lead isotope studies demonstrate the very extensive prehistoric trade in Mississippi Valley galenas to locations as far removed as southern Ontario and southern Florida (Walthall et al. 1979; Walthall et al. 1980; Farquhar and Fletcher 1980 and 1984; Walthall 1981; Austin et al. 2000; Stubbs 2004).

Historic Native Lead Exploitation in the Upper Mississippi Valley

In the Upper Mississippi Valley, several Native groups (particularly the Sauk, Mesquakie [Fox] and Winnebago tribes, and probably to some degree the Osage and Illiniwek) embraced the metallurgical knowledge they gained from the French and actively participated in the procurement, smelting, and trade of lead ore (Walthall 1981:25; Murphy 2000:79-84). This eventually became a full-scale and primarily Native-driven industry; however, large-scale production did not get truly underway here until nearly the end of the eighteenth century, with the arrival in 1788 of the trader Julien Dubuque (Hoffman 1930; Hanley 1942:173). This study is concerned with artifacts of presumably earlier dates, and so the details of Dubuque's tenure will not be greatly expounded on here. However, it is worth noting that his management of the mining area, coupled with his exceedingly good relations among the local tribes, ushered in a highly productive era of Native mining in the Upper Mississippi Valley. By the 1820s, hundreds of thousands of pounds of ore were being produced by the tribes annually, and lead rivaled and even began to overtake furs as a crucial commodity within Native economic spheres (Murphy 2000:79-84).

For the better part of the eighteenth century, however, there is a rather notable dearth of evidence relating to exploitation of the Upper Mississippi lead mines, Native or otherwise. Archaeologically, the Bell Site in Winnebago County, Wisconsin, believed to be the location of a Fox village from 1680-1730, produced evidence of lead smelting in the form of galena, lead ashes (incompletely reduced lead ore) and melted lead pieces (Walthall 1981:23). At what may be another Fox encampment in central Illinois (11ML6), occupied for only 23 days in 1730 as a group of 900 Fox Indians were under siege, two samples of galena and a lead bar have been isotopically linked to the Upper Misssissippi Valley (UMV) lead district (Stelle 1982; Farquhar et al. 1995; Martin 2004:197). At the Newell Fort site in north-central Illinois, which may represent a fortified Indian village dating from sometime between 1683 and 1722, one galena fragment and two pieces of lead scrap have also been traced to the UMV lead district (Hall 1991:28; Farquhar et al. 1995). These few archaeological examples provide some meager direct evidence of Native utilization of Upper Mississippi Valley lead in the early 1700s, and show the need for further examinations to be undertaken.

As for historical accounts, one rather important example of Native exploitation in the Upper Mississippi has actually been incorrectly attributed to southeastern Missouri. A letter written in 1710 by Antoine Denis Raudot, the co-Intendant of New France, provides some rare, direct evidence of how knowledge of lead mining and smelting was passed between French and Native groups at this early date. Walthall (1981:20) attributes this letter as a clear indication that smelting was in fact introduced to the Indian groups of southeast Missouri by the French. However, from varying interpretations of the document there appears to be considerable confusion regarding the actual meaning of the passage. It will be worthwhile here to clear up the misconceptions surrounding this historic source. The following translation of Raudot's letter, written from Quebec, is provided by Kinietz (1965:383-384):

> "The Miamis if all assembled together would number more than eight hundred warriors, included under the names Ouyatanons, Mingkakoia, Peangichia, Chachakingoya, Kiratica, and Pepepikoia. The first live on the St. Joseph River where it flows into Lake Michigan. The second live at Chicagou, at the mouth of the Illinois River on Lake Michigan. The third live on the Malamee River or the Barbue River, which flows into the Mississipy, and the three others live partly on the banks of the Mississipy and partly on the Wabash.
>
> There is near the Malameek a rich lead mine. Too imprudently, a few Frenchmen have taught these savages to melt lead and have even furnished them molds, with the result that we no longer sell it to them and they trade it with other nations."

First, it should be pointed out that the tribe indicated as living on the Malamee River corresponds to the Peangichia in the list, or the Piankashaws, a sub-tribe of the Miami Indians who were living in the vicinity of southern Wisconsin at this time (Kinietz 1965:162). Walthall (1981:20) misconstrues this passage, assuming the "Malameek" (which he mis-transcribes as "Melameek") to mean the Meramec River of the lead-mining region of southeastern Missouri. This is not at all too great a stretch, as many spelling variations on "Meramec" do exist in historical documentation. Here, though, Raudot's usage serves as a variation on "Merameg", a term which also served as an identifier for another sub-tribe of the Miami Indians as well as their village. This village of Merameg was apparently located either at the headwaters of the Fox River in Wisconsin, or directly on the banks of the Mississippi River (Kinietz 1965:162, 318-320). Further, as Raudot's letter shows, this Malamee or Malameek River is synonymous with the Barbue River. Barbue is the name used by the French for catfish, and there are any number of drainages thusly named by the French in colonial times (Western Historical Company 1880:520-521). One possibility for the intended location may be the mouth of Catfish Creek, on the western side of the Mississippi River near present-day Dubuque, Iowa, where Julien Dubuque established his lead mining operations (Abbot 1988:2). The matter is further confused by the fact that the Meramec River of southeastern Missouri was, indeed, also referred to on a 1755 map as the Barbue River (Hanley 1942:36; Ekberg et al. 1981:18); however, from the precise context of Raudot's quote, it is clear that he was indicating a much more northern manifestation of a drainage called the Barbue, one populated by the Piankashaw. In any case, it seems likely that Walthall (1981), in his pioneering and much-quoted study on North American lead sourcing, has mistakenly (but quite understandably) ascribed this crucial evidence of cross-cultural exchange to the wrong geographic area. The passage in Raudot's letter clearly refers to smelting having been taught around 1710 to Native groups residing in the Upper Mississippi Valley region, and not in southeastern Missouri.

Another quotation of what appears to be the same passage, which is almost certainly a mis-translation, provides a completely different take on matters: "Near the Maumee River there is a very productive lead mine. Some French have learned from the natives how to cast this lead, and have even been furnished with molds. As a result, they trade this with other tribes" (Silvy 1980:165; Kent 2001:185). This state of affairs puts the cart before the horse, but the example serves to demonstrate the considerable confusion and misunderstanding this one historical reference has generated.

Historic Native Lead Exploitation in Southeast Missouri

In southeastern Missouri, the record of Native involvement with lead production in the 18th century is similarly meager. There are some hints, though, of direct Indian exploitation of lead ores along the middle Mississippi Valley that can be gleaned from historical accounts. In 1711 the Governor of Louisiana, Jean-Baptiste le Moyen de Bienville, noted that "Doubtless there are mines west of the Mississippi. All the tribes north of the Red River [of Texas] know about these mines" (Ekberg et al. 1981:17; Ekberg 1985:9). Some of the earliest French explorers to arrive in the lead-bearing zones in the early 1700s indeed reported encountering extensive excavations already in existence. In 1719, a French official (des Ursins) involved with opening three shallow test pits reported that "The way to the mines is well beaten…" and that "You find similar mines everywhere, so to say, on the surface of the earth. The savages have made an infinite number of holes from which they drew lead in this neighborhood where there is such an abundance of similar mines" (Rothensteiner 1926:206).

It is almost certain that substantial Native mining of lead ore had taken place in the area worked by des Ursins, but it should also be kept in mind that French mining activity was at first very intermittent and completely unregulated. The galena was rich with chunks of metal-bearing ore that melted at a low temperature, and producing lead required no more than the ability to dig and light a fire. Schroeder (2000:62) notes that "Mining required no capital investment, no technology, no education in the mining business. In this respect it was like trapping for furs or shooting deer – an exploitative resource activity that one could engage in by himself." Many of the pits ascribed to the Indians may have also been dug in unrecorded early episodes by colonists and itinerant *coureurs de bois*. In the case of the "infinite number of holes" just mentioned, some 40 Frenchmen are reported to have worked that same area to an unknown extent only four years before, in 1715 (Alvord 1965:144). It is also entirely likely that Natives dug for lead during intervals when the mining regions went unworked or unoccupied by the French (Hanley 1942:30-32), abandonment brought on in part due to Indian hostilities which drove the French from the mines (Caldwell 1941:47; Ekberg et al. 1981:17; Ekberg 1982:139).

There is little evidence to suggest that any Native groups resided permanently within the lead mining region, but various tribes did actively exploit the region not only for its lead but for its abundant natural resources (Rothensteiner 1926:208). One of the few suggestions of a more permanent settlement derives from another of Bienville's letters dated 1736, which mentions that the Fox Indians had retired to "a village on the shores of the Meramek" after a skirmish with the Peorias. In 1741 he mentioned specifically that "Indians were exploiting a mine that had once been worked by Renualt [a prominent French miner] and his men" (Ekberg et al. 1981:17; his paraphrase). Thus, to some extent, Native and French extraction probably occurred simultaneously within the vast Missouri lead belt. As in the Upper Mississippi Valley, it is also possible (but undocumented) that some level of Native trade in lead ore developed (Swartzlow 1933:12; Swartzlow's insistence that no Native smelting occurred, however, is incorrect.).

Some lead artifacts found at distinctly eighteenth century-occupied Native sites in modern-day Illinois do indeed indicate that some processing of lead likely occurred within the Indian villages by at least 1730, and very possibly sooner. The Kolmer and Guebert Sites, located directly across the Mississippi River from the southeastern Missouri lead deposits, have yielded galena, lead balls, sprue, and scrap all demonstrated by isotopic analysis to be composed of southeastern Missouri lead (Farquhar et al. 1995). The presence of sprue and scrap in particular suggests the on-site manufacture of lead balls. The central Illinois sites of the Fox encampment known as 11ML6 and Newell Fort (already discussed in previous paragraphs in conjunction with the Upper Mississippi Valley) also yielded lead balls and galena that traced isotopically to southeastern Missouri lead, indicating reliance on both sources to some extent (Farquhar et al. 1995).

Additionally, the Guebert site, also known as the Kaskaskia Indian Village, has actually yielded catlinite molds used to cast lead crucifixes, ornaments, and lead balls. This village dates to 1719, as the Kaskaskia Indians had lived amidst the French in their own village of that same name from 1703-1719, at which time they were moved about one and a half leagues up the Kaskaskia River to what was considered a more discreet distance from the French settlement (Ekberg 1998:70). Here a cruciform mold was recovered that appears to have been used for making lead balls, and which still retained some lead in a runnel leading to the hollowed-out spherical bullet chambers. One side of a European-style iron gang mold that could cast six balls was also recovered from the Guebert site, though it must be noted the site was occupied until 1833 (Good 1972:87, 91). One researcher notes that wooden bullet molds (soaked in water to impede burning) were also likely used during this period, but would be unlikely to survive archaeologically (Kent 2001:188-189). Such a prospect would make it even more difficult to fully assess the full scale of Native ammunition production at this and other historic and protohistoric sites. Additionally, a charred feature that appears to have been a crude smelting area was excavated at the Guebert site (Walthall 1981:23). Clearly, even though evidence is fairly scanty, it appears that some Native groups in the vicinity of southeast Missouri (at least those in direct proximity to the lead mines) had begun to produce ammunition for themselves at some level by the early 1700s. There do not appear to be indications, however, that they produced lead with the same semi-industrial vigor of the French.

French Colonial Lead Mining and Processing in the Mississippi Valley

Nearly bankrupted by the extravagances of Louis XIV, the French Crown in the 17th and 18th centuries hoped rather fervently to match the fabulous mineral wealth encountered by Spain in the New World. As such, colonists, explorers, *voyageurs,* and Jesuit missionaries alike paid keen attention to the mineral resources in their North American territories. Naturally the initial aim was to uncover rich lodes of gold and silver, though in the end only baser metals such as lead would emerge as viable commodities in the French dominions. The drive for precious metals did, however, result in the discovery of the abundant lead deposits along the Mississippi Valley. In the second decade of the 1700s, these discoveries (rumored to be rich in gold and silver) even fueled a brief period in Europe of wild and disastrous speculation known as the Mississippi Scheme (Ekberg 1985:144-145). After the initial disappointment of having discovered only deposits of lowly *plomb*, French colonial industry finally applied itself, after some fits and starts, to a fairly steady extraction of this vital and relatively easily procured frontier resource.

French Colonial Lead Exploitation in the Upper Mississippi Valley

It is entirely likely that early explorers, such as Jean Nicolet, had introduced the use of firearms and ammunition to such Indian groups as the Wisconsin, Illinois, and Winnebago as early as 1634. Additionally, early fur traders, primarily illiterate *voyageurs* and *coureurs de bois*, likely exposed Natives to this novel use of lead as ammunition, and may have potentially learned from them or discovered on their own the location of natural lead ore outcroppings. However, the first recorded awareness of the French of the existence of Mississippi Valley lead sources came in 1658-1659, when the explorers Radisson and Groseilliers (later defectors to the English Hudson's Bay Company) heard of lead mines among the Bœuf or "Buffalo" Sioux in the vicinity of modern Dubuque, Iowa (Thwaites, 1895:272; Abbott 1988:12). Marquette and Joliet, traveling down the Wisconsin and Mississippi Rivers, made in 1673 numerous references to the mineral potential of the Upper Mississippi Valley. Marquette and La Hontan, traveling in 1689, made similar references but apparently never visited the mines in person (Thwaites 1895:272-273). In 1687, Henri Joutel, making the arduous journey to New France after surviving the disastrous failure of La Salle's ill-fated colony on Texas' Matagorda Bay, noted that "Travelers who have been at the Upper Part of the *Missisipi*, affirm they have found Mines there, of very good Lead" (Joutel 1714 [1968]:172). In his journal of this same voyage, Father Anastasius Douay likewise noted that "we found lead quite pure and copper ready to work" (Cox 1905-I:265). The same year a map by Hennepin indicates the presence of lead mines near modern Galena, Illinois (Thwaites 1895:272-273).

Starting in the 1690s, records begin to indicate a rather limited and abortive colonial attempt at a systematic exploitation of lead. Nicholas Perrot established a trading post among the Miami Indians below the mouth of the Wisconsin River, near modern East Dubuque, Illinois. In the course of his activities he apparently attempted to mine lead but found it "hard to work, because it lay between rocks [i.e., in veins] and required blasting". Even so, the ore, once extracted, "had very little dross, and was easily melted." This comment is also interesting in that it seems to indicate a very early application of explosives in lead mining, a technique apparently very little used even in later French colonial mining activities (Thwaites 1895:273). Indeed, even the suggestion of blasting as a French mining technique is not encountered again until about 1773 in southeast Missouri (Hanley 1942:73).

In 1700, the French chronicler Pénicaut, traveling with Le Sueur in an attempt to initiate mining activities, noted lead deposits above the rapids at Rock Island: "we found both on the right and left bank the lead mines, called to this day the mines of Nicholas Perrot, the name of the discoverer". He also noted lead deposits not much further upstream, one and a half leagues up the *Rivière a la Mine,* known variously as the Fever or Galena River. However, it appears that only a half-hearted attempt was made at starting any sort of mining enterprise. At another lead-bearing locality apparently near present-day Potosi, Wisconsin, Le Sueur "took notice of a lead mine at which he supplied himself." It seems, then, that no lead was taken during or as a consequence of Le Sueur's expedition other than that needed to furnish the party's immediate needs. In 1702 Le

Sueur abandoned his post, dying shortly thereafter during his return voyage to France (Thwaites 1895:273-274; Swartzlow 1933:14-15; Hanley 1942:165-168; Alvord 1965:129).

The development of French mining activity in the Upper Mississippi Valley was seriously curtailed for a long period, due to the violent Fox Wars (1712-1730) and other extended hostilities which made settlement of the region untenable. In 1737 the Fox tribe relocated to a French land grant along the Rock River in Wisconsin, a move that would help cement Native control of the northern lead fields in the coming decades (Hanley 1942:168, 197). Although lead production undoubtedly continued at some level over the years, accounts of such activity are very scarce prior to the advent of Dubuque's enterprise in the late 1780s. Before this, lead seems to have been extracted on a more casual basis, only as needed to fulfill immediate demands and not necessarily as a fully developed commodity. A rare account of such an event is revealed in the 1753 journal of the French explorer, military commander, and Indian diplomat Joseph Marin, who served as a rather influential figure in securing alliances and smoothing over French relations with such tribes as the Fox, Sauk, Winnebago, Menominee, and Illini (Birk 1991:255). Marin recorded during September of that year that ten of his men had been sent "to the mine to make musket balls with the sixty Sakis [Sauks] working there" (Murphy 2000:23, 33). This rare documentary account of a joint bullet-making foray seems to indicate that the French and Native groups were eventually able, on occasion, to conduct lead mining and smelting activities quite peaceably in each others' presence along the Upper Mississippi. Some of the resulting lead balls may even have very well wound up at a Minnesota site known as 21MO20, the remains of a mid-eighteenth century minor French outpost. This site has been tentatively linked to a temporary outpost named Fort Duquesne established by Marin and occupied during the years 1752-1753. Here "plentiful" lead shot and balls have been recovered, in addition to lead brooches and lead gaming pieces, with on-site casting suggested by associated lead runnels found on a hearth (Birk 1991:253-257, 262). Given the evidence of Marin's 1753 journal entry, an isotopic study of these lead artifacts, if revealed to show an Upper Mississippi lead signature, could help bolster the claim that site 21MO20 is in fact the location of Marin's short-lived Fort Duquesne.

Later, during the 1760s, the Native groups in control of the mines apparently allowed various traders to procure lead from the mines, unmolested (Hanley 1942:170-171). During the American Revolution, it seems that the Fox and Mesquakie were surreptitiously supplying the Americans with lead in defiance of their alliances to British traders, but neither the British nor the Americans seem to have been directly involved in the production (Hanley 1942:172-173).

Though significant and abundant, the lead mines of the Upper Mississippi thus remained under Native control throughout the 1700s, with European extraction occurring only on a limited basis, and at the pleasure of the tribes, for the better part of a century (Hanley 1942:164). Only faltering early attempts had been made by the French to reconnoiter and exploit the mineral potential of the Upper Mississippi, and after decades of turmoil it seems that the French eventually made some occasional, limited use of the mines (as seen by Marin's 1753 account). Not until nearly the end of the eighteenth century, though, with the arrival of Julien Dubuque, did these ore deposits achieve the same kind of industrial significance as the more southerly mines. For the better part of the

1700s, the attention of the French would be focused much more intensely on the lead deposits of the Illinois Country, the middle ground between the jurisdictions of Canada and Louisiana.

French Colonial Lead Exploitation in the Illinois Country, 1700-1765

For a time of some fifty-odd years, from about 1720 to 1770, only two lead mining districts in southeastern Missouri were utilized on a consistent and substantial basis in the French colonial period. These areas lay west and directly across the Mississippi from the French villages of Cahokia (founded in 1699), Kaskaskia (1703), and Fort de Chartres (1719), which served as the earliest permanent settlements in the area (Ekberg 1998:33-35). The first (and ultimately most significant) of these districts included the diggings at Mine la Motte, near the headwaters of the St. Francis River, which flows south-southeast and empties into the Mississippi about ninety river miles (145 km) above the mouth of the Arkansas River. Also adjacent to this area is Saline Creek, the valley of which served as the initial point of entry to the mines. It empties directly into the Mississippi just below present-day Ste. Genevieve, and much colonial activity centered on salt-making here. Discovered and worked shortly after Mine la Motte were the Meramec mines, located in the vicinity of the Meramec and Big Rivers, including such tributaries as the Mineral Fork of the Big River. Throughout much of the 1700s, these drainages were all considered part of the Meramec and hence the names were often used interchangeably in colonial times (Ekberg et al. 1981:12). These Meramec drainages flow generally to the north-northeast before draining into the Mississippi about twenty miles (32 km) below the mouth of the Missouri River. Overall, the historic lead belt of southeastern Missouri includes portions of the modern counties of Madison, Washington, St. Francois, Jefferson, and Ste. Genevieve (Swartzlow 1933:3).

The literature on the history of colonial lead mining in southeastern Missouri is somewhat scattered, but far more extensive and accessible than that available for the corresponding time periods in Mexico and Europe. At least four now-obscure master's theses have treated the mining history of this area (Swartzlow 1933; Willms 1935; Hanley 1942; and James 1957), of which those of Swartzlow, Willms, and Hanley provide better information on the French period prior to 1770. Hanley in particular makes extensive use of original manuscripts, and Swartzlow's early but still competent study can also be found published in greater part in a series of five articles in the *Missouri Historical Review* (Swartzlow 1934a, b, and c, and Swartzlow 1935a and b). The writings of Carl J. Ekberg in particular contribute much to our understanding of French colonial lead mining in southeast Missouri, and help to sort out much confusion that has been introduced into the general record (Ekberg et al. 1981; Ekberg 1982, 1985, and 1998).

The first direct historical references to the lead-bearing regions of southeast Missouri date to about 1700. Le Sueur, with his carpenter-historian Pénicaut, led in 1699-1700 what was essentially an expedition of discovery up the Mississippi, taking note of mineral deposits as they headed upriver (their observations from the Upper Mississippi region have already been noted, above). After arriving at the confluence of Saline Creek with the Mississippi opposite Kaskaskia, Pénicaut noted that "we went eight leagues farther up, where one finds a small stream, which is on the left, called the Meramec. It is by that stream that the savages go to a mine of lead which is fifty leagues from the bank of the Mississippi" (Swartzlow 1933:14-15). This estimate of fifty leagues (roughly 150 miles) conforms well with reality, if one computes distance by following the river channel; however, none of Le Sueur's party seems to have actually journeyed up the Meramec to these mines, as no mention is made of such a trip. It should be kept in mind that Pénicaut's chronicles are not generally regarded as overly reliable or truthful, although he seems to have usually been correct in his geography (Weddle 1991:160, 370-371).

At about the same time as Le Sueur's expedition, Father Jacques Gravier, journeying to the mouth of the Mississippi from Canada, wrote on October 10, 1700 that "we discovered the River Miaramigoua, where the very rich lead mine is situated, 12 or 13 leagues from Its mouth. The ore from this mine yields 3 fourths metal" (Thwaites 1900:105). Gravier likewise appears not to have visited the lead district, but reports on it only from hearsay. It is important to note that in the French colonial parlance, a "mine" did not necessarily indicate an active working, but could just as easily refer to a known but unexploited mineral deposit (Swartzlow 1933:10). Still, Father Gravier's notation of a mine on the Meramec indicates that not only was such a deposit already known by 1700, but that some degree of smelting (or at least an assay) had already occurred in order to arrive at an estimated 75% rate of recovery (Rothensteiner 1926:201; Swartzlow 1933:14-15). Hanley states that Le Sueur actually journeyed here to acquire lead for ammunition in 1702, just before his own enterprise unraveled (despite being surrounded by the northern lead deposits), so some unrecorded mining may in fact have already been underway (Hanley 1942:167). Father Gravier also summed up the early disappointment and uncertainty of the budding Illinois enterprise as relates to the dearth of precious metals: "I know not what the Court will decide with reference to the Mississipi, if no silver mines be found there; For they seek not lands to cultivate... The mines that have been sought for have not yet been found; but little heed is paid to the lead mines, which are very plentiful toward The Ilinois country, and higher up the Mississipi toward the Scioux" (Thwaites 1900:173).

In the first years of the Louisiana colony, Pierre Le Moyne d'Iberville (Governor and founder with his younger brother of the colony) made the first claim to the mines of southeast Missouri, seeking in 1702 exclusive rights to a huge area extending from the mouth of Saline Creek to the mouth of the Missouri River, and extending to the Osage River in central Missouri. He wrote that "We will be able to draw from this country sufficient (lead) to supply France with all that she needs. The mines are numerous and easy to find and work; to do this it will be necessary to have men in easy circumstances and laborers." He died, however, before his petition could ever be acted upon (Swartzlow 1933:15-16; Willms 1935:4-5). Even so, such a grand claim surely illustrates the optimism which the French held for the wealth of their new domain.

An expedition sent a few years later in 1708 sought to reconnoiter the Missouri River to its sources and also probed for mineral wealth. From this effort the commissary general of Louisiana, Diron d'Artaguiette, sent some samples of lead and copper ore procured in the Illinois country back to France (Alvord 1965:140). The outcome of the ensuing assay is unknown, but it is probably safe to assume that significant indications of silver had been hoped for, and that disappointment resulted.

In 1712, the entire commerce of Louisiana was given over to Antoine Crozat, a wealthy and well-connected merchant in France, for a period of fifteen years in the hopes that he would be able to stimulate and develop the economy of the colony. This included exclusive rights to mining, with one-fifth of all precious metals and one-tenth of all base metals produced to be granted to the Crown. To this end Crozat appointed as governor of Louisiana the man who had founded Fort Pontchartrain in 1701 (which eventually developed into modern Detroit), Antoine Laumet de La Mothe, sieur de Cadillac (Rothensteiner 1926:201; Alvord 1965:143). His name is properly given as La Mothe Cadillac, but is most often rendered "La Motte", the name afterward applied to the mine he discovered (Ekberg 1985:9). At the end of 1714, La Motte received at Dauphin Island in Mobile Bay (then capital of Louisiana, for New Orleans was not established until 1718) some silver-bearing ore from Claude-Charles Dutisné. Dutisné had been sent on an expedition to establish a French post somewhere in the vicinity of the Wabash or Ohio Rivers, a task which subsequently took him to Kaskaskia. There he inquired about the potential for mines in the area, and was given the sample of ore by some Canadians with a request that it be delivered to La Motte (Willms 1935:9-10; Wedel 1972:8). The samples assayed well for silver, and prompted La Motte to set out with a party early in 1715 in search of the mines of Kaskaskia. Dutisné appears to have been duped, however, as La Motte was told upon his arrival that the ore had actually come from Mexico and had been given to Dutisné in jest (Swartzlow 1933:19-20). Certain elements of this story may be apocryphal (how Frenchmen at an isolated outpost on the Mississippi would have procured Mexican ore at this time is unclear), but La Motte's expedition nevertheless set in motion the first substantial assessment of the southeast Missouri lead mines.

La Motte, accompanied by his son, probably numerous Frenchmen, and either two or four Spanish miners ("founders") of whom little is known, was guided by Tamaroas Indians (a branch of the Illinois tribe) up Saline Creek about 14 leagues into the hinterlands near the headwaters of the St. Francis River. Here they dug a trench some seven to nine feet deep before striking solid rock that showed rich mineral veins. Their crude tools proved no match for the rock, and so they returned to Mobile with samples of easily-gathered ore taken from the decomposed, overlying mineral-bearing layers (Thwaites 1902:325; Rothensteiner 1926:202-203; Hanley 1942:30). La Motte himself sailed back to France shortly thereafter, but his son and forty workers apparently stayed behind and worked the mine for some time (Thwaites 1902:325; Alvord 1965:144). They apparently produced enough lead to begin to satisfy local demands, as a proposed schedule of prices for goods offered by the colonists to the Crozat's monopoly included lead in bars valued at 10 sous a pound. However, the directors of Crozat's company declined to establish a quoted price for the metal "because there was no market for lead" (Willms 1935:12). The results of La Motte and his men had been generally disappointing to all involved, with only lead and antimony as rewards where silver had been ardently hoped for, but the area he had tested was known thenceforth as the "Mine La Motte" (Rothensteiner 1926:202-203; Hanley 1942:31).

Having had little success in extracting riches from Louisiana, Antoine Crozat relinquished his concession in August, 1717, and economic control of the colony passed to the Compaignie d'Occident (Company of the West). This soon became the Royal Indies Company (also called the Company of the Indies), a speculative enterprise based almost entirely on rumor, false presumptions, and blatantly misleading advertising. The speculation centered primarily on the still hoped-for wealth of the newly discovered mines west of the Mississippi. To this end, a flurry of expeditions were sent out on the

Company's behalf to locate mines and expand trade (Swartzlow 1933:21-23; Willms 1935:13; Alvord 1965:150-151).

Among these envoys was Dutisné, who was sent west in 1719 from his new post at Kaskaskia in an attempt to establish trade with the Panis (Wichita) and Padoucas (Plains Apaches and/or Comanches). The hope was that trade with these tribes would remove obstacles to direct trade with the Spanish along the Rio Grande in New Mexico. Dutisné was specifically charged to inquire about mines during his journey, and to acquire horses if possible to assist with mining activities in the Illinois. After meeting resistance from both the Missouri and Osage tribes, he did eventually make contact with a twin village of the Wichita in what is now southeastern Kansas. In the course of his travels, he noted that within twelve leagues of the Osage village there were some "very rich lead mines", but "that the Osages did not know how to make use of them" (Wedel 1972:8-13, 150). This reference is significant as it relates to the rich lead deposits of the Tri-State district, where the borders of modern southwestern Missouri, southeastern Kansas, and northeastern Oklahoma converge. There seems to be no record of this area being exploited in colonial times, however, and substantial lead production did not get underway here until the 1850s (Thompson 1955:97). It can be presumed, though, that through the diffusion of firearms and a knowledge of crude smelting techniques, some Native processing of lead ore may have eventually taken place here during the 1700s.

Another exploratory party sent forth by the Royal Indies Company in 1718-1719 included Marc-Antoine de la Loëre des Ursins, commissioner (*Ordannateur*, or Intendant) of the Company (Ekberg 1998:34). He arrived at Kaskaskia with Boisbriant (the new Commandant of the Illinois Country) and others in May, 1719 as part of the expedition which established Fort des Chartres specifically as a "post at the mines" (Willms 1935:14-15). Des Ursins set out shortly thereafter on a reconnaissance of the mining regions across the Mississippi, and Rothensteiner (1926:205-207) provides the translation of des Ursins' valuable report which is summarized here. The party departed from Kaskaskia in June, 1719 with a mixed group totaling 24 persons that included des Ursins, a French prospector named Jacques de Lochon, and several soldiers, slaves, and Indians – including the same Tamaroas Indians that had guided La Motte to the mining region four years before. There were also two Frenchmen who had also been present at La Motte's earlier digging. They went directly to La Motte's earlier prospect via the same route, along Saline Creek, and there reported finding La Motte's original shaft untouched. They then worked this pit and opened two new pits nearby, in the same crude manner that would characterize the region's lead mining for the next fifty years. They dug as best they could with metal tools, ruining many as they went, and noted alternating layers of soil and decomposed rock. Nearer the surface could be found chunks of lead "float", indicators of rich veins with traces of lead ore several inches thick trending through them. The deepest they penetrated was about ten feet. When the rock became too hard for their crude tools, or once water seeped into their excavations, they abandoned that test pit and moved to another. In all they worked their three shafts for five days, producing "20 gros of ore". (Here the translation may be misleading, as according to Ross [1983:59] a *gros* is equivalent to only 3.82 grams. Much more likely is that 20 gross of 144 livres were taken, or roughly one and a half tons. This amount could have been very reasonably transported by 24 men and the four horses they had available.) They attempted to perform some on-the-spot assays, but had left their "melting pots" in New Orleans and ran into difficulties when their skillets melted along with the ore. A much smaller amount of what des Ursins considered to be silver was also recovered, but it is suspected that de Lochon spiked the ore to put the effort into a better light (Swartzlow 1933:24). Des Ursins also commented on the abundance of pits opened here by "the savages" (as previously noted), although it is well to keep in mind that a contingent of forty of La Motte's men had apparently worked here for some unknown time in 1715 and afterwards.

Another mining engineer ("ingenieur pour les mines) sent forth by the Royal Company of the Indies was Philippe de La Renaudiere, whose men dug ore at Mine La Motte for a time as well as opening up the Meramec mines. In a report written from New Orleans in 1723, he describes conditions very similar to those encountered by des Ursins. At Mine La Motte he noted that traceable lead veins ran a half league east to west and five to six paces in width, with scattered ore distributed throughout the soil and often found only a foot below the surface. His own pits seem to have not gone deeper than seven feet, and he estimated the yield of lead from the ore at 40 to 45 percent. He apparently had some success in production, noting that with eight workmen about 10,000 pounds of lead could be made in a month; whether this figure indicates actual production, or merely serves as an estimate of the potential (as Hanley [1942:33] deduces) is unclear. Renaudiere also bemoaned the difficulty of transporting the lead across the hilly terrain to the Mississippi and from there to Kaskaskia, a problem which was to plague the lead miners and greatly add to production costs for years. He praised the natural abundance of the land, and favored establishing a settlement near the mines that would allow lead to be shipped directly down the St. Francis River to its mouth at the Mississippi, on pirogues loaded with 5,000 to 6,000 pounds of lead (Rothensteiner 1926:207-208; Ekberg et al.

1981:11-12). However, this remote area remained too dangerous for long-term settlement, as the violence of the Fox Wars (1712-1730) spilled over even into the Illinois country (Alvord 1965:147). Hence, lead continued to be laboriously transported overland and across the Mississippi to Kaskaskia for at least a few decades to come.

At the Meramec mines, Renaudiere spoke of mines with generally narrower veins but richer lead, estimating the yield as high as 80 percent – a figure well in concert with Father Gravier's comment in 1700. He also commented on the general abundance of good mining prospects in the vicinity. By his reckoning, these mines lay 14 leagues northwest of Mine La Motte, 30 leagues by land from Kaskaskia and Fort des Chartres, and 55 leagues by water via the Meramec from its mouth. Again he praised the region's richness and commented on its suitability for settlements, even going so far as to say that thirty slaves under good management ought to be able to produce "three hundred millions of lead per year" (Rothensteiner 1926:208-209). (Here I suspect a mis-translation, as 300,000 pounds of lead seems a reasonably optimistic estimate, while a thousand times that amount seems simply outrageous.)

Another person connected with the Royal Indies Company was Philipe François Renaut, who as director of mines for the Company came to be the primary figure involved in French colonial lead production during the 1720s and 1730s (Ekberg 1985:145). His name is also given as Renault and Renaud, though in signed documents he signed his name Renaut (Ekberg 1998:35). Under his direction occurred the first sustained, substantial production of lead in the Illinois country. He arrived in the Louisiana colony near the end of 1719, established himself near Fort Chartres in the Spring of 1720, had commenced mining by 1721 and by 1723 appears to have been heavily involved in directing lead mining in at least two locations on the Mineral Fork of the Big River (Willms 1935:19-21). This general vicinity came to be variously known as the Meramec Mine, Renault's Mine, and later, simply as "Old Mines" (Ekberg et al. 1981:12-13). From d'Artaguiette's journal, it is clear that by the first half of 1723 Renaut already had "thirty or so Frenchmen" working the "Meramek Mines" and that from a period of about a month and a half's work there were already "perhaps about six thousand pounds weight of lead melted down" (Rothensteiner 1926:210). In early 1722 he is even reported to have tested some ore brought by some Canadian *voyageurs* from the Kansas Indians (Willms 1935:20).

Despite what would seem to be promising returns of lead, Renaut was actually producing this metal only as a by-product of his continued frustrated efforts to find the silver so eagerly sought by the Company. After repeated failures made it quite apparent that no meaningful deposits of silver were to be found, Renaut was granted title to the mineral lands upon which he proceeded to extract lead purely for its own sake (Willms 1935:21-23). On June 14, 1723, Renaut was issued four very sizeable land grants totaling about 500 square miles in coverage. One of these centered on the region of the Meramec Mine, and another on Mine La Motte. A third parcel, on the east side of the Mississippi above Fort des Chartres, was developed as the village of St. Philippe with the purpose of serving as an agricultural base of support for Renaut's mining claims. The fourth, on the Illinois River near Starved Rock at Lake Peoria, was also envisioned as contributing to the overall success of the mining enterprise (Ekberg 1998:43; Schroeder 2000:103). It is clear, then, that Renaut worked and commanded authority over the two most promising mining areas known to the French at the time. However, owing to the great cost of supplies and freight in such an isolated region, Renaut had to rely entirely on credit extended by the Royal Indies Company in the startup of his mining enterprise. The untimely retraction of this credit would halt his operations just as production was reaching sustainable levels (Willms 1935:17-27).

In May, 1724, Renaut sold (or bartered, rather) 20,000 pounds (or *poids*) of lead to the government for the use of the garrison at Fort des Chartres (Surrey 1916:303). In exchange for the lead, which likely represented the sum total of his production to that point, a portion of his debt was erased (Willms 1935:23). The enterprise showed great promise, though, and by 1725 it was reported that Renaut would be capable of producing some 1,500 pounds of lead per day if only he had sufficient labor available to him (Willms 1935:24). Within a year he expected to be able to provide as much lead as the entire colony could consume, if only some protection from the Fox Indians would be granted him (Willms 1935:25; Alvord 1965:159). Unfortunately, these few figures from 1724-1725 appear to be the only quasi-firm numbers we have for lead production in southeast Missouri until 1741 (Briggs 1985:293). Shortly after this mid-1720s peak in production, mining activities were severely curtailed for some time. The violence from the Fox Wars, involving the complex intrigues of many allied tribes and their animosity towards the French along the Upper Mississippi, infected the Illinois region and caused skittishness on the part of the Royal Indies Company. Fort des Chartres itself was nearly abandoned, and in the latter part of 1725, Renaut, harassed by Indians such as the Fox, Sioux, Osage, and Chickasaw, and still deeply in debt but seemingly on the verge of running a profitable enterprise, had to suspend his mining operations (Willms 1935:26-27; Alvord 1965:158-159; Ekberg 1985:147).

Renaut did return to the exploitation of the mines several years later, presumably after the end of the Fox Wars in 1730, as the census of 1732 notes that his workforce consisted of seventeen black slaves and eight Frenchmen (Ekberg et al. 1981:14). This marks the first known sustained use of slaves at the lead mines (aside from the brief, abortive efforts of the De Lochon and Des Ursins party in 1719), but the practice never developed very fully under the French; it was not until the arrival of the Americans in the late eighteenth century that slaves were exploited as a major source of mining labor (Ekberg 1982:139).

Throughout the French period lead mining was almost strictly a seasonal operation, occupying lulls in the agricultural calendar (Ekberg 1985:148-149). There is some evidence, though, to suggest that a small, continuously-occupied settlement might have existed at Renaut's Meramec mines by the early 1730s, and that it was possibly fortified in some manner against the Indians who continued to be resentful of the French incursion into the lead regions (Ekberg et al. 1981:14). By this time, however, Renaut no longer had dealings with the Royal Indies Company, as their control of Louisiana had been retroceded back to France in 1731. Denied easy wealth and beset with numerous costly problems, the Company was only too happy to divest itself of its interests in North America. Renaut eventually gave up his mining concession in 1740 and returned to France in 1741 (a date often surrounded in confusion; see Willms 1935:29; Caldwell 1941:47; Hanley 1942:11; Alvord 1965:209; Ekberg et al. 1981:16). In any case, work at the Meramec mines and at Mine La Motte seems to have been carried on sporadically by various unknown, opportunistic miners into the 1740s. There were serious lapses, however, from the levels achieved around 1725, and output seems to have suffered for a number of years (Willms 1935:30-31; Ekberg et al. 1981:16-17). In 1733 the Governor of Louisiana, Etienne Périer, was driven to complain about the lack of lead in the entire province, indicating that the Missouri mines no longer produced a sufficient quantity for local consumption (Ekberg 1982:141).

Upon Renaut's departure, the French Minister of the Marine, Maurepas, requested detailed reports on the viability of the lead mines. Such reports were apparently drawn up, but unfortunately do not survive (Hanley 1942:12-13; Ekberg 1982:146 footnote 36). It is stated that two other persons were sent to work the mines (Alvord 1941:47), one of whom was probably Antoine Valentin de Gruy (often rendered as de Guis or de Gruis), an officer in the French military. He arrived in the Illinois Country in 1741 and soon established himself as a miner of some significance. He produced a report in 1743 of two expeditions he undertook into the mining regions in search of richer and more accessible outcrops of lead ore. Ekberg (1982) supplies a translation and commentary on this valuable report, which also provides some of our best observations and descriptions of the general operations of the lead mines for the entire French period. The bulk of the next few paragraphs is derived from this source.

The other person sent by the French government after Renaut's departure may have been Louis Robineau, sieur de Portneuf (Hanley 1942:17), for he and De Gruy both embarked from Fort de Chartres on two separate expeditions apiece during April, 1743. Portneuf seems to have also produced his own reports, but these apparently have not survived. Both men set out in the general direction of the area between the headwaters of the St. Francis and Big Rivers, probing about somewhat haphazardly, it seems. De Gruy's party was small, with two other Frenchmen and two Indians as seemingly reluctant guides. Hanley (1942:26) in fact suggests that these Indian guides quite deliberately skirted the area enclosed by the Mineral Fork and the Big River, a rich area she terms the "lucky horseshoe" where major lead strikes later occurred in the 1770s.

De Gruy's primary goal in these expeditions was to find new, accessible lead sources that did not lie in such hostile territory as the Meramec mines, and that also provided for easier, more direct transport to the Mississippi than was possible from Mine la Motte (Ekberg 1982:142). He comments specifically that Renaut had been driven from his Meramec mines by the Sioux and Fox, but does note that the area was back in production at the time of his visit, albeit at less than full capacity – the mines were being worked by "ignorant persons", mostly "wastrels sent to this spot involuntarily for not having been able to support themselves" (Ekberg 1982:146-147). He also paid special attention to areas where it seemed that cart transport and river navigation were especially feasible, as period correspondence makes clear that the fourteen leagues from Mine La Motte to the Mississippi at Saline Creek was a very hilly and arduous route (Pease and Johnson 1940:773-776, 818-819). In fact, Hanley (1942:89) has calculated that this difficult terrain caused transportation expenses from Mine La Motte to account for fully 20 percent of the operational costs.

De Gruy's obvious unfamiliarity with the general landscape, combined with the almost total dependence on what seem to have been rather disinterested Indian guides, shows that even after more than twenty years the French still knew relatively little about the mining prospects of southeast Missouri. His account also provides details which show that the rather primitive methods of mining had really not advanced much since the test pits of Des Ursins in 1719. He comments that each operation was a basically individualistic affair, with each worker randomly probing the ground with a metal rod to locate buried veins. These were crudely dug, following the vein until either the rock became too hard or water entered the excavation, at which point the unit was abandoned for another. This is essentially the precise manner of digging related twenty years earlier, and indicates that virtually no technological improvements had been introduced in the meantime. (Presumably more appropriate tools were taken into the mining fields by this time, an inadequacy that hampered both La Motte and Des Ursins). De Gruy comments that the mining was a seasonal affair, occurring only four or five months out of the year, and that once a sufficient quantity of ore had been gathered the smelting process began.

The crude method of smelting he described, the log heap furnace method, remained the primary method of reducing the lead ore throughout the French period. A simple box-like construction of large logs was erected over a shallowly dug hole in the ground, a sizeable quantity of ore placed within, extra wood stacked on top, and the entire mass fired. The rate of recovery from this process was estimated at only about 35 percent, from ore that could have often yielded as much as 60 to 70 percent (Swartzlow 1933:55, 66; Hanley 1942:144-145; Schroeder 2000:63). Much of the volatile lead was vaporized and lost in the process. It often took up to three such firings to adequately break down the sulphurous galena; the resulting heaps of incompletely reduced lead ashes and slag were also ignored and cast aside, but were re-worked decades later in specialized ash furnaces to reclaim their substantial yields (Hanley 1942:104-113, 121-122).

The molten lead that resulted from this crude bonfire style of smelting simply puddled on the ground in the divot which had been dug to catch it. These raw *saumons* of lead (Hanley 1942:22) were then remelted on-site into small flat bars weighing sixty to eighty *livres* (65 to 86 pounds) apiece for transport (Ekberg 1985:146). The bars were then hauled four or five at a time by horses to the Mississippi before being floated over to Kaskaskia, or loaded directly onto barges for shipment south (Pease and Johnson 1940:818-819). (It should be noted that the town of Ste. Genevieve, often erroneously cited as a depot established in the early 1730s for the convenience of the lead mines, actually did not come into existence until about 1750 – and then primarily as a center of agricultural production; see Ekberg 1985:10-15; Schroeder 2000:263-264.) Just before 1800 we have descriptions provided by Moses Austin of slightly improved stone smelting furnaces ("log hearth" as opposed to "log heap" furnaces) used in the area, but the date of their introduction is unknown (Garrison 1900:540; Hanley 1942:94-97, 144). Hanley (1942:9, 27) surmises from the wording of Renaut's land grants that he may have owned at least one masonry furnace, but this is uncertain.

Despite, the crudity of the methods, De Gruy states that in 1741 2,300 such bars of lead were produced at Mine La Motte, and 2,228 bars in 1742 (Ekberg 1982:148). These rare figures for annual production (if accurate) would equate to about 133,680 to 184,000 pounds of lead per year, or roughly around 67 to 92 tons of metal. The output at Mine La Motte was apparently more regular and productive than that carried on by the dissolute outcasts then in place at the Meramec mines, which an estimate in 1741 placed at 40,000 pounds per year (Caldwell 1941:47). In any case, these figures indicate a rather substantial production beyond even the immediate needs of the Illinois Country, as De Gruy indicates that the lead had "not only supplied this settlement but had also supplied such Canadian outposts as Ouiatenon, Missilimakinac, and Detroit."

A mere four months after returning from his expeditions in 1743, records show De Gruy entering into formal business partnerships and borrowing money to pursue the exploitation of the mines (Ekberg 1982:138). His efforts and that of others must have resulted in a string of good years of lead production, for lead from the Illinois Country was sent not only upriver to the isolated French outposts, but also downriver to New Orleans and on to France as well. In 1743 a royal French supply ship returned to France loaded with 30,000 pounds of Illinois Country lead that was allowed to be transported free of charge as ballast, as long as it did not displace other trade goods (Surrey 1916:303; Caldwell 1941:47; Hanley 1942:42). In this same year the Intendant of New France, Hocquart, estimated the total lead production of the Illinois country to be 75,000 pounds (Caldwell 1941:47). In 1744 another 30,000 pounds of lead were sent to New Orleans from the Illinois Country (Surrey 1916:303). In 1745 a total of 522 lead bars (roughly 31,000-42,000 pounds) were sent on two royal ships returning to France, but the War of the Austrian Succession (1744-1748) had begun and both ships were captured by the English (Surrey 1916:203-206).

Amazingly, in the face of such steady production, the commandant at Fort de Chartres, Bertet, received in 1746 orders from Maurepas, the Minister of the Marine in France, to focus the colony's energies on agriculture rather than mining: "Although the exploitation of the mines which are found in the Illinois region cannot fail to be of interest, there must not at present be any consideration of undertaking it. There is another object which deserves preference to all else; and this is the culture of the land" (Caldwell 1941:48). Bertet and the colonists seem to have ignored this decree in large part, and lead is again noted as being among the items received in New Orleans in 1747 and 1748

(Surrey 1916:203, 293; Hanley 1942:40-42). By 1752 De Gruy had apparently entered into a contract to supply Canada with 100,000 pounds of lead, although the new commandant at Fort de Chartres, Macarty, may have artificially inflated this figure in his correspondence with the Governor of Louisiana in order to place the region's economic potential in a more favorable light (Pease and Johnson 1940:563; Ekberg 1985:156).

Despite their success during the 1740s and 1750s, De Gruy and others (Briggs 1985:294-295; Ekberg 1985:10, 147-151) were evidently aware of their shortcomings in technology and labor and realized that production could have been even higher. In his initial 1743 report De Gruy suggested that, owing to the lack of slaves and their high cost in the district, it would be most advantageous if some of the convicted salt smugglers sent from France each year could be directed to the labor of the mines (Ekberg 1982:148; Ekberg explains that making and marketing salt was a government-controlled monopoly in pre-Revolutionary France.). Incongruously, Maurepas, who had so strongly encouraged that lead mining be put aside in favor of agriculture, agreed to send a dozen salt smugglers for the working of the mines. However, they were either never actually sent or used for farming labor instead (Caldwell 1941:47-48; Hanley 1942:206). Another plea for salt smugglers went out ten years later, in 1753, in a letter from Macarty to a different Minister of the Marine (Rouille) (Pease and Johnson 1940:818). In 1754 Pierre René Harpain de la Gautrais, a captain of the Illinois Country in partnership with de Gruy, wrote to Kerlerec (Governor of Louisiana) and d'Auberville (*Ordonnateur* or Intendant) pleading that a skilled workman or two knowledgeable in lead smelting be sent from France along with all proper tools and materials. Especially requested were workmen capable of recognizing the minerals in the vicinity of the La Motte and

Meramec mines. In forwarding Gautrais' request to Machault (yet another newly installed Minister of the Marine), the Governor and *Ordonnateur* noted that the lead workings yielded up to 60 or 70 percent metal, though they thought even more was possible (Pease and Johnson 1940:894-900; again, the figures may have been inflated to encourage the officials in France to look kindly upon the mining enterprise). Evidently, even though quite substantial quantities of lead were being produced, De Gruy and his business associates were well aware that their operations lacked sophistication.

In all, several factors presented ongoing economic challenges to the lead mines of southeast Missouri which prevented them from being exploited more efficiently during the French period: the general inaccessibility of the mines and the difficulty of transportation; the chronically small labor force composed primarily of free Frenchmen requiring high wages, and their inability to work the mines except on a seasonal basis dictated by the agricultural schedule; the frequent threat posed by hostile Indians; and the crudeness of the refining techniques which entailed increasingly expensive fuel costs as the mining regions became deforested.

By 1754 the French and Indian War had begun, known in Europe as the Seven Years' War. Commerce of all kinds was severely disrupted, although the great battle between Britain and France for the control of North America was decided almost entirely by actions in eastern Canada (Walthall and Emerson 1991:10). Little documentation seems to exist for the period regarding lead production in the Illinois Country, but the discovery of the Castor Vein near Mine La Motte in 1757 demonstrates that some mining activity did continue despite the turbulence (Hanley 1942:53-55). Overall, though, it seems reasonable that the industry would have been substantially impacted by the turmoil of the greater conflict. The population of the Illinois Country had never been great, having grown by 1752 to only about 1,400 people, including slaves (Willms 1935:31; Ekberg 1985:8; see also Alvord 1965:202 and Walthall and Emerson 1992:10 for slightly different estimates). Such a small population would have likely been incapable of sustaining completely normal patterns of commerce despite not being directly involved in the conflict. Additionally, many of the resources of the Illinois Country which were ordinarily sent downriver to New Orleans instead began to be diverted northward to isolated French posts where regular shipments of supplies from Canada had been cut off. This is manifested by the fact that, starting in 1753, the number of supply convoys sent from the Illinois Country to French posts on the Ohio and Wabash Rivers, as well as to posts in Canada, were increased from one to two convoys per year, and with double the usual number of boats (Surrey 1916:47-48, 297-298).

The great French fortress of Quebec fell to the British in September, 1759, and Montreal a year after that. By 1763 France had lost its domain in North America through the Treaty of Paris, ceding the lands east of the Mississippi (save for New Orleans) to Great Britain. Slightly earlier, by the Treaty of Fontainebleau in 1762, France had ceded to her ally Spain all the lands west of the Mississippi. This was done as a compensation for Spain's loss of Florida, as well as acting as a hedge against total British control of such a huge territory (Alvord 1965:193; Schroeder 2000:104). French rule of the Illinois Country continued until October 10, 1765, when the British finally arrived to take possession of remote Fort de Chartres (Alvord 1965:264).

Spanish rule had only a nominal effect on the general goings-on west of the Mississippi, where many French had resettled after learning their homes would soon lie within British territory. French practices, culture, and even administrators continued to prevail (Swartzlow 1933:47-48). Lead mining in Spanish Illinois saw generally increasing production from major new strikes such as Mine à Breton in 1774, only about six miles south of Renaut's original Meramec mines. The problem of occasional Indian hostilities still continued, though, with several miners killed in 1774 in an attack by either the Osage, Chickasaw, or Cherokee, virtually shutting the mines down for several years (Houck 1909[1]:100; Hanley 1942:145; Ekberg et al. 1981:17; Ekberg 1985:156). It was not until the end of the century that the lead industry would be revolutionized and the efficiency of production greatly expanded through the improved technologies and methods introduced by the American Moses Austin. He clashed severely with the French inhabitants, blithely claiming legal title to vast tracts which they had long worked and recognized only implicitly amongst themselves, but he would nevertheless come to dominate lead mining in southeast Missouri. It was only the eventual bankruptcy of his lead empire in 1820 that would cause him to seek, with his son Stephen F., to enter upon a colonization enterprise in Spanish Texas (Swartzlow 1933:49-83; Hanley 1942:116-135). The heritage of the French settlers would remain long imprinted on southeastern Missouri, however, with relict communities of French speakers in the mining areas carrying their culture well into modern times (Gold 1993; Schroeder 2003).

It should here be pointed out that of the large quantities of lead produced by the French in southeast Missouri, there is virtually no record of it having ever been manufactured into any sort of finished product such as lead balls. Once cast into bars, it seems that this is how it remained, whether being transported northward to the various French outposts and Canada, southward to New Orleans, or ultimately to France. At least one researcher has commented directly on this peculiarity, noting of French lead that they "did not develop any significant processing activity that would have added value to their product" (Schroeder 2000:63).

Undoubtedly much lead was cast locally into bullets for local consumption, a commonplace activity that would warrant little mention in contemporary accounts. One archaeological site on Saline Creek has yielded extensive evidence of the manufacture of lead balls, but apparently dates primarily to the late 1700s and early 1800s. The Kreilich site (23SG5), located on the north side of Saline Creek at its confluence with the Mississippi, represents the historic settlement of Grande Saline. In 1985, surface collections recovered large quantities of musket balls, lead spall, and gang molds in direct association with salt furnaces – clear signs of both on-site bullet and salt manufacture. However, the dominant diagnostic artifacts both here and in adjacent areas were Euro-American in origin, with ceramics suggesting a primarily late 18th to early 19th century occupation from about 1775-1810. However, four types of French faience were found in later testing, apparently hearkening back to the earlier salt production activities known to have been conducted by the French at the mouth of Saline Creek (Trimble et al. 1991:177-184). Whether the area was also used in the first two-thirds of the 1700s for bullet production remains unknown.

It would seem that for the most part, the task of casting balls from exported lead during this period was left mostly to the ultimate recipient of the raw product. This fact has direct and substantial implications for the interpretation of archaeologically recovered lead artifacts of probable French colonial origin, a matter will be expounded upon in greater detail in succeeding chapters.

CHAPTER 4

LEAD PRODUCTION IN MEXICO AND EUROPE

Spanish Silver Mining and Lead Production in Mexico

Unlike the mining of lead in the Mississippi Valley by the French, where precious metals did not occur in any meaningful quantity, lead in colonial Mexico (New Spain) was produced primarily as a little-noted by-product of the lucrative silver mining industry. Lead does occur in abundant co-existence with Mexican silver ores, however, and played a vital role in the silver refining process. As such, the generally ignored history of lead production in Mexico is inextricably tied to the much more intensively studied process of silver mining. The existence of large quantities of native Mexican lead, along with the complex patterns of exchange to which it was subjected, can be expected to play some role in the isotopic study of colonial objects originating from Mexico. For these reasons, it is proper to examine the procedures of Spanish silver mining in order to understand how lead may have been procured and distributed in colonial Mexico.

Rich outcrops of silver were discovered and exploited by the Spanish very quickly after the conquest of Mexico, beginning with the lodes of Zumpango del Río, Sultepec, and Taxco to the south and west of Mexico City in the early 1530s. These were quickly followed in the 1540s and 1550s by the great mining centers of Zacatecas, Pachuca, Guanajuato, and Real del Monte. (West 1994:118-119; Young 1994:110). Over the next 150 years, mining activity and new discoveries progressed steadily up the Sierra Madre

Occidental mountain range until reaching the region of present-day Chihuahua City in the early 1700s (Hadley 1975:4-5). In all, 433 total silver mines were discovered in New Spain prior to 1800 (Sánchez-Crispín 1994:163). Many of these produced only limited, but rich, bonanzas, while others experienced cycles of decline and renewal according to prevailing economic trends and the availability of new technology. Some areas, such as the *Provincia de la Plata* mining region near Mexico City, managed to produce silver throughout the colonial period (West 1994:125-126).

The abundance of lead which often accompanied these Mexican mines came to play a very large part in the processing of the silver lodes. Although records for silver production abound, relatively little documentation seems to exist in regards to the side manufacture of lead. This is no doubt due to lead's more lowly status as a base metal, which did not automatically generate the same riches and avarice (nor sharp-eyed Spanish accounting practices) as silver. Indeed, Alexander von Humboldt, observing the Mexican mines in the early 1800s, commented that "...iron or lead mines lie abandoned no matter how rich they may be, for the settlers' attention is entirely fixed on the gold and silver lodes, even when their outcroppings present only meager indications of riches" (Prieto 1973:35). For the Chihuahua mining district, one of the last great mining centers to be established in colonial times, figures on silver production date to 1703, but no figures seem to exist for lead production until 1881 (Megaw 1990:34). While very often overshadowed in the literature on historical mining, the production and distribution of lead was nevertheless vital in several ways to the refining of the Mexican ores.

In the first two decades of silver mining in New Spain, the richness of the first surface ores to be encountered generally allowed for simple direct smelting to refine the metal. The presence of naturally-occurring lead within the ore often assisted in the ease of the process, as lead acted as a flux to make the ore more "wet". Silver and lead would combine as an alloy with a lower melting point than either constituent alone, after which the resulting silver-lead ingots could be further refined (Young 1970:89-91). As mine depths increased, ores became increasingly infrangible due to the peculiarities of Mexican geology. Generally speaking, Mexican silver ores were deposited in highland uplift areas by upwellings of mineralized water containing silver sulphides and other metals. In the upper, oxidized reaches of rock, these sulphide minerals had undergone sufficient exposure to the elements to convert them into easily refined (and hence highly profitable) silver chlorides. Below this, in thick layers of fractured shale above the water table, silver remained in a sulphide form that was much more troublesome to refine. Below the water table, in addition to being more inaccessible, the ores became even more difficult to refine owing to their having had little opportunity to oxidize (Young 1970:72-74; Bakewell 1986:109-110).

After the chloride-rich surficial ores had played out, lead became an increasingly important ingredient to the refining process. Large quantities of lead or lead oxide (litharge) were needed as a flux, in order to coax the trapped silver into a more manageable lead-silver alloy. While some mines produced sufficient quantities of lead for their own smelting needs, others were saddled with the high expense of importing needed lead from such areas as Zumpango del Río, Tehuacán, and Mixteca Alta to the south of Mexico City (West 1994:127-131). Over the years, the great mining center of Zacatecas relied on lead brought in from San Martín and Nuevo León, and litharge (lead oxide) from Izmiquilpan some 250 miles away (Bakewell 1971:23, 147).

A new method of refining, the patio process, was introduced in 1555 by an ingenious miner, Bartolomé de Medina, that obviated much of the need for such large amounts of lead flux. Under the patio process, silver ore was crushed to a powder, spread in a courtyard basin, and mixed with common salt, *magistral* (copper sulphide derived from roasted pyrites) and mercury (Probert 1969). This chemical stew converted the intractable silver sulphides into easily processed silver chlorides, which could then amalgamate with the mercury to form an easily retrieved mass of metal. The amalgam was then retorted, driving off the volatile mercury and leaving a spongy, crispy mass of silver (Bakewell 1971:144; Young 1970:75-79; Bakewell 1986:115-117). The colonial miners were naturally ignorant of the underlying nature of the chemical reactions, but recognized the method's efficiency and utility nonetheless. The patio process served to revolutionize Spanish colonial silver mining, allowing for the widespread processing of previously unworkable ores and thus leading to the production of huge quantities of silver over the next few centuries.

Even in the improved and flux-free patio process, which allowed for the profitable extraction of silver from even poor-grade ores, lead still played a role. A 1599 account of the amalgamation process advised that after the resulting spongy silver masses had been reduced, it was best to cupel the silver in order to increase its fineness. Cupellation involves mixing silver with lead as a flux, as previously described, and re-smelting it using a container lined with (or made of) tightly packed wood or bone ash that will retain the molten lead but not the silver. To this end, the sixteenth-century chronicler noted that "it is well to add an ounce of lead for each mark of silver (about eight ounces), although some miners, in order to increase the weight of the silver, apply more lead than necessary and extinguish the fire prematurely…" (Flores 1994:150-151). It is of interest to note here that cupellation also occurred in conjunction with regular smelting, making use of lead oxide (litharge, or *greta*) in a reverberatory furnace, which in turn produced *cendrada*, or "hearth lead". This lead, retrieved from the ground-up cupels, could then be recycled for further smelting operations (Bakewell 1971:145-147). Additionally, forms of slag lead, known as *plomillo* and *temescuitate*, were also recovered and reused (Hadley 1975:238). Conceivably, such recaptured and well-mixed lead could perhaps have been recycled during colonial times in other ways as well. From an isotopic standpoint, such mixing would certainly have the potential to complicate the interpretation of affected lead signatures.

Despite the efficacy of the patio process, smelting did, however, remain important throughout the colonial period in certain areas. In some circumstances, the nature of certain ores and various economic factors (such as periods during which mercury was not readily available, or where remoteness of the mines made the large industrial infrastructure of the patio process impractical) favored use of the older method (Bakewell 1986:119). In particular, smelting underwent a rather strong revival during the late 1600s to 1700s (Brading and Cross 1972:556; Bakewell 1986:145). As examples, figures from one Chihuahuan mine show that, in 1730, roughly equal proportions of silver were produced via both amalgamation and smelting (Alvarez 1994:196-197). Pedro Romero de Terreros, one of the most influential silver barons in eighteenth-century Mexico, began in the 1750s to rely much more heavily on smelting at his Santa María Regla refinery, near to Real del Monte (Couturier 2003:69). Such activity coincided with a general, steady upward trend in the overall amount of silver being produced in New Spain in the 1700s, with the primary centers of production being Guanajuato, Pachuca, Zacatecas, Parral, and San Luis Potosí (Brading 1970; Bakewell 1986:62; Coatsworth 1986:265; Garner 1988:907). It is reasonable to assume that an increased production of silver via smelting also resulted in an overall increase in the amount of lead being produced.

This revival in smelting is especially true in the case of mining regions newly developed in the 1700s in arid northwestern Mexico, including such regions as Santa Eulalia, Sombrerete, Zimapán, and San Luis Potosí in present-day Sinaloa, Sonora, and Chihuahua (Hadley 1975:235; Sánchez-Crispín 1994:161). In these localities, ore bodies of particularly high lead content made smelting not only feasible, but the preferred method of refinement. In other regions northwest of Mexico City, including Guanajuato, Zacatecas, and Real del Monte, the importation of lead reagents from outside sources allowed for profitable smelting (Hadley 1975: 238; Hadley et al. 1997:87). A 1739 report on the realm of Nuevo León provides clear details on the importance and distribution of lead from the mines of San Pedro Boca de Leones (modern-day Villaldama), approximately 22 leagues or 88 kilometers northwest of Monterrey:

> "The minerals from this mine have been up to legal standard, with an abundance of silver. They are less plentiful now, but large amounts of lead and other alloys are recovered, without which the silver ores cannot be processed, since they must be smelted by fire instead of with mercury. The [ores] are taken from Boca de Leones to other mining towns in Nueva España, such as Zacatecas, Sombrerete, and Guanajuato, which are 20 to 30 leagues distant from each other and an average of 130 leagues from Monterrey. Likewise, the alloys and lead are transported to the mining camp of San Felipe de Chihuahua, which is 422 leagues from Nuevo León. When alloys are not available at these mines, the reduction of silver ore is delayed, compromising commerce and delaying payment of the royal fifth" (Hadley et al. 1997:87).

The same 1739 report also notes the presence at Pesquería Grande, eight leagues west of Monterrey, of "some silver mines...with abundant lead and alloys", and goes on to provide interesting information on the routes of colonial Mexican commerce by noting that "All traffic that comes and goes between the kingdom of Nuevo León and Mexico City, or the provinces of Nueva Galicia, Vizcaya, Nuevo Toledo, Sonora, Ostimuri, New Mexico, and other provinces to the west and south of Nuevo León passes through this jurisdiction" (Hadley et al. 1997:84). A different report of 1753 from northwestern Mexico notes that some mines of the Santa Eulalia district in modern Chihuahua, including that of Nuestra Señora de Guadalupe, produced ore with such a high concentration of lead that its main use was in the "smelting of metals of other mines". Similarly, at the Santo Domingo mine, the report notes ore "whose metals are leaden and only serve for processing other metals" (Hadley 1975:299, 301, endnotes 1 and 17). Along these same lines, a 1711 report from Nueva Vizcaya notes that "the mine at Mapimí was operating with seven or eight smelters in which a great deal of lead ore was extracted, along with silver of legal standard, precious metals, and many alloys needed to make other valuable metals useful" (Hadley et al. 1997:179).

Although certain regions tended to export or import lead as needed, it appears that entire mining districts did not always fit into an easy mold of being lead-rich or lead-poor. Sometimes mines within rather close proximity provided the lead smelting reagents which their neighbor lacked. For example, the Chihuahuan mines of Parral had to import lead bars and litharge from from as far away as the Saltillo region (as noted above), but also procured materials from neighboring Santa Bárbara (Hadley 1975:238).

As a rare, direct example of the Spanish colonial trade in lead, one Santa Eulalia merchant by the name of Sugaso supplied area refiners with pig lead (*planchas de plomo*) for their operations, and even operated his own small smelting furnaces to directly process the silver ore he often received as payment. Unfortunately, the account of his estate does not indicate the amount of lead stocks held at the time of his death in 1722, nor the outstanding amounts owed on lead purchases by his customers (Hadley 1975:208-213). Such information would prove interesting, as pricing data for lead and typical shipping quantities during the period appear to be scarce.

Clearly, the continued prosperity of smelting in colonial Mexico demanded a thriving trade in raw lead, lead ores, and lead-based reagents. Mule trains and ox carts were the method by which this and other commodities were transported throughout colonial Mexico and into the province of Texas. In fact, one writer comments that lead was probably the most important item carried along the *Camino Real* in the earliest days of silver mining (Bakewell 1971:21-22). Even by the early 1600s, this road and the Chihuahua Trail (from Durango to Santa Fe) had expanded to allow for transport of materials to and from Mexico's distant mining centers in Chihuahua and beyond. Caravans of five to thirty wagons pulled by oxen or mules were common, but on the long hauls, mules had greater endurance, were generally faster, and required fewer people to rig and drive them. (Ringrose 1970:49; Hadley 1975:161-182). Pack mule trains were thus generally cheaper to operate, and it is probably by this method that lead and most other products were transferred to the Spanish missions of Texas. For instance, 21 mules with harness were purchased in October, 1756 at Saltillo for use in establishing the Mission Santa Cruz de San Sabá (Weddle 1964:44). These same mules were doubtless some of those used to transport the myriad of goods procured in Mexico and San Antonio for the new mission (Hindes et al. 1995:69-78).

European Sources of Lead

As shall be seen, a number of the colonial-period artifacts analyzed in this study likely originated from European sources. The mining history of Europe is much longer and more complicated than that of the New World, and for this reason some basic understanding of the main areas of exploitation pertinent to this study and their general histories will be of use. An effort has been made here to identify the types of ore sources that would have been actually accessible to and exploited by early miners. As data for the colonial era proper can sometimes be scarce, this includes also taking into consideration mining activities in the ancient and medieval periods. Such deposits can be expected to have been worked in a fairly rudimentary manner not dissimilar to later centuries.

The main European powers under consideration, France and Spain, of course shipped vast quantities of goods overseas to support their colonies in the New World, and received products derived from the colonies in turn. This includes ammunition and other lead products that were sent to Canada, Louisiana, and New Spain throughout the colonial period, despite the fact that the previous sections have described how new, domestic lead-producing industries took hold in both the Mississippi Valley and Mexico. It will eventually unfold that the manner in which lead was produced and transported between myriad countries is actually a much more convoluted path than might at first be expected.

France

In France, mining of silver-bearing lead deposits during the ancient and medieval periods appears to have been rather active in the in the vicinity of the Massif Central uplift in the south-central portion of the country. The Cévennes district is of particular note, and prior studies point to lead production during the Roman era in the sectors of Les Malines or Mont Faulat (Trincherini et al. 2001:405), and in the medieval period along the Mont-Lozère Massif in the Cévennes Mountains (Baron et al. 2006). Lead isotope values from core samples taken from marshes along the southwest coast of France near Bordeaux, and dating back 6,000 years, show that ancient pollutants from smelting activities settled on the landscape during these Roman and medieval periods; however, in this case the particulate matter is ultimately traced to mining activity in southwest Spain and Central Europe (Alfonso et al. 2001:3602-3603). Closer in time to the period directly under consideration, the silver-bearing lead mines of Poullaouen and Huelgoat, located on the Brittany peninsula of northwestern France, are noted in 1854 as having been "formerly quite important". Huelgoat is said to have been worked prior to 1578, and work commenced at Poullaouen in 1729 with over 1000 men employed there in 1760 (Whitney 1970 [1854]:380-381).

As to outside sources from whence the French may have derived their lead in the 1700s, Savary's *Dictionnaire Universel de Commerce* (published 1759-1765, and with earlier editions dating to 1723) indicates that the majority of French lead was procured from England, some from Germany, and a certain amount from Poland imported by way of Holland, as well as smaller amounts originating from Spain, Portugal, Sweden, and some mined from the Limousin region of France (Kent 2001:184).

Spain

A similarly ancient, and even stronger, tradition of lead production obtains for Spain. Of particular note is the mining district of Rio Tinto in southwestern Spain, where lead, copper, tin, and silver were produced from Roman times onwards and shipped from the port town of Huelva. Early production was sufficient enough that an ancient Roman road, the *camino de plata*, connected the silver mines between Andalucía and Asturias (Couturier 2003:18). The Rio Tinto ores derive from one of the world's largest sulphide deposits, and have the added distinction of being very shallow in nature (and hence accessible to early miners), penetrating to only about 200 meters below the surface (Pomiès et al. 1998:139). Such depths were typically achieved, and exceeded, during the colonial period, with Mexican mines at Guanajuato (as an example) going deeper than 500 meters by the latter part of the eighteenth century (Brading 1970:667; Prieto 1973:24). Lead was also produced in antiquity in the Sierra Morena mountains of south-central Spain and in mines near Cartagena on the southeast coast in the vicinity of the Sierra Nevada mountains (Whitney 1970 [1854]:375; Trincherini et al. 2001).

The Alcudia Valley region of Spain (corresponding to the eastern Sierra Morena, and bordering the Linares and Pedroches mining districts) also bears very rich lead deposits which produced large quantities of metal after 1850, although evidence of much earlier workings exist in the area as well (Zalduegui et al. 2004:627). This region is of particular note, as the great cinnabar mines of Almaden are located in the vicinity of the Alcudia Valley. It was from here that most of the mercury used in the patio process of amalgamating silver in colonial Mexico originated. Though direct evidence of actual lead mining here during colonial times is elusive, the area certainly remained a hotbed of general mining activity from the mid-1500s on (Bakewell 1971:154-168). In the time of Bartolomé de Medina (inventor of the patio process), around 1550, silver-lead sulphide ores were known but remained unworked at Guadalcanal about 100 miles north of Seville (Probert 1969:101). These were finally worked starting in the early decades of the 1700s, along with other nearby mines. Meanwhile, the Rio Tinto mines continued to produce faithfully into the 1700s (Couturier 2003:18).

Central and Eastern Europe

Central Europe played host to numerous lead-silver-copper mining centers that were developed and exploited extensively during the Middle Ages. Primary among these were the mines of the Harz Mountains of north-central Germany and the Erzgebirge (literally, Ore Mountains) bordering the modern-day Czech Republic, where mining took off in the 11th and 12th centuries (Nriagu 1998:1622). Important mining centers in these areas of Saxony and Bohemia (modern day north-eastern Germany and the western Czech Republic) include Mansfeld, Freiburg, the Goslar and Rammelsberg vicinities of Silesia, and Kuttenberg near Prague (Nef 1941a:7-9). Mining in these regions especially received a boost from the introduction in 1451 of the *Saigerverfahren* (also known as *saigerhandler*) method of smelting, whereby lead was used to separate silver from silver-bearing copper ores (Nef 1941b:576; Burt 1995:34; Nriagu 1998:1622). In fact, the deliberate use of lead as a reagent in the smelting of more precious metals, among many other mining procedures later used throughout Europe and the New World, derived in large part from the technological developments introduced in medieval Germany (Brading and Cross 1972:545, 552). Other areas of Central European lead production mentioned for the medieval to early historic periods include Sweden, Prussia, Slovakia, the Kraków and Lublin regions of Poland, the Tyrol region of Schwaz in the eastern Alps, the Bleiberg district of Austria, Neusohl in Hungary, and the Vosges and Alsace regions of modern-day northeastern France (Nef 1941a:7-9; Nef 1941b; Wedepohl and Baumann 1997:294).

England

Another European source of lead production that must be considered is the United Kingdom. Here ores relatively poor in silver but exceptionally abundant in lead produced vast quantities of metal. Lead was produced here on an industrial scale shortly after the arrival of the Romans, with lead pigs cast into molds bearing imperial inscriptions that date them to as far back as 49 A.D. The chief lead mining areas in Roman times were the Mendip Hills in Somerset (southwest England), the Shropshire-Montgomery border area of England and central Wales, Flintshire in northeast Wales, Derbyshire adjacent to the Pennines in north-central England, and Yorkshire in northeast England (Tylecote 1964:32-35). These centers (especially Derbyshire) continued to produce lead into later times, along with the North and South Pennine field in general, the Lake District of northwest England, other portions of central and northeast Wales, and parts of Devon and Cornwall in the southwest (Burt 1969:250). As elsewhere, post-Roman mining in Britain went into decline followed by a resurgence in the Middle Ages, but England and Wales in particular experienced especially heavy production and export of lead during the seventeenth and eighteenth centuries. The English edition of Savary's *Universal Dictionary of Trade and Commerce* (1751-55) comments: "There are lead-mines in divers parts of England, Wales, Scotland, and Ireland, and the British plantations, and in various other parts of Europe; but Great-Britain has larger plenty than most countries, and exports great quantities." The ports from which lead was most often shipped included Newcastle, Stockton, Hull, Chester, and Bristol, as well as Aberdovey and Aberystwyth in Wales (Burt 1969:255).

The increased production of British lead in the late 1600s and early 1700s resulted from a generally more stable economic climate in England during this period, as the island nation was somewhat insulated from the turmoil that frequently roiled the Continent in these centuries. Additionally, Britain lacked the substantial silver deposits that drove boom-and-bust cycles elsewhere, so non-ferrous metal production was allowed to develop at a more steady rate free of the artificial swings inherent to precious metals extraction. The abundant and shallow lead ore deposits of England could thus be exploited quite profitably with little interruption. To this end, English mining achieved spectacular levels of growth, producing around twenty to thirty thousand tons of lead annually from the early to mid-1700s, with production as high as sixty thousand tons shortly after 1760. As British trade prospered, the price of lead fell and the less-profitably exploited mining regions of Central Europe went into steep decline (Burt 1995:23-27). Of England's astounding output, it is estimated that during the 1700s over 50% of the total production was exported. The great bulk of this was sold to southern Europe, from whence it may very well have been re-exported (Burt 1995:34-35). Another figure, a guesstimate provided by the Derbyshire mine owners to the British Treasury in 1785, suggests that only one-third of domestic lead production was shipped abroad (Burt 1969:264). In any case, rather significant amounts of English lead were entering the market during this period, with it possibly even making its way circuitously to the French and Spanish colonies in the Americas.

Aside from these production centers, other Old World lead sources were of course being exploited during the North American colonial period. However, those of Europe, and particularly those of France, Spain, Germany, and England, are likely to have the most bearing on the present study. The historical production and trade of lead in these countries is a rather complicated affair, with much interchange occurring in periods of turbulent political upheaval. Among the factors influencing mining was the steady input of vast quantities of silver from Mexico and South America, which drove precious metal values down, disrupting European economies and causing mining to be sporadic at many lead-silver lodes throughout Europe (Nef 1941b:589; Whitney 1970 [1854]:376; Nriagu 1998:1622). At the same time, the increasing popularity and availability of firearms both at home and abroad created a new market for a largely non-recyclable consumption of lead in the form of ammunition. By consuming thousands of pounds of bullets in battles waged with primitive and inaccurate firearms, the many wars which plagued the European nations in the 1600s and 1700s also helped to further stimulate the production of lead (Burt 1995:31-35).

It is to be doubted that nations actively at war would have knowingly supplied one another with lead for ammunition, and in fact it has been noted that, although domestic demand for lead generally increased in times of war, overall prices and production levels tended to go down during periods of major hostilities (Burt 1969:258). Such a decline would presumably stem from the loss of an acceptable market once hostilities had been declared. Still, it is not difficult to imagine stockpiles of imported lead having not been fully distributed for some time after their receipt, and eventually making their way into circulation. Considering the active production and importation of lead that occurred in Europe during the colonial era, it seems altogether likely that some of that product eventually made its way even to remote locations in eighteenth-century Texas and Oklahoma.

CHAPTER 5

THE HISTORIC CONTEXT OF FRENCH, SPANISH AND NATIVE TRADE

Having considered the most likely North American, Mexican, and European sources of raw lead that went into making the lead objects recovered from colonial-era archaeological sites in Texas and Oklahoma, this chapter will address the general issue of pertinent trade networks and distribution mechanisms during the colonial period. The pathways by which this relatively simple commodity transited from original geologic source to its ultimate consumption and deposition within the archaeological record are considerably more complicated and convoluted than might at first be expected. In the eighteenth century lead was being produced simultaneously in Europe, Mexico, and the Mississippi Valley, with its distribution affected by a dizzying array of factors. These range from differing trade policies among the French and Spanish, sporadic hostilities between Europeans and Native groups as well as between European powers in both Europe and North America, general economic trends, complex tribal movements, Native trade networks and attitudes towards the dispersal of firearms and ammunition to competing tribes, geographic considerations, the isolation and dependence of certain outposts upon imported goods, and the existence of illicit trade alliances among both Europeans and Native Americans. The story is of such complexity that the following series of vignettes will strive to illuminate the broader issues involved in colonial trade patterns, with special emphasis given particularly to the movements and origins of lead objects. The role of firearms and ammunition will be especially highlighted, and the reader is also directed to the chronological entries in Appendix D for additional details pertaining to the nature of the lead trade.

Competing Spanish and French Systems of Colonial Economy

Owing to the different systems of interaction with Native Americans employed by the French and Spanish, most of the trade in lead with Native groups was driven expressly by French actions. To be sure, the Spanish also engaged in substantial exchanges in ammunition, but it appears that more often than not they relied on French product in their dealings. For this reason alone, much of the bulk of this chapter will focus on the historical background of French trade activities, as such events tend to bear much more strongly on the archaeological imprint left by many of the artifacts under consideration in this study.

The French had quickly developed a highly sophisticated mercantile system in Canada by which various manufactured European trade goods, highly desired by Native groups, were exchanged for natural products and foodstuffs that the French desired equally highly. The French adapted this economic model just as readily to their domains in the Illinois Country and Louisiana beginning as early as the late 1600s, while also eventually incorporating elements developed in their West Indies holdings such as tobacco and indigo cultivation (Gregory 1973:282; Burton 2002:214-215, 221). To a great extent, and especially in the early decades of the 1700s, hides, meat, and other products derived from deer, buffalo, and bear formed the core of their economic exchanges with the new Native tribes they encountered. In addition to this, a thriving trade in horses and Indian slaves developed as well.

Concomitant and symbiotic with this activity was a policy of uninhibited provision of firearms and ammunition to the tribes who traded the profits of their hunting to the French. In a self-perpetuating cycle, Indians newly equipped with horses were offered the European-style weapons that allowed them to become more proficient and fearsome as hunters, warriors, and raiders. This in turn yielded increasing quantities of pelts, foodstuffs, horses, and slaves that they could trade for guns and the myriad other manufactured products upon which their altered lifestyles quickly became completely dependent (Griffith 1954:136-138; Usner 1985:83). In addition to arming Native groups for the purposes of the hunt, the policy of equipping Indian trading partners with firearms was part of a carefully calculated French strategy to entrench their power on the North American continent. By supplying guns to their established Native partners as an integral part of advancing a mutually beneficial and reciprocal economic system, the French also effectively developed an army of loyal allies that served as a deterrent to Spanish and English encroachment (Usner 1987:174; Brown 1992:19). In contrast, the Spanish generally expressly forbade any trade in guns and ammunition to Indians (although unsanctioned activities certainly occurred to some extent), and as a result the Spanish played a far lesser role in the overall distribution of weaponry to Native groups (Griffith 1954:137; Perttula 1992:207; Works 1992:273-274).

Further, the Spanish system actively sought to "reduce" their Indian charges through the civilizing effects of conversion and mission settlement. By bribing potential converts with offers of food and protection while simultaneously imposing the threat of military force, the Spanish sought to convince targeted Indian groups of the wisdom of settling into mission life. Here they would be instructed in agricultural, domestic, and religious activities, learn and adopt Spanish in preference to their own languages, adopt European styles of dress, and otherwise lose all vestiges of their savage origins (Weddle 1964:42; Tunnell and Newcomb 1969:141; Gilmore 1992:126). The French, on the other hand, took on a much more *laissez faire* attitude, with the French traders treating the Indians more as equal partners in a business relationship, often learning Native languages and even choosing to live and intermarry among them. From the Native standpoint, then, the French system seemingly demanded little external change or commitment on their part. However, the eager adoption of exotic manufactured objects such as firearms, coupled with involvement in the elaborate commercial affairs of the French, quickly drew affected Native tribes into a cycle of dependence that ultimately proved just as utterly transforming to their societies as the more forceful tactics employed by the Spanish (Griffith 1954:136-138, 148; Gilmore 1992:127).

In contrast to the economic model of the Spanish missions and presidios, which were established with the aim of harnessing indigenous labor through subjugation and reduction, French settlements tended to serve more as dedicated centers from which their trade operations could be conducted. Fortifications such as the Arkansas Post, Natchitoches, Saint Louis de Kadohadacho, and Fort des Chartres were not necessarily constructed with defense as the main goal (Brown 1992:22), but rather acted mainly as depots and distribution centers (or *entrepots*) for both incoming and outgoing goods. Keene (1991) provides a salient example by discussing the role of Fort des Chartres in particular as a component within a classical colonial mercantile system. This fort, which never came under direct attack, served primarily as a producer and exporter of raw goods and agricultural surplus, as well as being a consumer and distribution point for imported finished goods. Essentially, no large-scale processing or manufacturing ever developed within this system to add to the value of raw products prior to their export from the colony. As it turns out, this restriction also applied to the lead mined across the Mississippi from Fort des Chartres and Kaskaskia, a point that will be elaborated upon in the next chapter.

Earliest Interactions of the French and Spanish

In considering the trade networks of the French and Spanish during the colonial period, some background material relating to their early contacts with one another and with the Native groups they encountered will be helpful in making sense of the complex relationship that evolved between these rival European powers. These first interactions would help shape all future developments on the North American continent, as French trading ambitions collided with Spanish imperialist aspirations in a drama that would also indelibly transform Native cultures.

Initial French contact with tribes of the Illinois Country and of the Plains came in the late 1600s to early 1700s, when *voyageurs* from Canada and *coureurs-de-bois* exploring along the Mississippi and Missouri River systems encountered such groups as the Osage, Missouri, Kansa, Pawnee, and perhaps the Wichita and Apache. (The Apache, it should be noted, were sometimes called by the French *Padouca*, a term which was also used, but not exclusively as some have thought, to refer to the Comanche [Wedel 1981:34-38; Wedel 1982:125]). The French trade with such groups likely got underway rapidly, with sporadic, limited, and largely undocumented exchanges of firearms and ammunition already occurring prior to 1700 (Wedel 1972:15, 149-150; Wedel 1982:130; Works 1992:275; Perkins and Baugh 2008:389). By 1686 the Arkansas Post had been founded among the Quapaw Indians, west of the confluence of the Arkansas River with the Mississippi. This post, extremely isolated from other European settlements in its early years, saw only very limited activity in the late 1600s and early 1700s but would eventually become a substantial center of French trade (Wedel 1981:36; Smith 2000:18).

Around the same time, the Spanish were spurred to action along the Gulf Coast of Texas by the unwelcome intrusion of La Salle's failed colony at Matagorda Bay, the ruins of which a party led by Alonso de León destroyed in 1690 (Dunn 1917; Weddle 1973, 1987, and 2001). As part of this same expedition of 1690, two missions (San Francisco de los Tejas and Santísimo de Nombre María) were established in the vicinity of the upper reaches of the Neches and Angelina Rivers. Built among the Tejas Indians of the Hasinai Caddo confederacy, these missions constituted the initial thrust of a Spanish effort to thwart the effects of further French incursion. In 1691, Domingo Terán de los Rios led an ambitious expedition to found several additional missions among the Kadohadacho and Hasinai, but these efforts never came to fruition. Owing to the disinterest and contempt of the Caddoan tribes for taking on mission life, the initial two missions quickly failed and were abandoned by 1693 (Griffith 1954:136; Perttula 1992:150; Newcomb 1993:14; Foster 1995:33-49). The stage had been set, though, for a lengthy (and for the Spanish, generally frustrating) rivalry for the loyalties and trade opportunities presented by the various tribes living within the Spanish and French spheres of influence.

The French had established settlements at Biloxi and Mobile along the Gulf Coast by 1699, and, thinking New Spain to be rather closer than it was, they hoped rather eagerly to initiate a facile trade with the inhabitants of that realm. Early on, the French had even entertained notions of usurping the extravagantly wealthy Mexican silver mining regions (Wedel 1971:44-45; Weddle 1973:166-168). Initial efforts at establishing direct trade with the main Mexican port of Veracruz had failed miserably, though, with a 1710 French trade envoy turned curtly away (Weddle 1968:100). If the front door could not be gained, however, a more indirect route might yet prove profitable. Towards this end, in 1714 Louis Juchereau de St. Denis established the trading post of Natchitoches on the Red River, prompted by the arrival of unsolicited letters that had been sent in 1711 to the Governor of Louisiana (Cadillac) from a Spanish priest at the presidio of San Juan Bautista on the Rio Grande. The Spanish were still desirous of performing mission work on their frontier (and more importantly, wanted to hold their line against the French), but knew from the failure of their first efforts the difficulties presented in supplying such isolated outposts. For this reason, Father Francisco Hidalgo proposed an under-the-table gentleman's agreement whereby the Spanish missionaries would act as illicit trading partners with the French in return for tacit French support of the missionary effort (Weddle 1968:97-100; Gregory et al. 2004:66).

Bienville promptly directed St. Denis to establish the requested trading post among the Natchitoches Indians, and to seek out Father Hidalgo at San Juan Bautista. There St. Denis was arrested as an illegal interloper, but treated quite well. He was held in Mexico under a nominal house arrest for two years, more as a guest than a prisoner, married into the family of the commander at San Juan Bautista, Diego Ramón, and finally returned in 1716 to the vicinity of Natchitoches as a guide of sorts for an expedition led by Ramón's son (Weddle 1968:99-104; Gregory et al. 2004:66). Here the Spanish were rather dismayed to discover already among the Hasinai Caddo some 18 or 20 French guns, obtained from the Natchitoches post along with a variety of other imported goods (Griffith 1954:146).

The Spanish proceeded to establish a series of six missions and two presidios (Perttula 1992:151) among the Hasinai Caddo, for the presumptive purpose of thwarting French influence, but in reality the effort may have well been instigated with a view towards engaging in covert trade with the French from the onset. Such trade, the Spanish likely realized, would have been vital to the survival of the new missions and presidios (Gilmore 1992:124-125; Foster 1995:109-123). St. Denis, in complicity with the Ramóns, even organized a trade caravan that returned to Mexico in 1717 laden with French goods procured in Mobile. Such a transparent breach of Spanish policy could not be tolerated, though, and St. Denis was arrested and his goods confiscated. After a lengthy detainment, he purportedly issued a vague threat of instigating an uprising among the Tejas and Natchitoches Indians, the same among whom he had just helped the Spanish to situate their fledgling missions and presidios. He coyly reminded the Spaniards that these particular Indians were by now already well equipped with French firearms (Weddle 1968:121, 139-140). Such was true, for at the time of Martín de Alarcón's visit to resupply the East Texas missions in 1718, the Indians at Mission de la Purísma Concepción alone are reported as having 92 guns and Alarcón was greeted with a salvo of firepower greater than anything his own troops could muster (Griffith 1954:139; Perttula 1992:206; Foster 1995:139). St. Denis' impertinence resulted in an order for his arrest, however, and he was forced to escape back to Natchitoches, arriving early in 1719. Clearly, though, the instability wrought by the inequitable Spanish and French policies concerning firearms was already being invoked in a manner that would presage later conflicts.

The news of war between Spain and France (the 1719-1721 War of the Quadruple Alliance) caused the new establishments among the Tejas to be briefly abandoned in 1719, but only two years later they had been reoccupied. The massive 500-man expedition of the Marqués de Aguayo to restore the missions in 1721 is also notable for having in tow 600 mules, to carry the various supplies required for the effort and the necessary arms and munitions (including six cannons) in case the French would have to be forcibly expelled (Forrestal 1935:6; Gilmore 1992:125). Along with reopening the previous settlements, the Spanish made the addition of a new presidio, Los Adaes, which they deliberately built only a few miles to the southwest of Natchitoches. This Spanish fort was also designated as the capital of the newly delineated Spanish province of Texas in 1729, and would so serve for almost half a century. The re-occupied mission of Los Adaes was similarly moved to be closer to the Presidio of the same name, and to the French post at Natchitoches (Gregory et al. 2004:67). The French themselves would re-situate the village of Natchitoches in 1735 on the west bank of the Red River, against the weak protests of the Spanish, to be even closer to the Los Adaes complex (Burton 2002:32). Thus the stage was set for what would ultimately serve over the next several decades as perhaps the most egregious center for unsanctioned trade between the French, the Spanish, and the various Native groups under the thrall of their exotic commodities.

The extensive influence and role of Los Adaes in illegal trade will be further examined in its own section below.

In a xenophobic fervor, then, the Spanish had by 1716 ambitiously extended their claims far from their holdings on the Rio Grande. In 1718 the settlement of Presidio San Antonio de Bejár and its attendant missions helped to solidify these tenuous claims, along with the establishment of the Presidio Nuestra Señora de Loreto in 1721, built directly atop the torched remnants of La Salle's Fort St. Louis (Forrestal 1935:63-64; Foster 1995:127-132, 150, 155-158). By the second decade of the 1700s, then, the hazy line demarcating purported French and Spanish boundaries had been set in the isolated reaches forming the current border between modern northeastern Texas and west-central Louisiana. For half a century the French would exasperate the Spanish with their unabated efforts at expanding trade beyond their official bounds, while at the same time providing a lifeline to the isolated and poorly supplied Spanish outposts. With the establishment of New Orleans in 1718, soon to be made capital of the Louisiana colony over Mobile, the French were poised to make greatest use of the opportunities for commerce presented by the Mississippi River. Thus they proceeded in expanding their trade network well beyond any Spanish capabilities to deter it.

Early Forays by the French onto the Plains

In 1718 an ambitious and already worldly explorer, Jean-Baptiste Bénard, Sieur de La Harpe, arrived in Louisiana from his seaport hometown of St. Malo, lured by the propaganda circulating in France at the time as to the boundless and lucrative opportunities to be had in Louisiana. He found instead a colony on the brink of starvation, but was persuaded by Governor Bienville to remain and pursue a trade concession among the Caddo on the Red River, above the already-established trading post of Natchitoches. In part, La Harpe and the Louisiana officials hoped such a move would allow the French to make inroads into trade with New Spain. With a contingent of 31 other Frenchmen, and supplied with trade goods he had brought from France and others extended to him on credit at New Orleans, La Harpe struggled for almost four months up the Red River and overland to finally arrive at the village of the Upper Nasoni in April, 1719 (Wedel 1971:37-46). A few miles above here, likely at a location now known as the Eli Moores Site (41BW2) immediately south of the Red River and near modern Texarkana, he established his short-lived Nassonite Post (Wedel 1978:14-15; Gilmore 1986:11-14; but see also Miroir et al. 1973:158-163 and Odell 2002:2 for differing views). Also known as Fort St. Louis de Kadohadacho after the particular Caddoan Confederacy in which it was situated, he erected here a 110 x 20 foot cypress structure to serve as his warehouse and base of operations (Wedel 1971:43-44).

La Harpe's intentions of engaging in covert Spanish trade were thwarted, however, upon learning that Spain and France had gone to war. He therefore diverted his attentions northward, hoping to establish contact and open trade with the Wichita-speaking tribes known to live beyond the Caddoan groups. Taking Nasoni and two Kichai guides (members of a somewhat hybrid band falling culturally between the Caddoan and Wichita groups), La Harpe made an arduous overland journey through the Ouachita Mountains, eventually arriving at a bustling village that happened to have on hand some six to seven thousand Wichita. They were apparently fortuitously gathered for a rendezvous at the village of the Tawakoni, with their numbers swelling even further upon news of the Frenchman's arrival. This mass of people represented most of the major Wichita bands at the time, including the predominant Tawakoni, the Taovayas, Wichita proper, and Yscani. The location of this village has been reasonably well confirmed as lying on a bluff named Wealaka Ridge on the south side of the Arkansas River near modern-day Tulsa, and is now known as the Lasley Vore site (Wedel 1981:25-30; Odell 2002:1-9, 130; Odell 2008:471-486).

Here La Harpe was feted, serving as the focus of numerous ceremonies enacted by the Wichita bands who were quite eager to develop a trading relationship with the French. Although the Wichita had not entered into outright rivalry with the better-armed Osage by this time (who had enjoyed earlier and easier access to French weapons acquired more directly from the Illinois country [Smith 2000:24]), they were nonetheless wary of them and most assuredly desired to secure a reliable source of firearms for themselves (Wedel 1981:25-26). La Harpe distributed some 1,500 *livres* worth of trade goods, 22 pack horses' worth, as indications of the wonderful things the French could provide. (A *livre tournoius* was a French monetary unit; see the introduction to Appendix D for a discussion of the *livre* as a unit of both weight and currency.) Among the items dispensed were fusils, gunpowder, lead balls, hatchets, knives, and cloth (Wedel 1982:126; Odell 2002:8, 36; Odell 2008:485).

La Harpe left the Tawakoni village after ten days, but never had the opportunity to return. A second attempt in 1722 to reach the village directly by navigating up the Arkansas River failed, and in the meantime St. Denis took over the concession at La Harpe's Nassonite Post and apparently continued to operate it for a number of years (John 1975:221; Wedel 1981:37). La Harpe's initial gesture of bestowing material goods upon the gathered Wichita bands has likely left a rather modest imprint on the archaeological record (Odell 2002:8), but it serves to mark the first well-documented contact by the French in what would later become a thriving commercial trade with the Wichita.

Within weeks of La Harpe's expedition, and apparently unaware of his travels, Claude-Charles Dutisné (discussed also in the previous chapter) made his own attempt to reach the Wichita, traveling from Kaskaskia directly up the Missouri River. He had been charged with investigating the potential for opening trade with the Spanish on the Rio Grande, with searching for indications of mines, and it was hoped that he could procure horses from the tribes he encountered to assist with mining endeavors in the Illinois Country. He was stymied in his efforts, though, by the Missouri Indians, who barred his progress for the specific reason that they did not want the Wichitas or any other tribes to gain access to French firearms. The Missouris had already enjoyed the benefits of French trade for some forty years, and were loathe that others should also acquire the new weaponry (Wedel 1972:12-17). Rebuffed, Dutisné made another attempt, trekking overland directly to the village of the Great Osages. The Osages had also already been involved with French trade since at least around 1700, and were similarly unenthusiastic about Dutisné's intentions of contacting the Wichita and supplying them with guns. He insisted on proceeding, though, with the Osage allowing him passage after he agreed to take along only three guns for his own use and his interpreter (Wedel 1972:147-152).

Arriving at what was likely a twin village of the Taovayas Wichita in modern-day southeastern Kansas along the Verdigris River, Dutisné noted six fusils among them which they had already managed to acquire by this point (Wedel 1981:31), probably through indirect trade with other tribes. He did manage to trade his own three muskets, gunpowder, pickaxes, and some knives for two horses and a Spanish-branded mule that the still equine-poor Wichita only reluctantly gave up. He also received an old silver cup given in evidence of the Wichita's claimed contact with the Spanish of the upper Rio Grande at some point in the past, a connection which they said had been cut off due to hostilities with their mortal enemies, the Apaches. Dutisné's foremost intent was to navigate his way through the intervening Apache to reach the Spanish himself, but he found the Wichita just as leery of his continued progress as the Missouris and the Osages had been. They had no desire for the Apache, denied guns by the Spanish, to receive them via the French (Wedel 1972:157-161). However, they did offer to bring additional horses to Kaskaskia the next Spring (Wedel 1972:161), no doubt excited at the prospect of obtaining firearms and other merchandise directly from the French. Like La Harpe, Dutisné's journey itself would have left a rather negligible archaeological imprint if any, but is significant for initiating contact and setting the stage for the energetic Wichita – French trade of succeeding decades.

After a general hiatus of some twenty years, other French traders would eventually follow in the footsteps of La Harpe and Dutisné, leaving behind additional documentary evidence of their own journeys. These expeditionaries will be discussed in turn, but now that the fundamental historic scene has been set, a general overview of the actual processes of French colonial trade in Louisiana will be provided.

The General Nature and Manner of the French Trade

Throughout the French colonial period, but especially in the first decades of Louisiana, the colonists relied on essential foodstuffs provided by various Native groups. Even after agriculture had been reasonably established, the *habitants* of Louisiana found that simply trading French merchandise for food often remained easier than growing crops or raising livestock, a state of affairs that often vexed the French officials by serving as an impediment to the full development of a self-sustaining agricultural system (Usner 1987:168-169, 180-183). The existence of New Orleans in particular depended on a steady supply of meat, corn, and beans emanating from the interior hinterlands, as well as such luxury food items as pots of bear oil. This precious and much sought-after commodity, rendered from bear fat, acted to season foods and served as a perfectly acceptable substitute for olive oil in cooking (Burton 2002:217). Tallow was also an important product derived from animal fats, used in candlemaking and in oil lamps. The skins of deer, buffalo, and bear found some local use among the colonists as well, but more importantly this peltry formed a significant portion of the annual exports sent to France. In Louisiana deer skins formed the bulk of this trade in hides, which overall accounted for up to a third of the value of all commodities exported from Louisiana by the 1740s. Much of the buckskin sent to the seaport of La Rochelle was eventually used in the European leather industry for such objects as fine leather gloves and book bindings (Usner 1985:85-86). Among the southeastern tribes in particular, the French always faced rather stiff competition from the English traders of the Atlantic seaboard, who offered Natives consistently higher prices than did the French for their deer hides, and who often had a better quality of merchandise to offer in return. However, the French maintained an edge by providing bullets and gunpowder (in addition to liquor), items which the Indians could obtain from the English only with "great difficulty" (Rowland et al. 1984a:209; Usner 1987:175; Brown 1992:24; Waselkov 1992:42; see also entry for 1743 in Appendix D).

The French also dealt actively in horses, and to a considerable extent in Indian slaves. Since the colony was not at first self-sustaining, lacking the agricultural impetus which rendered most of the settlements so utterly dependent on trade and imports, the development of livestock herds also went overlooked. The French were thus eager to obtain the manual labor which horses and slaves might provide (Gregory 1973:71; Usner 1985:187; Perttula 1992:200-201). Surplus horses for trading purposes could be obtained by Natives not only through the natural increase of their own herds, but by raiding both Spanish settlements and enemy tribes (Works 1992:274). Instances of equines bearing Spanish brands entering into French hands are not unheard of (Wedel 1971:161). Similarly, the traffic in slaves encouraged intertribal warfare, as captives could be used in commerce just as readily as mounts or hides (Griffith 1954:146-149; Wiegers 1985:181-184, 191). A priest accompanying Martín de Alarcón (founder of San Antonio) on his supply expedition to the east Texas missions in 1718 even noted two Frenchmen near the mission of Los Adaes trading firearms, gunpowder, bullets, and clothing to the Kadohadacho in exchange for young slaves (Griffith 1954:149; Foster 1995:139). In their heyday, the Apache traded slaves that they raided from neighboring Plains tribes such as the Wichita, setting the stage for the bitter enmity against that tribe that would spark decades of retaliation (Works 1992:272). One effect of the horse and slave trade, then, was to induce increased violence and theft among the tribes involved, generally disrupting overall stability within the French colonial economic sphere.

In return for providing such items as hides, meat, horses, and slaves, Native groups received an array of manufactured European objects. These included firearms and their attendant accoutrements (lead balls, gunpowder, gunflints, and gun worms); iron objects such as knives, hatchets, hoes, wedges, and awls; brass kettles which were often reduced to metal strips and made into such decorative items as tinkling cones and beads; cloth, textiles and garments such as shirts; glass beads of many splendid varieties; alcohol primarily in the form of brandy, wine, and rum; and various trinkets and baubles such as mirrors, brass bells and vermilion (Griffith 1954:147; Harris et al. 1965:305-347; Usner 1987:178).

The significance and extent of the trade in cloth and textiles has often been overlooked (Usner 1985:83), as these materials do not tend to survive archaeologically, but the associated lead seals used to secure bundles of cloth are often found on archaeological sites (Kent 2001:939-944; Gregory et al. 2004:74). It is worth noting here that an isotopic study of this class of artifacts, imported along with the cloth directly from European seaports, would likely reveal a consistently European lead isotope signature. One example examined by Farquhar et al. (1995) indeed did. Too, many lead fabric seals were no doubt melted down and recycled into lead balls using single-shot bullet molds, and would have thereby imparted some minor component of European lead to the overall picture.

In addition to the goods for which Indian trading partners of the French bartered outright, most Native groups became accustomed to receiving an annual suite of presents, composed of goodly portions of the standard trade goods that also included firearms and ammunition. These gifts were distributed by the French as tokens of their alliance with the various tribes. Beyond being mere signs of commercial fidelity, though, these expected gifting ceremonies were usually necessary to ensure the continued loyalty of those tribes with whom the French dealt (Usner 1987:171-172). In years where inadequate supplies prevented or delayed distribution of the anticipated lagniappe, vocal Native displeasure set the French ill at ease (Thomson 1997:133; see entries for 1757 in Appendix D).

Burton (2002:230) has laid out a trading model for the French post of Natchitoches which can be taken as an example of the general economic structure throughout colonial Louisiana. She identifies a hierarchy of five main groups involved in trade (merchants, traders, *engagés*, hunters, and crewmen), headed by the merchants / shopkeepers who each Summer (typically) purchased newly-arrived European goods directly at such seaports as New Orleans. From there goods were delivered upriver to trading posts which served as regional distribution centers, and merchants provided stock in smaller lots (outfits) to traders who would then transport their wares to trading posts and Native villages in the interior. The traders were often accompanied by *engagés* (contracted hired hands), as well as by Indian and black slaves. In the Spring following their Winter hunting seasons, Native hunters would bring their pelts and other products to the traders to exchange for French manufactured items. The accumulated items were then transported downriver by riverboat crewmen in time for the next purchasing cycle to begin (Burton 2002:230).

The entire undertaking operated on the basis of an elaborate system of revolving credit between merchants, traders, and Natives. Merchants of sufficient solvency and integrity acquired the merchandise, which they then extended upon credit to traders, with the average outfit consisting of around 1,000 to 2,500 *livres* worth of goods by the mid-1700s. Traders, in turn, typically had to extend advances to their Native trading partners prior to the Winter hunt. It could often take several cycles to settle established debts through payments in skins and other produce, with the inherent potential for losses due to accidental death, mishaps, or evasion being rather apparent (Usner 1985:83-84; Usner 1987:175-180).

A similar model involving French traders and merchants holds for the commerce of French Canada as well. It is worth noting here that several accounts known as the Montreal Merchants' Records exist for the eighteenth century, and these documents provide a glimpse into the quantities and varieties of Canadian merchandise. Virtually identical to the situation in Louisiana, goods were shipped from France and redistributed in smaller lots by merchants of Montreal and Quebec to the traders who peddled the items in the interior (Anderson 1991:221; Kent 2001:1060-1085). One study making use of these records shows that during the period from 1724-1748, traders equipped in Montreal and bound for Green Bay, Ouiatenon, Detroit, and Michilimackinac consistently carried lead balls and shot as part of their inventories, which tended to make up roughly 3-5% of the value of their cargos. Gunpowder seems to have been even more essential than ammunition, being among the top three items carried to all four posts and comprising from 6.6 to 10.4% of the value of the cargos (Anderson 1991:218-236). These figures would appear to demonstrate the importance of firearms-related products in overall French trade during the second quarter of the eighteenth century. The seeming dominance of gunpowder over bullets in the trade inventories, however, may serve as an indication that the outposts of French Canada were perhaps supplying themselves to a considerable extent by this time with lead obtained from the Upper Mississippi Valley lead deposits. If this was the case, though, direct documentary evidence for such activities appears to be slim.

Flowing from merchant to trader to hunter, goods in French Louisiana were most typically trafficked upon the various waterways that connected outposts, with the Mississippi serving as the most obvious artery of French commerce. Finished goods for the consumption of both the colonists and for use in the Indian trade arrived in New Orleans, shipped via both royal supply vessels of the French government and private merchant ships. (Surrey [1916] provides a still very valuable analysis of colonial French shipping in her *Commerce of Louisiana During the French Regime, 1699-1763*. Several excerpts from this work are included in Appendix D.) These imported products were then most likely loaded onto *bateau* (also spelled *bateaux*), the primary type of vessel used in river commerce. These flat-bottomed boats, with tapered ends that caused one early nineteenth-century observer to describe them as somewhat coffin-shaped, typically measured about nine feet wide by forty feet long (a fairly standardized dimension during the 1700s), and were capable of taking on a cargo of somewhere between twelve and fifteen tons (Ekberg 1998:276-280).

The journey upriver against the current was extremely arduous, requiring upwards of 16 to 24 oarsmen (often including soldiers, slaves, or men unable to earn a living by other means) three to four months to reach Fort des Chartres and Kaskaskia in the Illinois

Country. Goods were often carried even farther upriver than this, but in a fairly typical exchange the imports would have been offloaded at Fort des Chartres and eventually replaced with all the accumulated products of the Illinois Country awaiting shipment to New Orleans and other posts downriver (Ekberg 1998:280-282). This included not only the bundles of hides, meat, tallow, and pots of bear oil obtained primarily through the Indian trade, but also the products of agriculture and industry from Illinois. Flour grown in the Illinois Country was especially vital to the sustenance of the colonists, along with salted hams and bacon from French-raised swine (Ekberg 1998:213-238). Surplus lead from the mines west of the Mississippi was also transported to those places where it was most needed, and the miner Philippe Renault apparently owned multiple *bateau* (Briggs 1985:247) on which he no doubt shipped his lead bars and the surplus generated from his agricultural holdings. The food items remained in the colony, while most of the hides and some of the lead eventually made its way to France – in more stressful years, though, most of the lead would eventually be sent directly north to supply troops cut off from other sources. After taking on cargo at Fort des Chartres, the typical return trip to the coast took only about a quarter of the time required for the upstream voyage, generally arriving in New Orleans within three to four weeks (Ekberg 1982:164-172).

Bateau were constructed both at New Orleans and further up the Mississippi as needed, with lumber more readily available in the Illinois Country. Commenting on the ease with which lead could be transported downstream, the military commander at Fort des Chartres commented in 1753 that "there is no want of wood to construct boats to carry it down to New Orleans" (Pease and Johnson 1940:818-819). Aside from *bateau*, a number of other types of vessels were employed in the river commerce, including smaller versions of *bateau* known as *chalands*, barges, canoes, and rafts. Probably second in importance to *bateau*, though, were large dugout pirogues carved from massive cottonwood or cypress trunks that were capable of carrying five to six tons. Both *bateau* and pirogues were sometimes fitted with decking to protect their cargos (Ekberg 1998:273-279). The *bateau* and other craft also tended to move in convoys, often guarded by soldiers against Indian attack. Many of the boats were owned and operated by the colonial government, although private *bateau* also plied the waters as suited their owners' convenience and also joined the official convoys for the protection that group travel provided (Briggs 1985:244-248).

Smaller crafts such as pirogues and canoes were also able to navigate quite substantial distances up such major waterways as the Arkansas, Canadian, and Red Rivers, thus allowing the French to eventually penetrate and more easily extend their commerce well into the regions of such tribes as the Wichita, Comanche, and Caddo. Hides and other goods produced for the French trade could be easily floated back to the Mississippi from these distant outposts for eventual stockpiling at New Orleans (Curths 1981; Gibson 1981). All navigable rivers undoubtedly were exploited to some extent. La Harpe commented on encountering a group of French hunters in 1722 who had descended the St. Francis River with 5,000 pounds of salted bison meat (perhaps cured using salt obtained from the saline springs at the mouth of that river?). Similarly, in 1752 two French traders are noted as journeying down the Mississippi with a cargo of fat, oil, and salted meat procured from hunting on the Tennessee River (Wedel 1981:57).

While the standard north-south run from New Orleans to Fort des Chartres and back was quite typical, other isolated posts were served by the *bateau* convoys as well.

Settlements south of Fort des Chartres also received goods directly from the Illinois Country, since it was much easier to supply outposts in need on the southward float down than it was to send emergency provisions upstream from New Orleans. Accordingly, the convoys would stop at such locations as the junction of the Arkansas River (to service the Arkansas Post further upstream), the Tonicas, Natchez, and Pointe Coupée to deliver foodstuffs and other goods. Some Illinois merchants even entered into contracts to supply these southern outposts, and this meant that in lean years New Orleans might receive a far lighter than anticipated shipment of edible merchandise (Ekberg 1998:217-218). Although most of the records that discuss this southward riverine trade involve food items, lead from the Illinois country undoubtedly made its way into the hinterlands via its delivery to such trade centers as the Arkansas Post. From here and other locations along the river, lead for ammunition was almost certainly diverted into the backcountry as a crucial trade item and subsistence-providing commodity.

Products of the Illinois Country also eventually began to be sent northward to posts on the Ohio and Wabash Rivers. In 1743, the miner-soldier De Gruy noted specifically that lead from Mine La Motte supplied not only the Illinois country, but also such Canadian posts as Ouiatenon, Michilimackinac, and Detroit (Ekberg 1982:141). In 1744, the French outpost of Fort de Cavagnial (known colloquially as *Fort des Canzés* or *los Canes*) was established on the Missouri River near a village of Kansa Indians in the vicinity of modern-day Fort Leavenworth, Kansas. Although the archaeological location of this post remains unknown, it was operated for nearly 20 years and was supplied by annual convoys sent from the Illinois Country (Wedel 1981:41). In 1752, mention is also made of traders from the Illinois supplying lead and tobacco to the Miami Post on the St.

Joseph River and to Detroit (Pease and Johnson 1940:465-466; Ekberg 1998:222). That same year, trade had expanded to the point that two annual convoys began to be sent upriver from New Orleans instead of just one (Wedel 1981:45).

In 1753, just prior to the onset of the French and Indian War (i.e., the Seven Years' War), Fort Duquesne (modern day Pittsburgh, Pennsylvania) was established by the French in the upper Ohio River Valley to prevent an English takeover of the area. The Illinois Country began to supply this new fort directly, as well as Fort Massac on the lower Ohio (established in 1757), with ammunition and other supplies sent via annual convoys comprised of fifteen to sixteen boats rowed up the Ohio River. Additional supplies were also soon sent up the Wabash to the French troops in Canada, including convoys sent to Fort Ouiatenon and the settlements at Vincennes (Surrey 1916:47-48; Briggs 1985:246; Keene 1991:38). As the war progressed, these convoys began to be sent twice per year with double the number of boats, in addition to special convoys as needed. After 1755, the date when Fort Duquesne became completely cut off from Canada, many of the northern frontier outposts found it increasingly difficult to receive goods via normal Canadian channels. With communication cut off due in part to British naval blockades of Quebec and Montreal, the Illinois country had to provide for troops in these areas as well (Surrey 1916:297-298; Ekberg 1998:223-224). Clearly, by the mid-eighteenth century, much of the produce of the Illinois Country (along with many of the imports sent from New Orleans) was no longer simply making the typical trek between the coast and Fort des Chartres. Rather, these items were also increasingly wending their way northward along upper tributaries of the Mississippi, to be delivered to increasingly isolated and cut-off French outposts.

A Particular Instance Illustrating Ammunition as Colonial Currency

As has been mentioned, the colonists depended vitally on the maintenance of trading activities for their very survival, particularly in the initial years before their own agricultural industries had been well established (Usner 1985:83; Usner 1987:180-183). French mercantilism also operated in such a way that markets were sometimes artificially manipulated to stimulate the Indian trade. An example related by Waselkov (1992:36-37) concerning Fort Toulouse (known also as the Alabama Post) provides an example of both these factors, and also serves as a direct illustration of how lead served as a fundamental commodity of exchange on the colonial frontier. Established for the purpose of trade in 1715 near where the confluence of the Coosa and Tallapoosa Rivers forms the Alabama River, Fort Toulouse and its associated village were unable to provide for their own subsistence needs prior to the 1740s. The undersupplied soldiers were thus forced to eke out a living by trading for food directly with the Creek Indians among whom they lived. In particular, the mainstay of their commerce was gunpowder and ammunition, supplied to them via Mobile. The Creek, who were more directly under the potential influence of English traders than were tribes further west, were able to acquire such crucial supplies more cheaply and readily from the French garrison at Fort Toulouse than they could from the English. Not only were the English wary of providing Natives with excessive amounts of firepower, but their goods would have to have been hauled overland from the Carolinas or Savannah at great expense. Among the French, though, their supplies had only to be rowed up the Alabama River from the coast at Mobile. Accordingly, the soldiers would use “powder and balls, which are the currency of the post” (according to a 1729 letter) to either purchase provisions outright, or to purchase deer skins which could then be exchanged for the needed supplies. Additionally, a letter of 1745 from the Governor of Louisiana, Vaudreuil, shows how the soldiers at Fort Toulouse were deliberately subjected to artificial forces in the colonial economy for the specific purpose of stimulating trade:

> "... we send nothing but flour for the subsistence of the garrison and which most frequently is in the situation of lacking it so that the garrison must necessarily trade in order to get a living, and it is likewise important that it be in that situation in order that the Indians may find a market for their products" (Waselkov 1992:36-37).

This particular example falls somewhat outside of the geographic realm of most of this study, but nonetheless serves to illustrate the substantial significance that lead balls and gunpowder held in trade matters. In a similar manner, the residents of Mobile are reported in 1708 to have been pleading for gunpowder, "to trade with the Indians for the things we need" (Usner 1987:180).

Waselkov (1992:43) even contends that the presence of lead balls at Creek archaeological sites with an early historic component may serve as one of the strongest positive indicators of French trade, and suggests that a detailed trace element analysis of these artifacts should be carried out. Dovetailing with this, Walthall and Emerson (1992:9) have pointed out that trade goods from the earliest periods of French occupation in North America were likely to consist of mostly high-value items that could be easily transported, including such objects as firearms and lead ammunition. Heeding Waselkov's call for the utility of a chemical analysis, a proposal is here made concerning lead balls from early eighteenth-century sites along the Alabama River: having probably been imported to Mobile on French supply ships as items of considerable practical and economic value, these objects are likely to present a distinctly European lead isotope signature. Such signatures would likely be akin to other lead balls analyzed in the current study which also derive from a scenario of likely French importation. In offering this prediction, I am prefacing a model for the interpretation of French colonial lead objects which will be introduced and more fully elaborated in the next chapter.

Later French Efforts to Expand Trade

After the initial forays of La Harpe and Dutisné in 1719, we have very little documentary evidence of further French trading expeditions west of the Mississippi to the Wichita or other groups over the next twenty years. The 1720s and 1730s were turbulent decades in French Louisiana and the Illinois Country, as ongoing hostilities with such groups as the Natchez, Chickasaw, Osages, and Fox Indians slowed commerce and deterred exploration. Although a diminished trade likely continued during these years with the Quapaw at the relatively safe Arkansas Post (which had languished in the 1720s but was eventually re-established in 1731), military concerns overshadowed the development and expansion of French trade networks at this time. A lack of supplies in general during this period, and a distinct shortage of guns in particular, made normal military operations difficult, much less a sustained trade with far-flung groups that would have required *coureurs de bois* to traverse hostile territory (Wedel 1981:37-40; Smith 2000:24). It will be recalled from the previous chapter that during this same period production at the lead mines of southeast Missouri was also drastically disrupted.

By 1733 Spain and France had entered at least nominally into peace, though, under the terms of the Family Compact (John 1975:306). Many of the French colonists hoped this might mean that Spain would relax its trade restrictions, and indeed there are some indications of a few French parties of *coureurs de bois* traveling independently up the Arkansas River during the 1720s and 1730s (Curths 1981:23). However, no significant expeditions to reach the Spanish occurred until the brothers Pierre and Paul Mallet journeyed overland with seven others from the Illinois Country to Santa Fe in 1739. Journeying along the Missouri River, their path took them well to the north and west of the Wichita, and northeast of modern New Mexico where they encountered Comanche Indians. At this time the Comanche had not yet fully displaced the Apache to the south, although in the next few years they would exert their dominance over the Southern Plains and force this mutual enemy of both the Comanche and Wichita to seek refuge southward of their traditional range (John 1975:304-314; Curths 1981:23-25; Wedel 1981:39-40; Works 1992:273).

Reaching Santa Fe, the Mallet Brothers' party surprised the Spanish governor greatly by their arrival, who did not seem to know quite how to deal with them. Their unexpected presence was essentially tolerated and even embraced, as they were allowed to remain in Santa Fe for nine months and conduct their trading activities, with two of the Frenchmen even marrying New Mexicans and staying behind (John 1975:315-316). The Mallets found the residents of Santa Fe quite eager to trade, since the annual caravans sent from Mexico provided mainly for official government, military, and missionary needs, with little remaining to entice the average settler (Works 1992:275). They also determined that the intervening Comanche could probably be easily won over with the inducement of trade, and eventually returned to the Illinois Country by way of the Canadian and Arkansas Rivers (John 1975:315-316). The apparent success of their effort excited the Louisiana officials and would lead others to make the attempt as well.

However, the French in their optimism overlooked the reality that the Spanish, however cozy things might be between the two nations in Europe, would never tolerate formalization of any trade that threatened to arm the Plains tribes (Harper 1953:276-278).

In 1741, Governor Bienville attempted to send André Fabry de La Bruyère to New Mexico using the Mallet Brothers' hitherto little-used return path of the Arkansas and Canadian Rivers. His was envisioned as a sort of diplomatic mission, intended to develop French commercial interests by also encouraging tribes such as the Comanche to refrain from attacking the New Mexico settlements. La Bruyère's expedition encountered difficulties, though, and the journey was abandoned as they cut south to the Red River and returned east (Harper 1953:276-277). In doing so, however, he encountered a recently relocated group of Tawakoni Wichita living with Kichai Wichita above the Yatasi Caddo on the Red River. The Tawakoni had moved south from the Arkansas River around 1737-1738 to the Canadian River, and shortly thereafter to the Red (Wedel 1981:31-32; Wedel 1982:128). Wedel (1981:40-41) conjectures that this may have represented the same Tawakoni village encountered by La Harpe in 1719, uprooted and displaced southward due to pressure from the encroaching and well-armed Osage, along with a desire among the Tawakoni to be closer to French traders at Natchitoches.

Other French traders were likely encouraged by the Mallet Brothers' success to attempt their own journeys to Santa Fe in the 1740s, but if such occurred little clear record of their ventures remains (Wedel 1981:40). However, two separate trips originating from the Arkansas Post in 1748 and 1750 did make it to Santa Fe, and their arrival resulted in a flurry of interrogations by Spanish officials that have left us invaluable archival information. The transcripts of these interviews provide us our best documentary evidence pertaining to the nature of the French fur trade as it hit full swing along the Arkansas River in northern Oklahoma during the 1740s and 1750s.

French-Wichita Interaction at Deer Creek and Bryson-Paddock

The twin Wichita Villages of Deer Creek (34KA3) and Bryson-Paddock (34KA5) serve as a prime example of French trade at its apex on the western outskirts of French influence. French trader-hunters of the mid-eighteenth century voyaged up the Arkansas River to the location of these Taovayas encampments, and there engaged in a symbiotic commerce based on the processing of wild game in return for French manufactured goods. This section will necessarily rely especially heavily on the brilliantly detailed ethnohistorical study undertaken by Mildred Mott Wedel (1981) of the Deer Creek site, which presents vital translations of rare primary documents relating to French trade on the Southern Plains. Her intensive analysis addresses virtually all of the critical aspects pertaining to how the French trade was conducted during this period. Offering a rich complement of both archaeological and ethnohistorical data, the case of Deer Creek and Bryson-Paddock serves as probably the preeminent example of French-Native interaction on the Southern Plains during this era.

Archaeological Context and Dating of Deer Creek and Bryson-Paddock

The Deer Creek and Bryson-Paddock sites lie very closely to one another on the south or west side of the Arkansas River near the modern Oklahoma-Kansas border, with Deer Creek only about 2.75 kilometers south of Bryson-Paddock. Archaeologically, although Bryson-Paddock has undergone testing while Deer Creek has only been subjected to surface survey, the sites manifest very similar assemblages of artifacts which appear to link them together quite strongly both culturally and temporally. Most notable among the artifact assemblages are large quantities of European trade goods, accompanied by copious amounts of bison bone and prolific numbers of large scraping implements made from the locally available high-quality Kay County chert (Steen 1953:177-178; Sudbury 1976; Hartley and Miller 1977:94, 238, 251-258). This evidence alone rather strongly suggests that large-scale processing of bison (as well as deer and bear to a lesser extent) was somehow linked to the influx of European glass and metal objects recovered from these sites.

Sudbury (1976:93-94) has proposed that Bryson-Paddock dates slightly earlier than Deer Creek based on a chronology derived from trade beads, and also suggests that Deer Creek was established a few years later somewhat downstream to better accommodate French traders coming up the Arkansas. Hartley and Miller (1977:254), though, question the accuracy and viability of bead-based timeframes. Nevertheless, both suggest a terminal date in the vicinity of 1760 (Sudbury 1976:79; Hartley and Miller 1977:253-257), with many researchers suggesting an initial date no earlier than 1700 (Wedel 1981:8 provides a synopsis) and Sudbury (1976:79) offering as precise a starting date as 1735. A series of seven radiocarbon dates from Bryson-Paddock, obtained from materials excavated in 1975 and 2004, do not conform very well to the date range anticipated from historic artifact type studies; however, the notorious tendency of protohistoric period radiocarbon assays to yield wide time spans is also noted (Drass et al. 2004:26-28).

Wedel (1981:23-25), using ethnohistoric lines of evidence, suggests that there is circumstantial documentary and cartographic evidence to suggest a Wichita occupation at the Deer Creek and Bryson-Paddock sites by as early as 1716. She maintains, however, that evidence is lacking to suggest a sustained occupational presence here into the 1740s, at which time more pronounced indications of activity exist (Wedel 1981:31-33). Wedel (1981:32, 67) also provides a strong argument suggesting that the twin villages of Deer Creek and Bryson-Paddock represent the uprooted and relocated twin villages of the Taovayas encountered by Dutisné in 1719 on the Verdigris River in southeastern Kansas. She suggests the Taovayas may have resettled here independently, or perhaps joined groups of Yscani or Wichita proper already in place. The joint French-Wichita enterprise would have experienced its greatest fluorescence in the late 1740s to early 1750s, and by about 1758 external forces had caused the abandonment of these twin villages on the Arkansas River (Wedel 1982:129). In any event, the ethnohistoric record for Deer Creek and Bryson-Paddock combined with available archaeological evidence provides us with an uncommonly vivid account of French and Native commerce in the mid-1700s.

Ethnohistoric Accounts of Deer Creek and Bryson-Paddock

The Wichita-Comanche Alliance

Around 1746 or 1747, the Wichita entered into an alliance with the Comanche, an event that would strongly stimulate French trade by establishing the Wichita as middlemen in passing goods from the French onto the western Plains. This alliance would also encourage French traders to make renewed attempts at establishing contact with the Spanish in New Mexico. The timing of this alliance was not an accident, as certain factors conspired to make such an arrangement mutually beneficial to both the Wichita and the Comanche at this time. The Comanche, on their end, were probably spurred in part by the fact that the Governor of New Mexico had finally officially cut off all forms of trade with the Comanche in 1746 in reaction to their repeated attacks on New Mexican settlements. On the Wichita end, they found the new proximity of the Comanche somewhat unsettling, these Plains warriors having displaced their traditional and mutual Apache enemies well to the south and west by this time. With the Apache had also gone their horse herds, which the Wichita were accustomed to raid in order to augment their trading stock. The recently trade-deprived Comanche were therefore especially keen to receive French firearms, which the Wichita could provide in return for Comanche horses (Wedel 1981:42-44; Works 1992:273).

This alliance would have been mutually beneficial to both the Wichita and the Comanche, and Newcomb and Field (1967:256-257) and Wedel (1981:42-43) both outline the reasons why purported French intervention to prod such an alliance into existence was likely unnecessary. Despite frequent claims of French instigation, both Native groups were sufficiently sophisticated and far-sighted enough to engineer beneficial agreements on their own. As a result of the new pact, the path to New Mexico finally became more open for the French, as the Wichita could now appeal to the Comanche to allow these outsiders safe passage. Some direct but probably minor French trade with the Comanche had already begun as early as 1724 (John 1975:219-220), but seems to have quickly withered; by 1747-1749, there is at least one isolated exchange recorded of *bastantes* (fusils) being traded for mules on the Jicarilla River (Wedel 1981:44).

The New Mexicans, in turn, much like the French of Louisiana, had become dependent on an array of goods provided by the Comanche that were similar to those required by the French: hides, meat, captives, and horses – and in the case of the New Mexicans, even guns. Spanish law not only forbade a trade in guns to Indians, but also restricted their availability to its own citizens. Thus, the Comanche through their Wichita allies even began to serve as source, to some extent, of firearms for the Spanish settlers of New Mexico (Works 1992:276). The trade in guns to the Comanche grew to such a degree, even, that the appalled and alarmed Governor of New Mexico, Tomás Vélez Cachupín, commented in 1751 on the substantial quantities of guns acquired by the Comanche and their increasingly greater skill in using them (Wedel 1981:46).

More significant to this study, though, is that knowledge among the French of the Wichita–Comanche alliance introduced the prospect of traveling to New Mexico unmolested by the latter. This prompted some French deserters to leave the Arkansas Post in search of either trade opportunities or to simply escape the usually deplorable conditions faced by soldiers there (Wedel 1981:44). It is from the testimony of these deserters that we have our only direct documentary evidence of the scope and nature of the French-Wichita enterprise in processing large quantities of meat and hides at Deer Creek and Bryson-Paddock.

Deserters from the Arkansas Post

In the Fall of 1748, three French soldiers (Luis del Fierro, or Febro; Pedro Sartre, or Satren; and Joseph Miguel Raballo) abandoned the Arkansas Post and headed overland to Santa Fe, almost assuredly passing through Deer Creek and Bryson-Paddock along the way. Expressing their desire to reach New Mexico, they were escorted by the Wichita further west into Comanche territory. Arriving in Santa Fe in 1749, they were all taken into custody and interrogated by the alarmed Spanish officials. In a re-examination of Satren in 1750, the transcription of his testimony to the Spanish explicitly spells out the nature of game processing operations at the twin Taovayas villages on the Arkansas River. It will be noted also that he provides a couple of the terms used by both the French and Spanish to refer to the Wichita – *Panipiques*, or "pricked Pawnee" in the case of the French, and *Jumanes*, or Jumano in the case of the Spanish (a term which was actually applied broadly to more than a single tribe in the Southwest [Weddle 1964:112; Wedel 1981:14]). Satren stated that they:

> "deserted in search of the Spaniards, having confidence in the alliance and friendship the *Panipiquees*, called also *Jumanes*, allies of the French, have with the *Cumanches* who gave them [the French] good treatment upon the recommendation of the *Jumanes*...the French hunters, hunting being their livelihood, go up to these towns of *Jumanes*, on the Arkansas River in canoes, in which they return with peltry, fat and lard of the bison, bears, and deer, this intercourse being facilitated by friendship with the *Jumanes*, who made peace with the *cumanches* about two years ago... Asked if he knew the other Frenchmen who later came to this kingdom, he answered yes and that their profession was hunting because of the profit resulting from the tallow and hides that the merchants who buy them took to Europe..." (Wedel 1981:11-13, 72).

In their nearly identical responses to the initial interrogation, Febro, Satren, and Raballo all stated that the Wichitas they encountered lacked gunpowder and bullets, which they eagerly requested, indicating that supplies of ammunition may have still remained unreliable at this time. However, the Frenchmen also made a duplicitous effort to deny any French complicity in supplying firearms to the Wichita, claiming (falsely) that the Wichita obtained their weapons only by taking them from the "Indians of New Orleans" and that the French had a strict policy against providing the Wichita with ammunition, the death penalty being leveled against anyone daring to do so. All three further stated that their party declined to provide the Wichita the bullets and powder they asked for, as they had none to give. They did admit, however, that the French made a practice of trading guns and ammunition to the long-established friendly tribes of their colony (presumably the Quapaw) in exchange for pelts. As for Comanche access to firearms, all three further commented that, having spent two months in early 1749 with the Comanche, they observed among them only five fusils and that they had no powder or bullets. Satren, in his re-examination, commented that "... in each [Comanche] tent there are three, four, and five warriors armed with the usual arrows, lances, little axes, and some fusils which the *Jumanes* give them with ammunition" (Wedel 1981:44, 68-72).

Felipe Sandoval, a Spaniard who had been captured by the English in 1742 and escaped from Jamaica on a French vessel two years later, traveled in 1749-1750 in the company of a German and four or five Frenchmen in an effort to make it to Taos from the Arkansas Post. They too passed through Deer Creek and Bryson-Paddock, and Sandoval's testimony provides a much more truthful explanation for the origin of guns and ammunition held by the Wichita:

> "...after fifty days we arrived at two towns of Indians, very friendly to the Frenchmen, which were situated on the banks of this river, and called *Panipiquees*. All are lined [tattooed]. The Spaniards call them *Jumanes*... There are about 500 men in the two towns. All use firearms, although they are not very accomplished in their use. They have powder and bullets supplied by the French... They are very friendly with the French and trade with them, and in my short time there, the commandant or French general, in the name of his sovereign, had given them various things: vermilion, beads, knives, guns, ammunition, hats, cloth, and other supplies, and the French flag* which is there. I saw it. They keep it in their town caring for it with diligence and affection" (Wedel 1981:73).

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* As an interesting side note, following the destruction of the Mission Santa Cruz de San Sabá this same French flag, or one similarly distributed to the Taovayas Wichita, may have well made an appearance at the failed retaliatory attack made by Diego Ortiz

Like Febro, Satren, and Raballo the year before, Sandoval was then directed by the Wichita to their Comanche allies further west; after some confusion and having to return to the Wichita villages twice, he eventually made it to Santa Fe where he was questioned by his fellow Spaniards. During his ordeal he witnessed an interesting exchange which shows the high value placed on French firearms – a Comanche brought three horses to the Wichita which he traded to them for a gun and a small handaxe. Upon finally arriving at the Comanche settlement, Sandoval commented "They have great quantities of horses, mares, mules, and asses." Describing his experiences while at the Comanche encampment, he makes note of what may have been a fairly ordinary trading expedition undertaken by the Wichita and the French after the formation of the alliance with the Comanche:

> Twenty *Jumanes* came to this settlement while I was there, along with two Frenchmen to carry on trade. I saw that the French, *Cumanches*, and *Jumanes* have established a great friendship. Having spent five days in trading guns, axes, beads, powder, bullets, buffalo hides, horses, mares, and slaves, the *Jumanes* returned leaving behind the Frenchmen, recommending that they [the Comanche] take them on to the Spaniards" (Wedel 1981:73).

Sandoval, as an actual Spanish citizen who had been caught up in circumstances beyond his control for several years, presumably received accommodating treatment upon his return to Spanish territory. His companions and the Febro party from 1748, though, considering their roles as interlopers, received surprisingly good treatment from the Spanish. As French deserters they were allowed to relocate in Mexico and pursue their lives as civilians. However, their arrival seemed to exhaust any further Spanish

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Parrilla in 1759 on the twin Taovayas villages of the Red River (Allen 1939:67). Similarly, the Marqués de Aguayo encountered Ranchería Grande Indians in possession of a French flag in the vicinity of the Trinity River in 1721 (Foster 1995:153).

tolerance of uninvited foreign visitors, as French traders arriving in the next few years (including Pierre Mallet on a return visit in 1750) experienced much harsher treatment. These later parties were imprisoned in Mexico City and eventually sent to Spain, thereby strongly discouraging further encroachments or efforts at trade by the French at this time (John 1975:319-321; Wedel 1981:47).

Taking into account both archaeological and ethnohistorical evidence then, the picture that emerges from Deer Creek and Bryson-Paddock is therefore one of an enterprise in which French hunter-traders were actively living and working among the Wichita. Here they filled highly symbiotic, reciprocal roles related to the procurement, processing, and transport of hides, salted meat, and oil (Wedel 1981:45). The Wichita villages were perfectly situated to take full advantage of the potential trade opportunities, being located at the furthest navigable point on the Arkansas River that could be reached by French canoes as well as enjoying close proximity to newfound Comanche trading partners (Leith 2008:556). Utilizing horses, which were obtained in raids on either the Apache or the Spanish, or through trade with the Comanche, the Wichita were able to range wider territories and obtain meat in sufficient quantities to engage effectively with the French (Wedel 1982:129). Also, by centralizing meat processing activities and utilizing the labor of nearly all members of the community, including a primary role of women in hide preparation, the resulting scale of combined Wichita-French production was much higher than could have been accomplished by small hunting parties working at scattered, temporary camps (Wedel 1981:59; Perkins and Baugh 2008:390-391; Perkins et al. 2008:431-444).

In exchange for the meat products that were loaded onto French pirogues for shipment downstream, along with occasional transfers of horses and Indian slaves, the French equipped the Wichita with all manner of trade goods which they eventually traded on to their newly forged Comanche allies to the west. The scale of the overall operation is rather striking, but the entire arrangement nevertheless appears to have remained largely informal, with no official status and no military garrison, nor even a common name for the locality having ever been mentioned in any of the surviving official French correspondence (Wedel 1981:57-59). Indeed, Wedel (1981:2) surmises that the types of activities carried on here may have been considered so commonplace as to not warrant mention. We are thus fortunate that the Spanish penchant for documentation has left us a clear record based on the interrogation of a few French trespassers.

The operations at Deer Creek and Bryson-Paddock appear to have achieved their acme during a brief peaceful interlude from about 1749 to 1754, a period in which France and Spain took a reprieve from warring against England. This window of prosperity, sandwiched between the end of the War of the Austrian Succession and the beginning of the Seven Years' War, marked the greatest economic growth experienced by any of the French colonies during the entire eighteenth century (Boulle 1974:51, 79). This general affluence dovetails nicely with the observation that the peak in the Louisiana fur trade occurred around 1740-1758, and that items such as guns, ammunition, gunpowder, axes, knives, and cloth became much more common on French inventories of trade goods after 1740 (Perttula 1992:208, 221-222). During this time ships laden with trade goods arrived at New Orleans in unprecedented numbers, and in 1750, Governor Vaudreuil was driven to exclaim that "there has come here since the peace such a large quantity of ships that the abundance is beyond all expression" (Wedel 1981:44). Vaudreuil still complained that not enough merchandise suitable to the Indian trade was being sent, but it would appear that an abundance of French goods found their way up the Arkansas River to the Wichita at Deer Creek and Bryson-Paddock all the same. Goods were not arriving only from New Orleans, either; for instance, in 1752 the annual shipment from the Illinois Country was noted as being so abundant that the posts downriver, including even Natchitoches, were able to be provisioned (Surrey 1916:297; Ekberg 1998:222).

Such prosperity would not last, though, as a surge in Osage attacks and the disruption of the flow in trade goods at the onset of the Seven Years' War would induce the Taovayas and Yscani Wichita, first encountered in 1719 by Dutisné in southeastern Kansas, to move south once again. This time they would settle on the north side of the Red River (John 1992:197-209), positioning themselves closer to the available French outposts and hence attempting to maintain access to the trade goods from which they derived their livelihoods and power as middlemen. Of key significance to this particular study, this move would also provide the Wichita a better vantage point from which to participate in the events which culminated in March of 1758 in the destruction of the Mission Santa Cruz de San Sabá (Wedel 1981:47-48).

Natchitoches and Los Adaes: A Striking Example of Illicit French–Spanish–Native Trade

The operation at Deer Creek and Bryson-Paddock, fairly well removed from the contentious Spanish-French border, served as an example of a well-oiled machine operating well within the legal tolerances of colonial trade. However, such was not always the case, and the more complicated role that illegal trade played in the overall scheme of things must also be considered. To accomplish this, the intricate relationship that developed between the French, Spanish, and their Native allies at Natchitoches and Los Adaes will be examined.

As mentioned earlier, the French had first established a trading post in 1714 at Natchitoches on the Red River, followed shortly thereafter by the Spanish with the founding in 1721 of the Presidio and Mission of Los Adaes just a few miles to the west. The Spanish fortress, presumably situated to counter the threat of French influence in the area, would soon become intertwined in a rather blatantly illegal trade partnership that persisted until the demise of French sovereignty in North America (Gregory et al. 2004). Natchitoches was also used as the base for an extensive trade with several Native groups in modern northeastern Texas and beyond. Since the relatively small populations of both the French and Spanish existed only at the pleasure of the much more numerous Native groups among whom they lived, the much better-aligned French were able to carry on their trading operations with relative impunity (Perttula 1992:199-217; Gregory et al. 2004:67). Even after the conclusion of the Seven Years' War and France's cession of her lands west of the Mississippi, French traders would continue to undermine Spain's attempts at controlling the distribution of contraband items among the Indians (Galán 2006:295-308).

The Spanish of Los Adaes and the surrounding complex of missions were so thoroughly cut off from official Spanish supply routes that they had no choice but to rely on trade with Natchitoches to sustain themselves. From the onset they would require corn, beans, and meat provided either directly by the French, or obtained from the Hasinai in exchange for other goods which could be acquired from the French. Such a basic level of need required Spanish officials to acquiesce to sanctioning a trade strictly limited to foodstuffs by the early 1730s. However, this activity quickly developed into a cover for an unsanctioned trade in firearms and other contraband (Perttula 1992:207; Burton 2002:227; Galán 2006:311). It would seem that St. Denis had cleverly anticipated just this set of circumstances when he guided the Spanish to the vicinity of his trading post, essentially affirming their claim to the area but at the same time creating a captive market for his enterprise (Weddle 1968:105; Weddle 1973:265-266).

The Spanish certainly realized to some extent that they were placing themselves in a situation in which they would be beholden to the French, although the administrators in Mexico often remained bureaucratically unattuned to the dire exigencies faced by the actual settlers stationed at these isolated outposts. Over its history, then, the commanders at Los Adaes nominally held the Spanish line while tacitly accepting their dependence upon the French, and several of the governors stationed there engaged quite shamelessly in illegal trade for their own benefit. These governors would attempt, though, to save face by periodically complaining about the detrimental effect of French trade in official correspondence, and by making occasional weak efforts to follow viceregal orders to suspend the trade altogether (Burton 2002:228; Galán 2006:276). Over much of their history, though, a spirit of mutual cooperation endured between Los Adaes and Natchitoches, exemplified by Spanish troops who came to the aid of the French when Natchitoches suffered an attack by the Natchez Indians in 1731, as well as the willingness of Spanish priests to say Mass when clergy at Natchitoches was unavailable. The only hostility, of sorts, between the two came in 1719 during the so-called "Chicken War". Apparently fueled by nationalistic fervor upon hearing of the outbreak of the recent war which placed France and Spain on opposite sides, a contingent of seven French soldiers surprised the lone soldier on duty at Mission Los Adaes, taking him as a prisoner and helping themselves to the chickens as well (Gregory et al. 2004:67-68).

At times, French traders were actually arrested by the soldiers of Los Adaes for engaging in illegal trading activities. The trade in firearms and ammunition particularly seemed to rouse the Spaniards' ire, and one such instance occurred in 1737. A Frenchman named Legros had actually been issued a license by the Spanish Lieutenant General Ybiricu for his intended trade with the Kadohadacho. Nevertheless, he was taken prisoner and among his confiscated goods were six *arrobas* (about 150 pounds) of ammunition and two and a half *arrobas* (62.5 pounds) of gunpowder – but only 3 guns (Galán 2006:272-273). This is not an insubstantial quantity of ammunition; considering that a popular French *calibre* for trade guns of the period was 28-30 balls to the pound (Miroir et al. 1973:155-158; see also Hamilton 1980:7 for a discussion of the difference between the English and French systems of caliber vs. *calibre*), this could have amounted to some 4,200 to 4,500 bullets taken from a single trader. As a point of comparison, the Governor of Canada had issued an urgent request in 1758, one year before the fall of Quebec, for half a million lead balls to be sent from France (Kent 2001:191). Hence, the trader Legros presumably had on his person when captured the equivalent of nearly one percent of the ammunition thought necessary for the defense of all of French Canada just prior to its collapse – again, not an insignificant amount.

A second event involving a French trader in 1737 shows that not only was food scarce at Los Adaes, but the Spanish garrison also did not hesitate to make use of French weaponry. The trader Delachaise had apparently been relieved of 25 pounds of ammunition and 30 pounds of gunpowder that Ybiricu had "taken" from him (Galán 2006:275). Whatever the actual circumstances, he actually went before the Spanish Governor, requesting to be recompensed for what seems to have been either an outright confiscation or perhaps a genuine transaction that simply went unhonored. Even the much smaller quantity involved here would still likely represent in the neighborhood of 700-750 lead balls.

Aside from their extensive activities with the Caddo and Wichita, the French out of Natchitoches had also established trade relations with a number of lesser tribes to their south and west. This would eventually lead to the arrest of yet another Frenchman whose operations instilled enough paranoia among the Spanish to catalyze the founding of yet another presidio and mission. By as early as 1723 or 1728, some French traders had begun to travel overland into modern southwest Louisiana and beyond, trekking deep into Spanish territory to trade amongst groups situated about the Trinity, Brazos, and Neches Rivers. These included such tribes as the Atákapa, Akokisa, Bidais, Deadose, and Tonkawas, as well as Opelousas and Avoyelles further to the northeast (Usner 1985:81; Weddle 1991:289-292; Galán 2006:283-285). Rumors of new French intrusions resulted in a 1746 expedition led by the commander of Presidio La Bahía, Joaquín de Orobio Basterra, that encountered members of these groups who spoke quite freely of annual visits by the French to trade hides for knives, guns, and cloth. (Weddle 1991:289).

This more southerly trade never developed to nearly the extent that it did with the Wichita or Caddo, as the difficult overland journeys and lesser quantity and quality of game in the area made for a less profitable commerce. Too, by probing deeper into Spanish lands it exposed the French who engaged in such trade to greater risk of capture

(Burton 2006:233). Still, this trade proved rather significant in that it put guns and ammunition into the hands of smaller tribes such as the Bidais and Tonkawas. These groups would later find themselves involved in such actions as the destruction of the Mission Santa Cruz de San Sabá, as part of the combined forces that came to be known as the Norteños (Weddle 1964). Also, the French incursions south of Natchitoches had ripple effects by creating an inter-tribal trade in their wares. The Tonkawa were supplied with some of their firearms indirectly through the Bidais and Akokisa, and these groups in turn even furnished guns to some extent to the Lipan Apache living near San Antonio (Burton 2006:233-234). This is quite interesting to note, as other groups that the French of Louisiana are most known for trading with (the Wichita, Caddo, and Comanche) would have never knowingly permitted actions that equipped their detested Apache foes with French guns.

In 1754, in reaction to rumors of a French trading post having been established just above the mouth of the Trinity River, the Governor of Texas, Barrios y Jáuregui, sent a contingent of 26 soldiers from Los Adaes to investigate the claims. Arriving near the mouth of the Trinity, the Spanish indeed found and arrested the French trader Joseph Blancpain, along with his brother, another Frenchman, and two black slaves. They proceeded to burn down the house he had built and destroyed his canoes, and of course confiscated his sizeable store of trade goods. This included 1,000 pounds of ammunition (perhaps representing upwards of 30,000 lead balls of typical size), another 200 pounds of "munitions", four and a half 100-pound kegs of gunpowder, and various flintlock fusils, pistols, and gun parts. On this expedition, they also reported finding 17 fusils, eight pistols, and 2,000 *piedras* ("rocks", or bullets) among the Akokisa Indians that had been supplied to them by the French. (Galán 2006:278-287).

Blancpain was shipped off to Mexico City where he died in prison a little over a year after his arrest. The incident was sufficient to stir the Spanish into founding a new presidio (San Agustín de Ahumada) and mission (Nuestra Señora de la Luz de Orcoquisac) directly atop Blancpain's attempted trading post. This compound came to be known collectively as El Orcoquisac, after the Akokisa Indians among whom it was founded (Weddle 1991:296; Gilmore 1992:128). This new establishment, in existence from 1756-1771, may have even been intended not only as a deterrent against illegal French trade, but also to discourage the illicit trade conducted by the Spanish of Los Adaes as well; the administrators of New Spain were beginning to realize just how rampant the illegal commerce had become (Galán 2006:280-281). In fact, it could well be that Blancpain had received such harsh treatment for having intruded upon the illegal and lucrative trade that Governor Barrios was carrying out for himself among the Indians of the Trinity and Brazos River region, or perhaps because he had actually operated in direct complicity with the Governor who feared having the Frenchman expose his fraud (Galán 2006:287).

In the entire history of Los Adaes, Governor Barrios, himself, was probably the worst transgressor of Spanish laws regarding illegal trade. He was not the first nor the last governor at Los Adaes to engage in illicit behavior for personal gain, but it could be argued he was the most profligate. In 1761, in a hearing conducted by Barrios' successor, Governor Martos y Navarrete, the testimony provided by the man who loaded mules with Barrios' contraband goods for nine years shows the depth of the former governor's transgressions. The muleteer Juan Antonio Maldonado testified that all during the governor's tenure from 1751-1759 and upon his behalf, he had transported hides and furs (obtained from the Indians) many times to Natchitoches to sell to the French. He claimed that upon every return trip he had twelve mules loaded with goods, often including guns, ammunition, and gunpowder, and also testified that Barrios had conducted trade with the Bidais, Tejas, Nabedache, Orcoquisa, Tonkawa, and Yojuanes* Indians – some of the same groups with whom Blancpain had endeavored to trade. Quantities of 50 pounds of ammunition and 25 pounds of gunpowder are specifically mentioned (perhaps characteristic of usual hauls?) as having been traded to the Indians. Further, Lieutenant Joseph Gonzales, who managed the governor's store at Los Adaes, testified that in one year alone the governor sold 9,900 buffalo hides to the French, transported to Natchitoches in nine separate trips. Barrios ruled his monopoly with an iron fist, and is even suspected of detailing Los Adaes soldiers to other presidios (Ahumada and San Xavier) to serve as proxies in extending his illegal trade even further among the Akokisa and Tonkawas (Galán 2006:245, 317-321).

Early in his term as Governor, Barrios had written to the viceroy in Mexico City on two occasions, in 1751 and 1752, to express what was perhaps only his feigned concern at the extensiveness of the French trade with the Indians of Texas in such goods as muskets and gunpowder (Galán 2006:276). Or, perhaps, he was merely irked by what he saw as undue competition with his own interests. Whatever his true inclinations, by 1753 he had the boldness to seek official permission to trade freely with the Indians in such items as gunpowder and ammunition. Having been denied such lassitude in his

* Note that Galán [318] takes *llojuanes* to possibly mean Illinois, but it seems apparent this actually refers to the Yojuane. See Newcomb 1993:17-22.

authority, Barrios, evidently feeling entitled to his sinecure, proceeded apace with his illegal ventures nonetheless (Galán 2006:245-246).

Even the missionaries at Missions Nacogdoches and Ais got in on the action, occasionally sending some hides to Natchitoches in order to obtain small quantities of gunpowder (four to six pounds) and ammunition (eight to twelve pounds), among other things. They could then exchange these items with the local Indians (who were not, generally, congregating in their missions) for such commodities as bear oil and other necessities that were needed to keep the missions operating at a minimally functional level (Galán 2006:261-262). A 1760 letter from Governor Kelérec of New Orleans further documents that this type of trade was carried on by the missionaries, and also shows the extent to which the Los Adaes governors preferred to monopolize trade for their own benefit. Kelérec wrote Governor Martos to admonish the Spanish against interfering too greatly with the French trade at a time when it would hinder their mutual efforts to forestall an English takeover in North America. As he pointed out, both of them knew that "his Missions Ais, Nacogdoches, and Orcoquisas purchase goods daily from Natchitoches for the money, a distribution which you do not even approve among your residents… you well know that they carry on commerce publicly with the Hasinais, Nadacotes, and Nacogdoches" (Galán 2006:293-294).

It is clear from the example of Los Adaes and Natchitoches that illicit trade on the Texas-Louisiana frontier was unabashedly pervasive and almost viral in its character. In terms of the movements of a single type of commodity, lead, it is apparent from the many instances noted that a thriving trade in guns and ammunition occurred. This commerce introduced French weaponry to not only a number of diverse tribes, but also provided firepower to the isolated Spanish as well. Costly shipments of Spanish goods from Mexico and San Antonio, while infrequent, likely did provide the presidios and missions with periodic cargos of lead derived from the Mexican silver-lead mines. It seems apparent, though, that at such distant outposts as Los Adaes and outlying communities and villages, Mexican-derived lead sources would play a far subservient role to those supplied by the French.

The situation of Natchitoches is also intriguing, as it is suggestive of the types of activities that probably occurred at other remote French trading posts. Several other such French trading centers existed in the vicinity, but without the benefit of an immediately adjacent "enemy" center such as Los Adaes to generate a rather extensive Spanish documentary trail. Among these are the military/trading post of Alexis Grappé which was likely located on the Red River at the site of Roseborough Lake (41BW5). Occupied from about 1733 to 1763 (and perhaps beyond – see Bolton 1914[1]:145 and Usner 1985:83), it was situated just a few miles west of the supposed location of the Nassonite Post established by Bénard de La Harpe in 1719 and which itself functioned for several years (Miroir et al. 1973:162; Wedel 1978:10-15; Gilmore 1986:12-17, 21, 39-40). Additionally, a trading post established among the Yatasi Caddo about 40 miles northwest of Natchitoches, initially known as La Pointe, grew to be a major center for smuggling eventually called Bayou Pierre. Here, old trading paths pre-dating the Europeans served to connect both the French and the Spanish with members of the Caddo confederacies, and by extension of Caddoan trade networks provided access to tribes of the Southern Plains (Galán 2006:271, 306, 312, 314).

The trade network became so extensive that French traders were even reportedly living in each of the Caddoan settlements by the 1750s (Perttula 1992:150, 179), and one such location may be represented by the Woldert site (41WD333) in the Sabine River basin near Lake Fork Creek, which has produced artifacts (including gun parts and lead balls) indicative of a mid-eighteenth century French-influenced hunting camp not dissimilar to Deer Creek and Bryson-Paddock (Perttula 1992:174). Similarly, the Gilbert site, dated to approximately 1730-1770 and thought to be a Kichai village in the Upper Sabine River drainage of Texas, shows such a profusion of casually discarded metal goods that Blaine (1992:192) suggests that such extravagance may be accounted for by the possibility of French traders actually living on-site. This, along with the Woldert site, then, would perhaps serve as yet another example of a cooperative hide-processing effort not unlike Deer Creek or Bryson-Paddock. Additionally, another French trading post in East Texas called Le Dout or La Doutte figured into a 1753 episode in which the Spanish tried unsuccessfully to force its removal, only to be rebuffed by the Native allies of the French who benefited directly from the trade it provided (Gilmore 1992:131; Perttula 1992:173).

In concluding this segment on the vibrant role of Los Adaes and Natchitoches in French, Spanish and Native trade, I feel compelled to indulge in speculation on a situation which may have direct bearings for the artifacts recovered from one of the sites involved in this study. Along with the multiple examples of Spanish governors and missionaries trading openly in weaponry with the French, and that of Delachaise requesting payment for the powder and balls taken from him, the case of Joseph Blancpain serves as another example of the manner in which ammunition of French origins might have made its way directly into Spanish hands. By following the thread of the goods involved in Blancpain's ordeal, it may be possible to establish a direct artifactual link to this episode.

Most notably, in disposing of Blancpain's contraband (which presumably would have included his thousand pounds of ammunition), an advisor to the viceroy wrote that "Governor Barrios y Jáuregui had the munitions, merchandise, and drugs confiscated then routed through Presidio San Xavier de Gigedo, near Mission San Xavier, and distributed among the auxiliary troops as plunder" (Galán 2006:279-280). The soldiers of this presidio, established in 1751 on the San Gabriel River for the protection of a cluster of three attached San Xavier missions, were eventually transferred in 1757 to the newly established Presidio San Luis de las Amarillas, which in turn was constructed for the protection of the fledgling Mission Santa Cruz de San Sabá. The garrison had in the meantime been shuffled back and forth some during the move, being shifted in 1756-1757 to temporary camps on the San Marcos River and to San Antonio (Weddle 1964:30-50).

It is of course somewhat tricky to make a leap from reading such an account to making specific predictions about the archaeological record, but this situation seems to pose some possibilities. Upwards of 30,000 lead balls (my somewhat speculative estimate) represents a large number of potential artifacts. In the interim between Blancpain's arrest in October, 1754 and the disbanding of the San Xavier presidio and missions in 1756, some of the confiscated ammunition sent to the San Xavier Presidio could have very well entered the archaeological record there, or perhaps even moved on with the troops to other assignments. But, would it have even remained in its original form? We don't actually know what *calibre* the bullets were. Possibly they were actually of perfectly acceptable dimensions and required no further modification to be used in Spanish firearms. If not of the proper size, though, would they have possibly been melted down and re-cast into balls of the correct proportion, or perhaps made into other objects altogether? If so, could this lead have possibly been mixed with lead brought in from Mexico in the process?

If melting and re-casting did occur, say, in combination with Mexican bar lead, such an admixture of leads (if even detectable isotopically) might suggest that the confiscated ammunition was doled out to the Spanish soldiers in parcels and re-cast in small lots; it seems that if a mass re-casting of such a quantity (a thousand pounds) took place, no new outside lead would have likely been introduced. If admixture did indeed occur, it may be that a significant signature of silver or other trace elements corresponding to what might be expected from Mexican ores could be present, skewed also by the added presence of the original French-derived lead.

Additionally, what's to say that Blancpain's confiscated cargo of bullets didn't actually get re-directed from San Xavier de Gigedo after arriving, or that the unscrupulous Governor Barrios didn't actually sell off the merchandise himself? Still, considering the number of lead balls involved, the known movements of the San Xavier garrison, and the fairly short timeframe involved, it is not altogether improbable, then, that some of these lead balls might have even made their way eventually to the site of Presidio San Luis de las Amarillas, located today on the County golf course near present-day Menard, Texas (Weddle 2000:vii; Weddle 2007:81). Of lesser but not inconceivable probability is the potential that some of these bullets even saw action in the assault on the Mission Santa Cruz de San Sabá.

Other Potential Scenarios of Lead Exchange, and the Overall Complexity of Eighteenth-Century Colonial Commerce

As the example of Natchitoches and Los Adaes has shown, there is distinct potential for French-origin artifacts to have entered into Spanish supply chains. This is by no means an isolated instance, as such scenarios played out in other venues as well, notably in interactions between the French and Spanish at Mobile, Pensacola, St. Augustine, and Veracruz. A few examples of this will serve as an added reminder that colonial goods were often subjected to convoluted exchange routes that could potentially frustrate attempts at tracing their origins.

Deagan (2007) has pointed out that Spain consistently failed in supplying its North American colonies with essential manufactured goods, and for this reason illicit trade blossomed in colonial Florida just as fully as at Los Adaes. At Pensacola, a mere twelve leagues west of Mobile (Dunn 1917:204), the desperate Spanish colonists received occasional official permission to engage in subsistence-oriented trade, but just as occurred on the Red River, such activities opened the door to larger illicit schemes (Deagan 2007:102). Such trade apparently re-opened quickly after the conclusion of the War of the Quadruple Alliance (the same conflict that prompted the "Chicken War" at Los Adaes, and in which a force of 1,200 men is said to have attacked Pensacola ([Gregory et al. 2004:67]), as we find Bénard de La Harpe assigned in 1723 to an expedition to deliver flour to Pensacola from Mobile as requested by the Spanish commander there (Wedel 1971:57). Oddly enough, though, it seems that French trade with Pensacola may have not been limited strictly to times of peace, as an invoice of 1747 (during the War of the Austrian Succession) indicates that Louisiana had received a shipment of flour from a merchant in St. Augustine, for which 154 bundles of deerskins were sent in payment (Usner 1985:84).

An interesting situation specifically involving lead presents itself in August, 1732, at which time the French rescued 120 Spanish sailors who had been stranded by a storm in the Gulf region. The French cared for them at New Orleans until they could be returned to Veracruz in 1733, at which point a French delegation asked to be rewarded for the good treatment the Spanish soldiers had received. The viceroy of New Spain was asked to not only repay the sum expended in their upkeep, but to also loan the French 50,000 *livres*, sell them 10,000 pounds of lead, and allow them to purchase a boat of about 70 tons (Surrey 1916:398). It should be mentioned here that in a letter from January of this same year, Governor Etienne Périer at New Orleans had complained about the lack of lead in all of Louisiana (Ekberg 1982:141); this period marked a lull in production at the Missouri mines, so the French were understandably looking to outside sources.

The viceroy did indeed allow the purchase of the boat, but did not grant them the loan. He apparently acceded in part to the remaining request, as he provided them with 35 quintals of lead (about 4,000 pounds), apparently in the form of ammunition. The intent of this exchange, though, was apparently for the French to deliver the lead to the Spanish garrison at Pensacola, as they had also been provided with 5,000 *livres* in money to cover freight charges and salaries of the French officers and crew on their return voyage to Mobile (Surrey 1916:399; Briggs 1985:293). The cargo of food and ammunition they carried, then, was apparently not meant for the consumption of the French, but rather intended for delivery to Pensacola; whether or not such critical supplies actually made it there is not stated, but the case presents the rather unusual situation of the French of Louisiana coming into direct receipt of lead from Mexico, presumably derived from the Mexican silver-lead mines. It would seem that such transactions did not become commonplace, though, as indicated by another action of the French delegation. Not to miss an opportunity, they also appealed to the viceroy at this time to permit more regular trade between Louisiana and Mexico, but the request seems to have had little effect (Surrey 1916:399). Still, in August, 1758 another record from the period of the Seven Years' War discusses concern over a French ship which had been dispatched four months earlier to Veracruz to procure a supply of ammunition, but nothing had been heard of it since its departure. Despite the fact that Spain had joined France in 1758 in warring against the English, Surrey (1916:406) reports that such transactions were difficult at this time as Mexican merchants were leery of accepting French credit.

Although this study has barely touched upon the role of English trade in relation to that of the French and Spanish, goods introduced directly from English sources also probably played a role to some extent in the area under consideration. Most notably, as a concession made by the Spanish under the Treaty of Utrecht, which ended the 1702-1713 War of the Spanish Succession (also known as Queen Anne's War), England received rights to the Spanish slaving contract (*asiento*) for a period of thirty years. A stipulation of the agreement entitled England to not only supply the Spanish empire with slaves, but also permitted the English to send to Mexico annually a vessel laden with 500 tons of duty-free merchandise (Bethell 1985:391, 410-413; Deagan 2007:101, however, states that two ships of 650 tons apiece were allowed). The French had actually held the *asiento* from 1640 to 1713, though apparently without the added stipulation allowing for unfettered additional shipping to Spanish ports. The English would retain the *asiento* until 1739, which allowed them for a quarter century to severely undercut standard Spanish merchandise which carried high prices due to Spanish monopolistic policies. The instigation of the War of Jenkins' Ear (1739-1748) would finally break Spain's obligation in this matter, with the South Seas Company formally renouncing the *asiento* and the attendant privilege of an annual trade ship in 1750 (Bethell 1985:391, 410-412). Still, though, for many years literally hundreds of tons of English merchandise made its way quite legally into the channels of Spanish commerce. Whether this included shipments of lead to New Spain, already quite rich in lead due to the Mexican mines, would be worth investigating.

To potentially confuse matters even further, the great bulk of merchandise emanating from Spanish ports did not actually come from Spain. Rather, it is calculated that around the end of the seventeenth century nearly 95% of manufactured goods sent to the Spanish colonies actually originated in France, England, Holland, and Germany (Bethell 1985:410; Deagan 2007:101). Such a circumstance probably obtained to a certain extent in France as well, where re-exportation of colonial products derived from throughout the French empire to other European nations drove a major sector of France's overall economy in the eighteenth century (Boulle 1974:50-52). Again, whether lead in either raw or finished form ever made up a substantial portion of typical cargos is worthy of examination, and the next chapter will offer some pertinent insights as to the nature of French imports.

Finally, brief mention should be made of potential English influence within the domains of the Illinois Country. As mentioned briefly previously, in the area comprising the modern southeastern states the French did have to compete rather stringently with the English in the hide trade, faced with the English ability to offer both higher prices and a better quality of merchandise among certain classes of goods. In the Illinois Country, though, despite the intrigues of the 1720s and 1730s in which English attempts to infiltrate French trading territory stirred up violence and rebellion, the French managed to mostly hold incursions of English trade goods at bay. Occasional lapses likely did occur, though, and perhaps quite a bit more frequently than we realize. In 1700, for instance, the virtually abandoned Arkansas Post was noted as hosting a single English trader from the Carolinas who had supplied the Indians there with fusils and swords (Wedel 1981:36).

During La Harpe's stay at the Tawakoni Village on the Arkansas River near present-day Tulsa, he recorded the arrival of a Chickasaw Indian who had come from the Yazoo River region loaded with a parcel of unspecified English trade goods. The chance meeting of La Harpe and this Indian peddler, whose wares also likely emanated from the Carolinas, seems to have surprised both of them. There is apparently nothing else to suggest, though, whether the Chickasaw's visit was part of a regular routine, or to indicate that the British were especially pushing to move their trade up the Arkansas at this time (Wedel 1981:35; Wedel 1982:127). Although this lone trader was probably capable of carrying relatively little physical merchandise, Odell (2002:36) notes that the event indicates "the vast geographic scale at which commerce was being negotiated". Perkins and Baugh (2008:394) even use this incident to raise the question quite directly of whether the Chickasaw could have been a possible source of English trade guns and gun flints among the Wichita. The quick answer is that, yes, the potential certainly exists, although most of the evidence would seem to suggest that French trade goods are likely to overwhelm British items at early to mid eighteenth-century Wichita sites.

Sites dating to later in the century, however, may present a more complicated picture. After the conclusion of the French and Indian War, Louisiana fell under Spanish control and new markets opened up within a fluctuating system as Spain tried to figure out how to handle the matter of trade in its new territory (Bolton 1914; Burton 2002:235-238). As Perttula (1992:213) has observed, though, it is not until after 1770 that the opening of markets to products of English derivation would likely begin to impart a more distinctively English imprint upon sites. Still, at Bryson-Paddock which has a presumptive terminal date prior to this, the excavation seasons of 1974 and 1975 did each yield a single hammer or cock attributed to the style used in an English trade gun (Hartley and Miller 1977:95-96). Apparently, then, at least two specimens of English trade guns made it this far up the Arkansas River in the eighteenth century, and quite possibly more. As Harris et al. (1965:316-320) were careful to warn, though, even presumably French guns and gun parts could have very well been manufactured outside of France, but were still intended for the French market and likely made according somewhat to French styles and tastes. English trade guns and gun parts seem to be less prone to such vagaries in manufacturing and style, but the example shows that it is still worth bearing in mind that manufactured goods of the eighteenth century have complex manufacturing histories which tend to defy overly simplistic interpretations.

A Note Regarding Tribal Movements in Response to Colonial Trading Activities

Several references have already been made in the preceding sections to movements of the various Wichita bands over the course of the eighteenth century: the probable Tawakoni visited by La Harpe moved from the Arkansas River to the Canadian and Red Rivers between 1719 and 1742, and the Taovayas likely encountered by Dutisné in 1719 had apparently moved from southeastern Kansas to the Deer Creek and Bryson-Paddock localities by some point in the 1740s. These latter would eventually resettle by 1758 on the north side of the Red River at the Longest Site, 34JF1 (Bell and Bastian 1967; John 1992). Generally speaking, such movements are usually attributed to a consistently southward response to increasing Osage hostility and a desire to be ever more favorably situated to the benefits of the French trade. These and later movements of the Wichita have been a major focus of study among many researchers (e.g., Johnson and Jelks 1958; Bell et al. 1967; Wedel 1981; Wedel 1982; Smith 2000; Smith 2008) and so will not be treated extensively here. However, such migrations do illustrate the dynamic processes underway during the eighteenth century, prompted in no small part by the trade in European goods. Accordingly, a lead isotope analysis of artifacts from Wichita villages during this time period would have the potential to provide new detail that could have some bearing on diachronic-oriented studies. By linking what is known about potential lead sources, mining history, trade patterns, and general colonial economic patterns, information could be revealed that might be pertinent to questions concerning tribal movements, tribal affiliation, ethnicity, and site chronology.

It is important to recognize, too, that the Wichita, despite being the most conspicuously studied, were not the only group to geographically re-orient themselves in response to the French trade. Caddoan groups also adapted geographically to the influence of outside goods, dispersing into better hunting areas and thereby reversing to a certain extent trends towards group aggregation that had been underway at the beginning of the historic period. Like the Wichita, some Caddoan groups also congregated closer to Natchitoches to maintain better access to and control over the French trade (Perttula 1992:152, 168-170, 181). Similarly, the Missouri Indians, who had probably enjoyed the benefits of French trade considerably longer than either the Wichita or the Caddo, moved in 1724 from their traditional village (the Utz site, 23SA2) to be closer to Fort d'Orleans, which had been established in 1723 well above the confluence of the Missouri with the Mississippi (Wedel 1972:13-16; John 1975:219-220). Such a move was likely made in order to position themselves nearer to the source of manufactured goods upon which they had come to rely. As these examples show, the French trade had quickly assumed a role of such importance that Native groups were quite willing to uproot themselves if it ensured better access to such necessities as firearms.

Summary

It should be apparent from the material presented in this chapter that the nature of colonial trade in the middle portion of the North American continent during the early to mid-1700s was a staggeringly complex affair. Lead especially served as an essential commodity within this framework, being transported and exchanged widely throughout the colonial world. Accordingly, lead objects are frequently recovered from historic period North American archaeological sites, and the technique of lead isotope analysis offers to open up the potential that such artifacts hold for illuminating various aspects of the overall colonial-driven system. Any attempt to draw meaningful conclusions about such objects, though, must be undertaken with a firm grounding in the overarching historical context from which they originated. This chapter has attempted to touch on many of the pertinent historical issues, and while the complexity of the overall situation may seem daunting, it is helpful to bear in mind a few relevant truths:

As a rule, the Spanish tended to not engage in a firearms trade, while the French did so quite eagerly. The French, Spanish, and Native Americans had many colorful encounters during the colonial period which would shape and flavor the course of their trading interactions throughout the trajectory of their tenures upon the colonial landscape. Lead would enter into colonial commerce in a variety of ways, either through importation from Europe or by way of more domestic production within the Western hemisphere. The goods that were brought in were not necessarily products of the mother country which delivered them, and things sometimes got swapped around in such a way that keeping track of who owned what can be confusing. For the most part goods were transported by river systems but also overland, and often in surprisingly ambitious ways that distributed them far beyond where we might expect things to wind up. Depending on events in French North America at a particular time, goods flowed either fairly routinely along the more customary routes, or more haphazardly by way of more makeshift routes. The desire for these goods was so great that entire populations would actually displace themselves to retain access to them. Under certain circumstances the Spanish sometimes acquired ammunition from the French, and more rarely the French acquired Spanish ammunition from Mexico. Finally, no amount of government decree would prevent the parties involved from carrying on a vigorous trade, if in breaking such laws the costs did not outweigh the benefits.

CHAPTER 6

THE INFLUENCE OF FRENCH IMPORTS OF AMMUNITION IN THE EIGHTEENTH CENTURY

Having now provided some conception of the complex manner in which goods were transported within French Louisiana, this chapter will address some special historical considerations pertaining to French importation of lead and ammunition during the eighteenth century. One of the key points to be made here is the recognition that, despite the development of a rather active domestic lead mining industry in the Illinois Country, tremendous amounts of European-derived ammunition were still being brought into French North America on a rather constant basis. The great demand for this imported ammunition resulted from not only its need in commerce and warfare, but also due to the rather surprising conclusion reached in the course of this study that no significant industry in the manufacture of ammunition ever developed in French Louisiana. A series of correspondence will be examined in this chapter that demonstrates this finding rather conclusively.

Because ammunition was not being manufactured by the French in North America on any sort of industrial scale, it had to be consistently brought in to meet the never-ending demand. Such imports were subject to disruptions in shipping caused by warfare, accident, and general economic trends, with such events in turn affecting the supply chain at its base. For these reasons an historical overview of French shipping will be provided, with particular emphasis given to the severe disruptions caused by the 1754-1763 French and Indian War / 1756-1763 Seven Years' War (as the binomial conflict is known in North America and Europe, respectively). Adaptations to normal supply chains caused by this war will also be considered. This one conflict and its disruptions, in addition to its importance as having ended French sovereignty in North America, is being examined somewhat minutely here because it has direct bearings on some of the sites involved in this study. This is especially true in the particular case of the Mission Santa Cruz de San Sabá, which was founded and destroyed in the midst of this greater conflict in 1757-1758. The active French importation of ammunition during the eighteenth century can also naturally be expected to have a sizeable impact on the isotopic character of lead objects recovered from French colonial sites of this era. The chapter will thus conclude with observations designed to warn against reaching premature conclusions about the *cultural* provenience of artifacts based solely on the context of *geologic* origins as revealed by lead isotope analyses.

The Lack of a Large-Scale Ammunition Industry in French Louisiana

As mentioned in Chapter 4, Louisiana and the Illinois Country operated to a great extent as components within a classical colonial mercantile system. As such, they operated primarily as producers of raw products and as consumers of imported manufactured goods (Keene 1991). As it turns out, this economic model came to bear rather directly on French colonial production of lead from the mines of present-day southeast Missouri as well. This state of affairs is revealed by the contents of three letters which entered into the official correspondence of Louisiana between 1752 and 1754. To begin, though, it is important to state emphatically that, as a practical matter, lead from the Meramec mines and Mine La Motte in southeast Missouri was certainly cast into ammunition by the French colonists, to some degree, for their own use and for trade. With its low melting point and the need for little else but fire, some manner of crucible, and a bullet mold, the process of forming bullets was a rather basic activity which required relatively little skill. Within a military garrison, an armorer or other person assigned to the duty could cast all the bullets needed by a regiment, or the task could simply have been undertaken by individual soldiers as needed (Parkerson 1974). Likewise, individual colonists were probably able to manufacture their own bullets as required for hunting or defense.

As mentioned in Chapter 3, the Kreilich site at the mouth of Saline Creek (just outside of the Missouri lead mining region) shows significant evidence of on-site lead and ammunition production in the form of furnaces and archaeologically recovered gang molds, lead balls, and lead sprue (Trimble et al. 1991). The activities at this site, which likely dates as far back as the early-to-mid 1700s (although indications also exist for occupation in the later 1700s to early 1800s) were probably typical of the sort of small-scale ammunition production underway during much of the French colonial period. Such production would have probably provided for immediate local needs, although it is unclear whether any surplus lead would have been traded outside the system only as a raw product, or if actual domestically-produced ammunition was also sometimes sold or exchanged. For instance, in 1743 the miner-soldier De Gruy noted that lead from Mine la Motte had "not only supplied this settlement [the Illinois country], but had also supplied such Canadian posts as Ouiatenon, Missilimakinac [Michilimackinac], and Detroit…"

(Ekberg 1982:141). Although not clearly stated, it would seem that raw lead rather than actual manufactured ammunition is implied. This is bolstered by the observation that De Gruy apparently had a contract by 1752 to provide a hundred thousand pounds of lead to Canada ("he has twenty-five men working at the mine, having undertaken to supply a hundred thousand to the posts of Canada" [Pease and Johnson 1940:563]), and it would seem odd that if such a quantity was actually in the form of ammunition that this would not somehow be more clearly specified. Further, for the years in which we have records of surplus Illinois Country lead being shipped to New Orleans and thence to France (1743, 1744, and 1745), that surplus always took the form of lead bars which had not undergone any further refinement (Surrey 1916:200-206). The evidence thus far, then, would seem to indicate the lack of any sort of major enterprise for manufacturing ammunition.

Between 1752 and 1754, there appears to have been something of a coordinated campaign waged by the officials of Louisiana to convince the authorities in France that the lack of a domestic, large-scale ammunition industry in Louisiana was severely hindering the development of the colony. Knowing the potential of the Missouri lead mines, and commenting on the great expense and effort required in importing ammunition, they pleaded repeatedly for the Crown to send them experienced mining engineers and persons skilled in "casting lead in grain" – i.e., bullet making.

A letter sent from Governor Vaudreuil to the Minister of the Marine, Rouille, dated April 8, 1752 begins the series; the pertinent text is provided more fully in Appendix D. In this letter, Vaudreuil comments on trouble being stirred up among the tribes by the English, and laments the fact that the regrettable omission of trade guns and ammunition from the previous year's shipment had made for a delicate situation. He implores the Minister to ensure that these vital supplies are not forgotten again in the current year, and comments that, for the time being, the affected tribes had "been supplied with… lead in grain and bulk from the king's storehouse which has been cast into the necessary bullets…" As a consequence of the feared insurrections, he notes that his Commandant at Fort des Chartres, Macarty, had informed him that such uprisings would "interrupt the manufacture of lead which was carried on yearly for the consumption of this country and that he will have to get it from the lower colony, where we are in extreme want of it" (Pease and Johnson 1940:581-589).

This passage shows the vital importance of regular imports of ammunition to the Louisiana colony, and also shows that bullets could be made in presumably fairly large quantities if absolutely necessary – although this incident seems to have created something of an inconvenient imposition. As for the "lead in bulk" used to cast the "necessary bullets", one wonders whether this raw lead came from France (as did, presumably, the finished ammunition already on hand) or whether it represents bars of Illinois Country lead purchased for the use of the troops. The latter scenario seems possible, as lead from the Illinois Country did find its way into the royal storehouses at times, as shown by a different letter from Macarty to Vaudreuil dated less than two weeks earlier (March 27, 1752). Here Macarty comments that the miner De Gruy was expected to "transfer to the king's stores twenty thousand of lead" as partial payment of the debts he held. It is hard to say whether this particular lead would have been used to "cast the necessary bullets" of which Vaudreuil spoke in his letter of April 8; the interval between March 27 and April 8 is rather short, and all the involved parties as well as the lead would had to have already been in New Orleans at the time for such a scenario to make any sense. Otherwise, neither the slow-moving colonial correspondence nor twenty thousand pounds of lead is likely to have been involved in such a quick exchange.

A year later, the Commandant Macarty would press the case initially advanced by Vaudreuil in another letter dated May 20, 1753 to Rouille. He touted the productivity of the lead mines, noting that already they supplied "a part of the posts of Canada and the tribes of that region as well as those here. If workmen were not so expensive, you could even supply this colony and carry on the trade with the Spaniards." It is interesting to note that the French military commander at Fort des Chartres seemed perfectly willing to open up a trade in lead with the Spanish, and would even hold such a prospect out as an inducement to the Minister of the Marine in Paris. He went on to comment:

> "If we had a caster of lead in grain, the king could dispense with sending it to this colony as none of it would be more expensive than in France if you wished to allow for the cost of the freight to carry it into these colonies and for its taking the room needed for other things. From the facility with which the posts on the river going down to New Orleans, and from New Orleans in the direction of Mobile could get it, it would save the king the transport of fifteen to twenty thousand pounds to be sent up here or into the posts. This expense would more than pay for a caster independently of the loss en route of lead in grain; and it would procure an article of commerce for the country. I hope, Monseigneur, that you will be good enough to give much attention to this point which is essential for this country" (Pease and Johnson 1940:818-819).

Clearly, Macarty desired that more productive use could be made of the rich lead deposits located just across from the river from his post. By appealing to the economics of the matter, he hoped to develop an ammunition industry for Louisiana and thereby win a little more security for the colony.

In September of 1754, a letter sent by Pierre René Harpain de la Gautrais (a business associate of De Gruy) to Governor Kerlérec and the Intendant of Louisiana requested that mining engineers knowledgeable in lead smelting be sent from France, in order that the productivity of the mines could be increased. This, he said, would allow the posts of the Illinois and Canada to be supplied with lead more cheaply and efficiently than could be accomplished by sending it via France. Finding his request to have merit, his letter was forwarded to the Minister of the Marine accompanied by the Governor's own letter. In it Kerlérec wrote that "by means of these workmen we will no longer be under the necessity of drawing from France the lead in shot for the consumption of this colony which mounts annually to more than fifty thousand…". He further vouched for the competence of De Gruy and Gautrais, noting that they had (apparently) already been entrusted by the Intendant to distribute the ammunition already sent that year from France for the use of the upcountry posts (Pease and Johnson 1940:894-900).

Nothing appears to have ever come of the multiple pleas sent to Paris requesting an independent, domestic means of producing ammunition on a large scale in French Louisiana, although the people most directly involved realized that the existence of the rich lead mines provided them with the fundamental means to do so. Since the sequence of letters just quoted dates to the 1750s, it is also clear that no major operations existed prior to this time. Thus, it would seem that localized, minor bullet production was forced to straggle along in the Illinois Country as best it could during the first half of the 1700s, while costly imports of ammunition from France remained the most significant source.

An Examination of French Colonial Imports of Lead to North America

The chronology provided in Appendix D lists dozens of events related to lead transactions in colonial North America. Examination of this list will reveal multiple episodes of lead having been imported to the French colonies, usually as finished ammunition, and typically in rather massive quantities by way of both the Gulf coastal ports and by way of Canada. This list is by no means an exhaustive compendium of such transactions, but rather represents a compilation of pertinent miscellaneous tidbits culled mostly from secondary sources. A thorough investigation of primary documentation would no doubt reveal numerous other instances of the transfer of large quantities of lead during the colonial period. This list serves, though, as a representative indication of the extent to which large shipments of lead products entered the French colonies.

Drawing from the entries listed in Appendix D, one can see that of the multiple shipments of lead bars and ammunition sent to Canada prior to 1700, most involved very substantial quantities in the thousands of pounds. Some deliveries were related to particular military campaigns, and others intended as annual presents to Native groups. This period also includes an entry for a smaller transaction in 1688, involving a Montreal outfitter who supplied 271 livres (or pounds, roughly) of lead balls to three traders bound for the Illinois Country. This record serves as an example and reminder of how European-origin lead objects may have arrived in the middle Mississippi Valley by way of both northern routes (via the St. Lawrence River) as well as southern routes (i.e., via New Orleans). It is worth noting that the founding of Fort Pontchartrain (modern Detroit, Michigan) in 1701 required over ten thousand pounds of lead (Kent 2001:1011-1015), and in 1716 sixty thousand pounds of imported lead were thought necessary to supply all of Canada on an annual basis (Bouchard 1977:5).

For lead sent to southern ports, the first record we have after the founding of Louisiana shows 2,400 pounds of lead shot and bars being sent from France to Biloxi in

1701 (Brain 1979:289-291); in 1703 8,500 pounds were sent, with over half the amount intended "to arm on the premises Indian allies of France, and to give to persons dispatched to friendly nations" (Brain 1979:294-295). Records for lead importation are rather scarce over the next thirty years, but in some telling correspondence of 1731 and 1732 Etienne Périer, Governor of Louisiana, outlines the clear necessity of undisrupted imports and provides an estimate of the normal annual consumption:

> "The quantity of powder and of lead both in bullets and in shot that is consumed in this province will appear surprising to you, my lord. We cannot do without it, both for making a living and for the safety of the country, and it is of the utmost importance that we should not be in want of it" (Rowland et al. 1984a:104-105). "In regard to the annual consumption, we cannot give it positively either for powder or for lead. That depends upon events, but without emergencies it may amount to 30,000 [pounds] of powder and to 60,000 [pounds] of lead, including that which is distributed in presents to the Indians and that which is sold to the inhabitants" (Rowland et al. 1984a:117).

In 1733, well after the pioneering miners Renaudiere and Renaut had opened up the Meramec Mines and Mine la Motte in southeast Missouri, 20,000 pounds of lead balls and 10,000 pounds of shot arrived in New Orleans from France. In 1734, well over twice this amount, 78,000 pounds total, was sent (Brain 1979:296).

The early 1740s marked one of the more prosperous periods for French Louisiana, and in 1743 and 1744 we have something of a reversal in the trend of importation. In each of those years, records show 30,000 pounds of lead actually being sent *from* the Illinois Country to New Orleans, with most of it probably being sent to France free of freight charges as ships' ballast (Surrey 1916:200-201, 303; Caldwell 1941:47; Hanley 1942:42). However, world events would soon cause a resurgence in French imports. From 1744-1750 there was a general, substantial increase in the amount of firearms and ammunition received from France, despite tremendous losses to French merchant shipping from 1744-1748 caused by English captures during the War of the Austrian Succession (Surrey 1916:202-204; Wedel 1981:41). Surrey (1916:203) notes that in the mid-to-late 1740s royal vessels continued to return to France with small amounts of lead, and an interesting situation presents itself in 1745: at the same time that imports of guns and ammunition from the mother country began to increase, two ships bound for France that were carrying 522 bars of Illinois Country lead were captured by the English. The 522 bars probably matched fairly closely the 30,000 pounds of lead that left New Orleans in 1743 and 1744 (assuming about 60 pounds per bar, which is reasonable), but more interesting here is the notion that for a brief time lead was probably being simultaneously delivered to and exported from French Louisiana in not insubstantial quantities. This odd set of circumstances probably did not obtain for long, and would seem to indicate perhaps a creative if not entirely efficient use of ships' cargo space. The only real advantage that lead could have possibly had over regular ballast stones would be that it represented a commodity that could be sold profitably upon arrival in France.

The Onset of the Seven Years' War and Its Effects on French Imports

As already noted in the segment on the Deer Creek and Bryson-Paddock sites in the previous chapter, the period from about 1749 to 1754 marked another period of prosperity for French Louisiana in which trade flourished, this being the time in which Governor Vaudreuil made his 1750 remark that "There has come here since the peace such a large quantity of ships that the abundance is beyond all expression" (Wedel 1981:44). From 1750 to 1754 several royal supply ships arrived regularly in New Orleans (augmenting an already considerable merchant trade), routinely carrying fresh soldiers as well as ammunition for the provisioning of French troops (Surrey 1916:211). The abundant streak would soon come to an abrupt halt, however.

In 1755, with the French and Indian War already underway in the Ohio River Valley and the stresses of the impending Seven Years' War building up on the Continent, no royal vessel was sent at all. To make matters worse, the only merchant vessel arriving that year sank in the mouth of the Mississippi, although part of its cargo was salvaged (Surrey 1916:218). It was, no doubt, though, a dismal year for the merchants and traders of Louisiana and the Illinois Country. Things would not improve much for colonial France after this point.

In 1756 six royal ships loaded with ammunition left France bound for New Orleans, but Governor Kerlérec would nevertheless comment that the royal warehouses and private merchants both lacked merchandise for the Indian trade (Surrey 1916:218; Wedel 1981:48; Rowland et al. 1984b:179). The situation would only worsen in 1757. On January 28 of that year he wrote "I find myself more and more in the most critical position. We have no more merchandise for the trade with the Indians or for their presents" (Rowland et al. 1984b:180). On March 13 he wrote:

> "All the King's warehouses are empty. This is the time to deliver the presents to the Choctaws, Alabamas, and other nations, as they all loudly announce… All the warehouses of private persons are also stripped of the things most necessary for the Indians and the needs of the settlers. No boat has come to us from France for a long time… We have hardly any gunpowder left. That in brief is the state of the colony, which has everything to fear, especially on the part of the Indians, if we do not receive promptly goods for their presents and their needs" (Rowland et al. 1984b:182).

He wrote again on August 28, saying, "I have… made known to you our needs, which are becoming more pressing from day to day. Up to the present I have held the Indians back by different pretexts, which are now as exhausted as the resources that we found in the warehouses of private persons." No relief would come that year, though, as no supply vessels arrived from France at all in 1757 (Surrey 1916:218).

In 1758 a total of four royal and merchant vessels would arrive in Louisiana, with two others lost at sea. Intensifying the loss of the two ships, fully 700 tons of cargo intended for Louisiana (apparently including ammunition) had been deliberately left behind in the warehouses of Rochefort, presumably deemed more critical to the mainland war effort in France. Kerlérec wrote with some alarm on December 12 of 1758, "We have seen ourselves for some time not provided with powder and bullets, which are the attractive items for the Indians, without taking into consideration the fact that they are the safety of the colony. This situation is unique and had never yet happened" (Rowland et al. 1984b:221).

Four vessels left France for Louisiana in 1759, all carrying ammunition and recruits for the army, but one was seized by the English on the outward voyage. The other three had all arrived safely by early January of 1760, with their cargos sufficient to alleviate "the most pressing needs." These same three ships would be outfitted in May of 1760 as ships of war, and were successfully used to drive out an English man-of-war that had established a blockade at the mouth of the Mississippi. By this point in time Quebec had already fallen, and an effective blockade of the Gulf of St. Lawrence had already cut off communication with Canada (Surrey 1916:222).

Numerous ships were sent from France in 1760 bound for both Canada and Louisiana, including a fleet of six ships heavily loaded with the armaments needed for the retaking of Quebec. Headed for Canada, this fleet met with disaster. One vessel was lost at sea and two others captured by the British on the outgoing voyage, including the *Aurore* which carried 76 200-pound kegs of lead balls. Sized at 18-22 to a pound, this makes for a rough total of somewhere around 300,000 bullets captured by the British from this single vessel alone. The remaining three French ships had been instructed to divert to New Orleans if they could not succeed in penetrating the British blockade of the St. Lawrence, but they prevaricated in following this order and instead came under British attack in July, sinking in Restigouche Bay of Nova Scotia. The result of this failure would be that Montreal would fall as well, in September of 1760 (Zacharchuk and Waddell 1984:15-19; Bryce 1984:7-8). To compound matters, it appears that none of the ships originally bound for Louisiana in this year ever arrived (Surrey 1916:221-222).

By 1761 the French Crown could only convince two ships' owners to hazard the voyage to Louisiana despite offering attractive payments for freight, and one of these was actually a Dutch vessel stocked by a merchant from Amsterdam. In 1762, five royal ships each bearing troops were sent from France, in a final desperate thrust to avoid the total loss of North America that would inevitably come (Surrey 1916:223).

The difficulties encountered in supplying French Louisiana from 1755-1762 are indicative of the overarching problems encountered in these tumultuous years. During the course of the French and Indian War / Seven Years' War, overall French commerce with its colonies would decline by a full 70% throughout the French empire. Out of 70 ships sent out from La Rochelle since 1756, by 1758 only six had returned (Boulle 1974:52-53). A major part of the problem (and one that no doubt affected shipping from 1744-1748 as well) was that in the hostile atmosphere it became increasingly more expensive, and eventually entirely infeasible, for merchants to insure their ships and cargos against almost inevitable losses. As a result, merchant shipping ground to a virtual halt with the onset of war, although a lucrative industry soon developed to accommodate the necessary military buildup. For those ships carrying munitions and other supplies for the Crown, an arrangement was established whereby ships were essentially leased from their owners, with the Crown assuming all risk of losses to both vessel and cargo (Boulle 1974:53, 66).

As a result of these circumstances, French ships plying the Atlantic Ocean from 1756 until France's capitulation in 1763 carried a greater proportion of royal military freight, but deliveries were sporadic, unpredictable, and undependable. As noted, these ships did tend to carry ammunition, firearms, and troops for the war effort, and attempted to bolster France's holdings in Louisiana and Canada (including the inflamed Ohio River Valley) by delivering materiel to both Quebec and New Orleans. After 1755, however, the frontier outposts (such as those on the Ohio and Wabash Rivers) found it increasingly difficult to receive goods by way of Quebec and Montreal (Surrey 1916:47-48, 218-223, 297-298). The British had conquered Fort Beauséjour on Cape Breton in 1755, and contact with Fort Duquesne on the Ohio River was cut off the same year. The Fortress of Louisbourg fell in 1758, and in the intervening years Britain would proceed to place an increasingly tight stranglehold on French shipping across the North Atlantic sea lanes and in the Gulf of St. Lawrence (Zacharchuk and Waddell 1984:15; Ekberg 1998:223-224).

Eventually, the British blockades of French shipping would become so effective as to render the delivery of supplies to Quebec and Montreal by way of the St. Lawrence River completely untenable, as the failure of the 1760 fleet would readily attest. With the fall of Quebec in September, 1759, followed by Montreal one year later, the interior regions of Canada found themselves utterly cut off from ordinary supply routes. In the meantime, the ongoing struggle in Europe left France largely incapable of tending to the privations faced by Canada (Zacharchuk and Waddell 1984:16). Prices of commodities at New Orleans skyrocketed in response to the disruptions, with a hundredweight barrel of flour doubling in cost inside of 1752 from a relatively normal 20 livres per quintal to 40, increasing to 280 livres per barrel by 1757 and even briefly commanding 600 livres a barrel in 1762 (Ekberg 1998:236). Such rampant inflation for a staple commodity provides some indication of how critical the need for supplies had become. Oddly enough, though, of the few ships that did make it to Louisiana in these years, they returned to France with cargo holds full enough of hides, tobacco, and indigo that both the value and quantity of exports during this period actually increased considerably (Surrey 1916:224-225). Critical supplies such as flour and lead, though, were almost assuredly either consumed locally or diverted to supply the outposts of the northern interior.

With the standard supply points for New France cut off, backdoor shipments via New Orleans and the Illinois Country to troops at isolated interior outposts became crucial. This resulted in a diversion of goods to such posts as Fort Duquesne and a doubling in the number of both boats and convoys being sent up the Mississippi (Surrey 1916:297-298). The importance of such a backdoor route was inadvertently revealed in a comment made in 1751 by the then-peeved governor general of New France, La Galissoniére, who saw little value at that time in maintaining the Illinois Country at all. He conceded, though, that the region had some merit in that it provided "subsistence for New Orleans, where it can send grain and meat in all seasons, despite all the naval forces in the world" (Ekberg 1998:223).

Supplies to the Indian allies of the French were also adversely affected, and the backdoor trade was vital in supplying and maintaining the loyalty of the friendly tribes to the north (Galán 2006:293-295). Notwithstanding the territorial tension between Spain and France along the Texas-Louisiana border at this time, it was not to Spain's favor for the French to suffer defeat by the English; such an outcome would only mean that Spain had to counter the ambitions of an estimated population of over one million English colonists as opposed to France's roughly sixty to seventy thousand (Zacharchuk and Waddell 1984:15; Walthall and Emerson 1991:5; Galán 2006:249). For such reasons, Spain also declared war against England in 1758. The French officials of Louisiana likewise sought to discourage excessive Spanish meddling in the illicit commerce that occurred at Natchitoches and Los Adaes. As long as the underground trade networks remained open, the French could rely on maintaining conduits for their goods that were well beyond the threat of British advances. To this end, in 1760 the French Governor Kerlérec at New Orleans wrote to the Spanish Governor Martos at Los Adaes, outlining the intricate and delicate nature of Indian alliances throughout both the French and Spanish territories (rattling off a list of 15 tribes in the process), in an effort to make evident to Martos the dire necessity of upholding the trade patterns at this critical time. By interfering in the free flow of the illicit trade, the Spanish would essentially be undermining the ability of the French to oppose their English aggressors, a circumstance which would not bode well for either of them (Galán 2006:293-295).

The Seven Years' War thus caused such severe disruptions to general commerce, trade, and shipping that during these years goods began to be channeled throughout French Louisiana by routes quite out of the ordinary. Products originally intended for

Canada had to be diverted to New Orleans, and these along with the produce of the Illinois Country began to be diverted by means of complex back channels to the interior outposts where they were most crucially needed. A quite conspicuous category among the affected goods was ammunition.

The overall complexity of the history of ammunition imports to French Louisiana shows that an analysis of lead artifacts from colonial-influenced sites may require more stringent methods of interpretation than might at first be expected. Throughout the entire first half of the eighteenth century, French import and distribution patterns fluctuated due to hostilities, economic trends, and accidental losses. Periods of abundance were punctuated by periods of disruption, and such factors were only exacerbated by the onset of the Seven Years' War. It can be expected, then, that these cycles of changes would leave a rather discernible imprint on the types of artifacts found at archaeological sites that were either directly involved in or tangentially affected by the different circulation patterns during this time. As such, analysis of presumptively French-associated lead artifacts from sites of the early to mid-eighteenth century may require special considerations in their interpretation. Some guidelines for making these kinds of interpretations are now proposed.

A Model for the Interpretation of Lead Objects of Likely French Colonial Origin

To be certain, in the early decades after the founding of Louisiana, before significant mining of local lead deposits had taken root, colonists had but little choice other than to rely on ammunition imported directly from the mother country. Lead mined in France could have clearly been used in the manufacture of French-made ammunition, but as pointed out in Chapter 3, the lead would not necessarily have had to originate geologically from the country from which it was exported. Rather, it could have been mined from an external source which was then imported to France either in raw form (likely as bars or ingots) or as an already finished product (such as ammunition). I would anticipate that imports of raw lead were rather more likely and preferable, as discrepancies in the French and English system of gun gauges would have potentially rendered ammunition of English manufacture unsuitable for use in French firearms (Hamilton 1980:7). Also, with the European nations so frequently at war with each other throughout the eighteenth century, a commerce in raw lead, despite being a critical component in gun warfare, was likely more palatable than an actual trade in finished ammunition or weaponry between nations. Lead also entered into a variety of other industrial applications as well, such as its use in ceramic glazes and as a base component along with tin in pewter making. These industries would also, it would seem, logically call for sources of raw lead.

These considerations set the stage for a model in which French products composed of either French or foreign-derived lead were shipped across the Atlantic to the colonies from such seaports as La Rochelle, Bordeaux, Bayonne, Nantes, Le Havre and Rouen (Boulle 1974:56, 75). The same scenario could obviously apply just as easily to the Spanish, with importation potentially augmenting locally-derived lead supplies prior to exportation from such Spanish centers as Cádiz and Seville (Deagan 2007:101). Given the abundance and proximity of European lead sources, it seems quite reasonable that sources from Britain, Germany, and eastern Europe would be the most likely candidates for supplementing French (and possibly Spanish) domestic production as opposed to more remote locales. As such, if lead objects are recovered from a North American archaeological site, which, based on its location, history and the total artifact assemblage, appears to be of distinctly French colonial character or influence, those lead objects may be reasonably expected to exhibit a distinctly European but not necessarily *French* lead isotope signature. If lead mined from the Mississippi Valley region also happens to be involved, this highly radiogenic lead will present a signature so completely different from almost all European lead that little room for confusion between the two will remain. As always, the potential for the admixture of lead of different sources also exists, and must be considered in the event of anomalous results.

Conversely, it should also be noted that one must be careful in drawing conclusions about lead objects from North American historical contexts that happen to conform well to a particular European lead profile. Given the possibility of various points of origin and commercial trajectories for an item due to intricate importation and redistribution activities, such objects should be thought of in terms of having perhaps been subjected to facets of an elaborate global trade network. The hasty application of cultural labels based only on a rather clear geologic provenience may obfuscate the true nature of matters. For instance, just because a lead artifact found on a rather distinctly French-associated colonial-era site may exhibit a strong British isotopic signature, this does not necessarily indicate that that object was either made, transported, owned, traded by, or left behind at that site by a subject of the British Crown. Such a connection may not be out of the question, and should be duly considered, but neither is it irrefutably implied. In this case, one could feel reliably certain as to the original British geologic origin of the lead, but to claim it as proof of direct English influence at the site without stopping to consider the greater cultural and historical context would be premature.

As development of the lead mining industry got underway in the Mississippi Valley, these sources also began contributing to the available stocks of metal. Once these mines had begun to produce lead in quantities at least adequate for local consumption, an industry developed in which, to an extent, colonists no longer had to rely solely upon European sources. Depending on a particular site's geographic and cultural proximity to the southeastern Missouri lead mines, one might therefore expect a sampling of lead artifacts from sites with somewhat later contexts or components (in general, post ca. 1720, the date at which the mines appear to have begun producing in earnest) to contain an increasing proportion of specimens with a Mississippian (i.e., more highly radiogenic) lead isotope signature. In fact, future lead isotope studies of artifacts from colonial-era sites with fairly well established date ranges may help refine our understanding of when mines in the Mississippi Valley began to be exploited – especially in the case of the more poorly documented Upper Mississippi Valley deposits. Again, though, it must be kept in mind that overall movements of lead objects and other types of artifacts would have been influenced by fluctuations in distribution, such as the disruptions of the Seven Years' War which probably caused most of the lead from the Missouri mines to be diverted northward during that time.

Some of the distinctly radiogenic lead produced in the Mississippi Valley would have likely been traded far beyond the immediate environs of its geologic source in colonial times. Indeed, as previously mentioned, several tons were even exported to France, with lead bars serving as ships' ballast. Although no doubt put to use upon arrival in France, or possibly re-exported, the input of this Illinois Country lead into the European market probably represented only the barest percentage of the overall global commerce. Its impact on the European market could probably even be safely overlooked almost entirely, although it would certainly be interesting to know what became of it and how it was used. More pertinent here, though, is the matter of how Mississippi Valley lead would have been broadcast throughout North America during the colonial period. Farquhar et al. (1995) have already demonstrated occurrences of lead objects derived from both southeast Missouri and Upper Mississippi Valley sources (as well as European sources) at four sites within the bounds of modern-day Illinois. Given the dynamic nature of colonial trade, though, the potential certainly exists for Mississippi Valley lead to be found much further removed from its geologic sources than this.

Transfer of trade goods by way of river corridors and overland pack trains opens up the prospect of Missouri and Upper Mississippi lead having made its way during the 1700s even onto the Southern and Central Plains, and perhaps well beyond. Further studies may eventually even reveal Missouri-origin lead at period sites as far west as New Mexico (and possibly even further?), introduced by such tribes as the Comanche who were engaged in elaborate and far-reaching trade networks. If performing lead isotope analyses eventually becomes de rigueur for lead artifacts recovered from colonial-era sites, a surprisingly far-reaching extension of peripheral endpoints for colonial period trade may be revealed.

The results of this study will indeed show that lead from both Europe and southeast Missouri did enter into the French colonial trade system in such a way that it was eventually deposited at sites rather far removed from its origins. However, without intending to harp on the point, the caveat can not be made too strongly that one can not rely too heavily on expectations about where lead artifacts "should" have come from, nor on presumptions about the players involved based on overly simplistic interpretations of what sourcing studies reveal. Only by considering the full historical, archaeological, and geological context of a particular lead artifact can one begin to make reasonable conclusions about where it originated and how it came to be found within an archaeological setting.

In the specific case of artifacts from sites in North America falling under French colonial influence (which includes sites that may have never been subjected to direct French visitation), assumptions about artifact origins will be frequently foiled if one does not take into account historic trends of French colonial imports of lead. In general, despite the significant role of the Missouri lead mines, the effect of such French imports will be to impart a much stronger European (and very possibly non-French) lead isotope signature upon assemblages of French colonial lead artifacts than might otherwise be expected.

The same caveat applies to a degree to North American sites falling under Spanish colonial influence, although perhaps not quite so strongly. The main difference between the two is that the Mexican silver-lead mines of New Spain appear to have been producing absolutely massive amounts of lead as a by-product. Even though firm figures for colonial Mexican lead production seem to be rather scarce to nonexistent, the incredible and scrupulously documented silver output would argue for a rather abundant yield of lead as well. This lead would have very likely been used to supply Spanish endeavors throughout Mexico and North America from even a very early date. Indeed, preliminary results from lead isotope analyses performed on lead arquebus balls associated with the Coronado *entrada* of 1540-1541 have indicated that Mexican lead from the area of Michoacan was used in their manufacture (Alyson Thibodeau, personal communication 2007). This would indicate that within only about a decade of the establishment of the first silver mines on the central Mexican plateau in the 1530s, Mexican-derived lead was already being used to equip Spanish expeditions with locally manufactured ammunition. This trend almost certainly continued, and though shipments of lead from the Iberian peninsula may indeed have occasionally occurred, the Spaniards of Mexico were likely quite capable of supplying themselves adequately with this heavy commodity for use in their endeavors north of the silver mining regions. In contrast, the sporadic French production of lead in the Mississippi Valley, while substantial, probably always remained fairly meager in comparison to Spanish output. Consequently, the French were obligated to make frequent imports of lead to meet demand in a way the colonists of New Spain never experienced.

A Note on Cultural Versus Geologic Provenience

The thrust of much the information presented in the past two chapters has been to build up to a seemingly relatively simple point: for colonial sites in North America, at least, despite all the promise of lead isotope analysis, it may not always be possible to make a completely clear-cut, dichotomous distinction using that technique alone to determine if a lead object is, say, either a "French" or a "Spanish" artifact. Degrees of separation, so to speak, remove such an object from receiving such a simple characterization depending on the complexity of the cultural processes and manipulations to which it has been subjected.

If, for example, a lead ball is found within the context of an isolated mid-eighteenth century Plains Indian village, where presumably that object had reached its end user through a series of intricate trade mechanisms (and barring the not unreal possibility that the lead was potentially mined and smelted and the bullet made by a network of Natives themselves), that object by dint of being found outside the normal colonial framework is already just that much further removed from our ability to grasp its true significance. The urge to make a premature, tidy, attribution of a such a European-style artifact as being of a specific *cultural* origin (whether French, Spanish, English, or whatever type of origin) must be resisted - despite however clear the geologically-oriented results of a lead isotope analysis may seem. In a similar vein, other types of chemical assays and trace element analyses, even if used in combination, can probably only get one so far. Absent a pertinent historic and archaeological context, the application of physics and chemistry alone will not always provide a full answer.

The argument being made here may seem superficially simple, but another case study may help drive home the genuine complexity of the issues faced. Using the potential scenario outlined in the last chapter concerning Joseph Blancpain's confiscated ammunition, a hypothetical example tracing the peregrinations of a single lead ball can be set up which is neither altogether likely nor entirely inconceivable: if a bullet was made in France from, say, a British source of raw lead and was then sent to New Orleans, and later made its way by happenstance to a Spanish presidio, only to eventually wind up at a Spanish mission established for one tribe but that was destroyed by a joint force of at least half a dozen other hostile tribes, to whom should we attribute it? Could we even possibly recognize it as such?

In most cases it might very well be impossible to unravel such a convoluted chain of events, even given a perfect scenario involving the full potential of lead isotope analysis, carefully controlled archaeological excavations, and thorough historical analyses. This is not to suggest, by any means, though, that all hope is lost. Many situations will indeed allow for reasonable and powerful conclusions to be drawn, provided that a proper approach is taken. The point here is not to enter into a strictly or unduly epistemological debate regarding what is or is not knowable about the particular artifacts in this study, or in other similar undertakings that may follow. Rather, the caveat is simply issued once more: In order to make meaningful interpretations of the data generated by a lead isotope analysis, a deliberate and consistent logic, combined with a healthy respect of the inherent limiting factors, must be applied to a full suite of accrued archaeological, historical, and geological data. Only then can results begin to be viewed in their proper cultural and scientific contexts.

Illustration 2: Archaeological Sites Considered in This Study (adapted from Bell et al. 1967:402).

CHAPTER 7

AN EXAMINATION OF LEAD ARTIFACTS FROM EIGHT SITES FALLING UNDER FRENCH AND SPANISH INFLUENCE

Historic Backgrounds and Artifacts Examined; Results and Discussions

Introduction

This chapter will present the results of lead isotope analyses conducted on 50 artifacts from eight eighteenth-century sites located within modern-day Texas and Oklahoma: Lasley Vore (34TU65), the Womack Site (41LR1), Deer Creek and Bryson-Paddock (34KA3 and 34KA5), Fort St. Louis / Presidio La Bahía (41VT4), a second incarnation of Presidio La Bahía (41VT8), Presidio San Sabá (41MN1) and Mission San Lorenzo (41RE1). The first part of the chapter will provide background information for each of the eight sites, following a roughly chronological and cultural trend. Sites of earlier contact or association will be generally presented ahead of later sites, with a shift from those sites showing evidence for the utilization of European and Mississippian-derived leads towards those utilizing Mexican lead. For each site a brief historical overview will be provided to place the site within its appropriate historic and cultural context; a few have already been discussed extensively in previous chapters. These background sections will then be followed by descriptions of the particular artifacts selected from each site for lead isotope testing. Brief discussions of other lead artifacts recovered from these sites are also included, to provide a broader perspective on the overall assemblages from which the selected artifacts were drawn. Technical details (weights, measurements, and other data) for individual artifacts are compiled in Appendix B, and photographs of selected artifacts are provided in Appendix C.

As a side note, the majority of the artifacts tested are bullets, and as such their caliber and other specifications provided in Appendix B will be of likely interest for studies more involved with the history and evolution of firearms. Many of the lead balls studied here are deformed from impact or otherwise mutilated, and other artifacts (such as the lead discs) may have been made by flattening or modifying lead balls. As such, the weight of these objects provides the best indication of their original dimensions. Sudbury (1976:37) developed a useful formula to derive the probable original caliber of a lead ball in inches from its weight: if dealing with weight in grams, the formula $d = 2(\sqrt[3]{0.021x})$ can be used, where d equals the calculated diameter of a ball in centimeters and x equals the known weight of the ball in grams. If using the weight in grains, the formula $d = 2(\sqrt[3]{0.00136x})$ can be used. The value obtained for d can be simply divided by 2.54 to obtain a standard figure for caliber in inches. This data is incorporated into Appendix B as well. The method is not foolproof, and it should be kept in mind that the French *calibre* system of a certain number of balls to a *livre* was completely different from the English caliber system that is based on the internal bore diameter of a gun barrel in inches (Hamilton 1980:7). Still, the method seems to provide a reasonably accurate means for pinning an additional level of useful metrical data onto otherwise misshapen lumps of lead. Additional information on correlating the weight of lead balls can also be found in Hamilton (1960:128-132), Blaine and Harris (1967:85) and Miroir et al. (1973:152-158).

Following the historic background and artifact description sections, the overall results for these eight sites will be presented with accompanying discussions. Since several of the sites are strongly related by overarching factors (i.e., geographic, cultural, and temporal proximity to one another, as well as the influence of either French trade or supply from Mexico), much of the data generated between sites is mutually reinforcing and thus more meaningful when considered collectively. Rather than introducing the results for each individual site in a piecemeal fashion, then, greater clarity and less repetition of similar results will be achieved by considering much of the data in a more integrated manner. Each site will still be considered individually to some extent, to pinpoint issues pertinent to that particular site. The case of Mission Santa Cruz de San Sabá (41MN23), for which the most complex data set has been developed, will be presented separately in its own chapter; this site presents a unique scenario that will benefit in its analysis from the results of the eight sites presented here.

Data Sources Consulted for Comparative Analysis

Isotopic data from numerous works of both archaeological and geological tenor were consulted in making comparative evaluations of the data from all of the Texas and Oklahoma sites under consideration. With very few exceptions (namely, only those papers that did not provide raw isotopic data or did not provide complete data sets for all four standard lead isotopes), the data presented in these papers were incorporated into spreadsheets used to generate the graphs presented at the end of this chapter. The graphs have been set up as standard bivariate plots comparing the ratios of $^{208}Pb/^{204}Pb$ and $^{207}Pb/^{204}Pb$ against $^{206}Pb/^{204}Pb$. In all, slightly over 2,000 outside data points for Europe, Mexico, and the Mississippi Valley were compiled.

As discussed in Chapter 2, not all of these data points will correlate directly to mineral deposits that were readily accessible through mining technology available during the eighteenth century. In particular, studies of very deeply buried ore deposits and of trace lead found in non-ore contexts may have little direct bearing on provenience studies of historic-period artifacts. Archaeometric data derived from samples taken at the actual locations of historic mining activities are to be preferred, but such data are currently still rather limited. Some archaeologically-oriented data sets are indeed available, but in order to get a better sense of isotopic variation on a broad geographic scale, much data derived from modern geologic studies has been examined here as well. These studies are often geared towards the economics of modern prospecting and the elucidation of geologic formation processes (Stos-Gale 1995:407). As such, some of these geological data sets (or portions of the data sets) may not be entirely appropriate in evaluating objects manufactured during the colonial period. However, by keeping in mind the historical context in which these objects were created, more probable sources of lead can be isolated in those situations where multiple possible interpretations seem to be presented.

The absence of data points from a particular reference within the visible region of a graph should not be taken to mean that the source was not consulted; rather, the data points do not conform closely enough to the primary data being presented to show up. The data given in some papers, then, although first selected for their anticipated possible affinity to the newly generated archaeological isotope values, are thus essentially eliminated from consideration. Still, any such negation of a data source remains pertinent in this context, since the elimination of a poorly conforming source can be just as meaningful, or even more so, as making a reasonably positive match. For this reason, a full, abbreviated list of all consulted sources used for comparative lead isotopic purposes is provided here, broken down by major geographic region. Those papers with a more strictly archaeological approach are underlined. Doe and Rohrbaugh (1977) served as a general source used in making some preliminary deductions, and remains a useful source of bulk worldwide lead isotope values, but has not been applied in the final analysis owing to the age of the data set and the availability of more specific information sources.

References Consulted for Comparative Lead Isotopic Analyses

Europe:

Britain and Ireland: Rohl 1996

Central and Eastern Europe: Large et al. 1983; Lippolt et al. 1983; Höhndorf and Dill 1986; Lévêque and Haack 1993; Krahn and Baumann 1996; Wedepohl and Baumann 1997; Monna et al. 2000; Niederschlag et al. 2003

France: Brévart et al. 1982; Marcoux and Bril 1986; Sinclair et al. 1993; Alfonso et al. 2001; Trincherini et al. 2001; Baron et al. 2006

Spain: Arribas and Tosdal 1994; Stos-Gale et al. 1995; Velasco et al. 1996; Canals and Cardellach 1997; Marcoux 1998; Pomiès et al. 1998; Trincherini et al. 2001; Zalduegui et al. 2004

Mexico and New Mexico/Trans-Pecos Texas:

Cumming et al. 1979; Joel et al. 1988; James and Henry 1993a; James and Henry 1993b; Miranda-Gasca et al. 1993; McDowell et al. 1999; McMillan et al. 2000; Torres-Alvarado et al. 2000; Luhr et al. 2001; Rodríguez-Alegría 2002; Housh and McDowell 2005; Verma et al. 2005

Mississippi Valley:

Heyl et al. 1966; Doe and Delevaux 1972; Heyl et al. 1974; Heyl 1983; Kisvarsanyi et al. 1983; Farquhar et al. 1995; Goldhaber et al. 1995; Hagni 1995; Millen et al. 1995

Site Summaries

Lasley Vore (34TU65)

Background History of 34TU65

This site has been discussed in previous chapters as the probable Tawakoni Wichita village visited by La Harpe in 1719, which at the time of his visit also had large contingents of Taovayas, Yscani, and Wichita proper on hand. Located on a bluff called Wealaka Ridge that overlooks the Arkansas River from the south bank, this site has produced trade goods in association with Native-made artifacts suggestive of a protohistoric early contact site. Both Wedel (1981:28-30) and Odell (2002:130; 2008:475-477) have argued that this location represents a bona-fide village site as opposed to merely a rendezvous point for ceremonial or trade purposes.

Odell (2002:130), particularly, is rather careful to not assert outright that the Lasley Vore site marks the definitive location of La Harpe's initial contact with the Wichita, but does regard it as the best known candidate for this event. The site dates to the earlier part of the eighteenth century based on the French trade goods present, and from the ethnohistoric account it appears to have been abandoned sometime during the late 1730s to early 1740s. This evidence comes to us through André Fabry de La Bruyère, whose failed attempt to reach Santa Fe by way of the Arkansas River in 1742 resulted in his stumbling across a Tawakoni Village on the Red River. Under pressure from the Osage and likely wishing to be within closer reach of French firearms and trade goods, the Tawakoni had reportedly moved there from a short-lived settlement on the Canadian

River. In turn, the move to the Canadian had been made from the Arkansas River around 1737-1738 (Wedel 1981:31-32; Wedel 1982:128; Odell 2002:137-138).

The site was excavated in 1988 in advance of the construction of a paper factory, and has now been essentially destroyed. Time for excavation was limited, with documentation of features such as storage pits and hearths the primary goal. To this end, much of the surface material was scraped from the site using earth-moving machinery to expose as many features as quickly as possible. The churned soil of the plow zone, estimated to have contained the great majority of artifacts located on the site, was thus stripped off and later used for landscaping purposes around the paper factory (Odell 2008:472-473). This strategy maximized the information on sub-surface features that could be obtained under the circumstances, but also likely resulted in a low recovery of lead balls. This particular class of artifact (which may not have been plentiful in the first place) was probably not routinely incorporated into the contents of storage or trash pits. As a result, only three lead balls were recovered from the site, two from metal detector units and one surface-collected from the south area of the site. Two of these are noted as misshapen from contact, and the third as still round (Odell 2002:102, 283-287).

Artifact Descriptions for 34TU65

George Odell graciously made the round (though pitted) example from the south area of the site available for sampling, although the two misshapen metal-detected pieces could not be located at the time of the request. Hence, the lead artifact sample from Lasley Vore consists of a single lead ball weighing 13.3 grams, corresponding to a calculated diameter of .51 inches according to Sudbury's formula.

The Womack Site (41LR1)

Background History of 41LR1

In a setting reminiscent of Lasley Vore, the Womack Site is situated on a high bluff overlooking the Red River in Lamar County, Texas. Based on its location and the suite of trade goods found at the site, Harris et al. (1965) attribute it to a Kichai Wichita village dating to between 1700 and 1730. They identify it specifically as the village visited by Du Rivage, who was one of the members of La Harpe's party; they had been sent by Governor Bienville in 1719 to establish the Nassonite Post (also known as Fort St. Louis de Kadohadacho) on the Red River above Natchitoches. After the establishment of the post, Du Rivage was sent west to make contact with the tribes reported there, laden with 1,500 *livres* worth of trade goods – the same value, incidentally, that La Harpe took to the Tawakoni Village thought to be represented by the Lasley Vore site.

During his journey, Du Rivage reported friendly encounters with the Kichai, Yojuane, Waco, and Tonkawa Indians, as well as an indeterminate Caddoan band (perhaps Nabedachi). He returned at the end of July, 1719 with two Kichai guides who would help lead La Harpe to the Tawakoni village on the Arkansas River later that September (Harris et al. 1965:287-288, 357-360). In addition to artifacts that could have resulted from this initial exchange, Perttula (1992:172) notes that similarities in bead styles and other artifact types suggest trade goods recovered from the Womack site likely emanated directly from trade activities with nearby Fort St. Louis de Kadohadacho. It should be noted, too, that Perttula (1992:171) considers the Kichai to be a more distinctly Caddoan than Wichita group based on such traits as ceramic styles, although the Kichai remain an enigmatic group most noted for a certain degree of fluidity between Caddoan and Wichita traditions (Rohrbaugh 1982:54-55; Blaine 1992:175-176, 192-193; Perttula 1992:255 note 2).

Artifact Descriptions for 41LR1

Three lead artifacts from the Womack site have been sampled, all unfired lead balls held by the Texas Archeological Research Laboratory (TARL) as part of the Rikard Collection (Texas Memorial Museum acquisition number 348-397). These artifacts derive from excavations undertaken by the University of Texas in 1931, and do not represent all of the lead objects held by TARL from this site. The three lead balls examined here weigh 15.9, 16.7, and 17.5 grams, corresponding to calculated diameters of .55–.56 inches according to Sudbury's formula. Other lead objects collected from the site by avocational archaeologists over the years also include six lead balls (of which five are deformed), two deformed pieces of small lead shot, and matching lead and brass discs perforated with four evenly spaced holes about the periphery (Harris et al. 1965:343-344, 354). The last item may represent a type of artifact known as a "whizzer" or "whirligig", although these objects are usually perforated at or about the center by only one or two holes. These items, known in both lead and brass versions, are considered to be childrens' toys. By tensing and relaxing a cord on which the whizzer is centered, a buzzing sound is created that is often enhanced by serrations carved into the circumference of the disc (Kent 2001:810).

Deer Creek (34KA3) and Bryson-Paddock (34KA5)

Background History of 34KA3 and 34KA5

The archaeological and ethnohistorical backgrounds of the Deer Creek and Bryson-Paddock sites have already been discussed in Chapter 5, and so only a brief review will be provided here. As previously noted, these sites both figured prominently into a thriving, cooperative French-Wichita effort in which French traders ascending the Arkansas River in pirogues lived and worked among the likely Taovayas/Yscani Wichita villagers, exchanging manufactured European goods for the hides, meat, and oil of bison, deer, and bear. Although the Deer Creek and Bryson-Paddock sites may have been populated by the early 1700s, the major hide-processing and trading operations appear to have gotten underway in the late 1740s. Spurred by an unprecedented burst of prosperity in French colonial North America that lasted from about 1749-1755, coupled with the expansion of trade networks through the formation of a Wichita-Comanche alliance just a few years earlier, these twin sites on the Arkansas River enjoyed a brief but vibrant fluorescence marked by a great increase in fur trade activities. Much of the archaeological debris recovered from Deer Creek and Bryson-Paddock likely dates to this period, including a number of lead balls that made up part of the entire firearms-dependent complex.

Since the Deer Creek and Bryson-Paddock sites are thought to have been occupied simultaneously by related Wichita bands in the mid-eighteenth century, with both sites intimately involved in the hide trade as revealed by large mutual assemblages of scrapers and extensive inventories of period European trade goods, these sites will be examined together. A total of 25 lead artifacts have been tested from these two sites to determine their isotopic composition, consisting primarily of lead balls of the sizes used in French trade guns of the period. Also included in the sample were a flattened lead ring, a lead sheet, and an unidentified chunk of lead.

Artifact Descriptions for 34KA3 and 34KA5

About half of these artifacts, 13 items, were supplied through the courtesy of Byron J. Sudbury of Ponca City, Oklahoma. In the course of his personal researches Mr. Sudbury amassed an extensive surface collection of artifacts from Deer Creek. Based on the study of these artifacts, he prepared a comprehensive (and to this date the only) report on the site (Sudbury 1976). Since no extensive or well-documented excavations have occurred at Deer Creek, this thorough report that focuses especially on trade goods remains our best assessment of the site. Also, through his contacts with private landowners and other individuals in the vicinity, Mr. Sudbury was able to procure a few additional specimens for testing that are held in private collections.

Six lead balls from Deer Creek and five from Bryson-Paddock were thus made available for study and sampling, along with a lead sheet and an unidentified chunk of lead from Bryson-Paddock. All of the lead balls range in weight from 11.5 to 17.7 grams, corresponding to a calculated diameter of .49 to .57 inches using Sudbury's formula. The lead balls from Deer Creek were all described and illustrated in Sudbury's report (1976:17-18, 36-37) and correspond to his bullets 1 and 3 through 7; bullet number 2 and the lead gunflint patch and lead bead also discussed by Sudbury were not among the Deer Creek items available to the current study. Bullets 1-4 originally came from the private collection of Mr. Norman Hiatt (see also Bell 2004:163), and bullets 5-7 were collected from the site by Sudbury himself. Three of these Deer Creek lead balls appear unfired, and three exhibit deformation that seem to indicate they were fired. The five lead balls from Bryson-Paddock all appear unfired, but with some cuts and gouges on the surfaces that the Deer Creek specimens exhibit to some extent as well. These marks perhaps indicate damage from being struck with a plow, or perhaps intentional modification by the sites' inhabitants.

In addition to the 11 lead balls obtained from Sudbury, a slightly irregular, rectangular-to-trapezoidal thin lead sheet weighing 295 grams and a lead chunk (both from Bryson-Paddock) were also sampled. The lead sheet has dull gray patination and surface blemishes that seem consistent with a possible eighteenth-century age, while the 26 gram blocky lead chunk has more of a rusty color that does not conform well with the patina of other artifacts encountered.

Four additional artifacts were made available for study from the collections of the Sam Noble Oklahoma Museum of Natural History (SNOMNH), including one lead ball and a flattened lead ring from Deer Creek and two lead balls from Bryson-Paddock. The two artifacts from Deer Creek are surface-collected objects, although the date and project affiliation of their collection is unknown. They are described and illustrated in a survey report compiled prior to the impounding of Kaw Reservoir (Wyckoff 1964:11-20). The lead ball examined here (13.8 gm) corresponds to item 6 illustrated in Plate VI of the 1964 report, and the flattened lead ring corresponds to item 13. Two other lead objects identified simply as "lead pieces" were illustrated in the 1964 report; of these, item 14 was not among the artifacts available to this study, and item 15 turned out upon sampling to actually be a small amorphous lump of brass rather than lead.

The flattened lead ring, measuring 4.7 cm long by 2.0 cm wide and 0.6 cm thick, is interesting for having its edges battered and crimped at one end, apparently after it had already been flattened. Jay C. Blaine (personal communication 2006) was not able to ascertain a specific use for such an item, but did not find it to be inconsistent with the kind of opportunistic exploitation of European trade items often encountered on colonial-period sites; objects were frequently used or modified for other than their originally intended purposes.

The other two artifacts provided for sampling by SNOMNH were two lead balls recovered from the 1974 and 1975 excavation seasons at Bryson-Paddock. These were the only two lead balls recovered during these field seasons, and the 1974 specimen (13.7 gm) was recovered from the single block excavation opened within a trash midden that year (Hartley 1975:54, 64-65). The lead ball recovered in 1975, weighing only 7.7 grams, is described in that season's report as heavily pockmarked with chewing suggested as the cause of the impressions. It was recovered from the vicinity of what was termed Structure B, the vestiges of a suspected small storehouse that was located beneath a localized trash midden (Hartley and Miller 1977:100-103, 122, 133, 223-225).

The remaining eight items from 34KA3 and 34KA5 are all unfired lead balls made available for sampling by the Oklahoma Historical Society (OHS). These specimens represent some of the earliest collections made from Deer Creek and Bryson-Paddock, but their provenience to either one site or the other remains hazy. Deer Creek did undergo some degree of excavation by Dr. Joseph B. Thoburn in 1917, and he later conducted excavations at Bryson-Paddock in 1926 as part of what was called the Marland Expedition (named for the former Governor of Oklahoma who funded the operation). No reports of these investigations were ever produced, however. The artifacts resulting from the 1926 excavations were apparently distributed amongst the OHS, the Chilocco Indian School, and the Ponca City Library. All three institutions had public displays of their artifacts for some time, but all of the collections were shuffled around to some extent and it would appear that much of the material was eventually lost. In the meantime, the OHS also acquired the "Ferdinandina" collection of Bert Moore, that being the mythical name applied to the supposed "first white settlement" in Oklahoma that the Deer Creek site was originally thought to represent. Mr. Moore had collected objects from both Deer Creek and Bryson-Paddock for a period of some fifty years starting in 1893, and his entire mass of 5,000+ artifacts from these two sites was absorbed into the collections of the OHS in 1956 (*Chronicles of Oklahoma* 1956:353-356; Wyckoff 1964:12, 20; Sudbury 1976:16-17, 91-92; Perkins and Baugh 2008:391).

As a result of these multiple potential sources for the OHS objects, which are poorly documented, it is impossible to ascertain definitively which site the individual lead balls came from. However, their provenience to either Deer Creek or Bryson-Paddock seems reasonably certain, and since the two sites have such a closely demonstrated cultural and temporal affinity they will be incorporated into this study alongside the other better-provenienced artifacts. In the graphs presenting the lead isotope data, these eight objects are referenced in the legend as "DC or BP". Seven of the balls range in weight from 15.3 to 18.3 grams, corresponding to calculated diameters between .54 to .57 inches according to Sudbury's formula. The one exception is a ball weighing only 8.7 grams.

In total, then, eight lead artifacts from Deer Creek have been sampled, nine from Bryson-Paddock, and an additional eight that could be from either site. It should be noted that there is some evidence for later but limited occupations at both Deer Creek and Bryson-Paddock. The Taovayas may have returned here briefly around 1770, by this point suffering from a Spanish-imposed curtailment of trade goods. By returning to the Red River, they hoped to re-initiate contact with renegade French traders from the Arkansas Post. There are also reports of Wichita returning seasonally to the region of the middle Arkansas River in the 1780s for their own hunting needs, and that as many as 200 Frenchmen possibly still worked in this now Spanish-controlled area, continuing the tradition of processing meat and hides (Wedel 1981:49). At Bryson-Paddock, a few problematic beads do suggest a possibly ill-defined later component. However, an 1830 religious medallion recovered in 1926 and originally attributed to the site did in fact derive from an unrelated site on the north side of the Arkansas River (Sudbury 1976:94-95; Hartley and Miller 1977:253-254; Bell 2004:42-43, 77). Thus, most of the artifacts from Deer Creek and Bryson-Paddock do seem to date rather reliably to the eighteenth century, although the possibility of a few objects of slightly later date can not be entirely ruled out.

Fort St. Louis / Presidio Nuestra Señora de Loreto (La Bahía I) (41VT4)

Background History of 41VT4

This site marks a dual French-Spanish occupation, being the location of both La Salle's doomed colony on Matagorda Bay of the Texas Gulf Coast and a later Spanish presidio built directly atop the French ruins. The episode involving the establishment of La Salle's failed colony can be rightfully considered a watershed event in the development of North American history, setting into motion a fevered Spanish search for the French intrusion that would in turn re-assert Spanish claims to a region long ignored. As such, the topic of the founding and demise of La Salle's colony has been treated extensively elsewhere (e.g., Parkman 1907; Bolton 1915; Dunn 1917; Gilmore 1973; Weddle 1973, 1987, 1991, 2001; Foster 1998) and will not be elaborated upon in detail here. Suffice to say, though, that the intended destination for the colony at the mouth of the Mississippi River was considerably overshot (most likely through navigational error rather than purposeful design), with a resultant settlement planted in 1685 on a high point overlooking Garcitas Creek in modern-day Victoria County. The approximately 200 or so French colonists involved in the enterprise faced daunting challenges in the strange new land, struggling with the natural elements and quickly succumbing to disease, malnutrition, overwork, threats posed by alligators, rattlesnakes, and even prickly pear cactus, bitter infighting, and attacks by the coastal Karankawa Indians (with whom the French had decidedly gotten off on the wrong foot [Weddle 2001:170-177]).

By 1689 an expedition led by Alonso de León (one of many dispatched by the frantic Spanish) finally found the sad and utterly wrecked ruins of the fort; the following year the remnants were burned to the ground. Over thirty years would elapse before the Spanish would finally occupy this precise location themselves, partly as something of a snub to French aspirations and more significantly as part of a concerted effort to form a defensive vanguard against a renewed threat of French intrusions. Thus, in 1721 a detachment of the Aguayo expedition to East Texas (discussed in Chapter 5) established the post of Nuestra Señora de Loreto de la Bahía del Espíritu Santo, with actual construction of fortifications underway the following year. In digging foundation trenches for the new presidio, the Spanish even uncovered "nails, pieces of gun locks and fragments of other things used by the French" (Forrestal 1935:64). This isolated post encountered many of the same challenges faced by La Salle's colonists over three decades earlier, and its associated mission (Espíritu Santo de Zúñiga) suffered a disastrous revolt in which the local Indians murdered the Spanish captain Domingo Ramón (the same individual who, as commander of San Juan Bautista, first had dealings with the French trader St. Denis in 1714). In 1726 the mission was relocated to a more salubrious location on the Guadalupe River some 23 miles inland, followed shortly by Presidio La Bahía. By 1730 the first manifestation of La Bahía had been completely abandoned and ordered demolished. (Bruseth et al. 2004:78-79, 91; Fox et al. 2006:35).

Artifact Descriptions for 41VT4

A total of five lead artifacts from 41VT4 held in the collections at TARL were selected for sampling among the many available. Although TARL maintains dozens if not hundreds of lead balls and other lead artifacts from this site, funding restrictions at the time of sampling prevented additional samples from being tested. The artifacts under consideration derive from the excavations undertaken by geologist Glen Evans from October to December, 1950 under the auspices of the Texas Memorial Museum. No report of the investigation was ever made, and the thousands of artifacts recovered were never subjected to any analysis at the time. Some very limited documentation of the effort can be found in the TARL files, though: after clearing brush from an area of about three acres, half a dozen long trenches were dug across the site (presumably with earth-moving machinery), two mounds were investigated, and 19 block excavations were concentrated on areas presenting lime, shell, and packed earth floors. Provenience of the recovered artifacts was not kept beyond the level of the individual excavation block or trench.

In a one-page summary of the entire operation, Evans specifically noted "numerous lead musket balls" and lead seals among the thousands of recovered objects of European origin. These lead balls were marked on their surface in pencil with the number of the excavation unit from which they had originated, but decades of rubbing against each other within common storage bags have effaced many of these numbers. Most of the labeled specimens originate from block excavations number 7 (termed "Test no. 1" in Evans's original field cataloguing system) and 12 (correlating to an area described simply as "melted lead balls"). TARL has 25 specimens from Block 12, and all are indeed misshapen and amorphous and appear to have melted at one point.

Care was taken to choose specimens still clearly labeled as originating from these particular block excavations, which were located near to the north and northwest edges of the site, close to Garcitas Creek. Excavations undertaken at 41VT4 by the Texas Historical Commission from 1999 to 2002 have revealed this portion of the site in particular to have produced the great majority of identifiably French artifacts (Bruseth et al. 2004:90). As a result, it is reasonable to think that the lead balls from the 1950 excavations in blocks 7 and 12 may derive from the initial French settlement of the site as opposed to the later Spanish presence. Accordingly, four unfired lead balls from Block 7 were sampled, ranging in weight from 9.9 to 10.5 grams and corresponding to calculated diameters of .47 to .49 inches (possibly pistol rather than fusil balls), as well as a single melted lead blob from Block 12 of undetermined weight.

The most straightforward way of definitively determining whether the lead objects recovered in 1950 derive from La Salle's enterprise would be to undertake a comparative isotopic analysis on a sampling of the massive amounts of lead balls and shot recovered from *La Belle*. This ship, part of La Salle's expedition, sank in Matagorda Bay in 1686 with most of the struggling colony's supplies on board. Lead balls and shot that had been offloaded onto shore had even been brought back onto the ship prior to its loss (Weddle 1991:29). Excavation of *La Belle* in 1996 and 1997 revealed that about a third of all the barrels found on the ship contained lead shot and balls, numbering in the vicinity of 300,000 specimens (Bruseth and Turner 2005:95-96). A research proposal sent in 2005 to the Archaeology Division of the Texas Historical Commission requesting access to lead artifacts from *La Belle* and the more recent excavations at 41VT4 was received and reportedly discussed, but went unacknowledged; it is my understanding that the forthcoming analysis of these materials has since been expanded to include lead isotope analyses.

Presidio Nuestra Señora de Loreto (La Bahía II) (41VT8)

Background History of 41VT8

The second manifestation of Presidio de la Bahía, having been moved from the location on Garcitas Creek, was located on the Guadalupe River above the present-day city of Victoria, Texas. It existed here alongside the similarly relocated Mission Espíritu

Santo de Zúñiga from 1726 until 1749, at which time both were removed once again to a location on the San Antonio River near present-day Goliad. The location of 41VT8 remained unknown until the 1960s, at which time concerns that its discovery would result in uncontrolled treasure hunting prompted a Texas Archeological Society field school to be held there in 1968. These investigations securely confirmed the identity of the site as the second incarnation of La Bahía, with thousands of artifacts (and particularly ceramics) conforming well to a Spanish occupation spanning the second quarter of the eighteenth century (Fox and Tomka 2006).

In addition to the Spanish component, a strong prehistoric occupation is also present at 41VT8, along with some limited later historic materials. A house foundation 300 meters southwest of the site of the presidio has been identified as the mid-nineteenth century residence of a prominent early property owner (Fernando de León), and one of two historic burials excavated in 1968 near the presumed location of the presidio's chapel included coins dating as late as 1849. This probably indicates awareness and subsequent use in the mid-nineteenth century of the old church site, but despite the input of some later materials the overall artifact assemblage dates securely to the 1726-1749 Spanish occupation (Fox and Tomka 2006:33-40, 60, 152-153).

Artifact Descriptions for 41VT8

Several lead artifacts were recovered in the course of the 1968 TAS field school excavations, along with numerous other items surface collected (or found in backdirt piles) after the fact by TAS members. Additionally, Victoria avocational archaeologist Virgil Branch conducted extensive metal detecting at the site in the years after the conclusion of the field school, and donated a large group of artifacts to TARL in 1973 (Fox and Tomka 2006:40, 77). The Branch collection contains 50 lead objects with a combined weight of over two and a half kilograms, and includes large, amorphous lumps of lead that evidently splattered on the ground, indicative of on-site casting. (These largest pieces have been misidentified as sprue in the 2006 report; the term sprue applies more correctly to the relatively small amounts of excess lead remaining from the process of casting lead balls in molds, as opposed to simply any extraneous lead spilled in the general casting process.) Also in the Branch collection are small, flattened pieces of lead and 12 lead discs, including a cloth seal that was punctured with two holes to create a whizzer. From the 1968 excavations and later collections, nearly half a kilogram of splattered lead and fragments were recovered, along with five lead cloth seals, 11 lead discs (including four that may have been used as gunflint patches), and, somewhat surprisingly, only 13 lead balls. The lead balls included seven described as .59 caliber, four as .49 caliber (pistol sized), one of .41 caliber, and one deformed ball (Fox and Tomka 2006:92-95).

From the many items recovered in the 1968 excavations, and from the later metal detecting surveys of Virgil Branch, five artifacts from 41VT8 were selected for sampling in this study. The 1968 materials include a lead disc weighing 23.3 grams from Trench 6 (which could have been made from a flattened lead ball with a calculated diameter of .62 inches), a semi-hemispherical partial lead ball weighing 15.0 grams from Trench 7, and a presumed lead ball weighing 16.0 grams with an unusual (perhaps sprue-like) protrusion from Trench 3. Metal-detected items selected for sampling from the Branch collection include a regular unfired ball weighing 18.2 grams (corresponding to a calculated diameter of .57 inches) and a perforated plain lead disc "whizzer" weighing 15.3 grams; if made from a flattened lead ball this last item would correspond to a ball .54 inches in calculated diameter.

Presidio San Luis de Las Amarillas (41MN1)

Background History of 41MN1

Located on the north bank of the San Sabá River on what is now the county golf course at Menard, Texas, the Real Presidio de San Sabá (as it was called after 1762) was established in 1757 in direct conjunction with the founding of Mission Santa Cruz de San Sabá. Together these outposts formed part of an effort to extend and secure Spain's northern border in Texas by establishing a military and religious presence among the Apache Indians. This tribe had started to raid San Antonio, San Juan Bautista and other Spanish settlements with regularity beginning in the 1720s, and it was hoped that the new San Sabá complex might serve as a buffer against not only the Apache, but also against the lesser known tribes of the North (Norteños) (Weddle 1964; Tunnell and Newcomb 1969:154; Walter et al. 2003:1-3).

Additionally, the founding of the entire enterprise was prompted to a great extent by the involvement of Don Pedro Romero de Terreros, a wealthy and influential Mexican silver mining baron. Terreros had offered to fully fund the establishment of missions among the Apache as a charitable deed, with the stipulation that his cousin, Father Alonso Giraldo de Terreros (a prominent missionary aligned with the College of Querétaro) would be named director of the new mission (Weddle 1964:40; Couturier

2003:138-143). The prospect of silver mining played a pivotal role in luring Spaniards to this remote location, as is perhaps hinted at by the patronage of Pedro Romero de Terreros. For this reason, a slight digression into the mining-related history of Presidio San Sabá is warranted here, and is especially called for by the results obtained from an artifact from 41MN1.

Reports of a Cerro de la Plata (mountain of silver) had instigated searches into the Llano uplift region some 70 miles east of Presidio San Sabá, beginning with a group of five miners from San Antonio in 1753 (Brady 2000:23-25). This region, referred to also as Los Almagres, is characterized by highly mineralized exposures of Precambrian and Paleozoic rock which would have indeed struck the Spanish as promising ore-bearing deposits. However, these potential lodes have been assayed in modern times as falling well below economically recoverable concentrations. More primitive Spanish colonial mining methods would have proven even less efficient, but efforts at mining were understandably made nonetheless (Caran et al. 2000:65; Helper 2000:33-47). Governor Barrios of Los Adaes dispatched his lieutenant governor, Miranda, to investigate the claims of riches at Los Almagres in 1756. The original commander of Presidio San Sabá, Colonel Diego Ortiz Parrilla, also promptly sent some of his soldiers there to investigate (Weddle 1964:27-28, 106). Corresponding to this, indications of mining activities which may date as far back as the mid-eighteenth century have been found in the vicinity of Packsaddle Mountain near present-day Llano, Texas (Caran 2000; Caran et al. 2000:65-73).

The ore retrieved by Parrilla's men was smelted and assayed at the presidio and did indeed produce a small though unpromising silver yield (Weddle 1964:106). Parrilla would submit a report dated February 28, 1758 (less than three weeks before the destruction of the Mission San Sabá) on the progress of this effort that shows a degree of skepticism on his part:

> "They identified it as a greenish silver ore mingled with lead. They refined four pounds of it in a small retort which they hastily put together, using four pounds of lead as a bath, but no other mixture or alloy, and produced a small quantity of silver. From this test it appeared that one *arroba* [about 25 pounds] of ore would yield about 1 ½ ounces of silver. For my part, while watching the test, I observed many defects in it which, indeed, the operators themselves admitted. They told me they could not extract the metal perfectly for lack of a suitable receptacle and other implements. They were of the opinion that ore produced from a deeper level and refined with proper equipment would produce a much greater yield than they had obtained by the faulty process they had had to use" (Nathan and Simpson 1959:141).

It is interesting to note here that four pounds of lead flux were used in refining only four pounds of ore; presuming that the lead came from available stock at the presidio which had likely been brought up from Mexico, it is likely that the lead itself had some considerable residual quantity of silver to begin with. Extrapolating the yield of return on such a meager sample under such conditions would indeed be tricky. A larger sample of three arrobas of ore [about 75 pounds] was also sent to the Villa San Fernando for more rigorous smelting (it was "fused and refined"), and this much larger sample also yielded 1 ½ ounces (Nathan and Simpson 1959:143). This would equate to a return of about 40 ounces of silver per ton of ore. Under the austere conditions of mining that would have existed on the colonial frontier, one estimate suggests that a return of somewhere on the order of 200 ounces of silver per ton would have actually been necessary to render an ore body economically viable. However, modern geochemical analyses of Llano County ores do not even approach one ounce per ton (Kyle 2000:59).

The prospects for historic mining at Los Almagres would appear to have been rather bleak, then.

Pieces of Los Almagres ore may have even been recovered in recent archaeological excavations conducted at the Presidio San Sabá (Walter 2004:101). Parrilla was sufficiently intrigued by the promise of Los Almagres that he would even recommend shortly after the destruction of the Mission San Sabá that the presidio should perhaps be removed to the vicinity of the mines (Nathan and Simpson 1959:144-147; Weddle 1964:106). Of special note here is that the ancient rock of Packsaddle Mountain does contain a minor component of lead along with silver, although in quantities that probably never did allow for anything but the most limited and casual of production. Still, the possibility exists that fairly rich but limited surface outcrops, concentrated through weathering, may have still been present at the time of the first Spanish inspections and mining attempts (Kyle 2000:58-59). It is not impossible, then, that some lead items might have been manufactured at Presidio San Sabá from Llano Uplift-region lead, even though the presidio was also supplied fairly regularly with shipments sent directly from Mexico by way of San Antonio. Much Mexican-origin lead might therefore be reasonably expected to be found here; additionally, there is the prospect of the possible input of French-origin lead, as shown in the hypothetical scenario involving Joseph Blancpain's confiscated ammunition that was outlined in the previous two chapters.

After the destruction of the Mission San Sabá, the presidio lingered on for a dozen more years, hosting hundreds of people (including soldiers and their families) and frequently coming under attack by the same Norteño groups that had destroyed the intended Apache mission. In an attack on the presidial horse herd that occurred on March

13, 1759 (almost exactly one year after the attack on the mission), nineteen of twenty soldiers guarding the herd were all killed with Norteño guns, with not a single arrow found among the corpses (Wade 2003:191). By 1762 sturdier stone construction had replaced the original *jacal* structures and wooden palisade at the presidio (Walter 2004:95), and this year also marks the founding of Mission San Lorenzo de la Santa Cruz to the south as a replacement for the destroyed Mission San Sabá. Continued attacks against Presidio San Sabá demonstrated Norteño displeasure with a perceived Spanish-Apache alliance, and an especially severe spate of attacks on the presidio in 1767 wore its defenders down greatly (Wade 2003:198). In June of 1768 the harried second commander of Presidio San Sabá, Felipe de Rábago y Téran, would abandon his post and withdraw his troops to this new mission. Rábago would be replaced as commander as a result, although his successor would only briefly re-occupy the fortification for less than a year. The presidio was thus effectively abandoned permanently in 1770, although it remained on the rosters as an official outpost until 1772 (Tunnell and Newcomb 1969:175; Walter 2004:95).

The abandoned fort would afterwards be used periodically by Spanish soldiers and citizens, and in later years by Mexicans and Texans, including some families who built their houses directly within the ruins and who also used the crumbling walls as a cattle pen (Walter et al. 2003:3). Some later objects, then, may have entered into the archaeological record here, although an active series of field school excavations conducted by Texas Tech University and the Texas Archeological Society since 2000 bear out the distinctly Spanish colonial character of this site.

Artifact Descriptions for 41MN1

Dozens if not hundreds of lead artifacts have been recovered from this site in excavations over the last decade. Lead balls by far make up the greatest proportion of these lead objects, and have been recovered rather ubiquitously throughout the site (Walter et al. 2003:74-75; Norment 2007:34-36). For this study a selection of 14 lead balls along with five small, odd, squarish pieces of lead have been selected for sampling. Additionally, a thin, flat, seemingly shaped lead piece that may represent some type of pendant was sampled. All of these items derive from Texas Tech University field school excavations conducted from 2000-2003. Unfortunately, though, isotopic results from 13 of the lead balls and the thin flat piece were not received in time to be incorporated into this study. All the lead balls selected are unfired, mostly undeformed specimens (as are almost all of the examples recovered from the site), ranging in weight from 11.1 to 23.2 grams. The one lead ball actually incorporated into the results here has a weight of 14.8 grams. Other lead objects found on the site include numerous examples of sprue and spillage from the molding process, lead cloth seals, lead discs, and lead gaskets (Walter et al. 2003:74-75; Norment 2007:56-59, 80, 84-86).

The five small squarish chunks of lead range in weight from 3.7 to 16.6 grams, and their function remains unknown. They vary considerably in size and shape, and could be described as cuboid, although two or three have cross sections that could be described as more octagonal than square. Except for the largest one, perhaps, they do not appear to have been made by flattening or shaping lead balls. Morphologically they appear very similar to irregular pieces of seventeenth-century lead type recovered from recent excavations in Harvard Yard (Urbanus 2008:34). However, since Presidio San Sabá is not known for having had a printing press, and since these pieces show no indications of typeface on their ends, this would seem to be a rather far-fetched attribution. Norment (2007:58-59, 86) notes that similar objects were found at Presidio Agustín de Ahumada, and raises the possibility that they may have served as some type of pencil. I am actually doubtful of such a conclusion, and think they may each perhaps represent a sort of customized lead plug. Admittedly, though, they do not seem to have the type of surface scars that would result from being wedged into any type of hole or crevice. They remain enigmatic, and all five specimens that were available (I believe others have been found since) were sampled in the hopes that a lead isotope analysis might reveal something more about their origin and possible use.

Walter et al. (2003:75) comment that the calibers of lead balls recovered from the 2000-2002 field seasons at Presidio San Sabá fit "within the range of both Spanish weaponry and the French muskets used by the Norteño Indians. It is therefore difficult to conclude whether the spent musket balls recovered outside the presidio walls were left by attacking Indians or by the Spanish troops themselves." A more extensive isotopic analysis of lead balls from the presidio would provide probably the only means for potentially distinguishing bullets of Spanish versus Native origin. Unfortunately, provenience information is not provided in the table of data given for the lead artifacts recovered in the first three field seasons at Presidio San Sabá (Walter et al. 2003:75), and original field records and inventory catalogues were not readily available during the course of this study. Lead balls severely deformed by impact were also not present in the sample of artifacts made available. It would seem that pinpointing for study deformed lead balls that were also recovered from the perimeter of the presidio walls (i.e., those which had been fired at and struck the walls) would provide the best opportunity for identifying substantial isotopic variability within the assemblage of bullets recovered from Presidio San Sabá. Future efforts here should be especially directed at linking the specific provenience of certain lead artifacts with their isotopic signatures.

Mission San Lorenzo de la Santa Cruz (41RE1)

Historical Background of 41RE1

The best source for the background of Mission San Lorenzo is undoubtedly W.W. Newcomb's excellent ethnohistorical account (Tunnell and Newcomb 1969:139-180), which in setting the stage for the events that unfolded at 41RE1 also draws heavily from related information gathered for a major study of Wichita Indian ethnohistory (Newcomb and Fields 1967). Mariah Wade (2003:192-202) also enriches what is known of this often overlooked mission.

From the background material provided in the previous section for Presidio San Sabá, it is evident that the history of Mission San Lorenzo is inextricably linked to the histories of both the Mission and Presidio San Sabá. After the destruction of the Mission San Sabá, a punitive expedition led by Colonel Diego Ortiz Parrilla to the twin Taovayas Wichita villages (now recognized as the Longest Site on the Oklahoma side of the Red River) ended in abject failure. The episode did not actually disgrace Parrilla, as he went on to serve as the Governor of Coahuila and would continue to serve the Crown in other distinguished ways. It did, however, demonstrate in rather humiliating fashion the inability of the Spanish to abate the Norteño threat. Following this campaign, Felipe

Rábago y Terán would take command of Mission San Sabá in Parrilla's stead. (Allen 1939; Bell and Bastian 1967; John 1992; Weddle 2007).

Following Parrilla's failed expedition, and faced with what appeared to be the now insurmountable threat posed by the Norteños, the Spanish and Apache found themselves in a mutual predicament that forced them into maintaining what was already something of an uneasy alliance – neither could continue to exist in the vicinity of Presidio San Sabá without the tacit support and cooperation of the other. To this end a new but officially unsanctioned mission among the Lipan Apache was thought essential to keeping equilibrium in the area. As a precaution against further disaster, though, Mission San Lorenzo would be founded well away from the Norteño threat. It was established approximately 100 miles to the south, halfway between Presidio San Sabá and the Rio Grande on the upper Nueces River (Tunnell and Newcomb 1969:162-164).

Established in early 1762 along with a second mission named Nuestra Señora de la Candelaria, the Apache actually congregated rather willingly in the first several years at the new settlements, protected by a detachment of thirty soldiers from Presidio San Sabá that Rábago could ill afford. Unable to provide fully for the Apache, or to completely squelch their hunting and gathering lifestyle, the Indians would leave the missions periodically on buffalo hunts and to gather plants like prickly pear and agave in season. On these forays they suffered sporadic attacks from the Comanche and their other enemies, highlighting the inadequacy of the Spanish to actually provide the Apache with either protection or sustenance. These hostilities would be brought to Mission San Lorenzo during the Fall and Spring of 1767-1768, at which time the poorly-equipped sanctuary suffered multiple direct attacks from the same Norteño tribes who had succeeded in destroying Mission San Sabá a decade earlier. This time the Apache inhabitants would be driven permanently away in the process. Of potential interest here is the fact that these violent conflicts also involved considerable exchanges of gunfire between the well-armed Norteño tribes (likely including Tejas, Comanches, Wichitas, and others) and the Spanish (Tunnell and Newcomb 1969:165-174; Wade 2003:192-199).

The inspection tour of the Marqués de Rubí in the Summer of 1767 would reflect badly on Mission San Lorenzo and the Presidio San Sabá, with recommendations made for the closure of both; Candelaria had already been abandoned by this time (Moorhead 1975:169-171). The desperate situation at Presidio San Sabá (suffering from the same kinds of attacks as San Lorenzo) would cause Rábago to abandon it and retreat to the mission on the Nueces in June of 1768. Just as Rábago had replaced Parrilla, a new commander, Manuel Antonio de Oca, would be sent to replace Rábago; Oca, too, would find it essential to retreat to San Lorenzo after re-occupying Presidio San Sabá for less than a year. By June of 1771 the mission itself was fully abandoned. This episode would fully mark the retreat of the Spanish from their northern frontier in Central Texas, as well as finally eliminating the Apache as a factor in determining Spanish policy (Tunnell and Newcomb 1969:174-176; Wade 2003:199-202).

Artifact Descriptions for 41RE1

Excavations carried out at Mission San Lorenzo in the bicentennial year of its founding, 1962, resulted in the recovery of 23 lead artifacts. These included three lead balls, two sprue fragments indicative of on-site casting of lead balls, one partial small lead ring with rectangular cutouts, a lead seal converted into a whizzer or button, nine other lead discs, a sheet of lead, and six leaden scraps probably representing spillage of molten lead (Tunnell and Newcomb 1969:70-73). Tunnell (1969:70) even suggests directly that "bulk lead in sheets and bars probably was brought to the site from Mexico and shaped into functional forms by melting/molding, cutting with shears, and hammering/ imprinting." I would also anticipate a distinctly Mexican origin for lead at this site, considering what is known (as presented in Chapter 3) about Mexican lead production and transport during this period.

Five objects held in TARL collections from the 1962 excavations were selected for isotopic analysis; these include an unfired lead ball weighing 14.2 grams with a sprue protrusion (it is illustrated as item G on page 71 of the 1969 report, and has a calculated diameter of .53 inches), one piece of lead sprue from what was apparently a three-ball mold (illustrated as item E in the 1969 report), and three lead discs. Tunnel (1969:72) notes that four of the lead discs recovered in 1962 appear molded while the others seem to have been cut from sheet lead, and suggests their possible function as balance weights; though I have no better sense of their purpose, I would also add the possibility that they might have been made by flattening lead balls. Of the three discs considered here, two weigh 19.2 and 23.8 grams, corresponding to calculated diameters of .58 and .62 inches – within the range of larger ammunition used in military-style muskets of the period. The third disc (pictured as item H in the 1969 report) weighs 106.5 grams, and from its rough edges and thickness would seem to be a crudely molded object; in spherical form it would assume a diameter of just slightly over one inch. Of the remaining lead discs from Mission San Lorenzo (excluding the refurbished lead seal and one very thin disk weighing only 1.2 grams), the other five specimens would correspond to calculated diameters of .48, .51 (2), .53, and .57 inches. Given these figures, the formation of most of these discs through flattening of lead balls seems probable.

Results of Analysis

Analytical Procedures

Interpretations of the sampled artifacts will be achieved through a combination of two analytical techniques; first, via predicted group affiliations as determined through a discriminant function analysis (the details of which are described in Chapter 2). The discriminant function analysis has provided a rather secure means of statistically assigning samples to one of three continental-level groups (Europe, Mexico, or the Mississippi Valley) based on their comparative affinity to a large database of known values. For this study, this method has achieved an accuracy on the order of 90% in successfully classifying samples to these three landmasses, despite the vagaries inherent in lead isotope data and the necessity of often relying on less than ideal geologically derived data. An interesting feature of the discriminant function analysis worth noting here is the distinctness of the Mississippian lead sources; for all project samples that were classified as being of Mississippi Valley origin, the probability was calculated at 100%, leaving no room for doubt as to the possibility of European or Mexican derivation in these cases.

The other analytical technique employed here makes use of the more traditional method of bi-variate graphical plottings (Figures 2-19, immediately following Chapter 9). This method also considers project data in comparison to raw archaeometric and geologic data culled from the literature, with affinity suggested by consistent clustering of like data points. Though also based on discrete quantitative values, this method admittedly works primarily through visual perception of distinct patterns. It thus provides the ability to quickly identify potential matching sources, or to discard poorly matching sources, within a given range of values. While discriminant function analysis has been used here to assign project archaeological samples to a continental-scale geologic provenience, the bi-variate graphs will be used to delve into finer (and somewhat more speculative) levels of geographic distinction. Though highly detailed and sometimes complicated, the graphs can provide an additional level of evidence that, when combined with historic detail, allows for potential source regions to be identified at a more distinct level than that of a major landmass. This will come into play particularly for lead objects of European origin, where relatively homogenous isotope values across individual nations sometimes prevent entirely clear-cut distinctions from being made.

The conclusions to be drawn from these two analytical methods are not meant to be entirely definitive, but rather illustrative of the types of interpretations that can be drawn within an acceptably low range of error. The results of the discriminant function analysis are statistically rather sound, while the readings of the lead isotope graphs rely to a degree on keenness of perception and common sense to formulate viable postulates. To truly pin down specific lead sources at the level of a particular geographic locality, though, would likely require additional corroborating procedures such as trace element analysis. Such studies may be the next step in securely identifying precise mining regions, and would preferably make use of ore samples from historic contexts. However, the foregoing statistical and graphical analysis should prove sufficient for demonstrating the utility of lead isotope studies in interpreting artifact origins and trade distributions in colonial North America.

Overall Results from Eight Sites

Lead isotope analyses on artifacts from these eight sites have revealed the exploitation of lead from three widely divergent geographic sources. Specifically, eighteenth-century networks of supply and exchange in the mid North American continent relied on lead derived from Europe, the Mississippi Valley, and Mexico (Figures 1-3). Given the historic contexts of these sites and the nature of colonial-era mining and import activities, these results could be reasonably anticipated. Probably the single most surprising result of this study, though, is that French and Spanish lead sources both appear to be far less well represented within the assemblages than might be expected, instead playing what appear to be only rather subsidiary roles at best (Figures 10 and 11). Despite the fact that all the sites, European and Native alike, are most notable for their connection to French and Spanish colonization activities, it seems that lead from the mother countries may not have played a significant role in supplying their respective colonies. Rather, in the case of France, British sources of lead appear to have predominated. For Spain, the silver-lead mines of Mexico seem to have produced lead with an abundance adequate to supply the needs of New Spain and Texas; European lead sources played only a minor role at best in Spanish colonial supply chains. Among the eight sites considered in this chapter, lead from the Mississippi Valley was revealed to be a source only at Deer Creek and Bryson-Paddock, where 14 of 25 artifacts returned a distinctly radiogenic signature.

Results for 34TU65, 41LR1, 34KA3, 34KA5, and 41VT4

The results of these five sites shall be considered concurrently at first, as they all manifest (in part) lead signatures of a strikingly similar nature. All of the artifacts tested from Lasley Vore (34TU65), the Womack Site (41LR1), and Fort St Louis / Presidio La Bahía I (41VT4) show a distinctly European lead signature, as revealed by the results of the discriminant function analysis. Deer Creek (34KA3) and Bryson-Paddock (34KA5) share in this trend, with nine of 25 artifacts classified as distinctly European in origin. From the data compiled in Appendix B, it can be seen that these objects (18 in total) were classified as European with probabilities ranging from 58.3% to 93.9%, and with an average probability of 77.0%. Considering that four of these sites were Native villages actively engaged in the French trade along the Arkansas and Red Rivers, a predominantly European (as opposed to Mexican) source for lead had indeed been anticipated. The lead bullets tested from the fifth site, 41VT4, may very well represent ammunition brought directly from France to supply that ill-fated European colony.

Taking into account the almost certain European derivation of most of the objects from these five sites, attention now turns to evidence provided in the lead isotope graphs beginning on page 285. Rather surprisingly, Figure 9 shows that virtually all of these 18 samples conform very well to many of the British sources provided in Rohl (1996). This single source of data for Britain is particularly valuable because it compiles some 400 data points from throughout England, Ireland, and Scotland, chosen from contexts directly related to historic mining and procurement scenarios. Rohl (1996) especially sought samples of galena ore from historically exploited British mineral deposits, with samples taken directly from in situ ore outcrops or from adjacent spoil heaps whenever possible. This data set was further augmented by samples provided by museum collections and from the private collections of early mining researchers (Rohl 1996:165-167). Figure 9 presents only a rather small portion of this overall British isotopic data set, but focuses on a very tightly bounded region into which the results of all these sites (34TU65, 41LR1, 34KA3 and 34KA5, and 41VT4) fit. In particular, the isotope data derived from these sites conform especially well to ore samples from the Northern and Southern Pennines and Mendips regions of central England, regions noted for the occurrence of lead and zinc ores in carboniferous limestones (Rohl 1996:167). Possible affinities also exist for the adjacent regions of Alderley, Cumbria, Cornwall, and northeastern Wales.

Viewed at the same level, French sources (Figure 10) can not be entirely ruled out, but do not match nearly as well as the English sources. Several points supplied by Brévart et al. (1982) in their geologic study of lead-zinc ore genesis in the southern Massif Central of France do fit within the area charted. These points, particularly from the Villemagne and Trèves localities of the southern edge of the Cévennes and Montagne Noire regions (as well as a few points from Nozières, Millau, Mont Faulat, Le Pradal, and Cambounes) may represent some direct input of lead from south-central France into the colonial fur trade of North America. Lead from these particular sources also conformed rather well to several Roman-era lead ingots that were recovered from a shipwreck just off the Mediterranean coast of France (Trincherini et al. 2001:402), indicating that these southern French sources may have been exploited for millennia.

It is also worth noting that the objects from Texas and Oklahoma do not conform especially well to what would seem to be another rather pertinent data set from this area, a study of medieval lead making from the Mont-Lozère Massif in the Cévennes mountain district (Figure 10). Baron et al. (2006) analyzed a number of mine tailings and slag heaps at silver-lead mines dating from the tenth through thirteenth centuries. These were fairly rudimentary near-surface operations which would have likely been exploited in a manner not much different from the technology of the early colonial period. In the scheme of things the Texas and Oklahoma data are not too far removed from these medieval-origin data points of southern France, although the very tight clustering of the North American data (and its affinity to many samples from Mission San Sabá, as shall be seen) indicate that British lead sources remain a much more likely match overall.

In examining potential Spanish sources which fall within the same range (Figure 11), four data points from the historically exploited Los Pedroches mining area do fit well within the plotted area (Zalduegui et al. 2004:630). Indeed, for the $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ values (but not $^{208}Pb/^{204}Pb$), the single point for Lasley Vore sits almost directly atop one of these points for which the location is noted as Membrillejos. However, out of the 125 new lead isotope data points presented by Zalduegui et al. (2004:627, 630-631), these four points constitute the smallest of four analytical groupings suggested by the authors for south-central Spain, exhibiting "compositions that are intermediate between those from southeastern and southwestern Iberian locations." While impossible to dismiss entirely, such a minor clustering from such a large data set need not necessarily imply direct affiliation.

The values provided by Velasco et al. (1996) for Northern Spain do show a slight affinity in the $^{207}Pb/^{204}Pb$ plot, but the $^{208}Pb/^{204}Pb$ values do not match well (Figure 11). The same can be said of a few data points from massive sulphide deposits of the Iberian Pyrite Belt of southeastern Spain (Marcoux 1998). Most notable, though, is the distinct lack of a match to the massive sulphide deposits of Rio Tinto, Spain (Pomiès et al. 1998). As noted in Chapter 4, the Rio Tinto deposits produced lead, silver, copper, and tin from Roman times well into the 1700s (Couturier 2003:18), but evidently did not factor significantly into lead objects exported to North America.

Overall, then, from a geologic standpoint Spanish sources have a rather poor but not infeasible probability of having contributed lead to sites on the Southern Plains during the 1700s. Moreover, from a historical standpoint, logic would argue against such a direct Spanish cultural and geologic connection to the Oklahoma and northern Texas sites; rather, lead supplied from Mexico would have more than likely served any tenuous links that might have existed. Instead, far more likely European sources provide much clearer and more distinct matches.

In terms of German sources (Figure 12), the tightly focused area currently under consideration also conforms rather well with isotope values obtained from galenas in the Upper and Lower Harz Mountain regions of north-central Germany. In particular, ore veins produced by hydrothermal processes during the Jurassic period are indicated, including the deposits of Bad Grund and Lautenthal in the Upper Harz, St. Andreasberg in the Middle Harz, and Straßberg-Neudorf in the Lower Harz (Lévêque and Haack 1993:202). The authors of this particular study also note that their 1993 data set is probably even spread out somewhat artificially, with two-thirds of the variation likely due to fractionation in the mass spectrometer used to obtain the data (203). A few stray data points from other German localities also creep into this field from the North Eifel and North Sauerland regions (Large et al. 1983), the southern Schwarzwald (Lippolt et al. 1983), the Bohemian Massif (Höhndorf and Dill 1986), and the Rheinisches Schiefergebirge (Krahn and Baumann 1996). However, these extraneous data points do not cluster reliably well or with enough density amongst the project data to indicate these as major potential sources.

It is interesting to note that the Texas and Oklahoma objects do not conform particularly well to the data sets offered by Monna et al. (2000) or Niederschlag et al. (2003). In the former study, lead isotope analyses were conducted on soil columns from overbank sediments of the Weser River in northern Germany; this demonstrated the stratified deposition of atmospherically contaminated deposits over time from mining and smelting activities in the Harz Mountains during the medieval and early Renaissance periods. The latter study is notable for providing an abundant database of isotope values for the Erzgebirge Mountains in eastern Germany in conjunction with a provenience study of Bronze Age artifacts. This data set for the Erzgebirge is comparable in quality and scope to the compilation for Britain discussed earlier, with a strictly archaeometric approach. A very few points from this study do fall within the tightly focused area under consideration, but the great majority fall well outside. It would seem, then, that the ores of the Erzgebirge of eastern Germany and western central Europe were not a primary source of lead for export to France, but that lead from the Harz Mountains might well have been.

Discussion of Results for 34TU65, 41LR1, 34KA3, 34KA5, and 41VT4

For a subset of the artifacts under consideration, then, some general conclusions may be drawn. Each of the artifacts tested from Lasley Vore, the Womack Site, and 41VT4, along with nine of the artifacts from Deer Creek and Bryson-Paddock, are all of distinctly European origin, and all fall within a very tightly defined graphical cluster. From comparison with a number of external sets of isotope data, it appears that the best ore matches for these artifacts would be in the Mendips or Pennines regions of England, the Harz Mountains of Germany, or the Southern Massif and Cévennes regions of southern France.

These findings comport very well with the entries found in eighteenth-century French and British encyclopedias first mentioned in Chapter 4. The quote from the 1750s English edition of Savary's *Universal Dictionary of Trade and Commerce* bears repeating here:

> "There are lead-mines in divers parts of England, Wales, Scotland, and Ireland, and the British plantations, and in various other parts of Europe; but Great-Britain has larger plenty than most countries, and exports great quantities."

Similarly, it will be recalled that this reference work, in its original French edition, noted that "the majority of the lead that was used by the French came from England, while some came from Germany and also a certain amount from Poland, the latter imported by way of Holland. Small amounts were also acquired from Spain, Portugal, and Sweden, while limited quantities were mined in France itself, particularly in the Limousin region" (Kent 2001:184). Further, it will be recalled that England did indeed export massive amounts of lead during the eighteenth century, sending twenty to thirty thousand tons a year (around half its total production) out of the country by the early to mid 1700s (Burt

1995). These somewhat obscure historical tidbits have now been verified archaeologically, with implications for the interpretation of colonial-period sites.

An additional clue of European origins can sometimes also be found in the morphology of the lead balls themselves. Hamilton (1980:128) has pointed out that bullets of this period that are almost perfectly round, and with faint mold lines, were likely manufactured in Europe using higher-quality brass gang molds capable of producing numerous lead balls at a time. Bullets produced on the frontier, on the other hand, were more apt to be lopsided or to have prominent mold lines due to the use of more rudimentary equipment. In fact, of the lead balls examined here which are not too badly pitted or mutilated, most are indeed quite round and have faint mold lines, and hence suggestive of European manufacture.

The case of Lasley Vore, with its single bullet tested, may seem to offer a rather meager data set. However, given the full archaeological, historical, and geologic background discussed up to this point, it deserves a bit of elaboration as an example of what can be determined about the origins of such a basic object. At this location on a bluff overlooking the Arkansas River, very possibly representing the Tawakoni Village visited by La Harpe in 1719, the lead used to make a bullet found there in 1988 probably originated from England; sources in northern Germany and southern France also remain as distinct possibilities. Even if this object was manufactured of British lead, it can not be taken as a positive indication of direct British influence at the site. Rather, this particular object probably played a role in the French colonial supply network that relied heavily on imports of ammunition throughout the eighteenth century. It is thus almost certainly of French cultural origin, regardless of its geologic composition.

It is even faintly possible that this particular bullet was part of the original 1,500 *livres* of goods which La Harpe distributed to the Wichita. It may have been among the trade items which he brought from France on his own, or could just as easily have been acquired with the remainder of the goods he obtained on credit in New Orleans. The Chickasaw trader (or another like him) who showed up at Lasley Vore at the same time as La Harpe, carrying British goods from the Carolinas, could also potentially be responsible for its introduction to the site. Given the totality of circumstances, though, and the fact that the Tawakoni Village was probably occupied for perhaps another two decades before it was moved to the Canadian and Red Rivers, I would aver that this particular bullet followed what was likely a fairly standard pattern during that period. It probably resulted from British-mined lead that was exported to France, whereupon it was cast into ammunition destined for the overseas fur trade. From there it was sent in a keg by ship to New Orleans, where a merchant of good standing extended it on credit to a trader returning up the Mississippi after delivering a load of that season's hides. A portion of the trade goods sent from New Orleans may have been further subdivided once they reached the Arkansas Post. There, an anonymous French trader or hunter, willing to face the challenges and dangers of a turbulent time, proceeded up the Arkansas River in a pirogue to do business with the tribes located there.

In very similar fashion, the distinctly European-origin lead balls found at the Womack Site are indicative of early French-Native trade on the Red River. These bullets could have very possibly been routed by a trader through both Natchitoches and the Nassonite Post on their way to the site's Kichai Wichita/Caddoan customers. At Deer Creek and Bryson-Paddock, the presence of nine lead balls of European origin shows that the Taovayas Wichita there were also plugged into an emerging global market dependent on water transport – first across oceans, and then up river channels.

At 41VT4, the indications of a non-Spanish European lead origin are particularly interesting, as this appears to demonstrate that the tested artifacts originate from the initial 1680s French occupation by La Salle's colonists, rather than from the ambitiously designed but more modestly constructed Spanish fortress erected there over three decades later. Graphically, four of the five bullets tested, including the melted piece, all cluster together extremely tightly, so much so as to nearly overlap one another even at this fine of a scale; the fifth item, in isotopic terms, remains right next door (Figure 9). All are clustered rather closely to some data points for the Mendips and Southern Pennines, suggesting that La Salle's French colony was very likely armed with bullets molded from British lead, perhaps even shipped to France from the nearby English ports of Bristol or Hull. Manufacture of the ammunition in France using gang molds, which often produced balls of many sizes within the same mold (Kent 2001:186-188), could account for the barrels of jumbled sizes of ammunition found aboard *La Belle* (Bruseth and Turner 2005:96). Further testing of lead artifacts from 41VT4 from areas of the site with a more distinctly Spanish imprint will likely reveal the presence of Mexican-derived lead as well, sent north in the 1720s to arm the short-lived first iteration of Presidio La Bahía.

Additional Results and Discussion for 34KA3 and 34KA5

One of the more notable findings revealed by this lead isotope study is the presence of several lead balls at Deer Creek and Bryson-Paddock with distinctly radiogenic isotope signatures, tying them clearly to lead sources of the Mississippi

Valley. From the discriminant function analysis, a total of 14 objects from 34KA3 and 34KA5 are unambiguously classified as deriving from Mississippi Valley lead sources (probability of each = 1.00). With $^{206}Pb/^{204}Pb$ values above 20.0, $^{207}Pb/^{204}Pb$ values above 15.75, and $^{208}Pb/^{204}Pb$ values above 39.0, these artifacts are comprised of lead in which a greater proportion of the metal derives from the radioactive decay of uranium and thorium. As noted in Chapter 2, the lead of the Mississippi Valley is extremely heterogeneous compared to less radiogenic sources, and as such the data for these sources are scattered graphically over a much broader area than the tightly clustered area examined in the previous section. Still, this lead is so completely different in composition from most European and Mexican ores that its attribution is a rather simple matter.

Goldhaber et al. (1995) and Millen et al. (1995) provide substantial isotopic data sets for the lead-bearing regions of southeastern Missouri (SEM) and the Upper Mississippi Valley (UMV), respectively; further, the latter source provides revamped data from an especially early study by Heyl et al. (1966) which has now been corrected for mass fractionation. Farquhar et al. (1995) provide the results of lead isotope analyses on artifacts from four colonial-era sites within Illinois, and compare that data to both published and unpublished data sources for Mississippi Valley Type (MVT) lead. These three data sets are used for the graphical comparisons presented here (Figures 13, 14, and 15).

In all, 56% of the items from Deer Creek and Bryson Paddock display a clearly MVT lead isotope signature (Figure 13): five lead balls from Deer Creek, the flattened lead ring from Deer Creek, three lead balls from Bryson-Paddock, and five lead balls which came from either of the two sites. More specifically, most of these artifacts appear to clearly match lead from deposits in southeastern Missouri (Figure 14), with several even showing a fairly close affinity with samples from the historic mining localities of Mine La Motte and the Old Lead Belt. Some of the isotope values shown derive from modern and deeply penetrating mining operations, and may not be entirely appropriate in making comparisons; the deeply buried Viburnum Trend, for example, was not opened until 1960 (Hagni 1995:47). Still, to my knowledge no data are available for this area from historic mine tailings, slag heaps, or surface outcrops of ore, if such indeed still exist. The area has now been extensively modified by modern mining and industrial applications, so data generated in the course of geological studies must be relied on for this region.

Three of the artifacts (two lead balls from Bryson-Paddock and one that comes from either of the sites) display extremely radiogenic makeups with $^{206}Pb/^{204}Pb$ values greater than 22.0 (Figure 13). There is some overlap between the SEM and UMV lead isotope regions, and these three items may possibly have affinity with the even more highly radiogenic UMV deposits. If such is the case, they would conform better in their makeup with ore samples taken from closer to the Mississippi River, as shown in an isochronal map of isotope values shown in Millen et al. (1995:B4), as opposed to more distant areas within southern Wisconsin and northern Illinois. However, although these objects fall at the outer extent observed for southeastern Missouri leads, they still remain close to some data points for SEM galena provided by Farquhar et al. (1995:642), as well as to some artifacts found at the Kolmer and Guebert sites directly across the Mississippi from the Missouri mines (641) (Figure 15). Although lead from the Upper Mississippi Valley could have very well made its way onto the Southern Plains in the eighteenth century by simply undergoing a longer initial voyage downriver, a Missouri origin for the lead artifacts from Deer Creek and Bryson-Paddock seems more likely overall, from a historical and logical perspective.

The implication of these results, clearly, is that most of these artifacts were assuredly made from lead mined in southeast Missouri, mining which in all probability was conducted by the French. Chapter 3 highlighted the possibility of early Native lead manufacture at the Missouri mines, which can not be entirely discounted. Since the trade materials found at Deer Creek and Bryson-Paddock likely date to the mid-eighteenth century, though, a period during which there seems to be no mention of actual Native mining and smelting activities alongside the French in southeastern Missouri, these objects likely represent a direct chain of French involvement in mining, smelting, bullet manufacture, and transportation. Further, we know definitively from the historic accounts provided by the 1748-1750 deserters from the Arkansas Post that French hunter-traders were living and working seasonally directly alongside the Wichita bands with whom they transacted business. The lead objects at Deer Creek and Bryson-Paddock could therefore have entered the archaeological record due to either Native or French loss, but a direct link with the French trade is indicated either way.

There does not appear to be any inter-site patterning detectible between the isotopic data values for either Deer Creek or Bryson Paddock. The points seem to be rather randomly and evenly distributed amongst themselves, lending credence to the already generally accepted notion that the two sites were occupied simultaneously during most of their existence by related groups.

As for the non-ammunition artifacts tested from 34KA3 and 34KA5, the flattened lead ring with battered edges from Deer Creek yielded a radiogenic signature which places it lowest among its companion artifacts in the left-hand corner of Figure 14; it is still, though, clearly composed of lead from southeastern Missouri. This particular artifact, then, can be confidently associated with the other eighteenth-century trade items found at Deer Creek. Its function remains unclear, but it seems certain that it followed the same path of introduction as the other Missouri lead. Whether it arrived on the site as a finished item or was made there is unknown; probably, though, it was used as a tool in a way other than originally intended.

The lead sheet and lead chunk found at Bryson-Paddock are more enigmatic. Statistically they are classified as being of Mexican origin (with respective probabilities of .655 and .782), although I believe them to be anomalous objects of non-colonial origin. Considered graphically, and particularly in the $^{208}Pb/^{204}Pb$ diagram, the lead sheet and chunk both fall well beneath the main trendline of both European and Mexican lead objects (Figure 3). Neither conforms well at all to either group, though, and both are rather isolated from any of the other artifacts tested. Since the primary sources of lead at 34KA3 and 34KA5 have been shown to be European and Missouri materials, these two larger artifacts might perhaps be thought to represent some degree of mixing between these two sources in order to produce the anomalous signatures. However, the addition of Mississippian lead to either European or Mexican lead would make the combination more radiogenic, not less, as is the case here.

It could be that both of these artifacts, surface-collected by John Paddock, may not date to the eighteenth century. A modern house built on the property by Mr. Paddock has been situated on the Bryson-Paddock site since 1975. Also, while portions of Deer Creek have in fact undergone cultivation, Bryson-Paddock has been subjected to more intensive agricultural plowing since at least the 1930s (Wyckoff 1964:20; Hartley and Miller 1977:3; Sudbury 1976:92; Bell 2004:186-187; Byron Sudbury personal communication 2009). These anomalous lead pieces might therefore be associated with modern occupations and uses of the site. As mentioned previously, the lead chunk has an odd reddish tinge which may indicate the presence of impurities. The lead sheet is of fairly uniform thickness with rather clean edges. Nearly identical isotopic results for a second sample from the lead sheet, taken from a different part of the sheet than the first sample, also indicate an overall uniformity of composition. For the time being the function, origin, and age of these two objects remains uncertain.

A Reconstructed Scenario for Ammunition Found at Deer Creek and Bryson-Paddock

Drawing from all the materials presented up to this point, then, the life story of a highly radiogenic lead ball from Deer Creek or Bryson-Paddock would probably read something like this: During an especially prosperous and peaceful time for the French in the Illinois Country and Louisiana, lasting from the mid 1740s to the early 1750s, mining activities in southeast Missouri were finally picking back up after a bit of a dry period. New explorations had been undertaken to identify promising mining prospects, and a decrease in Indian hostilities had made it safer to enter the mining regions once again. In the lull between sowing and harvesting their crops, some men would go to the mines for a few months at a time and work the ore deposits; there was an increased demand for products all around, as commerce in general boomed.

Toward the end of the season the actual smelting would get underway, with the unskilled miners using the crude log heap furnaces to extract about half of the lead actually present in their ores. The bars of lead thus produced, weighing about 70 or 80 pounds, would then be hauled over the hilly slopes to the mouth of Saline Creek (in the case of Mine La Motte) or perhaps carried overland a distance and then floated down the Big River (in the case of the Meramec mines). At the confluence of Saline Creek with the Mississippi, some of the lead may have even been re-melted and made into lead balls on site; the agriculturally-based village of Ste. Genevieve just north of here would have also just been getting started at this time.

Upon reaching the Mississippi, the lead may have been floated over to Kaskaskia or Fort des Chartres, or else began its journey either upriver or downstream to more distant places in need of it. Some would be floated on *bateau* downstream to the confluence of the Arkansas River, while some continued on to New Orleans and even to France. That sent up the Arkansas would make its way to the Arkansas Post, to be eventually distributed there to French trader-hunters along with many other types of goods. These items would then be loaded into the traders' pirogues and taken up the Arkansas River to its furthest navigable point. There, at a twin Wichita village that French officials never bothered to name or discuss in their correspondence, a booming trade in hides, meat, and oil was underway, fueled by a recent alliance that the Wichita had formed with the neighboring Comanche to the west.

By this point the French traders had perhaps already undertaken the chore of making ammunition from the stocks of raw Missouri lead, for both their own use and to be used in the hide trade. Arriving at the Taovayas villages, the bullets of Missouri lead would mingle with bullets made in Europe, perhaps brought in different years or by different traders from New Orleans. Some of these bullets would be used in the buffalo hunts which drove the entire operation, others would be passed along in trade to the Comanche and end up at points unknown, and a few would eventually find their way into the accumulated debris of everyday life at the villages.

Results for 41VT8, 41MN1, and 41RE1

The lead artifacts examined from the second manifestation of Presidio La Bahía, Presidio San Sabá, and Mission San Lorenzo were all likely made from Mexican sources of lead. According to the discriminant function analysis, 14 of the 16 items from these sites classify as being of Mexican origin, with probabilities ranging from 54.2% to 87.8%, and an average probability of 74.6%. The two exceptions are a single lead ball apiece from Presidio La Bahía and Presidio San Sabá, both of which classify as European in origin. Despite these statistical findings, however, I believe that these two objects are actually also of Mexican origin, a claim that can be reasonably borne out through close examination of Figure 21 (page 304), which presents a plotting of archaeological data points based upon their respective discriminant function values. This figure focuses on a region of considerable overlap between Mexican and European leads, and thereby shows a more constricted field (and therefore much more detailed) field of view than initially seen in Figure 1 (page 28).

A dashed line is shown on Figure 21 which approximately represents the dividing line between artifacts of Mexican and European origin according to the discriminant function analysis. Archaeological objects falling below this line are statistically classified as Mexican, and those falling above as European. However, as consistently accurate as this technique tends to be, it is important to keep in mind that among the 2000+ values used as predictor variables in setting up classification equations, nearly 12% of known Mexican data points and over 6% of known European data points were incorrectly classified (see Table 1, page 27). The method is thus not overly prone to error, but neither is it immune from it. In this case it will be noted that an upward-trending stream of Mexican data points falls alongside the more tenuously populated right margin of the European cluster. Just above the dashed line and within this marginal area is a grouping of archaeological samples which actually cluster rather closely to the group centroid (marked 4) for all of the archaeological samples considered in this study. This centroid of course takes into account the weighted effect of likely Mississippi Valley origin artifacts as well, but also happens to lie directly within a zone of especially dense European and Mexican overlap. The two lead balls from 41MN1 and 41VT8 that have been statistically assigned to a European derivation fall within this zone (denoted on the figure by their abbreviated site trinomial and their respective weights in grams: MN1 14.8 and VT8 18.2).

The remainder of the artifacts within this zone are all melted specimens from Mission San Sabá (41MN23), and will be discussed in detail in the next chapter. In brief, though, they were all excavated from a very tightly confined portion of that site thought to represent an area of burned storerooms based on both archaeological and historical evidence. While a European origin for these lead objects can not be entirely ruled out, there are many indications to strongly support the notion that these objects were in fact of distinctly Spanish cultural origin, and hence more likely to be composed of Mexican lead.

Although the intent here is not to be too easily dismissive of the results of the discriminant function analysis, it is important to recognize that this particular grouping may represent the Achilles' heel of the technique insofar as this particular data set is concerned. Too, it is worth noting that the statistical assignment as European of artifacts from this heavily mixed zone may be in part a spurious effect resulting from unequal sample sizes. It could well be that the much larger overall European sample size is allowing fringe values from this set to overwhelm the less numerous values forming the fringes of the Mexican data set. This issue could probably only be settled with complete finality if a trace element analysis were to be conducted on these objects. Such a study might indicate the presence (or absence) of silver and other minerals such as would be expected in lead emanating from Spanish colonial mines in Mexico. However, consideration of the bi-variate lead isotope graphs for these sites also lends credence to the suggestion that all the lead artifacts tested from 41VT8, 41MN1, and 41RE1 are of Mexican geologic origin.

In examining these lead isotope graphs, it is apparent that most of the artifacts tested from these sites express surprisingly radiogenic but strikingly consistent isotope signatures, lying at the outer fringes of previously reported isotope values for Mexico (Figures 16-19). However, they are not nearly as radiogenic as the Mississippi Valley sources (Figure 2), so there is no confusion in discriminating between these two sources. The Mexican sources are also sufficiently different from the European leads to effectively exclude a connection with those sources (Figures 3-4). While the data points for 41VT8, 41MN1, and 41RE1 are somewhat isolated from known Mexican lead isotope values, they follow the general trend and slope of Mexican isotope values as graphed. This isolation may simply be an indication of the fact that broad surveys of Mexican lead isotope data are lacking. In fact, Cumming et al. (1979) remains the only attempt to characterize the overall lead isotope variation throughout Mexico, and this much-referenced study provides only 34 data points. To my knowledge, no attempt has ever been made to sample ore from historic mining contexts in Mexico; a study of materials from historic mine tailings would likely be very informative.

In general, the artifacts tested from these three distinctly Spanish colonial sites seem to conform best with lead from the silver mining regions of the Sierra Madre Occidental, and particularly the Chihuahuan mines. Some input may also be indicated from mines in the Mexican states of Durango, Nuevo León, and Coahuila, and possibly from some of the mining centers of the Central Mexican Plateau such as Taxco and Pachuca.

At Presidio La Bahía II, dating to 1726-1749, the data points for the five artifacts tested are somewhat scattered (Figures 16-18). Two of the lead balls (including the one bullet statistically classified as European) and the two lead discs cluster fairly tightly, while the partial, semi-hemispherical lead ball plots well away from both its companion artifacts and from any of the other artifacts included in this study. This partial lead ball remains on the trend line for Mexican objects, however, and may simply indicate the input of an anomalously radiogenic source of Mexican lead. This peculiar result is likely not the result of admixture of different sources, as it seems unlikely that a more radiogenic mixing component (such as Mississippian lead) would have been introduced to this Spanish site during this time. The other four items from 41VT8 plot most closely to a series of data points provided in Cumming et al. (1979) that correlate to a broad region of Cenozoic-age limestone replacement deposits extending from Nuevo León into Coahuila. This cluster, noted for being especially radiogenic among Mexican leads, incorporates the localities of Santa María de La Paz, Reforma, and El Diente. It will be recalled from Chapter 4 that a 1739 report on the province of Nuevo León commented very specifically on the abundance of lead produced at the mines of San Pedro Boca de Leones and Pesquería Grande, both near to the capital of Nuevo León at Monterrey. The same report, intended to cast Nuevo León in a favorable economic light, also spoke of the importance of Nuevo León as a hub for traffic to all regions north and south (Hadley et al. 1997:84). Given this combination of historic and geologic evidence, then, it may well be that the province of Nuevo León supplied the lead which was transported to Presidio La Bahía in the second quarter of the eighteenth century.

As tidy as this argument may seem, another possibility can not be entirely overlooked. Three of the 41VT8 artifacts also plot fairly closely to data points provided by Arribas and Tosdal (1994) and Stos-Gale et al. (1995) for the San José and Rodalquilar districts of the Cabo de Gata region of southeastern Spain. This region has intrusive lead-zinc veins with galena-bearing ores, along with associated silver, copper, and gold components. The Miocene-age deposits are hosted in rocks associated with the pyroclastic deposits of the Cabo de Gata volcanic field, which is located less than 200 km down the coast from the Cartagena mining district (Arribas and Tosdal 1994:1078-1086). This area was significant as a lead-producing region in antiquity, as demonstrated by the recovery from a Mediterranean shipwreck of lead ingots produced at Cartagena in the first-century BC (Trincherini et al. 2001:395, 398). Although the provisioning of Presidio La Bahía with lead produced in Nuevó Leon seems more likely, the possible input of lead from southeastern Spain should not be entirely dismissed. Further sampling of artifacts from 41VT8 may result in more defined clustering, and trace element analyses may be helpful as well.

At Presidio San Sabá, the five enigmatic cuboid pieces of lead are notable for having virtually identical isotope signatures (Figure 19). Four of the data points cluster so tightly as to almost overlap one another even at a rather close scale, with the value of the $^{206}Pb/^{204}Pb$ ratios varying from one another by only four thousandths of a point. The fifth cuboid piece, the largest, is only slightly removed from the others. This suggests that at least four of these squarish objects were made from the same stock of lead. Cuttings from a single thin lead bar might even be indicated, except that the objects all have slightly different dimensions. Their isotopic values do little to reveal their function, but it is apparent that they almost certainly share a common origin. These values also form their own distinct cluster separate from the artifacts at Presidio La Bahía II. This cluster is somewhat isolated, but a few surrounding points from Housh and McDowell (2005:684) and Miranda-Gasca et al. (1993; no raw data available) suggest that these values lie towards the extreme end of the field of values known for the Sierra Madre Occidental and eastern Chihuahua (Figure 17).

The one lead ball tested from Presidio San Sabá (which classified statistically as European) has a much different and less radiogenic signature than that of the five isotopically isolated cuboid pieces, placing it well within the known values for Mexican lead (Figures 16-18). Based on data from Cumming et al. (1979), this particular isotope value seems to fit best within regions of Cenozoic deposits with low-to-medium radiogenic values correlating to either western Sinaloa, Mexico (including Tigre, Copala, Tayoltita, and Cosala) or to a band running through Chihuahua (including El Pavo and Ojuela). James and Henry (1993a) and Housh and McDowell (2005) both provide a number of similar values which derive from the Sierra Madre Occidental and eastern Chihuahua, so this region is likely a better potential match than Sinaloa.

Additionally, Joel et al. (1988) performed a lead isotope analysis on a number of sherds of early Mexican majolica (dating to pre-1573) found in excavations of the Metropolitan Cathedral in Mexico City. Several of the sherds tested were demonstrated to have used Mexican-origin lead in their glazes, with sources similar to those just mentioned (as based on Cumming et al. [1979]); the lead ball from 41MN1 fits well within the cluster defined by these sherds. While not a direct geologic source, these majolica sherds provide some secondary, circumstantial evidence to suggest a distinctly Mexican origin for the lead in the one piece of ammunition tested from Presidio San Sabá.

A much more provocative explanation for this one bullet at Presidio San Sabá is the possibility that it could have been made from lead mined in the Llano Uplift region of Central Texas, and perhaps even from the legendary Los Almagres. Goldhaber et al. provide four lead isotope values derived from galena samples in the Llano district of Texas, and characterize the region as a "subeconomic Mississippi Valley-type district" (1995:1881-1883). Though much different than the Upper Mississippi deposits which this paper discusses (and much less radiogenic), Goldhaber et al. include the Llano data due to the region's having undergone a mineralization process similar to the phenomenally productive Viburnum Trend of southeast Missouri. Of the Llano area galenas, one sample was taken from the Silver Creek prospect, two from the Hog Thief Bend Prospect, and one from the Pedernales River area. Of these, the single tested lead ball from Presidio San Sabá plots fairly closely to one of the Hog Thief Bend samples in the $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ values, although not nearly as closely in the $^{207}Pb/^{204}Pb$ values (Figure 18). The other Hog Thief Bend and Pedernales galena values lie rather far removed, while that of Silver Creek is much more distant. While the potential implications of this are intriguing, additional lead isotope data are needed from both the Llano Uplift district and from the artifacts and possible ore samples found at Presidio San Sabá. As yet it would be quite premature to declare any sort of definitive proof for Spanish colonial lead and silver production from Los Almagres ores based on this lone (and perhaps only fortuitous) instance; the connection is simply far too tenuous at this point.

The three lead discs and the piece of lead sprue from Mission San Lorenzo all cluster rather closely together, with values quite similar to the cuboid lead plugs from Presidio San Sabá (Figure 19). The data for 41RE1 are spread out slightly more than they are for the lead plugs, but a similar lead origin within the Sierra Madre Occidental and eastern Chihuahua seems to be indicated. Interestingly, the one lead ball tested from Mission San Lorenzo has an appreciably different isotope value than does the piece of sprue – clearly, this particular lead ball was not one of the three bullets cut from this particular piece of lead sprue. The isotopic value of the lead ball is in fact nearly identical to the value for the plain lead disc tested from Presidio La Bahía II (Figure 19). As argued for La Bahía, this suggests a lead source for the lead ball from 41RE1 of either Nuevo León or perhaps the Cabo de Gata ores of southeastern Spain. Again, a Mexican source seems more probable here, based simply on the relative logistical ease of supplying an isolated Spanish colonial outpost with Mexican versus Spanish lead.

Discussion of Results for 41VT8, 41MN1, and 41RE1

The artifacts tested from the three distinctly Spanish colonial sites considered in this chapter present a slightly simpler picture than do the artifacts of the more French-influenced sites. Isotope values for artifacts from the two later and closely related sites (Presidio San Sabá and Mission San Lorenzo, spanning the years 1757-1772) cluster very tightly together, suggesting perhaps a shared supply network – something which could be reasonably expected. Although many of the values obtained lie at the fringes of what is currently known for Mexican leads, nearly all the artifacts from Presidio La Bahía II, Presidio San Sabá, and Mission San Lorenzo clearly derive from Mexican sources; two objects which statistical analysis classified as European may well actually be Mexican. Mining centers that are known to have been active in eighteenth century Mexico constitute the most probable sources of lead for these objects. Specifically, lead produced as a by-product of the silver mining industry in Chihuahua appears to be well represented. However, at Presidio San Sabá, the possible linkage of a lead ball to the fabled mine of Los Almagres has the potential to confirm in at least some small way the legends of Spanish silver mining in Central Texas.

In the case of Presidio La Bahía II and one artifact from Mission San Lorenzo, a rather direct connection to sources within Nuevo León seems to be strongly indicated by a combination of geological evidence and historic documentation. Also, a possible Spanish source from lead-bearing deposits known since antiquity can not be entirely ruled out, although additional testing of artifacts from these sites on the Spanish colonial frontier may help to refute or corroborate the contribution of Spanish lead.

Unfortunately, the hypothetical scenario outlined in the previous chapter concerning ammunition confiscated in 1754 on the Trinity River from the French trader Joseph Blancpain can not be adequately addressed at this point. While it seems entirely possible that some of this French ammunition eventually made its way to the troops who would serve at Presidio San Sabá a short time later, more data is needed. The results from thirteen additional lead balls submitted for lead isotope analysis but unavailable at this time will help to verify or refute the likelihood of this intriguing scenario.

Summary

The exploitation of lead sources from the three major geographic regions of Europe, Mexico, and the Mississippi Valley has now been archaeologically and geochemically demonstrated for eight colonial-era sites in Texas and Oklahoma. At the more heavily French-influenced sites of Lasley Vore, the Womack Site, Deer Creek and Bryson-Paddock, the paths taken by a European-manufactured commodity vital to the operation of the fur trade, lead ammunition, can now be distinctly traced from the Old World to the New. Of probable British but possible French or German geologic origin, this material made its way across the Atlantic Ocean and up rivers to arrive on the South Plains as part of a transformative cross-cultural enterprise. Similarly, lead wrenched from the earth in crude fashion by French colonists of the Illinois Country would impart its own distinctive signature upon the landscape of French-Wichita-Comanche trade relations. At La Salle's Fort St. Louis, barrels of ammunition likely made of lead extracted from the hilly and mountainous regions of central England were unable to protect the ill-fated colonists from inevitable disaster. The second incarnation of Presidio

La Bahiá, moved from its original location atop the failed French colony on the Texas coast, probably received lead as part of mule train shipments sent from the province of Nuevo León; some items, though, may have also potentially arrived from the Iberian peninsula. At the star-crossed sites of Presidio San Sabá and Mission San Lorenzo, lead was probably among the items occasionally carried in by a shared supply train from Mexico. Near Presidio San Sabá, in addition to a wealth of Texas legends, a quest for silver at a place called Los Almagres may have also produced some useable quantity of metal for making Spanish bullets. At another ill-fated location, the Mission Santa Cruz de San Sabá, bullets of all varieties would eventually be found in profusion.

CHAPTER 8

MISSION SANTA CRUZ DE SAN SABÁ (41MN23)

As the subject for a comparative lead isotope analysis, the Mission San Sabá presents an ideal test case. Having existed for only 11 brief months from April, 1757 to March, 1758, it was destroyed in a fiery and violent cataclysm involving a clash of many cultures. Its destruction also came precisely in the middle of a period of massive conflict and upheaval in the world at large, in which the isolated and doomed Mission San Sabá played a tangential but fascinating role. Built by the Spanish for the pacification of the Lipan Apache Indians, its very existence invoked the wrath of a horde of aligned Norteño tribes brandishing a devastating complement of French firearms. As a result of the attack the mission was utterly annihilated, leaving behind an abundance of bullets and other lead objects as a testimony to the violence that occurred there. The site itself was abandoned, with little else occurring at the location for the next 240 years beyond the use of the land for modern agricultural purposes. The situation of Mission San Sabá thus offers a rare archaeological opportunity: its existence is very tightly and precisely defined in both time and space, with a context virtually uncontaminated by the overprint of succeeding events. Combined with the abundant historic accounts generated by the event, the evidence of the mission's brief life and apocalyptic death is thus relatively free from much of the uncertainty presented by many archaeological sites.

Historic Background of 41MN23

Mission San Sabá was officially founded on April 18, 1757, the culmination of many years of Spanish debate as to whether establishing a mission among the Apache would even be a worthwhile endeavor. Apache raids on San Antonio had finally quieted by 1749, with Apachean groups under mounting pressure from well-armed and vindictive Comanche, Wichita, and Caddo enemies to the north. In need of some respite, the Apache would eventually make overtures to the Spanish by requesting the placement of missions within their territory. This turn of events fired the apostolic zeal of the missionaries who had long desired to Christianize the Apache, while the civil and military authorities remained dubious. However, the circumstance of the closure of the San Xavier missions on the Guadalupe River, coupled with the munificent patronage of Don Pedro Romero de Terreros for new missions, offered a prime opportunity to enact the Lipan Apache experiment on the northern border of New Spain. In doing so, the Spanish would find that they had unwittingly interjected themselves into a brewing storm of Native politics beyond their full comprehension. After a fitful start and months of disappointing prevarication by the itinerant Apache, prospects for the success of the mission appeared gloomy from the onset. Finally, in a release of the pent-up aggressions that had been inexorably building between the despised Apache and their vengeful foes, a combined Native force leveled the mission on March 16, 1758. The alliance which devastated the fledgling Apache refuge was a complex amalgamation of Indian bands, consisting of Taovayas, Tawakoni, and Yscani Wichita, Comanches, Tejas of the Hasinai Caddo Confederacy, Tonkawa, Yojuane, and Bidais. It was a well-strategized campaign bent on utter destruction of what was perceived by these Norteño tribes as an Apache blight in their midst. The attack would deal an insufferable blow to prospects of further Spanish expansion on the Texas frontier (Dunn 1914; Nathan and Simpson 1959; Weddle 1964; Gilmore 1967; Tunnell and Newcomb 1969; Hindes et al. 1995; Wade 2003; Weddle 2007).

The details of the attack on Mission San Sabá will be crucial in properly interpreting the isotopic data obtained from the dozens of bullets and other lead artifacts recovered there. Our single best source for how the attack on the mission unfolded comes from the official deposition of Fray Miguel Molina, the only missionary of the three stationed there to survive the attack of March 16, 1758. Granted, this particular account probably presents a somewhat skewed and one-sided narrative of a complex and rapidly evolving situation, but nevertheless represents our best understanding of the events surrounding the mission's destruction. His account, dated March 22, is published in full, in both the original Spanish and translated into English, in Hadley et al. (1997:511-526), accompanied by a forwarding letter of Colonel Diego Ortiz Parrilla. Molina's account is also presented in a different translation by Nathan and Simpson (1959:84-92), along with the testimony and depositions of several other survivors of the attack. Combined, the multiple depositions provide a rather clear view of the events involved in the destruction of Mission San Sabá. The translation of Molina's account by Hadley et al. (1997) will be primarily relied upon here, with additional information drawn from Nathan and Simpson (1959) and other sources.

The synopsis of the mission's destruction offered here will emphasize especially those matters pertaining to the weaponry involved in the assault, along with architectural features which may be expected to figure into the archaeological interpretation of the site. In order to prevent this section from becoming unduly cumbersome from the frequent interchange of the two primary references, material quoted from the translation of Molina's account by Hadley et al. (1997) will be identified by plain page numbers in parenthesis (e.g., 526), while that taken from Nathan and Simpson (1959) will be identified by page numbers with an asterisk affixed (e.g., 76*). Other references will be attributed in the normal fashion.

The Attack on Mission Santa Cruz de San Sabá

Rumblings of some sinister plan had reached the Spanish prior to the attack, and accordingly Colonel Diego Ortiz Parrilla had ventured to the mission only the day before, on March 15, to encourage Father Terreros to retreat with everyone there to the Presidio San Sabá for safety. Terreros resisted this, although according to Molina their discussions seem to have centered on the vulnerable position of the mission and Parrilla's persistent desire that it should be situated closer to the presidio. It would seem, then, that even Terreros was fully aware of the danger their exposure posed, with certain activities such as tilling new ground for crops being held off just prior to the attacks. From this passage (519), I would even infer that Father Terreros was perhaps actually entertaining the notion in March, 1758 of removing the mission to be closer to the presidio as Parrilla wished. If such was the case, though, plans of this nature would never have a chance to come to pass.

Molina reports that the next morning, just after sunrise, "an outcry or raging commotion was heard from outside the compound, about a musket (*escopeta*) shot away at the area of the crossing or ford of the river" (515). Father Terreros had already celebrated Mass that morning and had retired to his quarters, while Father Santiesteban was only just beginning his own liturgy. "With one great rush and discharge of their *fusils*" (as the word appears in the original Spanish, as opposed to the offered translation of "rifles"), the Indians "had surrounded the stockaded compound and its buildings" (515). The priests quickly withdrew to Terreros' office, where several others had already gathered, and were soon informed by the corporal of the guard (Ascencio Cadena) and another soldier (Enrique Gutiérrez) that the assembled tribes included Tejas, Tonkawas, Bidais, and other Indian nations who were now making gestures of peace in an attempt to gain easy access to the inner stockade.

On that fateful day the priests were not entirely defenseless, having on hand the benefit of "two stone mortars (*dos pedreros*), bullets (*balas*), powder (*pólvora*), muskets (*escopetas*) and seventeen men, including the Indians assigned to that place" (519, 526). The Sergeant of the presidio would later testify that on the day of the attack a total of 27 men capable of wielding arms were on hand, including soldiers assigned to the mission, friendly and/or resident Indians, and servants of the mission (52*). Thus the priests went forth to assess the situation for themselves, and Molina relates his terror upon entering the courtyard:

> "I saw with true wonder and fright that all that could be seen anywhere were Indians armed with *fusiles* and dressed in the most hideous clothing. In addition to having painted their faces red and black, they had adorned themselves with the skins of wild beasts, the tails of animals hanging and dangling from their heads, deer antlers, and other embellishments of various animals; some had plumes on their heads. All were armed with *fusiles*, sabers, and lances with pikes" (515, 522).

Molina would report that "about two thousand attacked, and a conservative estimate of the number of barbarians who came equipped with firearms would exceed one thousand" (518). Several other deponents involved in the attack similarly gauged the overall number of hostiles at an estimated two thousand, and repeatedly marveled at the novelty of encountering a force of Indians so well equipped with firearms and so skilled in their use (8*, 47*, 52-53*, 66*, 76*, 82*, 117*). One in particular called attention to the French design of the firearms (82*). Completely unfamiliar to the Spanish were the Wichita bands, the Taovayas, Tawakoni, and Yscani, groups for which they did not yet even have names, referring to them only vaguely as "others of this northern land" (513; Weddle 2007:2). The Spanish were certainly not unaware that the French had been making firearms directly available to the Norteño tribes for decades. Juan Leal, identified as a colonel with 25 years of experience in the Province of Texas, spells out in his deposition a keen understanding of the French trade from which the Norteños had acquired their guns:

> "It was also evident that the said nations and many other Indians had been trading and associating with the French, from whom they obtained arms and ammunition, helmets, and other prized possessions which they used to good advantage. The French supplied them with things of that sort in exchange for horses, mules, and the meat, hides, and fat of buffalo and bear, and the skins of deer, which the Indians take in great numbers in the open country" (76*).

Parrilla, in forwarding a packet of depositions to Viceroy Amarillas on April 8, would likewise note that the new threat posed by the Norteños was of an entirely different magnitude compared to the more easily pacified tribes of southern Texas and northern Mexico with whom they had dealt in the past:

> "They [the previously encountered tribes] live wretchedly in the country, naked and totally defenseless, armed only with bows and arrows, and only

> a few of them are troublesome. But the heathen of the north are innumerable and rich. They enjoy the protection and commerce of the French; they dress well, breed horses, handle firearms with the greatest skill, and obtain ample supplies of meat from the animals they call *cíbolos* [buffalo]. From their intercourse with the French and with some of our people they have picked up a great deal of knowledge and understanding, and in these respects they are far superior to the Indians of other parts of these Kingdoms" (138*).

The Spanish had clearly never before encountered the consequences and totality of the French trade with such gravity.

The Norteños, knowing full well the distinct advantage they held, brazenly opened the gate to the stockade themselves, with "as many as would fit – some three hundred, more or less" pouring in (515). With the Indians still feigning at first friendly intentions, the priests tried for a time bribing them "in profusion" with "tobacco and other things they like" (516). Even as they did so, the Norteños began to openly pillage and ransack the mission, searching the rooms and taking anything that struck their fancy, including horses, cookware, and the soldiers' coats. The priests at this point, having lost all control, only wished to devise some scheme to get them all to leave, hoping thereby to avert a larger disaster. It was suggested that they should continue on to the presidio where many more horses and "a great deal of everything" could be had (516).

After some dissimulation in which a Tejas leader reported that he had attempted to do just this but had come under attack, despite bearing a written pass that Father Terreros had provided him, the Father President of Mission San Sabá offered to accompany him. Evidently, then, the looting of the mission went on for some time, as the time between the writing of the note and the reappearance of this Tejas Indian was long enough that the ruse he perpetrated may have had some shallow ring of believability to it. In any case, by this point Father Terreros was apparently willing to do anything that might halt a situation that seemed certain to escalate into total annihilation of the mission. In the time that elapsed in carrying out this deceit, Molina commented that "the number of barbarians grew to more than two thousand" (517), indicating that besides the many hundreds of Norteños who could not fit into the stockade walls, others had perhaps been lurking earlier in the area just out of sight. Or, perhaps, mounting terror simply made it seem like the Indians were multiplying.

In attempting to exit the stockade gate to play their parts in the ruse, Father Terreros and the soldier Joseph García were both shot and killed; also killed during the ensuing attack were Father Joseph de Santiesteban, Lázaro de Ayala, and Enrique Gutiérrez, along with several soldiers sent from the presidio. In all, ten Spaniards would be killed in the episode (Wade 2003:188). The soldier Andrés Villareal was shot and had a bullet lodged under his arm, and at some point during the day Molina himself would have a bullet "lodged in his right breast" (56*, 514). All of the victims would be "killed with bullets or lances" (57*), and Parrilla would later report that Terreros' body was "pierced by two bullets and a lance thrust" and that the body of Santiesteban "was separated from his head" (513).

There was thus no longer any pretense of peaceful intentions, with everyone suddenly involved in "a brutal battle" (517). Molina and others fled to Terreros' quarters within the church, apparently considered one of the more secure locations within the mission, while still others sought refuge wherever they could. This occurred at about eight in the morning, suggesting that a couple of hours had already elapsed since the initial alarm was sounded just after sunrise. Among the others holding out in the church were five soldiers from the presidio assigned to the defense of the mission, as well as two other Spaniards and a mule-train driver (Wade 2007:199, 204-205).

Father Terreros' quarters evidently had small windows or portals through which the refugees from the attack could view the assault and fire upon their attackers; in Molina's original Spanish account these openings are referred to as *troneras*, with Hadley et al. (1997:517) translating the term as "embrasures", while Nathan and Simpson (1959:54, 70-71, 88) use "loopholes" throughout most of their translations. It was through one of these windows that a shot hit Molina above the right nipple in the course of the battle, with splinters from a shutter wounding his arm (78*). Molina reports on being able to see "through the embrasures (*troneras*) of the room" that the Indians had "set fire to the four sides of the stockade with great violence and extensive placement of firewood." He also comments that "we fired on them through the embrasures of our locked room" (517). Similarly, the room's occupants were shocked at some point in the later part of the day (apparently after they had managed to flee to another outbuilding [53*]) by the appearance of a soldier from the presidio, Joseph Vázquez, whom they could identify by seeing him between the wall boards (518). From this last detail, it also seems possible that the wattle-and-daub construction of the mission buildings (Hindes et al. 1995:55-64) may have left gaps between the posts; the occupants of the room were perhaps able to see and fire through unchinked interstices in the walls of the *jacal* structure. On the other hand, Sergeant Flores, either viewing from a distance or relating what had been reported to him about the matter, would comment that these "loopholes" had been cut into the walls by the defenders to provide a gunport (54*).

At some point during the afternoon, Juan Leal and some of the other survivors who had at first scattered to other buildings managed to regroup with the others inside the church. Here Leal mounted either one or both of the small cannons (called *pedreros* by Molina, and translated elsewhere as "stone mortars" [526] and "light guns (51*) – possibly swivel guns?) atop "several chests facing one of the entrances" (75*). The soldier Andrés de Villareal had attempted to man these cannon earlier in the attack, but was prevented from repelling the invaders when he was shot under the arm (69*). Villareal also commented that everyone at the mission was capable of wielding firearms, and that Terreros "had a reserve supply of powder and ball" (72*). Indeed, Sergeant Joseph Antonio Flores noted that only a few days prior to the attack Colonel Parrilla "had sent to the Reverend Father President a quantity of lead for bullets and a supply of powder, in addition to what was already at the mission" (51*). Parrilla would be careful in later depositions to point out that "at the side of the Fathers there were other men who could take up arms kept in reserve and use the ammunition and the artillery pieces which I had also [set] as prevention; the missionary Fathers were not unprotected…" (Wade 2007:205).

Regardless of the exact nature by which matters played out, it is clear from all these details that the men holed up in the rooms of the mission could keep up to some extent with the proceedings outside, that they were well armed, and that they were actively returning fire. Vázquez would comment that he witnessed "one of the enemy killed by a ball, and others being carried away as though dead" (81*). Some seventeen Norteños are noted as having been killed by the Spanish during the entire ordeal (82*). Although the matter of Native casualties in the attack is seldom addressed in discussions of the event, they actually outnumbered Spanish deaths by almost two to one. The overall consequences for the Spanish were far graver, though.

Vázquez, incidentally, had been sent with several other soldiers to the mission's aid upon first receiving reports of the attack. A large contingent of Norteños were milling about in the general area, with some perhaps heading to the presidio to inflict damage there as well. On encountering the outgoing detachment of soldiers from the presidio they opened fire, killing several. Vázquez was shot and received a "grave wound to the chest" (518), and then either played dead or remained unconscious as the Indians stripped him of his clothing. He later managed to make his way to the mission and eventually to the room in which Molina and others were hiding out.

In the meantime, the looting and the inferno both raged on, with the Norteños apparently so fixated on their pillaging and confident of the fire's deadly effects that little heed was paid to the plight of the sequestered Spaniards and their few Apache wards. Much of the looting focused on the mission's storerooms: Molina comments that they remained in Terreros' quarters until after midday "while the enemy was occupied in the pillage and looting of supplies stored for the intended mission Indians" (517). Likewise, upon arriving at the mission Vázquez had been "discovered by the enemy, most of whom were occupied in opening bundles of clothing and boxes from the storeroom and taking their contents away" (518); he was lucky that they only threw him against (or over) the burning stockade wall but did not kill him. In the aftermath of the destruction, Sergeant Flores would note that

> "the ground was strewn with smoldering debris from [the church's] ruins. We moved on to inspect the other buildings, only to find them all destroyed and the wreckage still burning. We also saw bales of tobacco, boxes of chocolate, barrels of flour, and boxes of soap, broken apart and

> burning. We found crates of church ornaments broken to pieces and charred by the flames, as well as various sacred jewels and pictures smashed to useless fragments" (56*).

Clearly, the mission storerooms had been thoroughly ransacked, with whatever had not been pilfered subjected to intense fires.

As the fire progressed and began to consume the hideout being used by the Spanish and their Apache charges, the Norteños' inattention allowed them to shift to "another room adjoining the church", but upon being seen the Indians "renewed their attack, firing *fusiles* at us and stoking the embers from the burned room, trying to make us leave the church, which, although also on fire, was less damaged" (517, 524). Somehow the survivors managed to hide out in this way until after midnight. When the detachment sent from the presidio under Sergeant Flores caused dogs at the mission to start barking, it created enough of a distraction among the still gathered Norteños to allow the refugees to slip away under still very dangerous conditions (54*, 76*). Juan Antonio Gutiérrez, however, father of Enrique, perished at the mission along with his son, as Molina reports he could not join the escape owing to a "grave wound in the thigh" (517).

The remainder made their way in darkness as stealthily as possible towards the presidio, and Father Molina reports that he finally arrived there on the morning of March 18. He would remain there for several days, even as the presidio itself was thought to be under threat of imminent attack. With the assistance of a secretary, owing to his injuries, he composed his deposition concerning the events at the mission. He would leave for San Antonio several days later, once the chest wound he had received had improved some. Parrilla would venture to the smoldering remains of the mission the day after the attack, reporting that "Although I reconnoitered and searched at the site just a few hours after the enemies had abandoned it, I found no part spared from the fierce fire, nor any articles that had not met with equal ruin" (514). The destruction wrought at Mission San Sabá had been virtually total.

Excavation History and Artifact Descriptions for 41MN23

After having been lost to recent memory, the location of Mission Santa Cruz de San Sabá was rediscovered in September of 1993 by V. Kay Hindes, Mark Wolf, Kim Wolf, and Grant D. Hall (Hindes et al. 1995). Previous efforts at discerning the mission's location had also been made (Gilmore 1967; Carlson 1991) but had not resulted in success. The crucial elements leading to the 1993 discovery involved a footnote in an obscure historical pamphlet that described the location of the mission in 1905 (Hunter 1935 [1905]:21) and the fortuitous circumstance that the pasture marking the mission grounds had just been freshly plowed, removing a thick carpet of alfalfa and revealing a surface scatter of artifacts. The site is located immediately adjacent to Texas Farm-to-Market Road 2092, three miles east of Menard, Texas from the intersection of FM-2092 with Texas State Highway 83 (Hindes et al. 1995:1-19). The site does not seem to extend to the south beyond the highway, and a fenceline immediately north of and parallel to the highway separates the main portion of the site, on private land, from a narrow strip of state-owned right-of-way. A state historic marker originally erected during the Texas centennial year of 1936 further to the west has now been re-located to directly in front of the actual site.

Initial investigations at 41MN23 in the Fall of 1993 located large amounts of fired clay daub consistent with the burning of wattle-and-daub (*jacal*) structures, along with Spanish colonial ceramics of the proper time period for Mission San Sabá. Limited excavations were carried out in May and January of 1994, in conjunction with a systematic metal detector survey over much of the site. The metal detector survey resulted in a total of 34 widely scattered lead artifacts, of which 20 (and possibly more) were identified as musket balls. Proveniences were recorded for nearly all of these objects, although a few artifacts managed to slip by without provenience data. Excavation of one particular four-square-meter block that had an especially heavy concentration of fired daub on the surface produced 12 pieces of mostly misshapen, previously melted lead. This block was located in the southern portion of the site, immediately adjacent to the fenceline separating the agricultural field from the highway right-of-way (Hindes et al. 1995:19-25, 42-46).

These initial investigations were followed by extensive excavations across the entire site in the Summer of 1997, in conjunction with a Texas Tech University archaeological field school conducted under the direction of Dr. Grant D. Hall; I participated in the 1997 investigations as a field assistant and undergraduate student at Texas Tech. These 1997 excavations also produced large numbers of lead artifacts, primarily in the form of spent lead balls. Numerous additional pieces of lead were found adjacent to the $4m^2$ area excavated in 1994, with pieces similarly appearing to have melted and puddled on the ground surface at the time the mission burned. A few lead artifacts were also found in the course of backhoe trenching operations at the site. The final report of the 1997 excavation season, which involved nearly the entire site area, is currently being prepared.

A recent highway expansion project on FM-2092 has resulted in further excavations on the state-owned right-of-way portion of the site. A total of 80 square meters were excavated in 2007 to mitigate the impacts of the highway expansion, with a total of 20 lead artifacts recovered. These included mostly melted pieces, consistent with the 1994 and 1997 excavation units located directly across the fenceline from the 2007 units (McWilliams and Boyd 2007:60-61; McWilliams and Boyd 2008:36, 50-51). Samples from these twenty artifacts have been separately submitted for lead isotope analysis, but the results were not available in time to be incorporated into this thesis.

One factor that must be taken into consideration is that archaeological remnants of Mission San Sabá lie in an active agricultural field. The land has been in constant production since the late nineteenth century, with the surface extensively plowed over the course of more than a century. As a result, a thick plow zone of churned soil has destroyed all but the lowermost levels of the mission's footprint. The only apparently intact Spanish-colonial era deposits lay along the southern fenceline marking the boundary of the pasture. A series of hand excavations were conducted in this area. Across the remainder of the site (and after the metal detecting survey), a backhoe was used to dig a series of trenches and to remove plow zone overburden. In this way a number of features such as foundation trenches, post hole molds, and soil stains dating to the mission's occupation were uncovered. Provenience was noted for artifacts recovered in the course of backhoe operations, although this information could usually not be known at a more precise level than a particular trench. Few lead artifacts were recovered in this way, with most resulting from metal detecting surveys and hand excavations. Some shifting of objects in the ground due to repeated plowing over the decades can therefore be expected. However, small, dense objects like lead balls have probably been affected to a rather minimal degree in their movements, and evidence presented later in this chapter will demonstrate that most have probably generally retained their original positions.

A total of 60 lead artifacts from Mission San Sabá were selected from the 1994 and 1997 excavations for lead isotope analysis. All were made available for study through the kind cooperation of the landowner, Monte Lyckman. The sample included every artifact readily identifiable as a lead ball, as well as objects that based on shape or weight appeared to be spent bullets. One especially large, undeformed lead ball (item 164), was not tested, as it is currently on display along with other artifacts from the Mission at the Bank of Menard. In all, at least 47 lead balls appear to be present in the assemblage, and possibly more. Many are quite deformed from impact, and some of the melted or badly mutilated pieces still fit within the weight range expected of period ammunition. The objects clearly identifiable as complete or somewhat deformed lead balls range in weight from 9.4 to 17.7 grams (excluding one small ball weighing only 5.4 grams), corresponding to calculated diameters between .46 and .57 inches according to Sudbury's formula [$d = 2(\sqrt[3]{.021x})$]. The great majority have calculated diameters between .50 and .56 inches, or about the proper size for use in trade guns (fusils) of this period. Nine items have calculated diameters of .38 to .49 inches (including the smallest ball) and may be better regarded as pistol balls. Two larger pieces of lead weighing 42.1 and 156.6 grams were also tested; they are deformed and of odd shape, but unlike the melted pieces they are lumpy and not flat. The remainder of the objects are amorphous blobs of lead, misshapen and flat from melting and puddling on the ground.

Results and Discussions of Lead Isotope Analyses for Mission San Sabá

Using both graphical and statistical procedures, the lead isotope data for Mission San Sabá reveal distinct patterning that allows for separation into well-defined groupings. Perhaps the most significant overall finding at this site is the presence of lead from all three major geographic regions considered in this study: Europe, Mexico, and the Mississippi Valley. The diversity of lead sources encountered at this one briefly occupied site speaks to its position at a crossroads in both time and space, set amidst the swirling vortices of French, Spanish, and Native interests.

Additionally, the results from Mission San Sabá are doubly meaningful, as they can be evaluated in a manner not possible for the other sites already discussed. Since this site has yielded such a wealth of lead artifacts of varying isotopic composition and with carefully recorded proveniences, the locations of individual objects can be plotted on a plan view of the site. These individual points can then be further correlated with their respective isotope clusters, allowing for visualization of where on the site artifacts made from European, Mexican, and Mississippi Valley leads have been found (Figure 20). By considering the context and patterning of artifacts grouped by isotope clusters across the site, an entirely new level of detail is brought forth by the data. This aspect of the analysis will allow for a clear pattern to emerge of the battle which occurred at Mission San Sabá, in addition to illuminating some details of everyday life at the mission.

Throughout the following discussions, individual artifacts will be referred to by the lot numbers which were assigned to them in lab processing, and these numbers are also linked to data points provided in the isotopic map of the site and in selected graphs of isotope data (Figures 6-8 and 20).

Overall Results of Statistical and Graphical Analysis

Using discriminant function analysis on the 60 total samples submitted from 41MN23, fully two-thirds (40 samples, or 66.7%) classified as European in origin, 16 (26.7%) as Mexican, and four (6.7%) as Mississippi Valley Type (see Appendix B). However, as argued in the previous chapter for a couple of lead balls from Presidio La Bahía and Presidio San Sabá, I believe that eight of the artifacts classified as European at Mission San Sabá may in fact be of Mexican geologic origin. This is based on their apparent Spanish cultural affinity as suggested by historic and archaeological circumstances, which will be discussed more fully under the heading of Isotope Group 4, below.

In terms of graphical comparison, since the data set for 41MN23 is substantially larger and more complex than sites previously considered, results for Mission San Sabá will be treated on the basis of discrete isotope groupings which serve to break the data up into more manageable subsets. This approach has the analytical advantage of allowing for clear distinction among multiple subgroups while still pairing closely related objects for the convenience of interpretive purposes. These groupings were initially revealed through graphical analysis, and then refined based on insights gained from the results of statistical analysis. In all, data from 41MN23 group within five distinct clusters, with a few stray points being placed for convenience into two additional, more poorly-defined clusters (Figures 5-8).

Lead Artifacts of European Geologic Origin at 41MN23

Isotope Cluster 1

This group consists of a total of 23 objects, all of which are classified very solidly as European based upon discriminant function analysis (probabilities for this subset range from 64.1% to 92.1%, with a high average probability of 83.3%). A total of 22 lead objects (Cluster 1) form an extremely tight cluster, bounded by $^{206}Pb/^{204}Pb$ values ranging from 18.39 to 18.47, $^{207}Pb/^{204}Pb$ values ranging from 15.62 to 15.66, and $^{208}Pb/^{204}Pb$ values ranging from 38.42 to 38.54. This range of values is even smaller than, and completely within, the tightly defined area that marks the overall boundaries of European values observed for Lasley Vore, the Womack Site, Deer Creek, Bryson-Paddock, and Fort St. Louis (Figure 9). Correspondingly, as with the results from those sites, a very large portion of the artifacts sampled from Mission San Sabá conform especially well to British sources of lead in the Mendips and Pennine regions of central England, with adjacent regions of England (Alderley, Cumbria, Cornwall, and northeastern Wales) possibly represented as well. Correspondingly, Spanish sources match very poorly (Figure 11) and a possible French source involving potential input from the Massif Central region of southern France is only weakly indicated (Figure 10). German values from galena sources in the Harz Mountains, however, do conform well to this tight cluster, though data from the Erzgebirge Mountains do not (Figure 12). Overall, then, a rather distinctly British or German source for the lead seems to be indicated. An additional item, artifact 224, plots very slightly outside the main concentration of Cluster

1, but remains sufficiently close to warrant inclusion within this cluster. This makes for a total of 23 artifacts included in Cluster 1 (Figure 5).

Quite significantly, each of the 23 objects in this tightly defined cluster is clearly identifiable by shape or weight as a deformed lead ball. This subset in fact spans the entire range of variation in weight mentioned previously for lead balls, ranging from 9.4 to 17.7 grams, with a calculated diameter of .53 inches serving as both the median and the mode of this subset. Further, as the isotope cluster map of the mission shows (Figure 20), these objects are all found, with only a couple of exceptions, grouped rather tightly together at the core of the site. A bit of a central void within this concentration is also suggested. This is no coincidence, as this portion of the site corresponds directly with the footprint of the mission chapel. A series of post hole stains and wall foundation trenches uncovered in this area distinguish this portion of the site as the main structure located at the heart of the mission complex (Grant Hall, personal communication 2006). It was here that the bulk of the survivors hid during the attack, and this structure correspondingly drew the bulk of gunfire from the Norteño weaponry. The central patterning and substantial deformation of most of the balls forming this isotope cluster suggest as much; it seems evident that the great majority of these balls struck the log and post walls of the church, either dropping to the ground, becoming embedded in the structure, or perhaps passing through the crudely constructed walls. In the process, these lead balls suffered considerable flattening and distortion, as none remain completely in the round. They do not, appear, however, to have been subjected to melting from the ensuing fire.

The distorted but unmelted condition of the lead balls which struck the chapel may be accounted for in part when one considers the relatively low energy of a ball fired from an eighteenth-century fusil. At fairly close ranges these weapons assuredly had the power to be deadly, but with increasing distance the energy of a bullet decreased dramatically. Brumwell (2002:249-250) points out that in the battle for Quebec in 1759, only 40 British soldiers were actually killed, and some 600 wounded, owing in large part to the French error of opening fire from too great a distance. As a result, many British redcoats received nasty bruises imparted by musket fire but did not suffer mortal wounds. One soldier struck in the right shoulder recounted afterwards that the impact "pained me a good deal, but it did not disable me from my duty then, or afterwards"; in a separate battle, a lead ball struck a retreating British soldier on the nape of the neck, where his queue of plaited hair absorbed the impact, giving him nothing worse than a stiff neck. The tendency of musket balls to spread and deform upon splatting against a hard surface was evidently quite well known to soldiers of the period, as another British soldier wrote (presumably joking) that in the battle of Ticonderoga his friend had a ball "absolutely flatten'd" against his forehead like "a bullet of clay when it has been thrown against a stone wall" (Brumwell 2002:250).

Given these considerations, I would suggest that many of the bullets hitting the walls of the mission buildings likely just deformed on impact and dropped to the ground, lacking sufficient momentum to embed themselves in or pierce the wall. This would help explain the lack of melting from the ensuing fire which consumed the mission, although some of the bullets may have indeed lodged into the walls. At least one study (Stacy et al. 1990) has attempted to ascertain the architectural makeup of an impact surface by studying microscopic inclusions found within a flattened colonial-period lead ball, and such an approach may have bearing at Mission San Sabá as well.

One item in Cluster 1, artifact 564, was actually found about 25 meters north of the core of the site, away from the main concentration. This may perhaps represent a Norteño bullet which struck the north stockade wall. Incidentally, this object also bears the distinction of having the lowest probability within Cluster 1 of being European, at 64.1%. Whether it is possible to read much into this combined circumstance of increased distance and relatively low probability remains difficult to say, though. A few other lead balls (185, 606, 602, and 588) lie slightly to the south of the main dense core of the site, but overall seem to enhance rather than disrupt the general pattern.

The clear implication of all these details, then, is that this particular aggregation of 23 lead balls of likely British or German geologic origin is a direct result of Norteño firepower directed toward the chapel at the center of the mission compound. The bullets originated from the common French practice of importing raw sources of foreign-produced lead, followed by later export of finished ammunition to the Louisiana colony. Some of this ammunition entered into the fur trade, and would have been received by the aligned Norteño tribes from French traders active along both the Red River (in the case of the Wichita, Comanche, and Tejas) as well as clandestine traders operating further to the south in vicinity of the Trinity, Brazos, and Neches Rivers (in the case of the Tonkawa, Yojuane, and Bidais). Some of the ammunition may have even conceivably been procured by the hostile tribes through illicit trade with the Spanish at Los Adaes and elsewhere, with the Spanish in turn often receiving ammunition directly from the French themselves. In this case, the rampant illegal trade underway at this time could mean that Spanish citizens may have unwittingly contributed to the destruction of one of their own missionary enterprises. However, given the overall predominance of French ammunition in trade, in isotopic terms the event would still carry a pronounced hallmark of French involvement, regardless of how the contortions of colonial trade actually played out.

Isotope Cluster 2

Returning to a discussion of the isotope values, a few stray items of seeming European provenience remain to be explained. Unlike most of the other clusters that will be identified for Mission San Sabá, Cluster 2 is not actually a tightly defined area of isotope values, graphically; rather, it has been established as a catch-all grouping for seven artifacts with widely scattered but assuredly European isotope signatures (Figures 3-5). These artifacts (133, 160, 562, 567, 574, 583, and 601) are clearly distinct from Mexican and Mississippian sources, but their identification poses significant challenges. Discriminant function analysis classifies them as very strongly European, with probabilities ranging from 63.6% (the next lowest is 87.4%) to 98.7%, with an average probability of 88.5%. In the case of 160 and 133, their exceedingly high probabilities (98.7% and 98.4%) result in part due to the fact that these points lie somewhat near the European group centroid but in a direction opposite to nearly all of the Mexican data points.

In checking the lead isotope graphs, it is quite strange to note that two items (583 and 601) plot well within the $^{206}Pb/^{204}Pb$ and $^{207}Pb/^{204}Pb$ values of Cluster 1, but fall well outside of Cluster 1 in comparison to the $^{208}Pb/^{204}Pb$ values (Figure 5). Interestingly, these two items fall at either end of the $^{206}Pb/^{204}Pb$ values of Cluster 1, but for whatever reason have a higher relative ratio of ^{207}Pb compared to the other objects (Figure 6). One of these objects (item 583) is a not particularly deformed lead ball weighing 14.2 grams. Like other items from Cluster 1, it, too was found at the core of the site. The other object (item 601) is the largest single piece of lead found on the site, an amorphous lump weighing 156.6 grams. This single piece of lead would be sufficient for making nearly a dozen lead balls of average size, and in spherical form would assume a diameter of 1.17 inches. It has some marks and surface abrasions, and looks like it may have been struck with a plow a few times, but otherwise is not flattened in a way that would suggest pooling of molten lead. It was found some 15-20 meters to the southeast of the core of the site, and was initially thought to perhaps represent a mass of lead fired from one of the swivel guns stationed by Juan Leal inside the chapel. As aberrant as the lead isotope signature of this item may be, though, it is not made of Mexican lead, which seems to put this theory in doubt. Perhaps it represents raw stock held by one of the Norteño warriors, although this explanation has little founding and remains unsatisfying.

I would be willing to speculate that, akin to Cluster 1 objects, artifacts 583 and 601 are probably both products of British (or possibly German) lead that happen to display a greater natural variation in their concentration of ^{207}Pb. It is difficult to comprehend any mixing scenario in which only ^{207}Pb levels would be enhanced. This could possibly be a matter of instrumentation error as well, although periodic inter-run tests of NBS lead standard 981 revealed very consistently low errors on the order of hundredths of a percent throughout testing. Objects 583 and 601 might both derive from a matching source of lead, but for the time being they remain enigmatic. Though both show a distinct affinity to Cluster 1 artifacts in two of the three compared isotope ratios, they remain distinct enough in their makeup to warrant inclusion within Cluster 2 along with five other artifacts showing scattered isotopic signatures.

Item 574 (a lead ball) in particular is quite isolated (graphically) from every other artifact tested in this study, expressing ratios indicating low contributions of radiogenic ^{206}Pb, ^{207}Pb, and ^{208}Pb (Figure 2, lower left-hand corners). These values do not conform well with either the main trends of European lead nor the typically more highly radiogenic Mexican lead. No British leads seem to match it. Among French leads there are some somewhat similarly low values reported by Trincherini et al. (2001) for the Montagne Noire vicinity of southern France. In Germany some remotely similar values are reported for the Waldsassen region on the border with the Czech Republic (Höhndorf and Dill 1986) and for the Vogtland and Central Erzgebirge regions (Niederschlag et al. 2003:79). In Spain two lone points out of hundreds suggest perhaps an aberrant value from the Linares-La Carolina district (Trincherini et al. 2001) or the Sierra de la Demanda massif of northern Spain (Velasco et al. 1996). The unlikely prospect of matching sources from Trans-Pecos Texas and far north Chihuahua (James and Henry 1993a and 1993b) seem to round out the meager possibilities for this isolated data point. Little else can be said about item 574, other than that it is a slightly flattened lead ball found about 30 meters to the north-northeast of the core of the site. It perhaps represents a bullet strike against the stockade wall.

Points for artifacts 562 and 567 (two lead balls) plot well to the left of Cluster 1 (Figure D). These two objects inhabit roughly the same area as two items from Bryson-Paddock and/or Deer Creek. This area remains well populated with British isotope values, including several nearby points for different regions of Wales, as well as some affinity to Cornwall values for artifact 567. Scattered points from the Haut-Allier area of southern France's Massif Central are also indicated (Marcoux and Bril 1986). Neither German nor Spanish values align well, with seeming correspondences in $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ values, but significant offsets in $^{207}Pb/^{204}Pb$ values. Item 562 was found within the core of the site, while 567 was located about 25 meters to the north, perhaps representing (along with 564 and 574) another strike against the stockade that surrounded the mission complex.

Artifacts 133 and 160 plot above Cluster 1 (Figure 5) in an area generally devoid of German or Spanish data points. Again, a British or possible French signature is indicated, with either portions of Wales, Cumbria, or the Pennines suggested for England, and the southern Massif Central of France also rather weakly hinted at. Item 133 is the second-largest non-melted piece of lead recovered from the site, a lump weighing 42.1 grams (enough to make about three lead balls of average size), found at the southeast edge of the central concentration of lead artifacts. The largest piece of lead, 601 (already discussed) lies about 10 meters to the southeast, and another 10 meters to the east of this is artifact 160, a lead ball weighing 11 grams. Whether there is any significance to this string of three artifacts with anomalous signatures (133-601-160) found in the eastern portion of the site remains difficult to say.

Overall, the seven artifacts placed in Cluster 2 (which is perhaps better thought of as simply Group 2) are some of the most puzzling artifacts at Mission San Sabá from an isotopic standpoint. Four of them were found more at the periphery of the site, while the other three came from the site core. All are clearly made from lead of European origins; given their context and general association with the artifacts of Cluster 1, there seems to be a good probability that the artifacts of Cluster 2 are also made from British or German lead.

Lead Artifacts with a Mississippi Valley Geologic Origin at 41MN23

Isotope Cluster 3

Only four artifacts from Mission San Sabá displayed the unmistakable and highly radiogenic signature of lead from the Mississippi Valley, with all four registering a 100% statistical classification as such (Figures 13-15). Still, this represents a mere 6.7% of the total sampled assemblage, which is otherwise overwhelmed by European and Mexican sources. In fact, the preponderance of European lead over Mississippian lead found at Mission San Sabá is the factor that fueled the greater part of this entire study. A pattern of isotope signatures had been anticipated at 41MN23 more akin to what was found at Deer Creek and Bryson-Paddock, as it was expected that around half or more of the spent ammunition from Mission San Sabá would have derived from Mississippi Valley leads. When the data from 41MN23 failed to bear this expectation out, an explanation was sought to explain the perceived deficiency of highly radiogenic lead artifacts. This in turn resulted in an extensive investigation into the historic background material presented in Chapters 5 and 6. By taking into account the intricate details of French colonial trade patterns in the eighteenth century, the continued dependence of Louisiana and the Illinois Country on frequent exports of ammunition, and the disruptions in French commerce caused by the Seven Years' War, a model was eventually arrived at which adequately explained the lack of Mississippi Valley lead objects recovered at Mission San Sabá.

The four artifacts found at Mission San Sabá with Mississippian lead isotope signatures (176, 582, 600, and 620) are all deformed lead balls, ranging in weight from 13.6 to 16.8 grams, corresponding to calculated diameters of .52 to .56 inches. Three were found within the core area of the site, while the fourth, artifact 620, was found on the surface near Backhoe Trench 4. The exact position, orientation, and length of Backhoe Trench 4 is unclear at this point, and more detailed pinpointing of artifact 620's provenience must await production of a final site map. However, the location of the remaining three lead balls directly within the core of the site, in distinct association with the many deformed lead balls of Cluster 1, suggests that they share a common Norteño origin. Like the Cluster 1 bullets, the Mississippian-derived ammunition was fired toward the church where it became deformed on impact with the walls.

Three of these bullets (176, 582, and 600) actually plot rather closely together considering the isotopic heterogeneity that Mississippi Valley leads are noted for. These three specimens all fall well within the range of values for southeastern Missouri, as compared to data from Goldhaber et al. (1995) and the archaeometric study of four Illinois sites undertaken by Farquhar et al. (1995) (Figures 14-15). The fourth point, for 620, has a more radiogenic signature and lies some distance from the other three, but also seems to conform better with a southeastern Missouri source than with an Upper Mississippi Valley signature (Figure 15).

It is evident that French-supplied bullets made from British or German lead played the largest role in the 1758 assault on Mission San Sabá, but it appears that a few of the attacking Norteños (and perhaps even a single individual) still had some lead balls on hand made from lead procured at the French mines of southeast Missouri. Supplies of this particular resource had likely been entirely diverted up the Mississippi for at least a couple of years by this point in time, but some residual stock no doubt lingered within the trade network. It may even be that a few of the Taovayas hunter-warriors, having recently moved in the mid-to-late 1750s from Deer Creek and Bryson-Paddock to a newly established twin village on the Red River, may have had a few stray Missouri-origin lead balls remaining in their bullet pouches. In such a fashion, lead produced by seasonal French miners at mid-century could have traveled some 750 miles from the ore-bearing hills of southeastern Missouri, to be eventually used in the attack that would leave both the Mission San Sabá and further Spanish colonial ambitions in total ruin.

Lead Artifacts of Mexican Geologic Origin at 41MN23

The remaining lead artifacts sampled from Mission San Sabá present four distinctly separate clusters of lead isotope data, all with rather clear signatures of Mexican lead. An argument will be made, though, that some of the bullets made from Mexican-origin lead may have actually been fired by the Norteños.

Isotope Cluster 4

As noted in the introduction to this results section, eight of the nine samples which are here placed into Cluster 4 as specimens of Mexican lead were actually statistically classified as European samples through discriminant function analysis. However, it is my contention, based upon a suite of historic and archaeologically related details, that these artifacts do in fact originate from Mexico rather than Europe. To begin with, the assigned probabilities are substantially lower than previously encountered, ranging from 56.4% to 71.2%, with an average calculated European probability for Cluster 4 of 64.8%. (The one object I have assigned to this cluster which did classify statistically as Mexican, 475, did so only very weakly, with a probability of 54.1%.)

Following and expanding upon the argument first presented in the previous chapter, there is a statistical cut-off, shown approximately by the dashed line in Figure 21, which separates the classification of archaeological objects as either Mexican or European. This cut-off point is mathematically dictated by the totality of weighted calculations performed for known values, and follows a distinctly linear pattern. However, when examining Figure 21, it is impossible not to notice a trend of known Mexican data points which carries above this dashed line, limning and intermingling with the right edge of the data cloud formed by known European data points. This column of yellow dots constitutes some of the 47 points, known to be Mexican, that were nevertheless incorrectly classified as European data points during statistical analysis. These points thus contribute to the overall 11.9% error rate in classifying Mexican samples (see Table 1). Within this same region of Figure 21 is a cluster of archaeological samples which follow the same Mexican trendline. It is my contention that these can also be readily identified as potentially mis-classified Mexican-origin samples, since distinct external traits, historic background information, and details of on-site provenience all conspire to trump the blind assignments provided by a startlingly accurate but not entirely error-free statistical procedure.

Cluster 4 is comprised of nine artifacts, all but one of which are clearly melted examples. Graphically they form a fairly tight grouping (Figures 5 and 17-18) that conform rather well with the series of points provided by Joel et al. (1988) for that study's analysis of lead glazes of majolica ceramics of early Mexican manufacture (Figure 18). As was the case with the individual lead balls from 41VT8 and 41MN1, this majolica evidence provides some indirect but corroborating support that these samples match well with lead sources known to have been exploited in Mexico as early as the sixteenth century. The addition of these nine eighteenth century samples (plus the two others from VT8 and MN1) helps to reinforce this overall pattern.

These nine samples also conform relatively well to a series of points in Cumming et al. (1979) corresponding to the highland plateau of Mexico, including samples from Pachuca, Taxco, and Angangueo. A small region to the north including Charcas in San Luis Potosi is also potentially indicated, as is Ojuela in the eastern Chihuahua, and points in Sinaloa including Copala and Tigre. Such a smattering of points from across all of Mexico is not terribly helpful, though. The data points of this cluster also match well with some points for Chihuahua and the Sierra Madre Occidental provided by Housh and McDowell (2005) and McDowell et al. (1999). The Sinaloa connection is possibly reinforced by the fields shown in Miranda-Gasca et al. (1993).

If nothing else, the bulk of the graphical data indicate that these values are definitively Mexican, since British, French, and German data points are virtually absent from this region of isotope values. Of the Spanish data points which do align fairly well in the $^{207}Pb/^{204}Pb$ plots from Stos-Gale et al. (2005), Marcoux (1998), and Arribas and Tosdal (1994), the corresponding $^{208}Pb/^{204}Pb$ values are considerably offset. A few scant data points from Velasco et al. (1996) which conform consistently in both plots indicate a possible connection with dolomite host rocks of the Santander district in northern Spain.

However, given the overall trend of the evidence and the historical context from which the items of Cluster 4 derive, a Mexican source seems to be strongly indicated.

The data points from Cluster 4 also fall alongside the results from the single lead ball tested from Presidio San Sabá (Figure 18). As discussed during the analysis of that object, a single value from the Hog Thief Bend Prospect of the Llano Uplift Region matches this zone of values very closely in regard to $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ values, but much more poorly in respect to the $^{207}Pb/^{204}Pb$ values. Some Cluster 4 artifacts share this same close yet distant association. Again, the tantalizing prospect of a tenuous connection with the fabled Los Almagres mine is hinted at, but much more data will be required to adequately assess any such claim.

The nine artifacts of Cluster 4 present a very interesting situation, in that eight of them (201, 275-1, 275-2, 367, 390, 395-1, 396-2, and 475) are distinctly melted objects, misshapen and flat, giving the appearance of having puddled on the ground after being brought to a molten state. Further, each of these eight items was found in a very small area at the south end of the site, adjacent to the modern highway, that produced numerous similar melted lead pieces. Only a small subset of the several dozen lead pieces recovered in this area were tested, of which many have rough surfaces with the appearance of intermixed impurities. This appears consistent with molten lead pooling on bare soil. It had been suspected well before this study ever developed that this portion of the site represented the Spanish storerooms which were thoroughly pillaged by the attacking Norteños before being burned to the ground (Grant Hall, personal communication 2006). These findings seem to resoundingly confirm that notion. In all likelihood, supplies of surplus Mexican lead brought to the mission were kept here, with much of the lead melting during the inferno which destroyed the outbuildings.

Lead, either raw or manufactured, was not actually among the items listed in the original inventory of supplies purchased for the mission. Combing the inventory translation prepared by Philip A. Dennis in Hindes et al. (1995:69-78), I find no direct mention of any lead objects, a finding also corroborated by Jennifer McWilliams (McWilliams 2001 and personal communication 2009). Two "long Castilian shotguns" are indicated in the inventory, and powder is mentioned, too; however the powder is clearly of the glutinous variety used in sizing paper, as it is listed alongside items such as inkwells, reams of paper, and sandboxes for use in writing. The only possible indication of an article possibly serving as ammunition comes in an entry for "8 bunches of *granizo*", which Dennis notes literally means "hail" (Hindes et al. 1995:72). The form or function of this mysterious "granizo" remains unknown. However, it is evident from the accounts of the attack provided earlier that the survivors had ample ammunition available to them with which they attempted to defend themselves.

Additional evidence for the presence of not only lead on the site, but specifically Mexican lead, is found in a letter and map penned by one J. J. Callan in 1901. On a map, Callan indicated a spot near the now-known location of Mission San Sabá which he labeled "Presidio. Smelter." The spot marked is apparently incorrect in referring to the presidio, and Jennifer McWilliams speculates Callan may have interpreted the remains of the mission as a smelter (McWilliams and Boyd 2008:44). In a corresponding letter about the mission environs, Callan commented that:

> "Hundreds of prospectors…have been here from time to time within the past fifty years… [looking for] the lost mine and hidden treasure. But none

> ever succeeded in finding anything to indicate the presence of either, excepting the remains of the smelter, some crucibles, a few small slabs of lead containing a considerable per centum of silver, some tools and impliments [sic] and parts of human bones" (McWilliams and Boyd 2008:75).

This seems to indicate that at the turn of the twentieth century lead slabs were still present at the site of Mission San Sabá; it will be recalled that in 1905 John Warren Hunter made casual note of the location of mission's remains, ultimately leading to the site's rediscovery (Hunter 1935 [1905]:21). It seems entirely likely, then, that Callan could have been familiar with the location in 1901. The critical point here is that the lead slabs commented upon by Callan are said to have contained a considerable percentage of silver. Evidently someone at some point bothered to assay some of these lead bars, probably as part of a quest for the Menard area's legendary silver mines, and determined the lead to have some appreciable silver content. This is precisely what might be expected of Mexican lead produced as a by-product of the Mexican silver mining industry. It would not be uncommon for lead derived in this way to contain an easily detectable residual quantity of silver, and trace element analysis of the artifacts comprising Cluster 4 may help to confirm the link between Callan's comments of 1901 and the lead pieces recovered archaeologically in 1994 and 1997. Additional lead pieces recovered in the 2007 right-of-way excavations likely have similar origins. The key point here is that Callan's letter seems to offer strong circumstantial evidence that supplies of lead held at Mission San Sabá derived from Mexican sources.

A letter written by the director of the San Antonio missions only five days after the destruction of Mission San Sabá also shows that the Spanish missionaries were accustomed to getting their lead directly from Mexico. Thinking even Presidio San Sabá to be destroyed, and uncertain of the degree of danger faced by the San Antonio missions, Father Maria Ano de los Dolores wrote to the priests of the Rio Grande missions, imploring them to send him lead for use as ammunition: "I will appreciate if, with all diligence, Your Reverences request a *carga* [12 *arrobas*] of lead and as much gunpowder as you can, and send them without delay by Indians of those missions [the Rio Grande missions], as these missions are short of ammunition" (Wade 2007:201). Wade offers that 12 *arrobas* was equivalent to 300 kilograms of lead, with 25 kg to the *arroba*, although other sources (Nathan and Simpson 1959:141; Kyle 2000:59) state the equivalency at 25.3 pounds or 11.5 kg per *arroba*. Either way, Father Dolores was requesting a substantial amount of lead for the defense of the San Antonio missions.

The Mexican origins for the melted lead pieces which form isotope Cluster 4 thus seem to be well established through both isotopic analyses, archaeological provenience, and corroboration with the historic record. Notwithstanding the results of the discriminant function analysis, which would impute a European origin upon these artifacts, I feel that there is substantial and overwhelming evidence to suggest that they are instead of Mexican derivation. This allows for a particularly interesting conclusion to be drawn regarding the final item to be considered from Cluster 4, artifact 688. This is a deformed lead ball weighing 14.5 grams (corresponding to a calculated diameter of .53 inches) that was found within Feature 26 during the 1997 excavations at 41MN23. This feature, measuring some four by three meters in extent, contained a great deal of burned animal bone and scorched earth. It is thought that this feature northwest of the chapel footprint may represent a Spanish colonial period trash pit (Grant Hall, personal communication 2006). If so, this deformed and slightly scorched lead ball, matching the isotopic profiles of the melted pieces at the southern end of the site, could be explained as a piece of Spanish ammunition made on-site from a stored stock of raw lead. It may have been used to kill a deer or other game animal for use as a food source, and could have been incorporated into the rubbish heap as a result.

Isotope Clusters 5, 6, and 7

Relatively little can be said about the isotopic composition of the remaining three clusters, which contain a total of 17 artifacts, except that they appear to be formed of distinctly Mexican lead. Statistically, all but two of these objects classify as Mexican origin lead via discriminant function analysis. The two non-conforming examples (197 and 572) belong to Cluster 7 and classify as European, although similar to Cluster 4 I believe a case can be made that these are indeed Mexican samples but once again simply mis-classified.

Graphically, few reported data points for geologic sources inhabit this region of isotope values, although the values for Clusters 5, 6, and 7 fall along the general trendline for Mexican leads if extended to include increasingly radiogenic sources (Figures 17 and 19). As with the squarish pieces of lead from Presidio San Sabá and four of the five items tested from Mission San Lorenzo, a few scattered points from Housh and McDowell (2005) and plots of unreported raw figures by Miranda-Gasca et al. (1993) suggest a connection with sources from eastern Chihuahua and the Sierra Madre Occidental, as well as the Fresnillo district of the Guerrero terrane of Mexico. Such locations would be entirely consistent with the active silver mining underway within these regions during the eighteenth century.

Clusters 5, 6, and 7 are being lumped together here to some degree owing to a couple of uniting factors: the lack of sufficient geological or archaeological comparative data to adequately distinguish them other than by their raw values, and the fact that most of the 17 items in these three clusters are identifiable as lead balls. This differs from Cluster 4, in which most of the artifacts appear to have come from melted stocks of raw lead. The implication here is that many of these bullets likely represent ammunition connected with the Spanish either during the attack or during the course of everyday life at the mission prior to the attack. Cluster 5, though, presents a possible exception to this overall Spanish connection, as will be explained.

Following the rather clear pattern established by Clusters 1, 2, and 3 of incoming Norteño ammunition composed of European and Mississippi Valley leads, a corresponding pattern of outgoing Spanish bullets composed of Mexican lead might be likewise expected. This model of events does hold up to some extent, although not quite as clearly for the Spanish output as what was seen for the Norteño input. For one thing, the Spanish were firing outward under duress, and while some of their bullets may have struck the surrounding stockade, many likely continued on for some distance. Many Spanish bullets may yet remain buried in the fields and pastures surrounding the mission site. The Norteños, on the other hand, were able to concentrate their firepower on a single, central location. It might not have been the broad side of a barn, but they were at least aiming at some type of structure. The dense central pattern of bullets surrounding the footprint of the mission's chapel is therefore probably a result, to some extent, of the fact that these items were logically more concentrated and thus easier to find. It is clear, though, that both sides did a good bit of shooting, if the Spanish managed to kill 17

Norteños during the ordeal as has been reported. Still, the Spanish were vastly outnumbered, and would presumably have left behind fewer bullets as evidence, and those much more scattered, than did their attackers. With these thoughts in mind, brief reviews of isotope clusters 5, 6, and 7 will now be presented.

Isotope Cluster 5

Discriminant function analysis attributes the six artifacts of Isotope Cluster 5 to a Mexican source, with probabilities ranging from 61.1% to 80.1%, with an average probability of 67.6%. Graphically, these six artifacts (167, 172, 246, 363, 594, and 706) compose a very tight cluster well removed from the bulk of European values (Figures 5, 7, and 19), and all are identifiable by weight or appearance as lead balls. All but item 706 are rather deformed, with weights ranging from 12.3 to 14.0 grams, with corresponding calculated diameters of .48 to .55 inches. Two of these objects, 363 and 706, have no provenience data, although 363 is stretched out and curled in a manner suggestive of melting; it may have accordingly come from the southern portion of the site near the supposed storerooms, where the fire seems to have been most intense.

Of the remaining four artifacts from Cluster 5 for which we do have provenience data (167, 172, 246, and 594), two were found directly within the core of the site while two others lie immediately adjacent to and on the southern fringe of the main concentration (Figure 20). These four lead balls are especially notable for being deformed and having been found in close association with the footprint of the chapel. I would therefore argue that there is the distinct possibility that these particular bullets, despite being made of what appears to be distinctly Mexican lead, may have also been fired by the Norteños towards the church. A few main mechanisms by which a Norteño warrior may have come into possession of Spanish-produced bullets of Mexican geologic origin are readily apparent: either by illicit trade directly with the Spanish, through indirect receipt of Spanish goods by way of elaborate trade channels, or through raiding activities. As has been demonstrated in the historical background material in Chapter 5, these types of activities occurred to a considerable extent, and it would be folly to think that Spanish ammunition or weaponry remained strictly within approved trade channels. To be sure, French trade goods were certainly easier to obtain and remained the primary source; however, the particular circumstance of these four deformed bullets of Mexican-origin lead gives a strong suggestion of contraband Spanish items occasionally making their way into Norteño hands.

Isotope Cluster 6

Isotope Cluster 6 consists of seven artifacts (131, 161, 393, 394-1, 571, 596, and 608) in another rather tight grouping (Figures 5, 8, and 19). Statistically these seven items classify very strongly as being of Mexican origin, with probabilities ranging from 77.3% to 90.4%, and an average probability of 81.8%. By appearance and weight five of these seven items also appear to be lead balls, ranging in weight from 12.0 to 12.8 grams, and with corresponding calculated diameters of .47 to .51 inches. The two oddly-shaped objects (393 and 394-1) also fit well within the normal weight range for lead balls at 13.8 and 14.5 grams, respectively, with calculated spherical diameters of .55and .59 inches. Objects 393 and 394-1 were found in the south portion of the site, directly alongside the clearly melted artifacts comprising Cluster 4. This suggests that the strange shapes taken on by artifacts 393 and 394-1 are the result of melting (394-1 in particular appears only partially melted, forming two bizarre lobes), and further suggests that already formed ammunition made from a different lead source may have been kept in the mission storerooms alongside stocks of raw lead. This would also serve as an indication linking the other scattered artifacts of Cluster 6 more definitively to the Spanish.

Of the remaining five lead balls comprising Cluster 6, three were found within the core of the site and two somewhat on the periphery to the north and east (Figure 20). Artifact 571 in particular is one of the few still mostly round balls recovered from the site; if fired, it did not strike anything hard, and may have even been dropped or lost here at some point as opposed to being fired. It is somewhat difficult to explain the patterning on the site of Cluster 6 artifacts, and it is not impossible that these too, may have derived from Norteño gunfire. However, the inclusion of the melted items 393 and 394-1 within the region of the storehouse would seem to tie the Cluster 6 artifacts more closely to the Spanish.

Isotope Cluster 7

This cluster of four artifacts is notable for consisting of three undeformed lead balls (572, 580, and 581) found at the periphery of the site, along with one badly distorted item (197) that came from the southern storeroom area so intensely affected by fire. The three undeformed lead balls weigh 9.2, 12.2, and 12.9 grams, corresponding to calculated diameters of .38, .48, and .51 inches. The figures for the melted/mangled artifact 197 are 15.6 grams and .61 inches. All four items are found outside the core of the site, lying to the east, west, and south (Figure 20).

Statistically, Cluster 7 is technically a split group, with the results of a discriminant function analysis classifying two of the items (197 and 572) as European (probabilities 60.2% and 82.9%) and the other two items (580 and 581) as Mexican (probabilities 54.8% and 67.4%). As was the case with Cluster 4, though, I contend that all four of these artifacts are more than likely actually Mexican in origin. In Figure 21, item 197 sits directly within the cluster of objects that I believe to also represent mis-classified Cluster 4 objects of Mexican origin. Item 572 sits well off by itself, and is harder to explain away, but it is not inconceivable that its combination of discriminant function values simply marks an errant Mexican lead isotope value well outside the norm. When viewed graphically, 572 certainly conforms much better with the generally more radiogenic Mexican data points (the highest point seen in Figure 19) than with rather distant European values. Further, the high calculated probability of item 572 as European (82.9%) derives primarily from its nearness to the European group centroid in Figure 21 and its corresponding distance from the Mexican group centroid. Similarly isolated (and mis-classified) known Mexican data points seen well above the dashed line in Figure 21 would similarly register erroneously high, but incorrect, European probabilities. (The intent here is not to dismiss a troublesome data point out of hand, but rather to deal with an idiosyncratic case in as logical a manner as possible.)

Isotopically these items also form a strange grouping, with items 197, 580, and 581 plotting somewhat closely to Cluster 5 in the $^{206}Pb/^{204}Pb$ and $^{207}Pb/^{204}Pb$ values, but offset quite a bit from Cluster 5 in $^{208}Pb/^{204}Pb$ values (Figures 5 and 19). This is akin to the behavior of items 583 and 601 from Cluster 2. Clearly a higher component of ^{208}Pb is indicated, but the rationale for certain items to "jump" in respect to other more stable groupings remains unclear. Thus, while items 197, 580, and 581 seem to pair fairly well with Cluster 5 in their $^{207}Pb/^{204}Pb$ readings, they leap towards the region occupied by the isolated data point for 572 in their $^{208}Pb/^{204}Pb$ pairings. Meanwhile, artifact 572 retains its relative position in both isotope pairings with regard to Cluster 5. Again, Cluster 7, like Cluster 2, serves as something of a catch-all grouping for artifacts which do not conform especially well to more distinct patterns found in the data.

As mentioned, the four objects from Cluster 7 were found about the periphery of the site, but not too far (generally, only 15-20 meters) beyond the area marking the footprint of the chapel. The three undeformed lead balls clearly have either not been fired or did not strike anything hard enough to cause deformation in the course of being fired. Perhaps they were fired from the mission during the course of the battle, and entered the ground; conceivably, the soil may have been soft enough and the velocity low enough to prevent massive deformation, although this is purely speculative. Further conclusions regarding the isotopic and geographic patterning of Cluster 7 artifacts remain difficult.

Summary

Lead isotope analyses were performed on a selection of sixty lead artifacts from Mission San Sabá, revealing the presence of lead from European, Mexican, and Mississippi Valley sources. Using statistical and graphical means to define groups, a total of seven isotope clusters were identified, with half (30) of the tested artifacts tracing to likely European sources. These artifacts, by and large, demonstrated isotope values strongly consistent with known British sources of lead from historic mining contexts.

Taken in combination with what is known about the significance of British lead exports to France during the eighteenth century, a British geologic origin for most of these European-derived artifacts seems highly probable. However, German sources and possibly others from throughout Europe can not be entirely discounted. Statistically, 16 artifacts from 41MN23 were attributed to Mexican sources via discriminant function analysis, although it is my contention that an additional ten Mexican-origin artifacts were mis-classified as having derived from European sources. Of these 26 total lead objects derived from Mexico, then, the eighteenth-century mining centers of Chihuahua and the Sierra Madre Occidental likely provided much of the metal as a by-product of active silver mining in those regions. The remaining four artifacts had highly radiogenic isotope signatures and were clearly composed of lead from the mines of southeastern Missouri.

By combining provenience data with the isotopic profiles of individual artifacts, it was possible to map the distribution of lead artifacts across the site according to their respective isotope groups. This revealed many patterns, with the main pattern consisting of a distinct concentration of deformed lead balls clustering about the area known to define the footprint of the mission's chapel. It was here that the survivors of the attack took refuge, with many bullets fired by the attacking Norteños striking the walls of the church and becoming mixed with the surrounding soil. Over a century of modern agricultural plowing at the site has failed to obliterate this pattern, with deformed bullets made from likely British and Missouri lead forming the bulk of the concentration found at the core of the site. This ammunition would have been acquired by the attacking Norteños through the intricate networks of French trade, with a few bullets of Mexican origin lead also perhaps coming to the Norteños by way of illicit Spanish trading activities or through raiding. A second major pattern to emerge from the data set is the isotopic similarity of many melted pieces of lead found on the site, indicating the presence of stockpiles of Mexican lead within the plundered storehouses of the mission.

Mission San Sabá has offered an ideal test case for the application of lead isotope analyses to colonial period sites, involving the explosive clash of multiple cultural components at a site very narrowly defined in time and space. A network of aligned Native American tribes armed with French weaponry violently attacked this short-lived Spanish outpost, definitively asserting their own combined political will and stifling that of the Spanish in the process. In doing so, they left behind a substantial residue of lead artifacts which help to tell the story of not only Mission San Sabá, but also of distant events which affected even this isolated outpost on the Spanish frontier. The 1758 attack on the mission came directly in the midst of a larger imperial conflict being waged between France and England on both the North American and European continents, a conflict which had a tremendous effect in disrupting the normal supply chains of French trade.

As shown by the lead isotope evidence from Deer Creek and Bryson-Paddock, lead from the mines of southeastern Missouri was a staple in the fur trade carried on with some of the Native groups who would go on to attack Mission San Sabá. With the outbreak of the French and Indian War in 1754 and the beginning of the Seven Years' War in 1756, this vital resource was quickly diverted from its normal distribution patterns. Missouri lead would instead be sent northward from the Illinois Country, to places where the French had urgent need of it to wage war against the British. At the same time, massive amounts of European-manufactured ammunition were being imported by way of New Orleans to circumvent the British blockades of Quebec. Some of this material would be allowed to be diverted to the Indian trade, in order to maintain the crucial Native alliances that were dependent on ongoing commerce. In this way the wartime breakdown of French trade networks is keenly manifested in the overall lead isotope signature at the star-crossed Mission Santa Cruz de San Sabá. As an unwitting and indirect player in a drama of global scale, even this humble and isolated outpost shows evidence of the greater turbulence that was unfolding half a continent and a world away.

CHAPTER 9

CONCLUSIONS

A total of nine colonial-era French and Spanish-influenced archaeological sites were selected for evaluation in this lead isotope study, all of them dating rather securely on the basis of historic and archaeological evidence to the first three quarters of the eighteenth century. This span from roughly 1700-1775 was specifically chosen because of the sensitivity of this time period in evaluating the utility of lead isotope studies on colonial-era sites of the middle North American continent. By 1700 the French had just established a permanent presence in Louisiana, and by 1775 the Spanish had fully retreated from the farthest advances they would make on the Texas frontier.

During this period both France and Spain engaged in a vigorous competition for control of the North American continent, and for the loyalties of the dozens of Native tribes they encountered. Widely divergent French and Spanish economic systems took root in the demanding environment of a New World, one based on a *laisssez faire* attitude of trade and engagement and the other upon deliberate conversion of both religion and identity. The colonizers would both briefly prosper and eventually wane, leaving behind distinctive physical evidence of their dealings with one another and of their transformative influence on Native societies. After the French and Spanish had faded from the scene of North America, the imprint of their contributions to the cultural landscape would stand as their most lasting legacy. Among the many physical objects left in their wake were a multitude of lead artifacts, often thought of as rather mundane objects worthy of little attention in their own regard. However, in combination with their historical, archaeological, and geological contexts, these have the capacity to speak volumes about French, Spanish, and Native interactions during this tumultuous period.

Lead isotope studies have been previously applied to great effect in the Old World, where possible trade networks remained somewhat constrained owing to inherent geographic and technological restrictions. The emergent and competing trans-oceanic economic systems of eighteenth century Spain and France, however, have presented an opportunity to evaluate the dynamics of a larger system involving multiple cultures during a period of great transformation. In particular, the simultaneous utilization of lead derived from three widely divergent sources (Europe, Mexico, and the Mississippi Valley) within the same system has offered the potential of drawing particularly insightful conclusions as to the nature of French, Spanish, and Native commerce and conflict in colonial North America.

Perhaps the greatest conclusion to be drawn from this study overall is the sheer complexity involved in tracking down the origins of objects involved in eighteenth-century colonial trade. Certain expected trends were indeed borne out – as anticipated, lead sources from Europe, Mexico, and the Mississippi Valley all played critical roles in the supply and commerce of French, Spanish and Native trade. However, the mechanisms by which these commodities were eventually transported to an end consumer turned out to be considerably more complicated than imagined. Using lead artifacts as a hallmark for other trade goods, then, we also gain a better sense of the overall extensiveness and far-reaching implications of the colonial trade. One also begins to appreciate the difficulty with which many of these items were produced and transported. In light of the evidence presented in this study, it was no mean feat for colonists to distribute their products quite as widely as they did. The French quickly began to extract lead from the mines of southeast Missouri, but still found it necessary to ship kegs of ammunition across the Atlantic to meet an insatiable demand. Many of these bullets would wind up at far-flung outposts of the fur trade on the Southern Plains, and were perhaps distributed even well beyond through the activity of extended Native trade networks. Similarly, the Spanish would laboriously haul goods from Mexico by ox cart or mule train to their northern provinces, attempting to supply their outermost settlements in a usually frustrated effort aimed at thwarting French encroachment.

Although some fairly routine routes were used to transport items manufactured either overseas or domestically to their intended consumers, objects may have well been subjected to a number of non-standard stages within any given transaction. The prospect of illicit trade in particular presented the opportunity for objects to enter irregular supply chains, with French materials commonly entering into Spanish hands at such exchange nodes as Los Adaes. The disruption of standard supply chains during periods of hostility or warfare had even more substantial impacts on how goods were moved about. In the tense decades of the 1720s and 1730s in the Illinois Country, during which Indian raids made settlement of the backcountry excessively hazardous, little development of the Missouri lead mines could be achieved. No development of a domestic bullet-making industry followed, and as a result ammunition sent from the mother country continued to be essential for the duration of French sovereignty in North America.

Wars on the European continent also had the effect of stifling the flow of goods, as seen with the slowdown caused by the War of the Austrian Succession from 1744-1748. And, as ultimately demonstrated by the peculiar lead assemblage manifested at the Mission Santa Cruz de San Sabá, turmoil on both continents in the form of the Seven Years' War and the French and Indian War would cause a nearly complete breakdown and re-arrangement of supply chains. Domestically produced lead and other products normally sent south to New Orleans were instead sent north in support of isolated and cut-off French outposts, in combination with even larger than normal shipments of ammunition sent directly from France. The resulting shift in circulation patterns would even be manifested on the Spanish frontier of Texas. The isotopic composition of the bullets found at Mission San Sabá, deposited there at the height of the trans-continental conflict, show that even this isolated and short-lived endeavor bears some signature of the greater geopolitical context into which it had been thrust.

Another significant conclusion made readily apparent in the course of this project is that geologic proveniencing does not necessarily provide quick and easy answers as to the cultural origins of objects. In this particular study, lead isotope analysis was indeed used successfully to secure the geologic provenience of nearly all the tested artifacts on a continental scale. The identification of European, Mexican, and North American lead sources was rather readily accomplished, with some strong indications even of specific landmasses (such as England) and localities (such as Nuevo León in the case of Presidio La Bahía I) serving as sources. However, absent the proper historic and archaeological context, such results have the potential to lead one astray. British traders certainly made inroads into French trading territories, but the presence on a site of objects made from

British lead need not indicate a direct English influence. Rather, the knowledge that France relied to a great extent on lead imported directly from Britain completely redefines the cultural context of such an object. Likewise, it must be kept in mind that the intricacies of colonial trade may have placed some objects well outside of their expected or normal contexts. For example, illicit trade between the French and Spanish has the distinct potential to muddle the picture, especially at locations such as Los Adaes where the two European powers came most directly into contact. Thus, while the technique of lead isotope analysis may provide information as to where the metal actually originated, such results alone can not serve as the definitive statement for an object's cultural origin. This same lesson could probably be well applied to any number of contexts involving complex interchanges of material goods between disparate groups.

The question has been raised at times throughout this study as to the possibility that recycling of lead might have had the potential to affect or blend lead isotope signatures to the degree that few meaningful conclusions could be drawn. This clearly seems to not be the case. Lead of clearly discernible European, Mexican, and North American character was revealed at sites where the presence of such signatures made good sense based on their individual historic contexts. Recycling of lead may have thus been considerably more limited than what we would reasonably expect. It would also appear that whatever recycling did occur probably involved re-melting of objects of similar isotopic character, likely originating from very similar stocks. For the most part, lead of widely varying composition does not appear to have been frequently mixed in such a way as to significantly skew the overall lead isotope picture.

Beyond mere provenience issues, lead isotope analyses seem to have the potential to address other topics of historic or anthropological concern. The distribution of spent ammunition across sites such as Mission San Sabá offers the potential to reconstruct the intricate details of violent historic conflicts in ways not otherwise possible. Lead isotope analysis will thus probably become an increasingly common tool in battlefield archaeology; such a trend is already demonstrated by recent studies of the Texas battlefields of San Jacinto (Michael Ketterer, personal communication 2007) and Palo Alto (Bonine et al. 2009). Additionally, given a large enough sample and the proper context, lead isotope analyses may even provide a means of inferring rather sensitive data relating to chronology and group affiliation. By knowing to some degree the details of when lead was being mined at different places and to whom it was traded at a particular time, it may be possible use lead artifacts as a tool for refining or confirming postulated notions of site age and affiliation. The case of Deer Creek and Bryson-Paddock has already served in some regard as a model for this. The lead assemblage found at those sites accords well with the known details for the time period; the mixed presence of objects made from European and Missouri lead sources speaks to a period of prosperity intimately connected with the heyday of the French fur trade. By examining the makeup of lead artifacts from other period sites that are less well understood, it is entirely likely that lead isotope analyses could reveal some meaningful information on site histories and corresponding group interactions.

Lead isotope analysis may even have the potential to address issues relating to tribal migrations and fluctuations within tribal economies. Such a thing has already been hinted at in this study. It will be recalled that the Taovayas Wichita are thought to have lived at Deer Creek and Bryson Paddock on the Arkansas River in the 1740s and 1750s, followed by a move south to the Red River in the mid to late 1750s. During this transitional period, the Taovayas participated in the attack on Mission San Sabá. These sites, despite being separated in their occupations by probably only a few brief years, show a marked divergence in their assemblages of lead artifacts. In particular, a precipitous drop in the amount of items bearing a distinctly Mississippian signature at Mission San Sabá speaks to the tremendous flux in commercial systems underway in the late 1750s. An analysis of lead artifacts from the Longest Site and Spanish Fort, the locations of later Taovayas villages on both the Oklahoma and Texas sides of the Red River, would be interesting in that it would round out the suite of sites known to be directly influenced by the Taovayas during this period. These sites were occupied into the late 1770s and beyond, by which time revised Spanish trading policies were in effect (John 1992). An examination of lead artifacts from these sites would likely make for an interesting case study, tracking the movements of materials in accord with a known ethnic group over a period of dynamic transition.

This study has focused exclusively on sites dating to the 1700s, a timeframe deliberately chosen to avoid further historic complexities likely to be encountered at sites of later date. While studies of post-1800 sites can no doubt benefit from the inclusion of lead isotope analysis as an anlytical tool, any such endeavors must be similarly rooted in a firm understanding of the proper historic and archaeological contexts in order to be truly meaningful. It should be kept in mind, though, that the traffic and trade in lead during the eighteenth century, as complex as it was, still remains a considerably traceable affair. Points of manufacture and modes of distribution can be somewhat reliably pinned down for the 1700s, allowing for relatively straightforward conclusions to be drawn based on isotopic patterns in combination with historic profiling. After this point in time, though, quantum increases in the complexity of global markets are likely to make tracking the movements of a single commodity such as lead a considerably more difficult task. The development of rapidly expanding and ever more complicated exchange networks may present substantial challenges in accurately determining the circuitous routes to which lead was subjected during the 1800s and later. The potential remains great, though, for discerning additional historic details not obtainable otherwise.

The potential of lead isotope analysis for illuminating issues of colonial history and Native interaction is by now evident. This study of sites in Texas and Oklahoma has served as a test case for broader application of the technique in answering questions pertaining to not only provenience studies, but to derivative cultural considerations as well. It is my hope that a more thorough analysis of historic lead artifacts will eventually become a standard component of archaeological investigations. By incorporating lead isotope data into a broad historic and archaeological framework, entirely new dimensions of meaning are added to a class of artifacts which have typically received rather short shrift in most archaeological reporting.

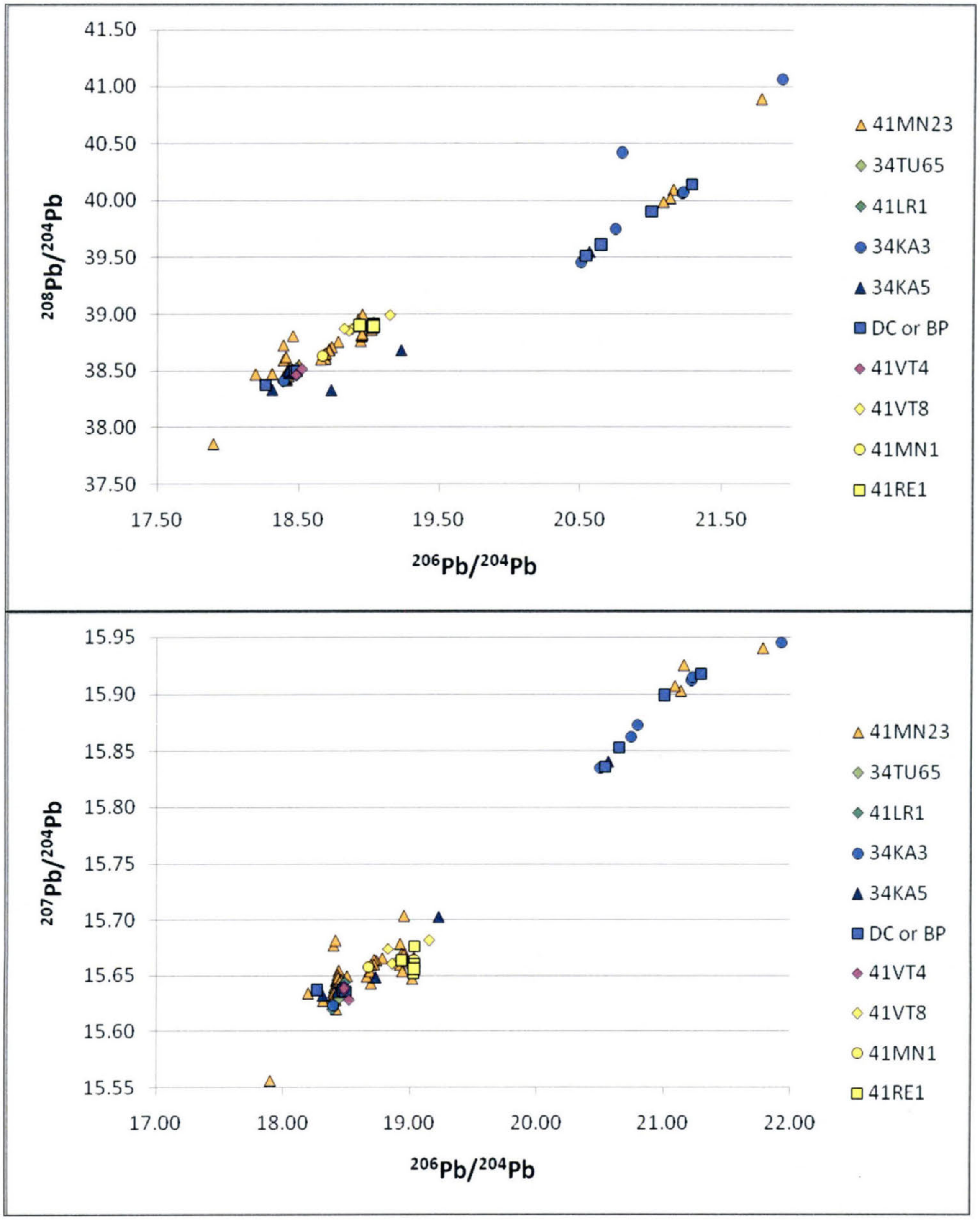


Figure 2: All Project Data

Items derived from European and Mexican lead sources lie in the lower left corner; items derived from Mississippi Valley lead plot in the upper right corner.

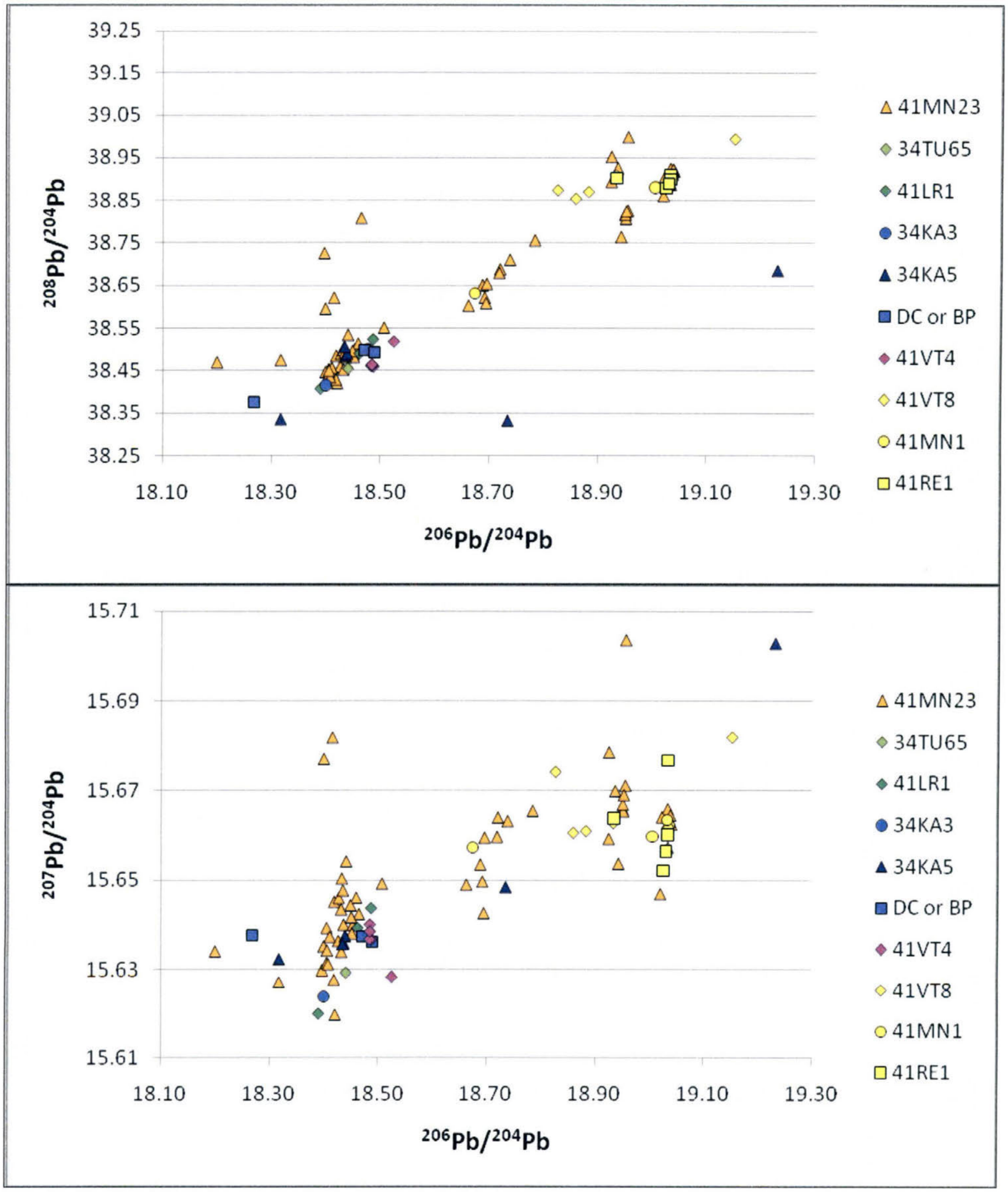


Figure 3: All Non-Mississippi Valley Project Data

Note the separation at about 18.60 in the 206Pb/204Pb value which separates objects thought to be derived from European lead from those objects thought to be derived from Mexican lead. Particularly in the 208Pb/204Pb plot, two highly anomalous items from 34KA5 (a lead sheet and chunk) fall well below the main cluster of Mexican values.

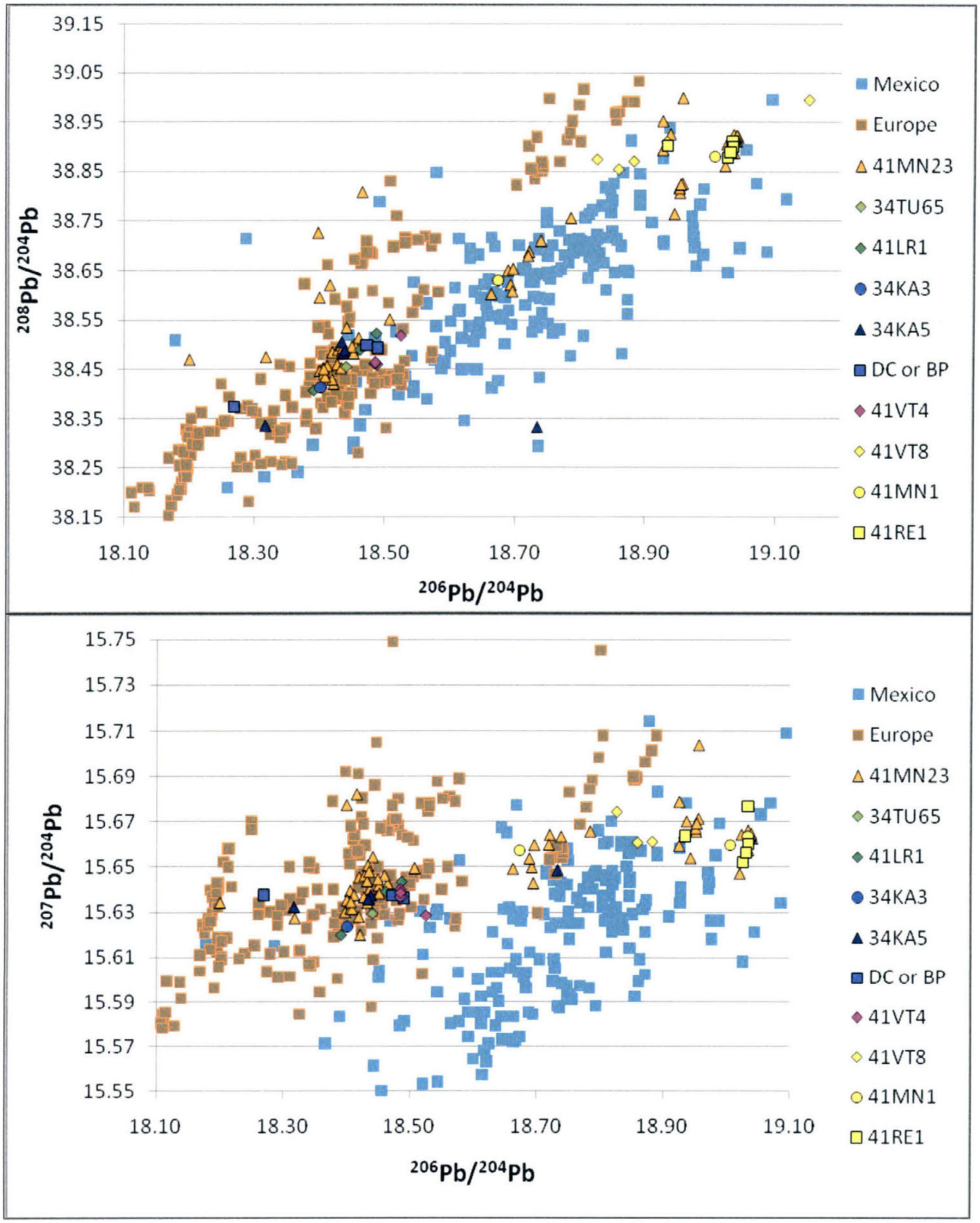


Figure 4: Project Data Compared to General European and Mexican Data

These diagrams, using a random sampling of data from consulted reference sources (including about one-quarter of all European and one-half of all Mexican data examined) show the general divergence between European and Mexican lead values.

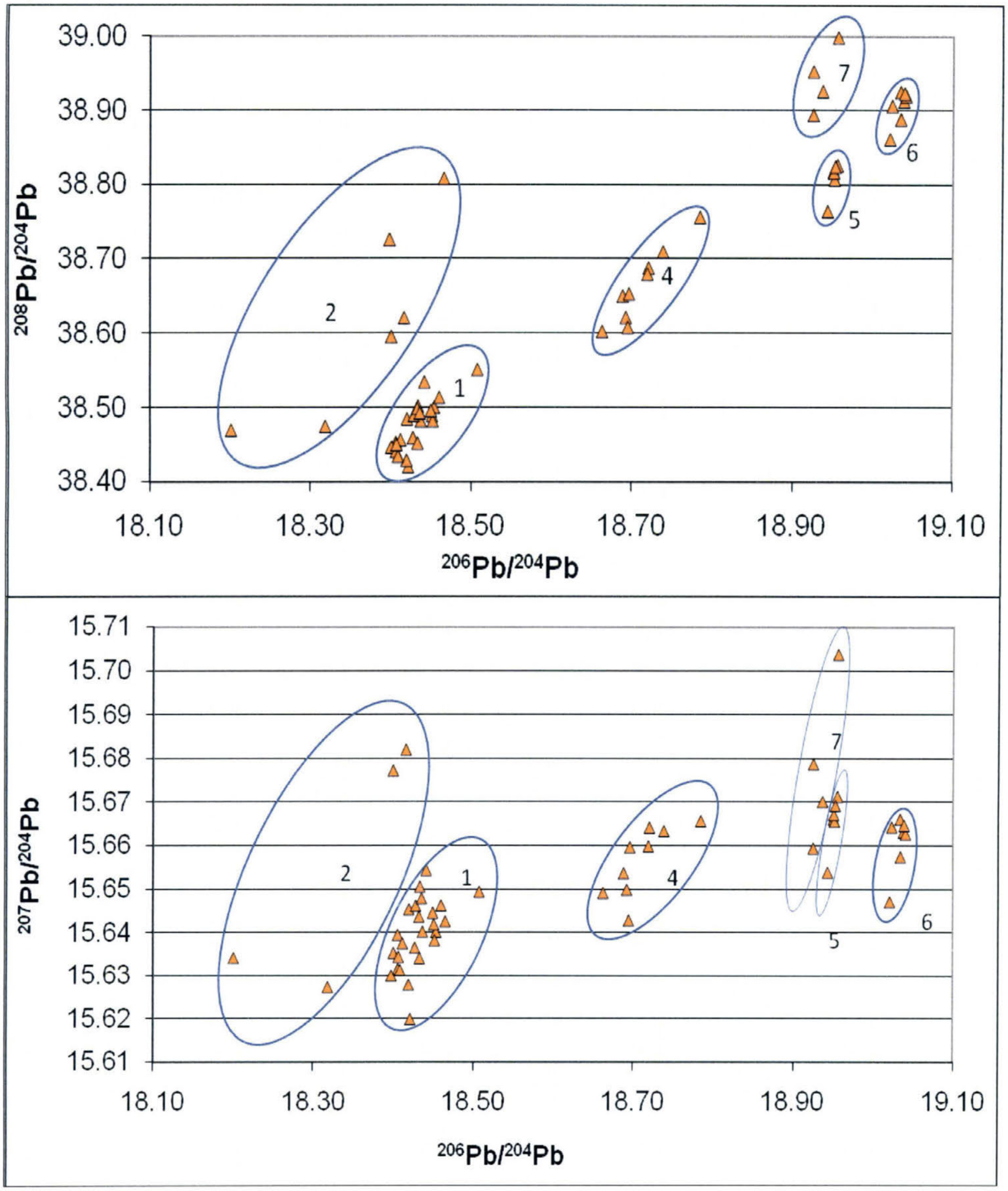


Figure 5: Mission San Sabá Isotope Clusters 1-2 and 4-7

Clusters 1 and 2 comprise artifacts of likely European derivation. Clusters 4-7 comprise artifacts of likely Mexican derivation. Cluster 3 (not shown) comprises artifacts of Mississippi Valley derivation. Note that two points that fall within cluster 2 in the upper chart actually fall within cluster 1 in the lower chart.

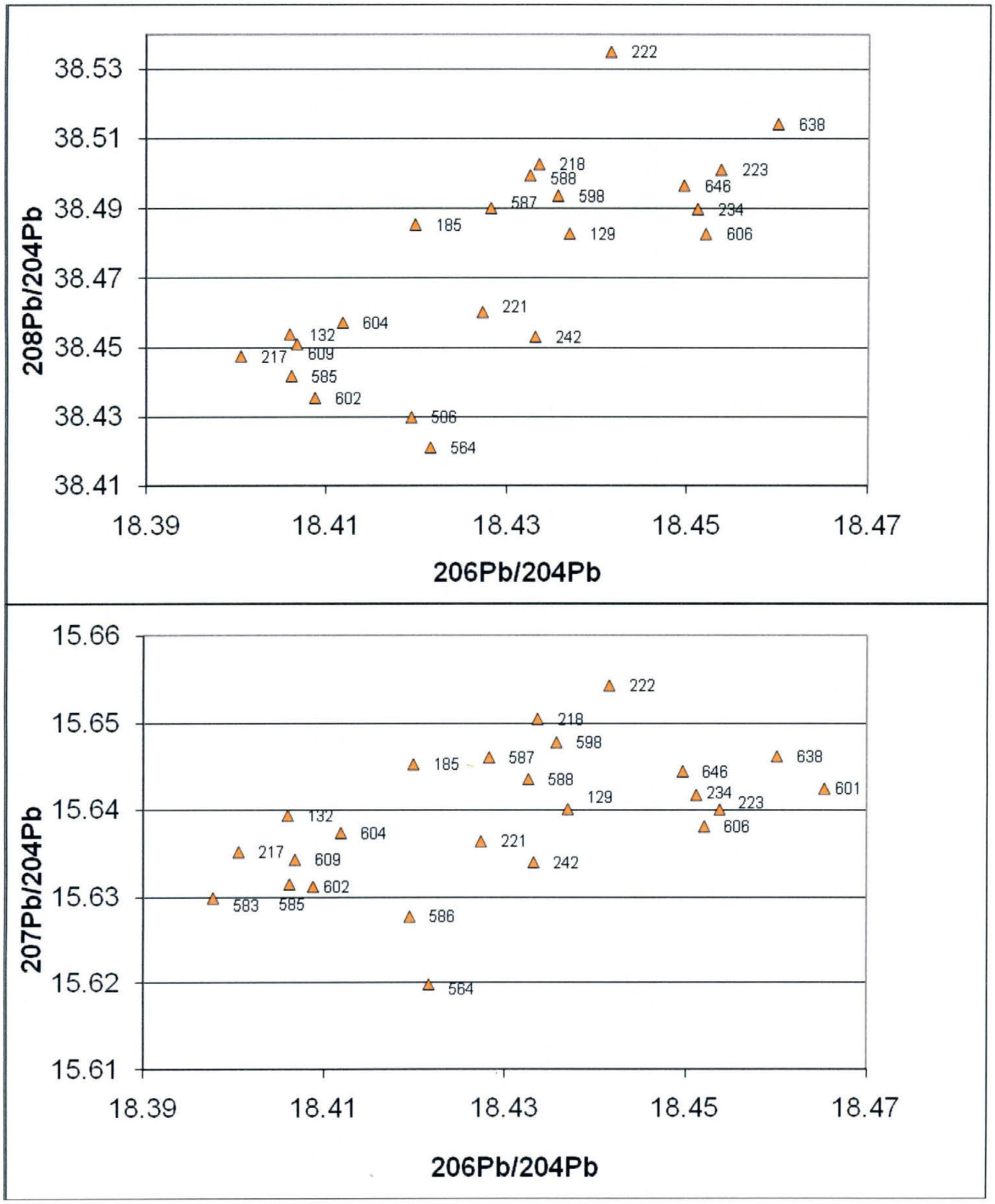


Figure 6: Mission San Sabá Isotope Cluster 1

This view tags the individual data points for Cluster 1 with their respective artifact numbers.

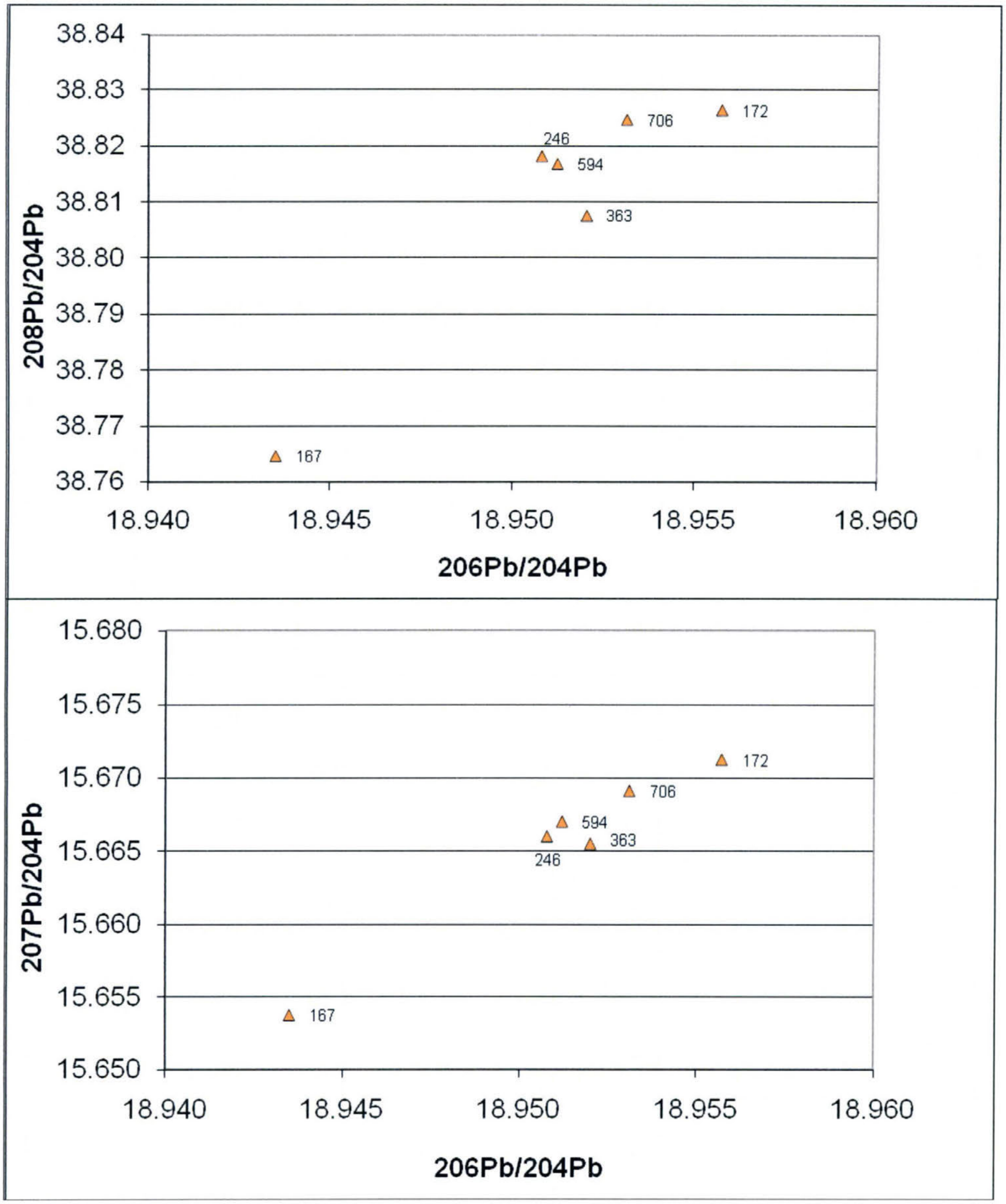


Figure 7: Mission San Sabá Isotope Cluster 5

Tagged artifact numbers for Cluster 5 are shown. The scale here is very tightly constrained; artifact 167 is included since it is more similar to items within Cluster 5 than any other cluster.

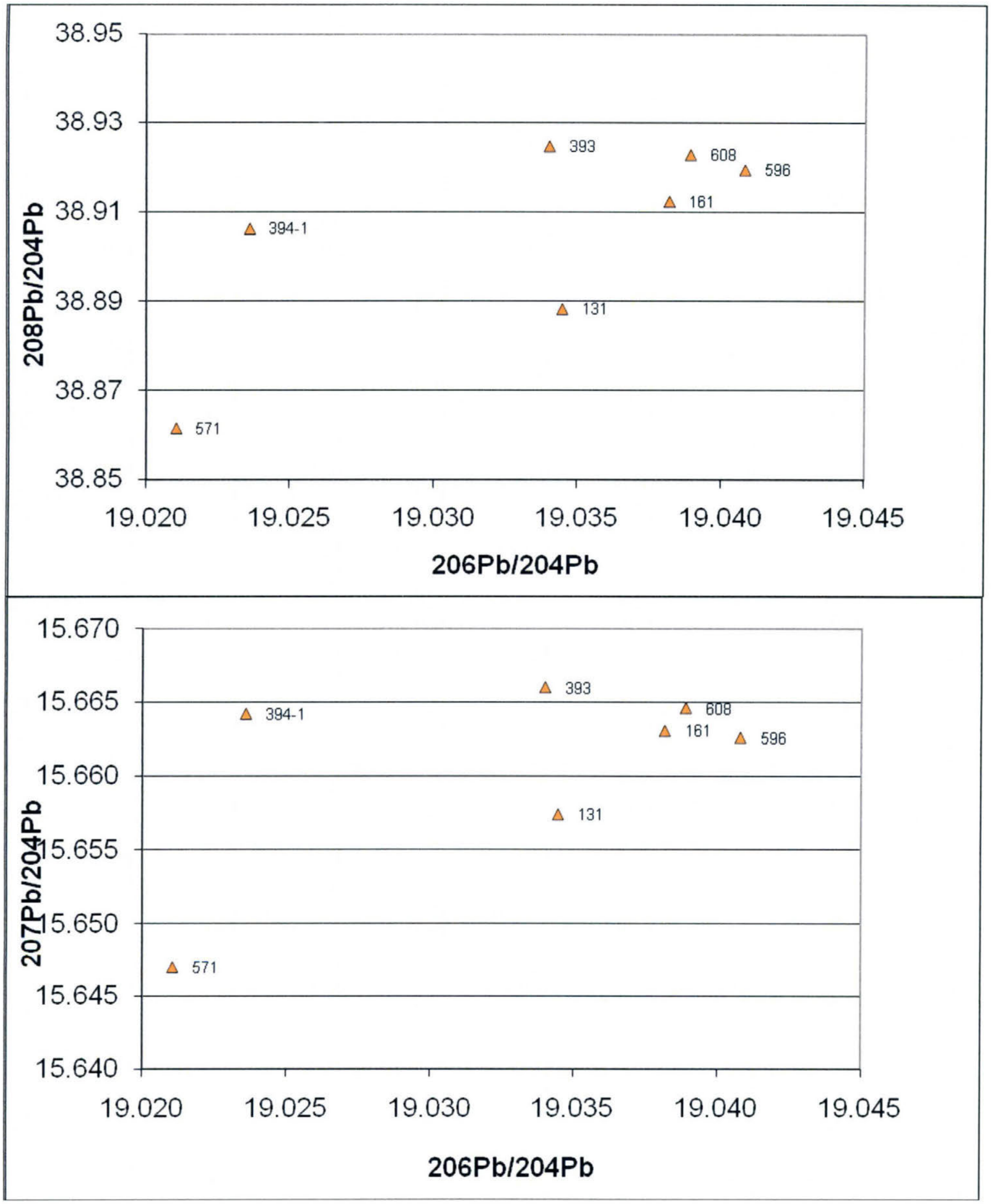


Figure 8: Mission San Sabá Isotope Cluster 6

Tagged artifact numbers for Cluster 6 are shown. The field of values displayed is actually quite narrow.

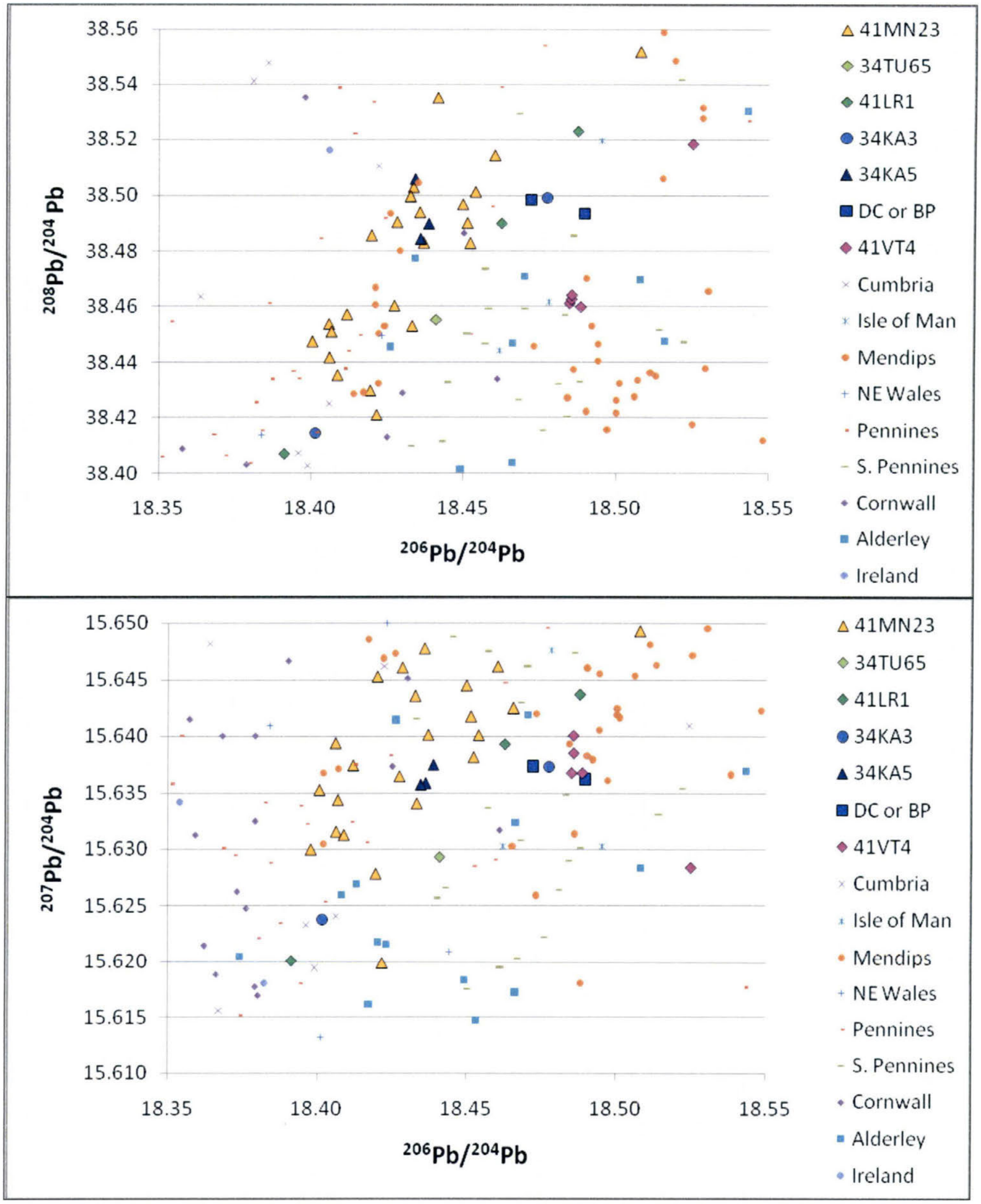


Figure 9: European Lead Isotope Data Part 1: England

Data points for 34TU65, 41LR1, 34KA3, 34KA5, 41VT4, and Mission San Sabá Isotope Cluster 1 all show strong affinity with historic lead sources from England. All British lead isotope data provided by Rohl (1996).

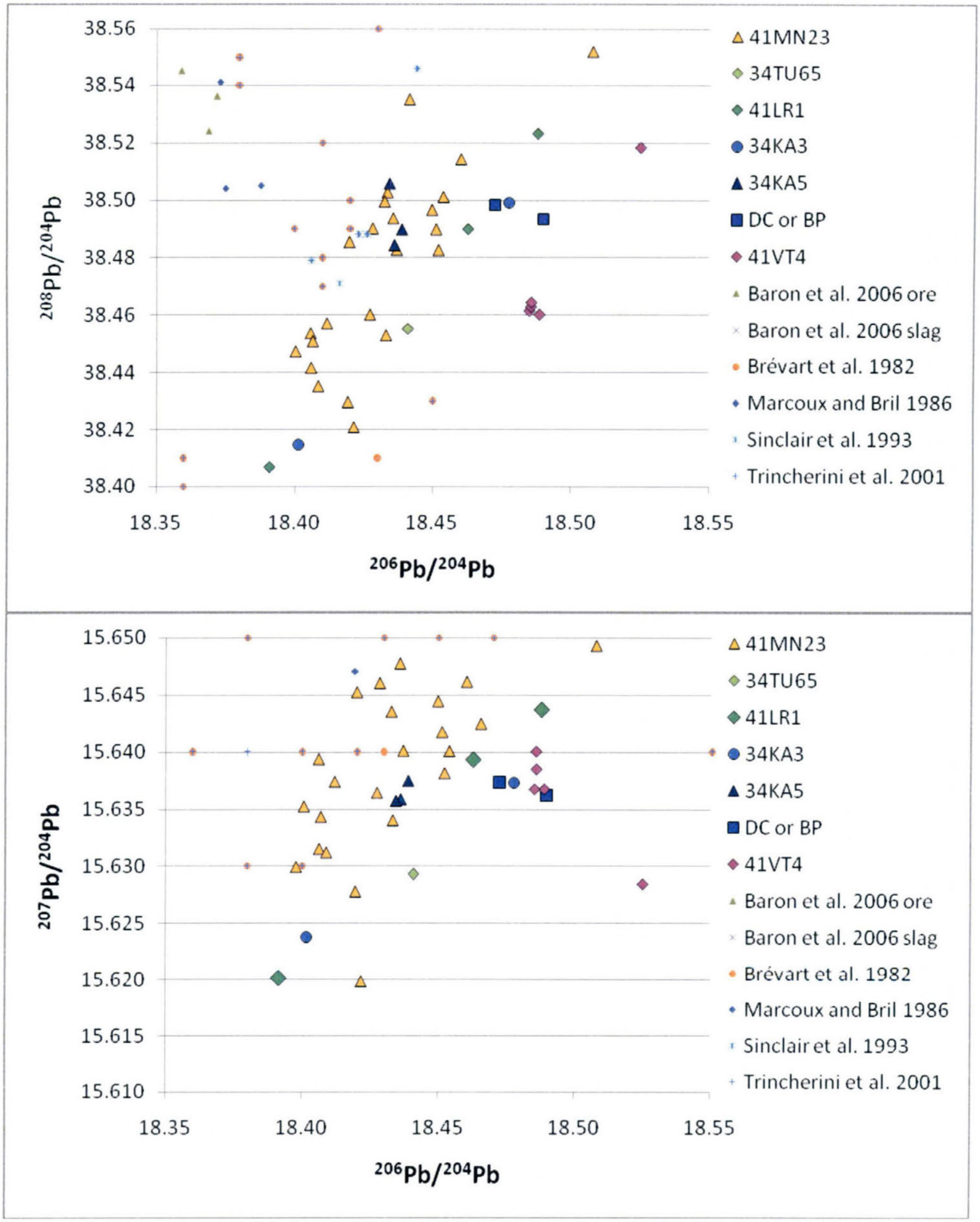
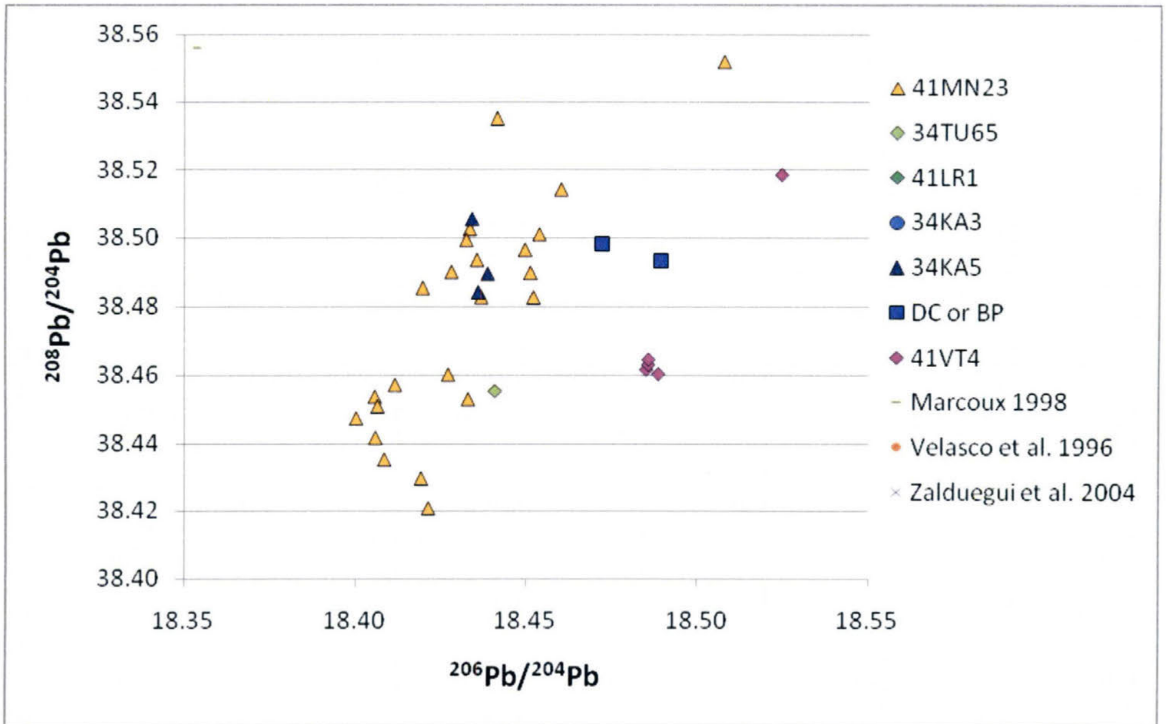


Figure 10: European Lead Isotope Data Part 2: France

Data points for 34TU65, 41LR1, 34KA3, 34KA5, 41VT4 and Mission San Sabá Isotope Cluster 1 show much less affinity with French lead sources than with British sources. French reference sources with no values in this data field are excluded from the legend.



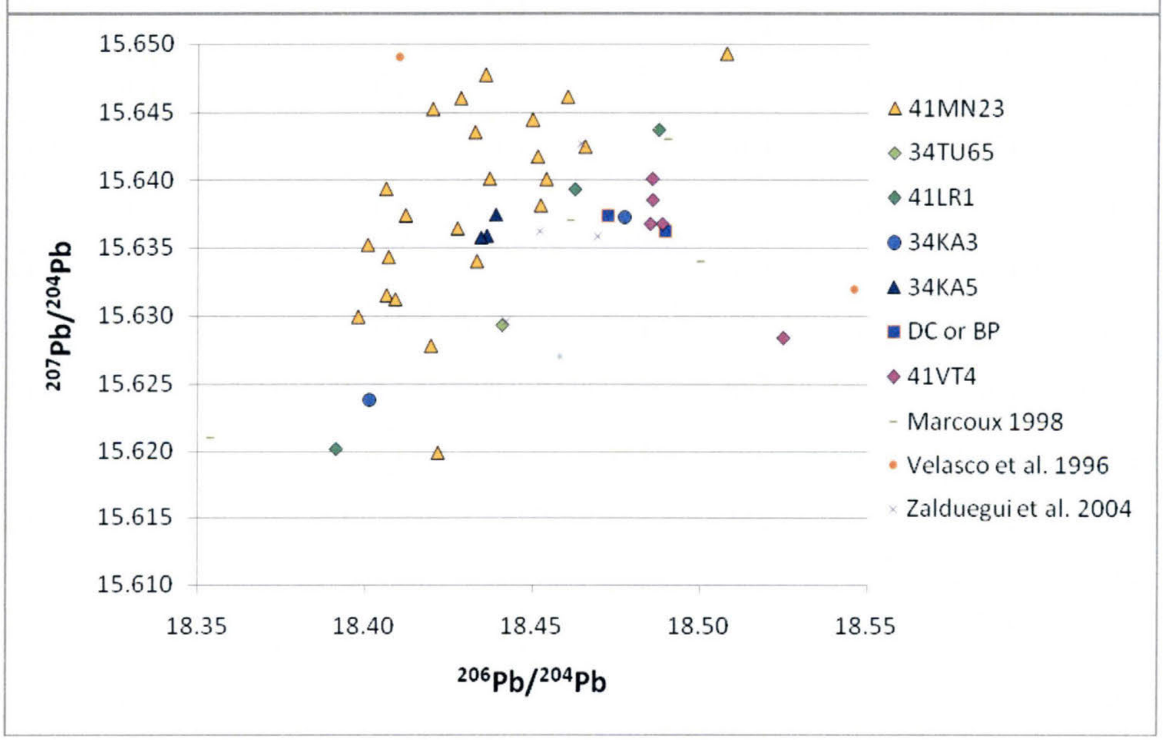


Figure 11: European Lead Isotope Data Part 3: Spain

Data points for 34TU65, 41LR1, 34KA3, 34KA5, 41VT4 and Mission San Sabá Isotope Cluster 1 show very little affinity with Spanish lead sources. Spanish reference sources with no values plotting within this data field are excluded from the legend.

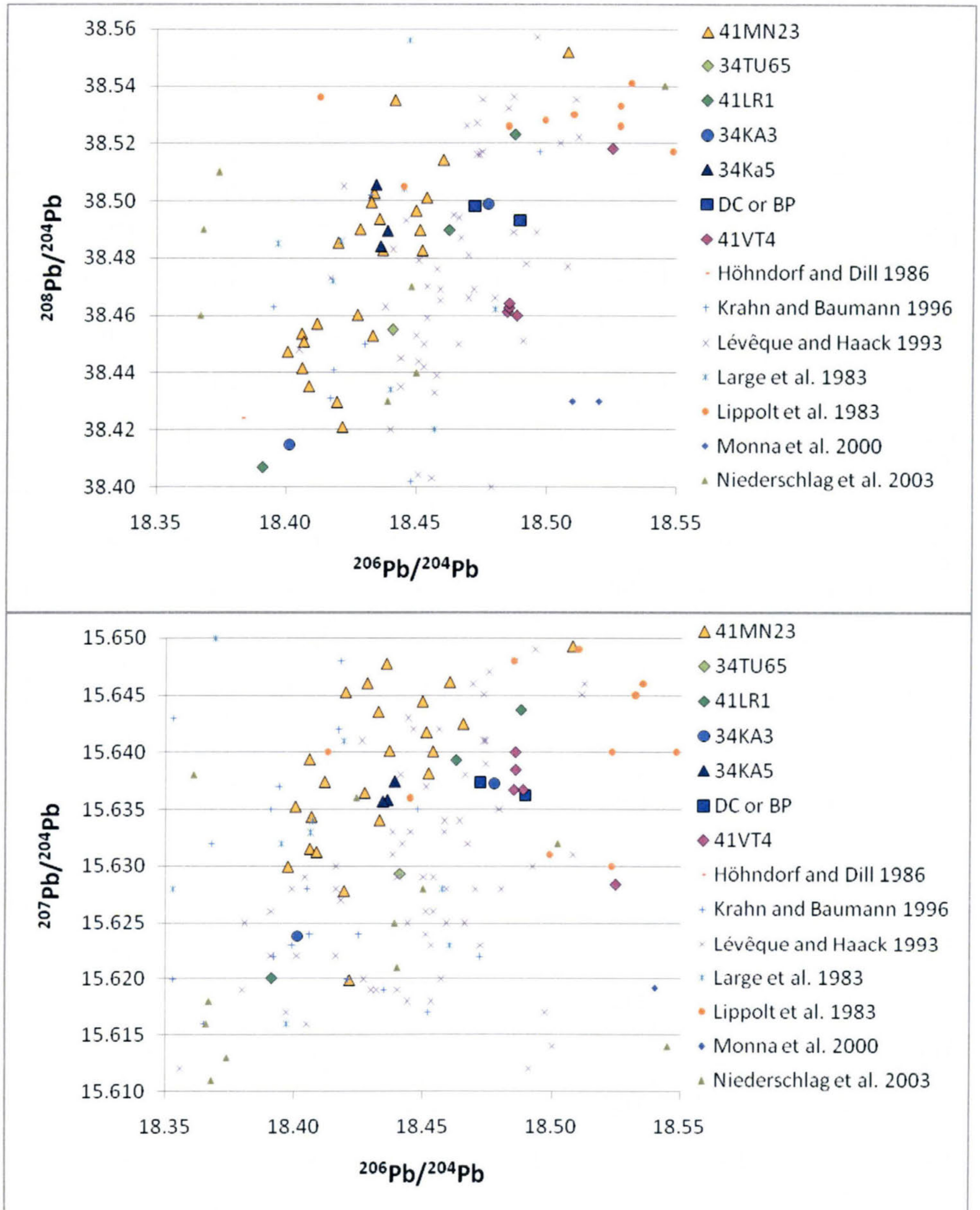


Figure 12: European Lead Isotope Data Part 4: Germany

Data points for 34TU65, 41LR1, 34KA3, 34KA5, 41VT4 and Mission San Sabá Isotope Cluster 1 do show a strong affinity with several German lead sources.

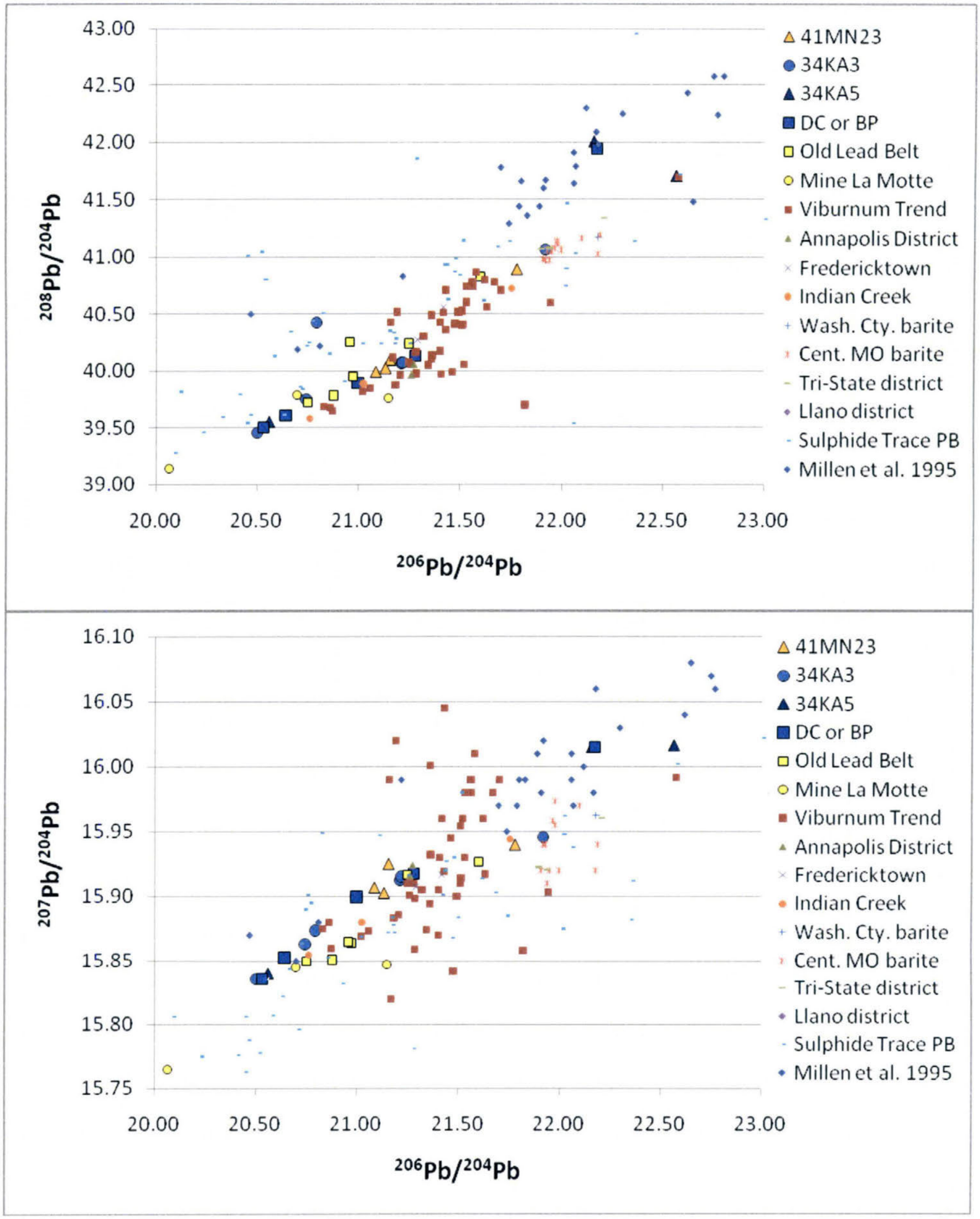


Figure 13: Mississippi Valley Lead Isotope Data Part 1

Data provided by Goldhaber et al. (1995) for southeastern Missouri has been broken down into sub-regions. Data for the Upper Mississippi Valley data is provided by Millen et al. (1995). This data region corresponds to Mission San Sabá Isotope Cluster 3.

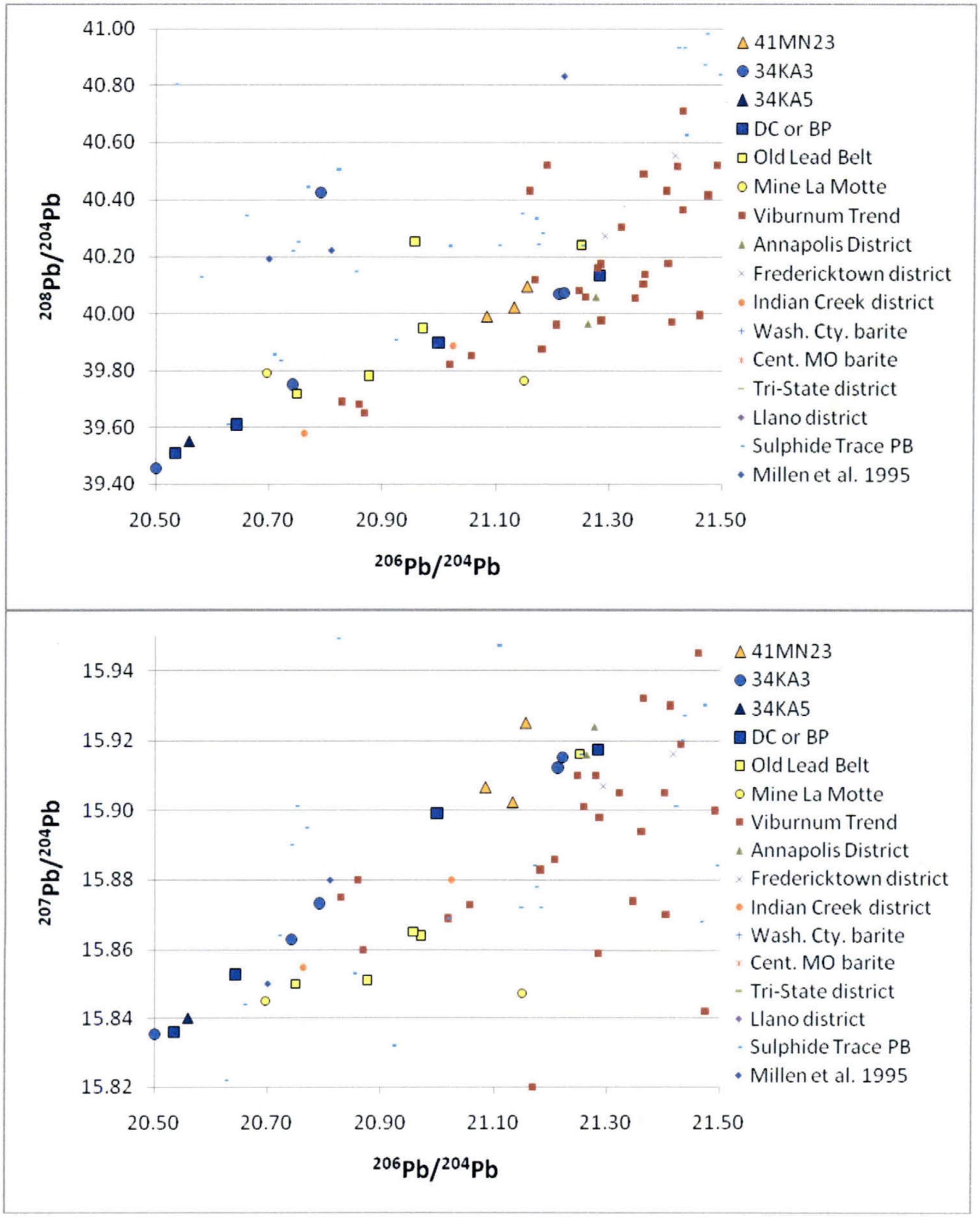


Figure 14: Mississippi Valley Lead Isotope Data Part 2

These graphs show a tighter view of the region shown in Figure L. Note especially the proximity of closely matching isotope values from Mine La Motte and the Old Lead Belt.

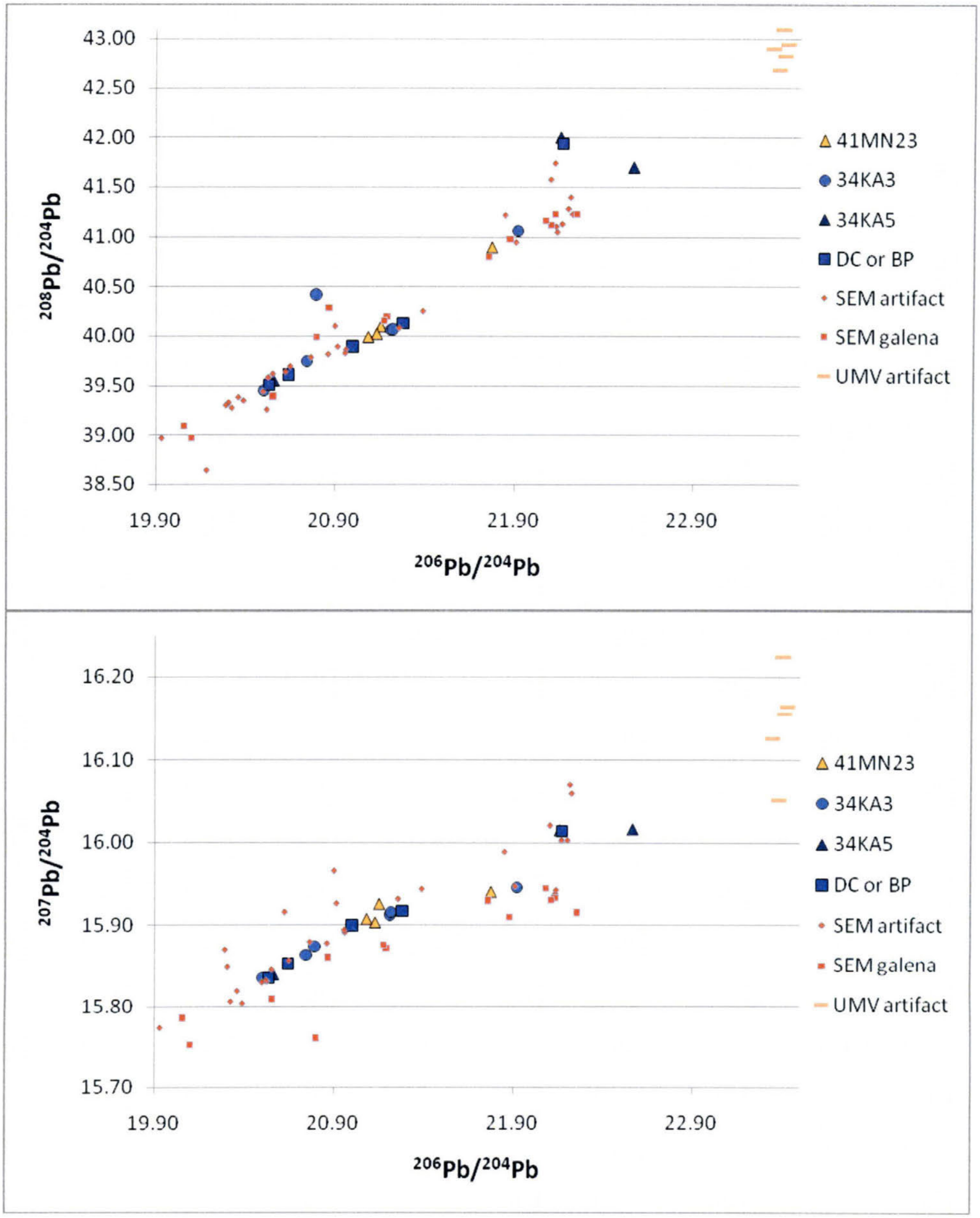


Figure 15: Mississippi Valley Lead Isotope Data Part 3

These graphs show data for Mission San Sabá, Deer Creek, and Bryson-Paddock in relation to lead isotope values obtained by Farquhar et al. (1995) for other artifacts and galena ore samples from southeastern Missouri (SEM) and the Upper Mississippi Valley (UMV).

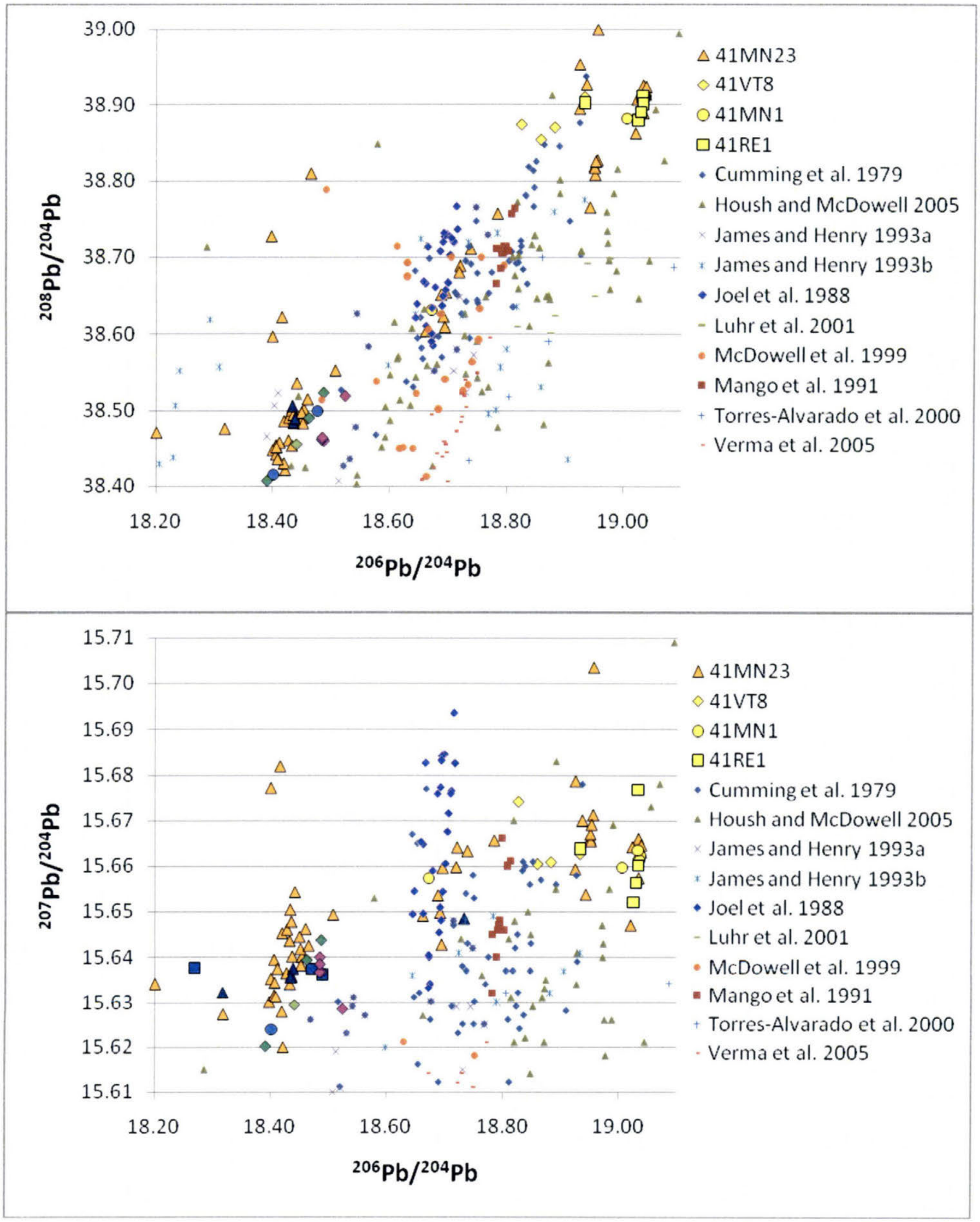


Figure 16: Mexican Lead Isotope Data Part 1

These broad views are presented especially to show the wide separation of isotope clusters 1 and 2 (to the left side of the graph) from most of the Mexican data field. Data from Presidio La Bahía II (41VT4), Presidio San Sabá, and Mission San Lorenzo conform well to Mexican data points and to the general Mexican trendline.

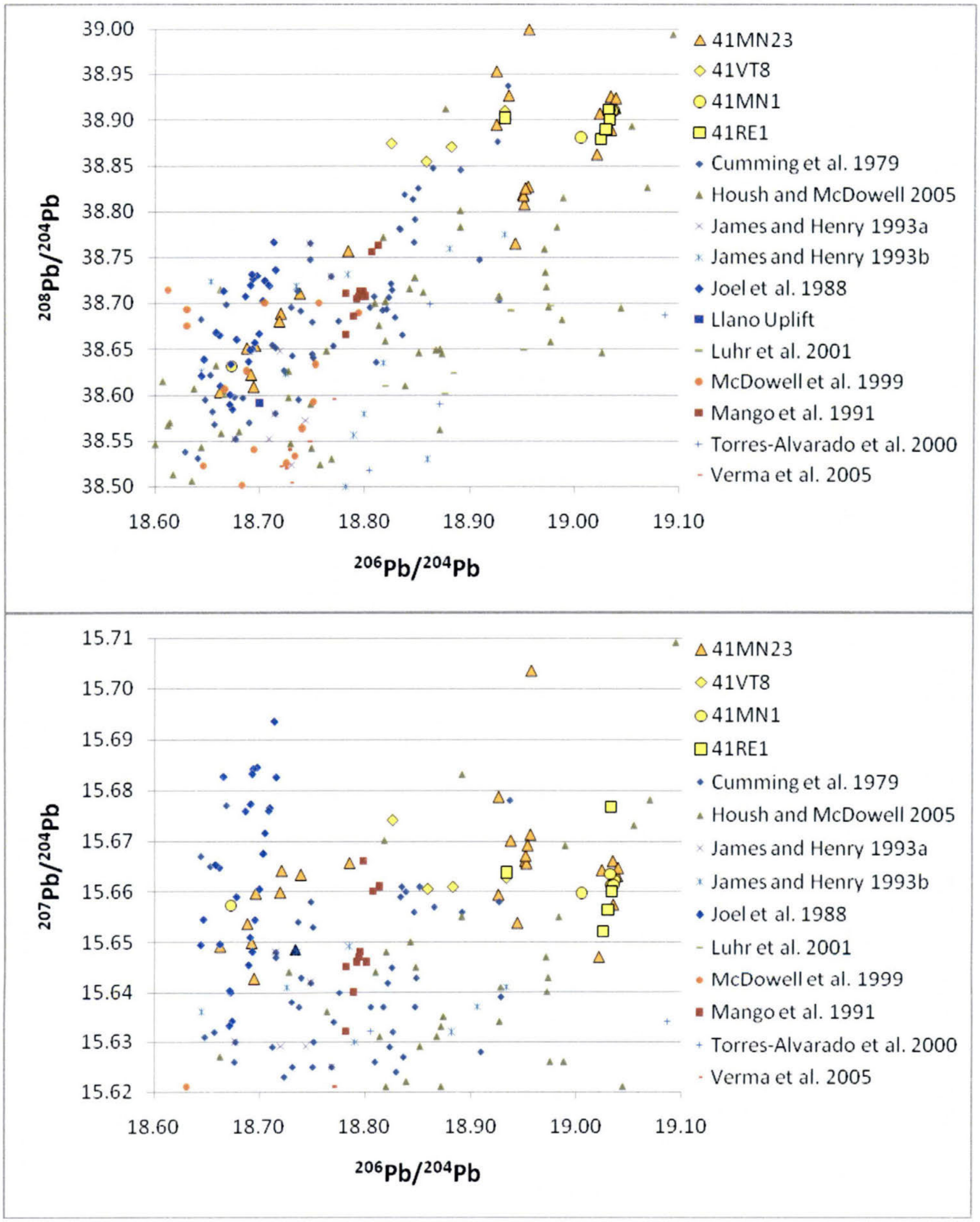


Figure 17: Mexican Lead Isotope Data Part 2

These views show all data points for Presidio La Bahía II, Presidio San Sabá, and Mission San Lorenzo in relation to known Mexican lead isotope values. Data for Mission San Sabá isotope clusters 4-7 is also shown. Llano Uplift data from Goldhaber et al. (1995)

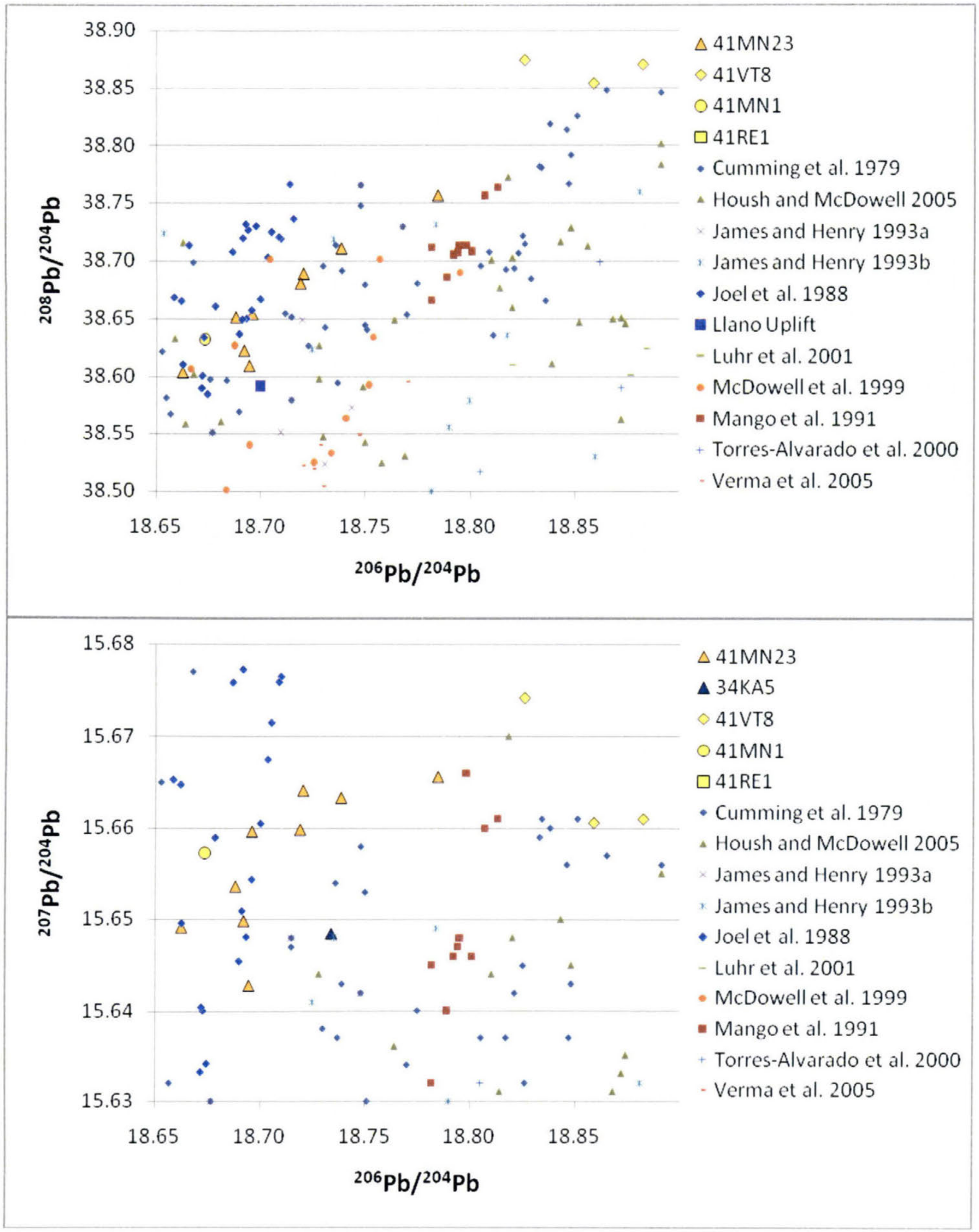


Figure 18: Mexican Lead Isotope Data Part 3

A tighter view of the region surrounding Mission San Sabá isotope cluster 4. Note the proximity of multiple data points from Joel et al. (1988), which mark points derived from Mexican-origin lead glazes on early Mexican majolicas . Note also the presence in the $^{208}Pb/^{204}Pb$ chart the presence of a single ore value for the Llano Uplift region.

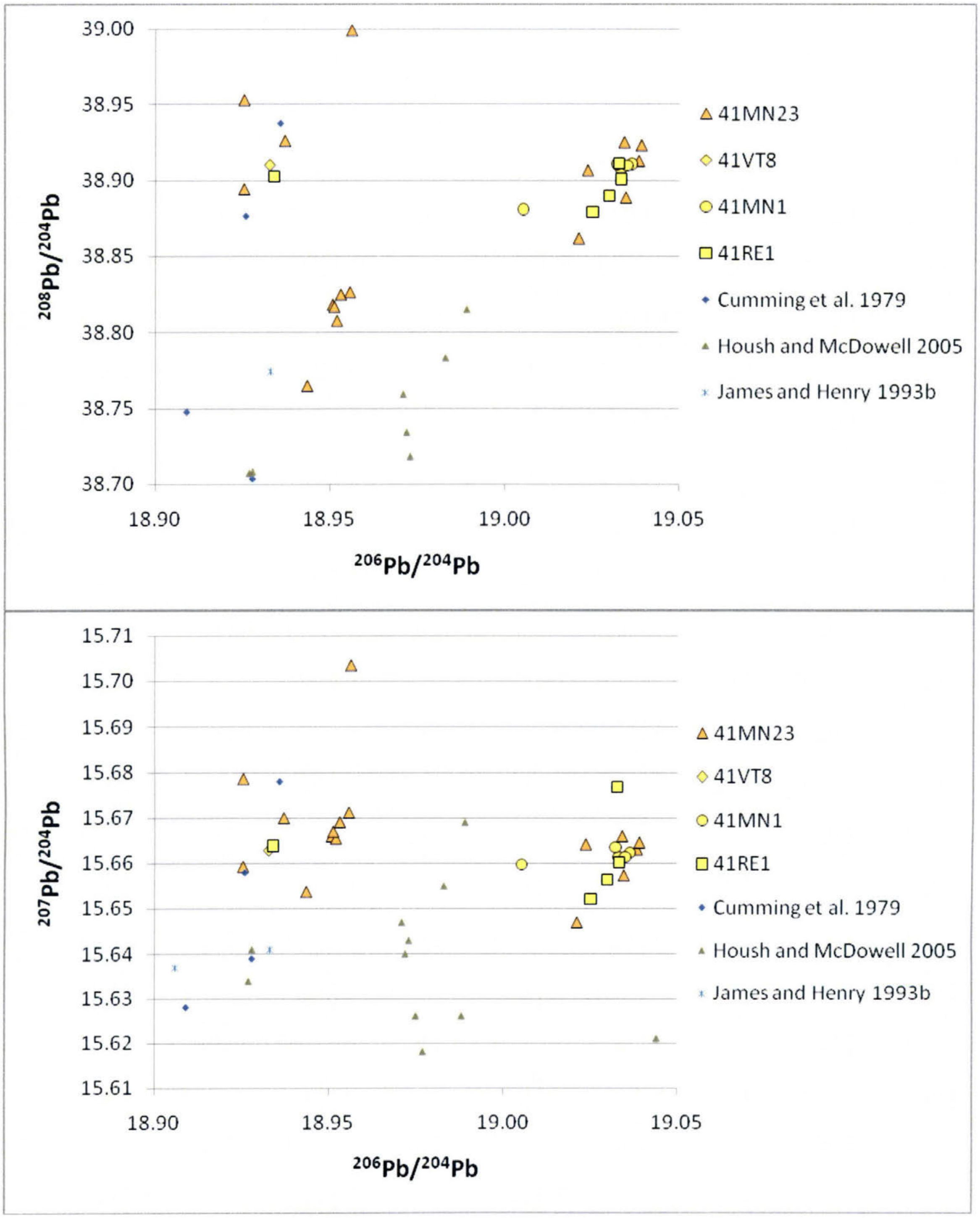


Figure 19: Mexican Lead Isotope Data Part 4

These graphs, corresponding to Mission San Sabá isotope clusters 5, 6, and 7, show the general isolation of most of these artifacts from known Mexican isotope ore values. Note that objects from Mission San Sabá isotope cluster 6 group particularly well with other artifacts from Presidio San Sabá and Mission San Lorenzo.

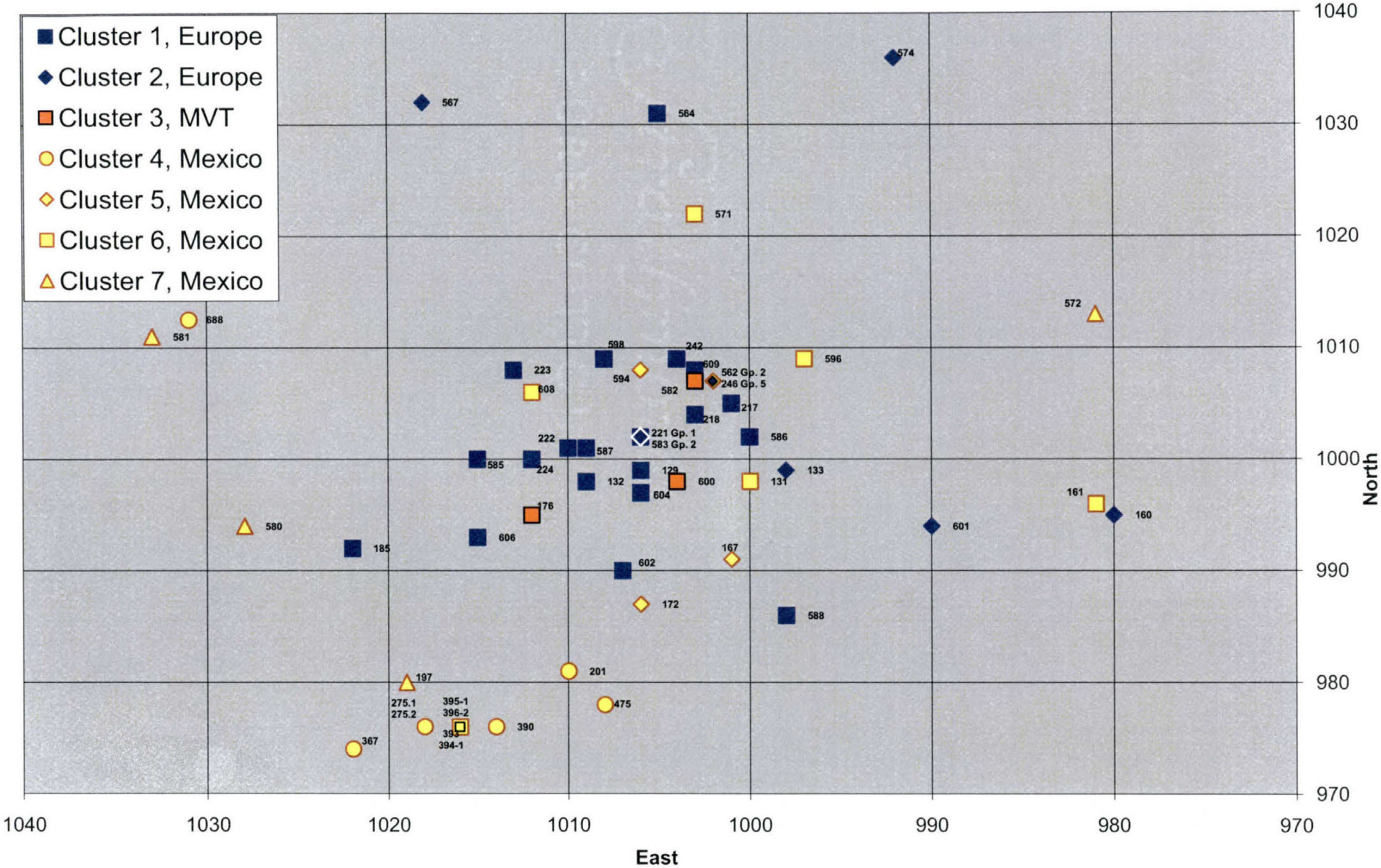


Figure 20. Mission San Sabá: Map of Lead Objects by Isotope Group

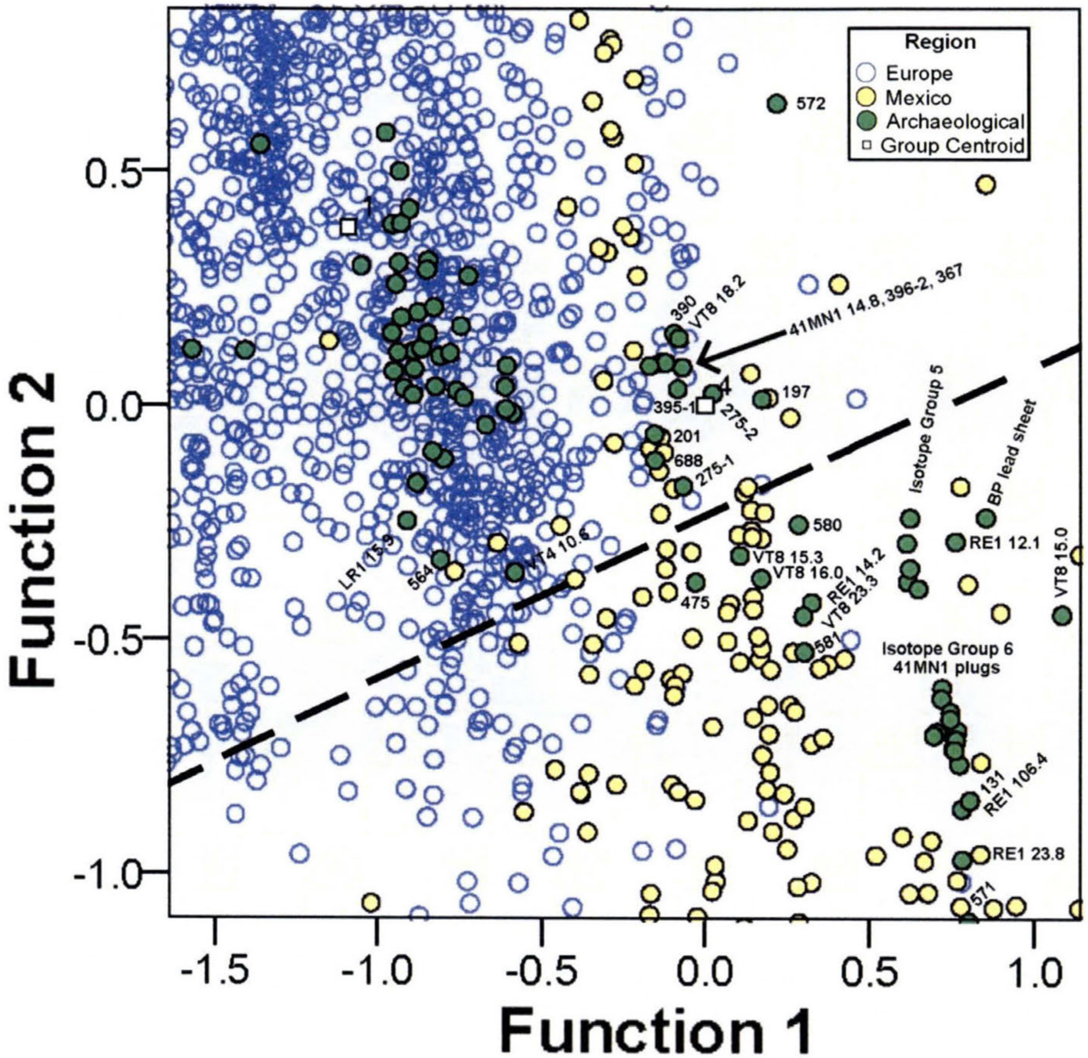


Figure 21: Discriminant Function Analysis: Overlap Between Mexican and European Data

APPENDIX A:

LEAD ISOTOPE DATA FOR ALL STUDY SITES

Site	Artifact and/or Lot #	Test Set	V-208	206/204	ppm s.e.	207/204	ppm s.e.	208/204	ppm s.e.	207/206	ppm s.e.	208/206	ppm s.e.
34TU65	lead ball	4	7.9	18 4409	40	15.6293	58	38.4552	75	0 84755	18	2.08530	36
41LR1	lead ball, 15 9 gm	3	7.7	18 3912	52	15 6201	82	38.4069	114	0 84933	30	2 08833	63
	lead ball, 16.7 gm	2	18 3	18 4624	27	15.6393	34	38 4898	46	0.84708	10	2.08472	25
	lead ball, 17.5 gm	2	10.4	18.4875	19	15.6437	25	38.5229	36	0 84619	14	2.08384	27
34KA3	lead ball, 12.4 gm	2	10.9	20.7432	26	15 8628	41	39.7507	55	0.76471	12	1.91631	27
	lead ball, 12.6 gm	1	10.2	21.9199	40	15.9451	51	41.0613	60	0.72742	14	1.87323	30
	lead ball, 14.0 gm	2	11.6	18.4772	19	15.6373	25	38.4988	36	0.84631	9	2.08366	17
	lead ball, 16.1 gm	2	14 1	21.2135	20	15.9122	26	40.0684	35	0.75011	8	1.86983	19
	lead ball, 17.1 gm	2	11.9	21.2215	21	15 9150	24	40 0736	35	0.74995	9	1.88840	16
	lead ball, 17.7 gm	1	3.7	18.4014	43	15.6238	45	38.4147	54	0.84903	10	2.08759	29
	SNOMNH lead ball	4	6.6	20 7925	59	15.8733	85	40 4231	118	0.76342	30	1.94413	67
	SNOMNH lead rıng	4	6 0	20.5022	81	15.8355	113	39.4566	155	0 77240	35	1.92458	76
34KA5	lead ball, 11.5 gm	2	14.1	22.5659	26	16.0159	34	41 7023	44	0.70975	11	1.84806	21
	lead ball, 14.5 gm	1	8.0	22.1588	34	16.0147	41	42.0022	54	0.72273	13	1.89557	35
	lead ball, 15.1 gm	2	14.8	20.5601	31	15.8400	41	39.5512	54	0.77042	12	1 92380	26
	lead ball, 15.2 gm	1	4.3	18.4387	40	15.6375	46	38.4896	59	0.84806	9	2 08736	25

34KA5	lead ball, 15.9 gm	1	6.3	18.4360	34	15.6359	38	38.4842	51	0.84811	13	2 08744	34
	lead chunk	2	11.9	19.2293	25	15.7027	38	38.6838	52	0 81662	14	2 01177	26
	lead sheet	2	14.8	18.7338	27	15.6485	40	38.3324	48	0.83530	11	2.04618	22
	SNOMNH lead ball, 7 7 gm	4	8.6	18.3174	76	15.6323	112	38.3357	147	0.85341	39	2 09274	77
	SNOMNH lead ball, 13.7 gm	4	6.2	18.4343	37	15.6357	49	38 5057	94	0.84820	18	2 08836	72
34KA3 or 5	OHS 8387.1	4	7.2	18.2695	59	15.6376	89	38.3747	124	0.85596	30	2.10058	62
	OHS 8387.2	4	7.9	20.6436	52	15 8529	78	39 6086	107	0.76794	29	1.91866	58
	OHS 8387.3	4	6.8	18.4721	47	15.6374	65	38.4982	88	0.84652	22	2.08398	44
	OHS 8787.4	4	6 4	21.2832	52	15.9175	68	40.1334	89	0.74790	21	1.88567	41
	OHS 8387.5	4	7.1	20.9998	171	15.8993	104	39 8969	77	0.75719	65	1 89998	116
	OHS 8387.6	4	4.8	18.4894	65	15.6362	88	38.4934	114	0.84570	27	2.08186	57
	OHS 8387 7	4	8.3	20.5359	36	15 8360	47	39 5088	68	0.77115	16	1 92390	32
	OHS 8387 8	4	7 5	22.1733	55	16.0142	75	41.9357	100	0.72221	24	1.89124	52
41VT4	lead ball, 9.9 gm	1	7.4	18.4855	25	15.6400	28	38.4627	46	0.84609	9	2 08071	31
	lead ball, 10.2 gm	1	15.5	18.4856	20	15 6385	26	38.4643	42	0.84596	7	2.08073	32
	lead ball, 10.6 gm	1	6.8	18.5248	32	15.6284	35	38.5183	48	0.84363	10	2 07935	27
	lead ball, 11.5 gm	1	6.7	18 4885	29	15.6367	39	38.4600	49	0.84574	14	2.08021	36
	melted lead piece	1	7 3	18.4849	32	15.6367	41	38.4613	56	0.84592	13	2.08070	34
41MN1	cube, 3.7 gm	2	15.7	19.0322	25	15.6634	34	38.9106	43	0.82299	10	2 04450	20
	cube, 5.2 gm	2	14.3	19.0351	18	15.6613	20	38.9094	28	0.82276	8	2.04408	18
	cube, 8.2 gm	2	11.8	19.0364	20	15.6622	26	38.9104	30	0.82275	7	2.04403	18
	cube, 9.4 gm	2	12.4	19.0332	17	15.6613	24	38.9075	31	0.82286	5	2.04422	18
	cube, 16.6 gm	2	14.3	19.0052	23	15.6597	29	38.8807	40	0.82396	9	2.04576	18
	lead ball	4	3.8	18.6735	52	15 6573	72	38.6316	98	0 83845	23	2.06876	53

41VT8	lead ball, 16.0 gm	4	7.4	18.8825	49	15.6609	68	38.8700	95	0.82941	23	2 05862	50
	lead ball, 18.2 gm	4	5 0	18.8259	38	15.6741	50	38.8738	68	0.83258	17	2 06489	33
	partıal lead ball	4	5.6	19.1507	43	15.6818	57	38.9941	71	0.81890	17	2 03621	32
	lead whızzer	4	4.0	18.8590	43	15.6605	53	38.8537	69	0.83044	15	2.06038	32
	lead disc	4	4.7	18.9328	54	15 6627	71	38.9097	92	0.82726	21	2.05508	45
41RE1	lead ball, 14 2 gm	2	12.0	18.9340	29	15.6637	38	38.9020	45	0.82728	10	2.05466	25
	sprue	2	15.9	19.0327	23	15.6766	37	38.9105	56	0.82307	15	2.04451	36
	lead dısc, 19.2 gm	2	9.7	19.0332	18	15 6600	20	38 9003	27	0.82278	10	2 04380	20
	lead dısc, 23.8 gm	4	4 9	19.0251	41	15.6521	53	38.8789	67	0.82268	16	2 07360	34
	lead dısc, 106 4 gm	4	3 9	19.0298	47	15.6564	64	38 8895	82	0 82272	21	2 04364	40
41MN23	129	3	16.7	18 4369	63	15.6401	111	38 4828	151	0 84837	39	2 08750	80
	131	3	17 1	19.0345	62	15.6574	93	38.8883	128	0 82259	31	2.04317	66
	132	3	8 2	18.4059	19	15 6394	26	38.4537	31	0 84965	8	2.08913	25
	133	3	12.5	18.3999	24	15.6772	32	38.5961	39	0.85201	10	2 09772	30
	160	5		18 4158		15.6819		38.6215		0 85150		2 09712	
	161	3	12.8	19.0382	50	15.6631	72	38.9124	95	0.82272	27	2.04388	62
	167	5		18.9435		15.6538		38 7646		0 82624		2.04639	
	172	5		18.9557		15.6712		38.8264		0.82669		2.04820	
	176	5		21.1559		15.9249		40 0952		0.75271		1.89526	
	185	5		18.4198		15.6453		38.4854		0.84939		2.08946	
	197	5		18.9255		15 6786		38.9525		0.82840		2.05811	
	201	5		18 6885		15.6536		38.6510		0.83757		2.06812	
	217	5		18 4005		15.6352		38.4474		0.84970		2.08934	
	218	5		18.4335		15 6505		38 5027		0.84901		2.08870	
	221	3	18.5	18.4273	65	15.6365	98	38.4602	137	0.84855	34	2.08717	66
	222	3	13.7	18.4415	89	15.6543	126	38.5350	166	0.84885	38	2 08957	84
	223	3	8.4	18.4537	17	15.6401	23	38.5011	40	0.84752	8	2.08631	28
	224	3	14.3	18.5076	76	15.6493	109	38.5518	145	0.84552	35	2.08302	73

41MN23	234	5		18.4512		15.6418		38.4898		0 84768		2.08613	
	242	5		18.4331		15.6340		38.4530		0.84810		2.08594	
	246	5		18.9508		15.6660		38.8181		0.82665		2 04834	
	275-1	3	8.8	18.6925	57	15 6498	84	38.6221	105	0.83718	24	2.06629	53
	275-2	5		18.7848		15.6656		38.7565		0.83394		2.06331	
	363	5		18.9520		15 6655		38.8075		0.82660		2 04775	
	367	5		18 7388		15.6633		38.7106		0.83586		2 06582	
	390	5		18.7208		15.6641		38.6887		0.83669		2.06635	
	393	5		19.0340		15 6660		38.9247		0.82306		2.04514	
	394-1	5		19.0236		15.6642		38.9063		0.82343		2.04519	
	395-1	5		18.7194		15 6598		38.6803		0 83657		2.06651	
	396-2	5		18.6963		15.6596		38 6539		0.83756		2.06738	
	475	3	13.1	18.6950	86	15.6427	128	38 6088	172	0 83670	41	2 06524	87
	562	3	7.0	18 2007	208	15.6341	33	38.4703	49	0 85898	209	2 11389	209
	564	3	6.2	18 4216	44	15 6199	67	38 4210	87	0 84793	20	2 08572	47
	567	3	11.4	18.3181	87	15.6273	30	38 4754	34	0.85308	72	2.10024	86
	571	3	8 3	19 0210	26	15.6470	29	38 8616	33	0.82260	10	2 04305	20
	572	5		18.9562		15.7036		38.9987		0.82834		2 05735	
	574	3	8.2	17 9017	56	15.5561	83	37.8569	120	0 86896	29	2.11479	73
	580	5		18.9371		15.6700		38.9257		0.82750		2 05561	
	581	3	13 3	18.9255	23	15 6593	31	38.8940	45	0.82743	12	2 05517	26
	582	3	2.5	21 1332	49	15.9023	53	40.0214	59	0.75245	10	1.89368	33
	583	3	19.2	18 3977	53	15 6299	79	38.7265	113	0.84955	29	2.08871	66
	585	5		18.4061		15.6315		38.4416		0.84923		2.08849	
	586	3	17.2	18.4194	18	15.6278	20	38.4297	27	0.84846	8	2.08647	19
	587	5		18.4282		15.6461		38.4901		0.84902		2 08862	
	588	5		18.4325		15.6436		38.4995		0 84877		2.08866	
	594	5		18 9512		15.6670		38.8167		0.82672		2.04827	
	596	5		19.0408		15.6626		38 9194		0 82261		2.04421	
	598	5		18.4356		15.6478		38 4937		0 84874		2 08788	
	600	5		21.0855		15.9066		39.9888		0 75434		1 89636	
	601	3	10.0	18.4653	309	15 6425	29	38.8088	32	0 84707	301	2.10169	314

41MN23	602	5		18.4087		15 6312		38.4353		0 84916		2.08785	
	604	3	10.2	18.4118	55	15 6374	84	38.4571	128	0.84931	35	2.08903	81
	606	5		18 4521		15.6381		38.4827		0.84748		2.08557	
	608	5		19.0389		15.6646		38 9228		0.82279		2.04425	
	609	5		18.4067		15.6343		38 4509		0.84935		2 08887	
	620	5		21.7783		15.9398		40.8893		0.73190		1 87753	
	638	5		18.4601		15.6462		38.5142		0.84754		2 08633	
	646	5		18.4497		15 6445		38.4966		0 84793		2.08647	
	688	3	14.9	18.6629	21	15.6491	33	38.6032	40	0 83850	11	2 06849	23
	706	5		18.9531		15.6691		38.8247		0.82671		2 04844	

Inter-sampling Runs for Bias and Correction Using NIST Lead Standard NBS 981

	Date(s) of Testing	V-208	206/204	ppm s.e.	207/204	ppm s.e.	208/204	ppm s.e.	207/206	ppm s.e.	208/206	ppm s.e.
Test Set 1	**6/9/2006**	2 9	16 9403	49	15 4966	55	36.7186	68	0 91476	16	2 16766	37
		2 9	16 9408	53	15 4974	64	36.7263	73	0 91479	25	2 16792	40
		2.9	16.9397	53	15.4955	61	36 7204	72	0 91474	22	2 16773	41
		3 0	16 9412	34	15.4958	47	36 7226	69	0.91471	17	2 16753	33
		mean	16 9405		15.4963		36.7220		0.91475		2 16771	
		std dev	0 0007		0.0008		0 0033		0.0000		0 0002	
		% rsd	0.0041		0 0054		0 0090		0.0035		0.0076	
Test Set 2	**7/27/2006**	4.1	16.9449	33	15.4991	34	36.7281	42	0.91470	10	2 16748	31
		4.4	16.9374	34	15.4926	40	36 7115	50	0.91470	14	2.16757	26
		4.6	16.9414	31	15.4968	40	36.7217	50	0.91473	11	2.16759	24
		4.7	16 9378	24	15.4937	28	36.7152	33	0 91471	12	2 16759	20
		4.3	16.9399	27	15.4969	33	36.7231	46	0.91482	15	2.16790	25

	7/28/2006											
		4.6	16.9404	38	15.4972	45	36.7252	54	0.91481	12	2.16791	22
		4.7	16.9417	37	15.4978	38	36.7292	47	0.91479	12	2.16792	20
		mean	16.9405		15 4963		36.7220		0.91475		2.16771	
		std. dev.	0.0025		0.0023		0.0066		0.0001		0.0002	
		% rsd	0.0150		0.0149		0 0179		0.0056		0.0089	
Test Set 3	**8/28/2006 and 8/29/2006**											
		3.5	16.9348	39	15.4887	42	36 6991	49	0 91460	11	2.16706	30
		3.7	16.9437	35	15.4998	40	36.7324	58	0.91484	15	2 16794	33
		3.8	16.9405	26	15.4972	36	36.7265	51	0.91478	12	2.16794	37
		3.9	16 9430	28	15.4995	28	36.7300	41	0 91478	13	2.16790	38
		4.4	16.9339	31	15.4860	37	36.6837	49	0.91449	10	2.16634	26
		4.4	16.9350	29	15.4894	31	36.6976	38	0.91463	11	2.16698	27
		4.2	16.9484	52	15 5075	65	36.7617	89	0.91498	19	2 16895	42
		4.4	16.9447	43	15.5022	53	36.7450	71	0 91490	16	2 16856	35
		mean	16.9405		15.4963		36 7220		0.91475		2.16771	
		std. dev.	0.0054		0.0075		0.0264		0 0002		0.0009	
		% rsd	0.0319		0.0484		0.0719		0 0178		0.0399	
Test Set 4	**10/11/2006**	4.8	16.9417	37	15.4981	44	36 7298	53	0.91478	14	2 16797	23
		3.7	16.9430	38	15 4975	42	36.7285	51	0.91467	12	2.16768	21
		3 9	16.9401	39	15.4958	41	36.7190	53	0 91476	13	2 16771	25
		3.9	16 9394	27	15 4954	31	36.7178	34	0.91476	12	2.16761	21
		4 0	16.9377	36	15.4941	43	36 7140	45	0 91473	12	2 16751	18
		4.0	16.9410	34	15.4970	41	36.7230	45	0.91480	11	2 16777	20

	10/12/2006	4.6	16 9392	29	15.4942	35	36 7175	42	0.91472	10	2 16766	18
		4.4	16 9427	34	15 4984	48	36.7267	58	0 91476	14	2.16771	23
		4.5	16.9395	33	15.4963	35	36 7218	42	0.91477	12	2.16776	18
		mean	16 9405		15.4963		36.7220		0.91475		2.16771	
		std. dev.	0.0018		0 0016		0 0054		0.0000		0.0001	
		% rsd	0.0104		0.0102		0.0148		0.0042		0 0058	
Test Set 5	**January 5, 8-10, 2007**											
		mean	16.9405		15 4963		36.7220		0.91475		2.16771	
		std dev.	0.0019		0.0030		0.0088		0.0001		0.0004	
		% rsd	0 0114		0.0195		0.0240		0.0144		0 0192	

APPENDIX B:

WEIGHTS, MEASURES, AND STATISTICAL ANALYSES OF ARTIFACTS EXAMINED

Site	Artifact type	Source	Lot #	Weight (grams)	diam., mm[1]	diam., inches	Probability European	Probability Mexican	Probability Mississippian	Statistical Attribution
34TU65										
	lead ball	GHO[a]		13.3	13.1	0 51	0 728	0 272	0.000	Europe
41LR1										
	lead ball	TARL[b]		15 9	13.9	0.55	0.695	0.305	0.000	Europe
	lead ball	TARL		16.7	14.1	0.56	0.802	0 198	0.000	Europe
	lead ball	TARL		17.5	14 3	0 56	0.815	0.185	0 000	Europe
34KA3										
	lead ball[2]	JBS[c]		12 4	12.8	0.50	0 000	0.000	1 000	MVT[17]
	lead ball[3]	JBS		12.6	12 8	0 51	0 000	0.000	1 000	MVT
	lead ball[4]	JBS		14.0	13.3	0.52	0.765	0.235	0.000	Europe
	lead ball[5]	JBS		16.1	13 9	0 55	0 000	0.000	1 000	MVT
	lead ball	JBS		17.1	14.2	0.56	0.000	0.000	1.000	MVT
	lead ball[6]	JBS		17.7	14 4	0.57	0.721	0.279	0.000	Europe
	lead ball[7]	SNOMNH	8	13.8	13.2	0.52	0.000	0.000	1.000	MVT
	flattened lead ring[8]	SNOMNH[d]	8	55.3	n/a	n/a	0.000	0 000	1.000	MVT
34KA5										
	lead ball	JBS-RP[e]		11.5	12.5	0.49	0 000	0.000	1.000	MVT
	lead ball[9]	JBS		14.5	13.5	0.53	0 000	0.000	1.000	MVT
	lead ball	JBS-RP		15.1	13.6	0.54	0.000	0.000	1.000	MVT
	lead ball	JBS		15.2	13.7	0.54	0.817	0.183	0.000	Europe

34KA5	lead ball	JBS		15.9	13.9	0 55	0.806	0 194	0.000	Europe
	lead chunk	JBS-RP		26.0	n/a	n/a	0.218	0.782	0.000	Mexico?
	lead sheet	JBS-RP		295.1	n/a	n/a	0 345	0.655	0.000	Mexico?
	lead ball[10]	SNOMNH	415	7.7	10.9	0 43	0 879	0.121	0 000	Europe
	lead ball[11]	SNOMNH	6	13 7	13 2	0.52	0.813	0 187	0.000	Europe
34KA3 or 5										
	lead ball	OHS[f]	8387 1	18.3	14 5	0.57	0.939	0 061	0.000	Europe
	lead ball	OHS	8387.2	17.7	14.4	0 57	0.000	0 000	1.000	MVT
	lead ball	OHS	8387.3	15.3	13.7	0 54	0 773	0.227	0.000	Europe
	lead ball	OHS	8387.4	17 1	14.2	0 56	0.000	0.000	1 000	MVT
	lead ball	OHS	8387.5	16.8	14 1	0 56	0.000	0.000	1 000	MVT
	lead ball	OHS	8387 6	15.5	13.8	0.54	0.734	0.266	0.000	Europe
	lead ball	OHS	8387.7	16.6	14.1	0.55	0.000	0 000	1 000	MVT
	lead ball	OHS	8387.8	8.7	11.3	0.45	0.000	0 000	1.000	MVT
41VT4										
	lead ball	TARL	1044-7	9.9	11.8	0.47	0 769	0 231	0.000	Europe
	lead ball	TARL	1044-7	10.2	12.0	0.47	0.754	0.246	0 000	Europe
	lead ball	TARL	1044-7	10.6	12.1	0.48	0.583	0.417	0.000	Europe
	lead ball	TARL	1044-7	11.5	12.5	0 49	0.730	0 270	0.000	Europe
	melted lead piece [12]	TARL	1044-12	?	?	?	0.736	0.264	0.000	Europe
41MN1										
	cuboid lead	TTU[g]	11	3.7	8.5	0.34	0.203	0.797	0 000	Mexico
	cuboid lead	TTU	1105	5.2	9.6	0.38	0.181	0.819	0 000	Mexico
	cuboid lead	TTU	1158	8.2	11.1	0.44	0 187	0 813	0.000	Mexico
	cuboid lead	TTU	33	9.4	11.6	0.46	0 182	0.818	0.000	Mexico
	cuboid lead	TTU	942	16 6	14 1	0.55	0.198	0.802	0 000	Mexico
	lead ball	TTU	266	14.8	13.5	0.53	0.698	0.302	0.000	Europe

41VT8										
	lead ball[13]	TARL	7	16 0	13.9	0 55	0.421	0.579	0.000	Mexico
	lead ball[14]	TARL	339	18 2	14 5	0 57	0 705	0 295	0 000	Europe
	partial lead ball[15]	TARL	223	15 0	13.6	0 54	0 226	0 774	0 000	Mexico
	lead whizzer	TARL	340	15 3	13.7	0 54	0 458	0 542	0.000	Mexico
	lead disc[16]	TARL	17	23 3	15 8	0.62	0.360	0 640	0.000	Mexico
41RE1										
	lead ball	TARL		14 2	13 4	0.53	0 367	0 633	0.000	Mexico
	sprue	TARL	21	12 1	12.7	0 50	0 340	0 660	0 000	Mexico
	lead disc	TARL	13	19.2	14 8	0 58	0.171	0 829	0.000	Mexico
	lead disc	TARL	18	23 8	15.9	0 62	0 122	0 878	0.000	Mexico
	lead disc	TARL	21	106 4	n/a	n/a	0 146	0 854	0.000	Mexico
41MN23										
	lead ball	ML[h]	129	15 4	13.7	0.54	0 838	0.162	0.000	Europe
	lead ball	ML	131	11 9	12.6	0.50	0.148	0 852	0 000	Mexico
	lead ball	ML	132	17.7	14.4	0.57	0 860	0.140	0 000	Europe
	lead lump	ML	133	42.1	19 2	0.76	0.984	0.016	0.000	Europe
	lead ball	ML	160	11.0	12.3	0 48	0 987	0 013	0.000	Europe
	lead ball	ML	161	12.2	12 7	0.50	0.192	0.808	0 000	Mexico
	lead ball	ML	167	12.6	12.8	0.51	0 199	0.801	0.000	Mexico
	lead ball	ML	172	16.1	13 9	0 55	0 389	0 611	0.000	Mexico
	lead ball	ML	176	16.8	14.1	0 56	0.000	0.000	1.000	MVT
	lead ball	ML	185	15 5	13.8	0 54	0 888	0 112	0 000	Europe
	lead ball?	ML	197	22.4	15.6	0.61	0.602	0.398	0 000	Europe
	melted piece	ML	201	9.0	11.5	0.45	0.633	0 367	0.000	Europe
	lead ball	ML	217	14.7	13.5	0.53	0 836	0 164	0.000	Europe
	lead ball	ML	218	11.1	12.3	0.48	0.906	0.094	0.000	Europe
	lead ball	ML	221	15.0	13.6	0 54	0 816	0.184	0.000	Europe

41MN23	lead ball	ML	222	14.3	13.4	0.53	0 921	0 079	0.000	Europe
	lead ball	ML	223	11.5	12 5	0 49	0.823	0.177	0.000	Europe
	lead ball	ML	224	14.0	13:3	0.52	0.841	0.159	0.000	Europe
	lead ball	ML	234	11.7	12.5	0.49	0.836	0.164	0.000	Europe
	lead ball	ML	242	9.4	11.6	0.46	0.786	0.214	0.000	Europe
	lead ball	ML	246	16.2	14.0	0 55	0 331	0 669	0.000	Mexico
	melted piece	ML	275-1	59 4	n/a	n/a	0.564	0.436	0.000	Europe
	melted piece	ML	275-2	43 1	n/a	n/a	0.637	0.363	0.000	Europe
	melted lead ball?	ML	363	13.7	13 2	0.52	0 319	0 681	0.000	Mexico
	melted piece	ML	367	15.2	13.7	0.54	0.678	0.322	0.000	Europe
	melted piece	ML	390	15.0	13.6	0.54	0.712	0.288	0.000	Europe
	melted piece	ML	393	15.8	13.8	0.55	0.227	0.773	0.000	Mexico
	melted piece	ML	394-1	19.7	14.9	0 59	0.220	0 780	0.000	Mexico
	melted piece	ML	395-1	25.3	16.2	0 64	0.661	0.339	0 000	Europe
	melted piece	ML	396-2	15 3	13.7	0 54	0 692	0.308	0.000	Europe
	melted piece	ML	475	89 2	n/a	n/a	0.459	0 541	0.000	Mexico
	lead ball	ML	562	17.3	14 3	0 56	0 964	0.036	0 000	Europe
	lead ball	ML	564	17 1	14.2	0.56	0.641	0 359	0.000	Europe
	lead ball	ML	567	16 1	13.9	0 55	0.874	0.126	0 000	Europe
	lead ball	ML	571	12 6	12.8	0 51	0.096	0.904	0 000	Mexico
	lead ball	ML	572	5.3	9.6	0.38	0.829	0.171	0 000	Europe
	lead ball	ML	574	13.8	13 2	0 52	0.636	0 364	0.000	Europe
	lead ball	ML	580	10.9	12.2	0 48	0 452	0 548	0 000	Mexico
	lead ball	ML	581	12 8	12.9	0.51	0.326	0.674	0.000	Mexico
	lead ball	ML	582	15 9	13.9	0.55	0 000	0.000	1.000	MVT
	lead ball	ML	583	17 0	14 2	0 56	0 862	0 138	0.000	Europe
	lead ball	ML	585	13 2	13.0	0.51	0.798	0 202	0.000	Europe
	lead ball	ML	586	17 4	14.3	0.56	0 739	0.261	0.000	Europe
	lead ball	ML	587	16.7	14.1	0.56	0.886	0.114	0.000	Europe
	lead ball	ML	588	17.0	14.2	0 56	0 869	0.131	0.000	Europe
	lead ball	ML	594	14 6	13 5	0.53	0.342	0.658	0 000	Mexico
	lead ball	ML	596	10.3	12.0	0 47	0.187	0 813	0.000	Mexico

41MN23	lead ball	ML	598	14.6	13.5	0.53	0.890	0.110	0.000	Europe
	lead ball	ML	600	13.6	13.2	0.52	0.000	0.000	1.000	MVT
	large lead lump	ML	601	156.6	n/a	n/a	0.889	0.111	0.000	Europe
	lead ball	ML	602	14.1	13.3	0 52	0.790	0.210	0.000	Europe
	lead ball	ML	604	14.8	13.5	0 53	0.841	0 159	0.000	Europe
	lead ball	ML	606	14.9	13.6	0.53	0.804	0.196	0.000	Europe
	lead ball	ML	608	12.5	12.8	0.50	0.207	0.793	0.000	Mexico
	lead ball	ML	609	13.0	13.0	0 51	0.823	0.177	0.000	Europe
	lead ball	ML	620	14 5	13.5	0.53	0.000	0.000	1.000	MVT
	lead ball	ML	638	14.4	13 4	0.53	0.862	0.138	0.000	Europe
	lead ball	ML	646	16.1	13.9	0.55	0.858	0.142	0.000	Europe
	lead ball	ML	688	14.5	13.5	0.53	0 607	0.393	0.000	Europe
	lead ball	ML	706	11 0	12 3	0.48	0.367	0.633	0 000	Mexico

Notes to Appendix B:

[1] Based on the equation $d = 2(\sqrt[3]{0.021x})$, where d=diameter in cm and x=weight of lead object in grams

[2] Sudbury (1976:37) bullet 6, Figure 9.21

[3] Sudbury (1976:36) bullet 1, Figure 9.16

[4] Sudbury (1976.37) bullet 5, Figure 9 20

[5] Sudbury (1976.36) bullet 3, Figure 9.18

[6] Sudbury (1976:37) bullet 4, Figure 9.19

[7] Wyckoff (1964.17), Figure VI-6

[8] Of fairly uniform thickness. Measures approx. 3.85 mm thick on one side, and 2.25 mm on the other. Wyckoff (1964.17), Figure VI-13

[9] Lead ball exhibits a band of flattening around its circumference - an indication of separation from the patch, according to Jay Blaine

[10] Hartley and Miller (1977.100-101), Figure 10.O

[11] Hartley (1975.54)

[12] 25 pieces total in this lot, combined weight 233.2 g

[13] with strange protrusion (Trench 3)

[14] largest lead ball in this lot of five pieces

[15] semi-hemispherical partial lead ball (Trench 7)

[16] middle-sized disk in this lot of three pieces (Trench 6)

[17] Mississippi Valley Type

Sources

[a] – George H. Odell

[b] – Texas Archeological Research Laboratory

[c] - J. Byron Sudbury

[d] – Sam Noble Oklahoma Museum of Natural History

[e] – J. Byron Sudbury (via Rose Paddock)

[f] – Oklahoma Historical Society / Oklahoma Museum of History

[g] – Texas Tech University

[h] – Monte Lyckman

APPENDIX C:

PHOTOGRAPHS OF ARTIFACTS EXAMINED

Photo 1: Artifacts from Lasley Vore (34TU65), the Womack Site (41LR1), and Bryson-Paddock (34KA5)
Provided by George H. Odell, the Texas Archeological Research Laboratory, and Byron Sudbury. Photos by Monica Trejo.

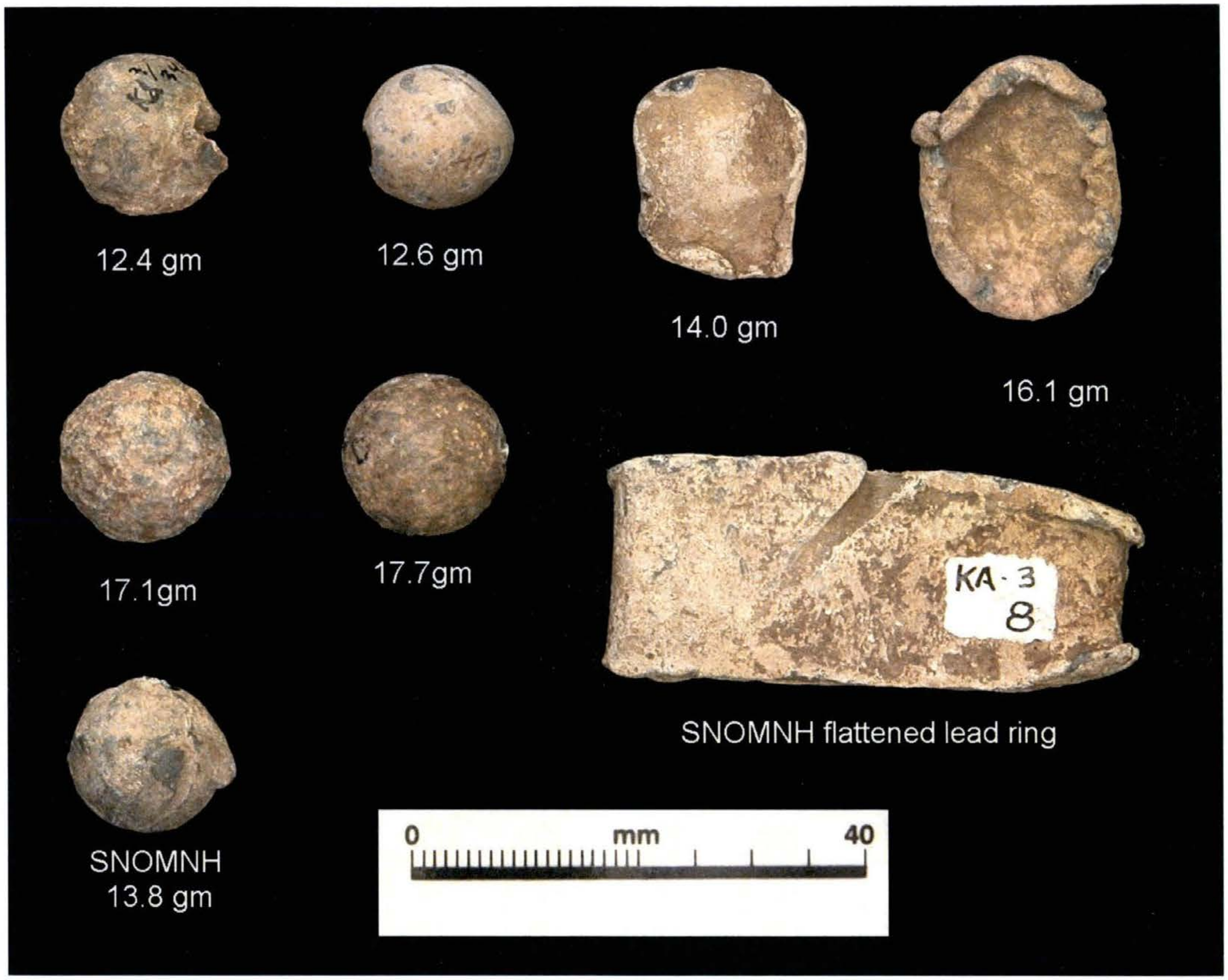


Photo 2: Artifacts from Deer Creek (34KA3)
From the collections of Byron Sudbury and the Sam Noble Oklahoma Museum of Natural History. Photos by Monica Trejo.

Photo 3: Artifacts from Bryson-Paddock (34KA5)

From the collections of Byron Sudbury and the Sam Noble Oklahoma Museum of Natural History. Photos by Monica Trejo.

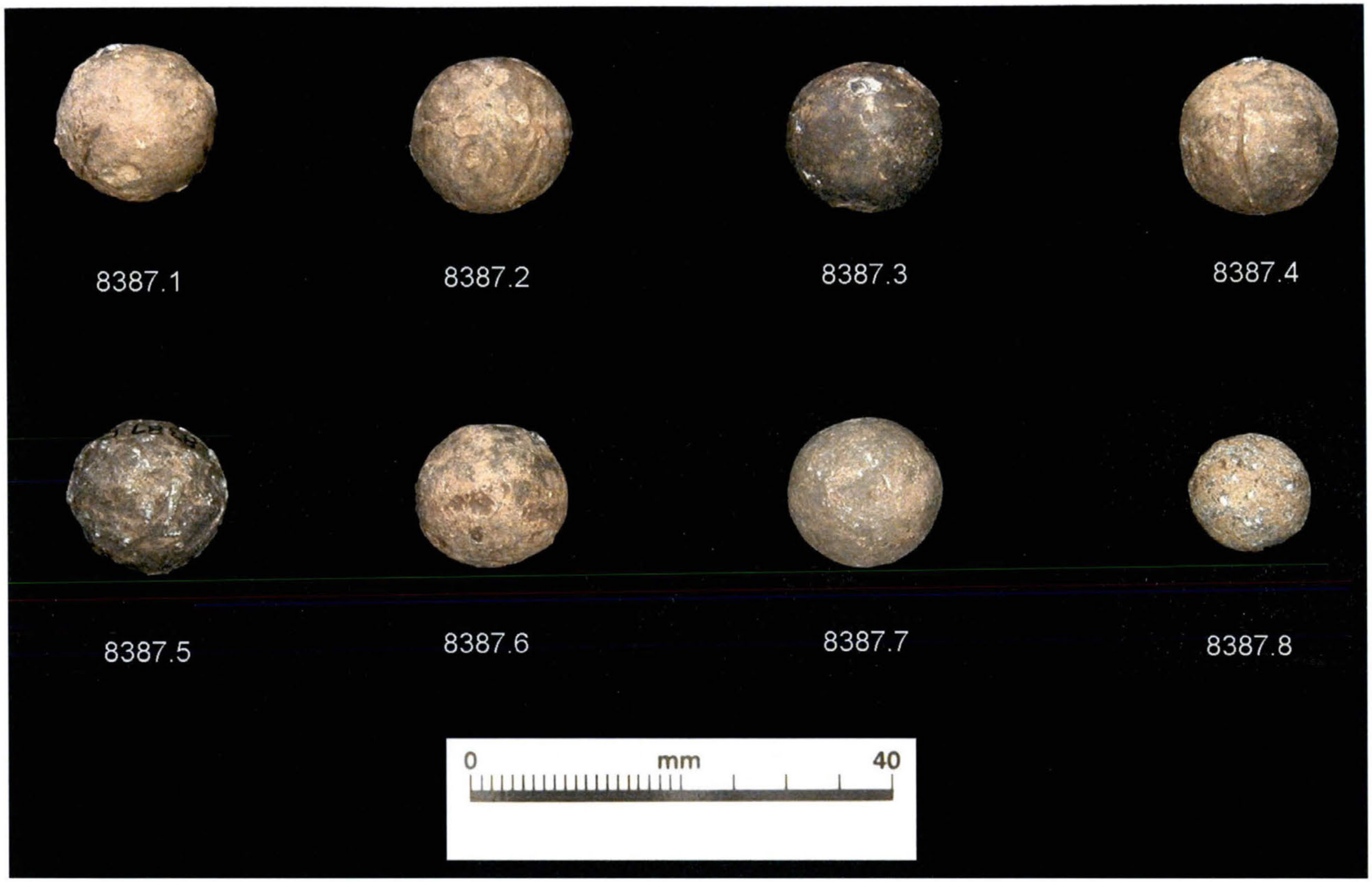


Photo 4: Artifacts from either Deer Creek (34KA3) or Bryson-Paddock (34KA5)
From the collections of the Oklahoma Historical Society. Photos by Monica Trejo.

Photo 5: Artifacts from Fort St. Louis (41VT4) and Presidio La Bahía (41VT8)
From the collections of the Texas Archeological Research Laboratory. Photos by Monica Trejo.

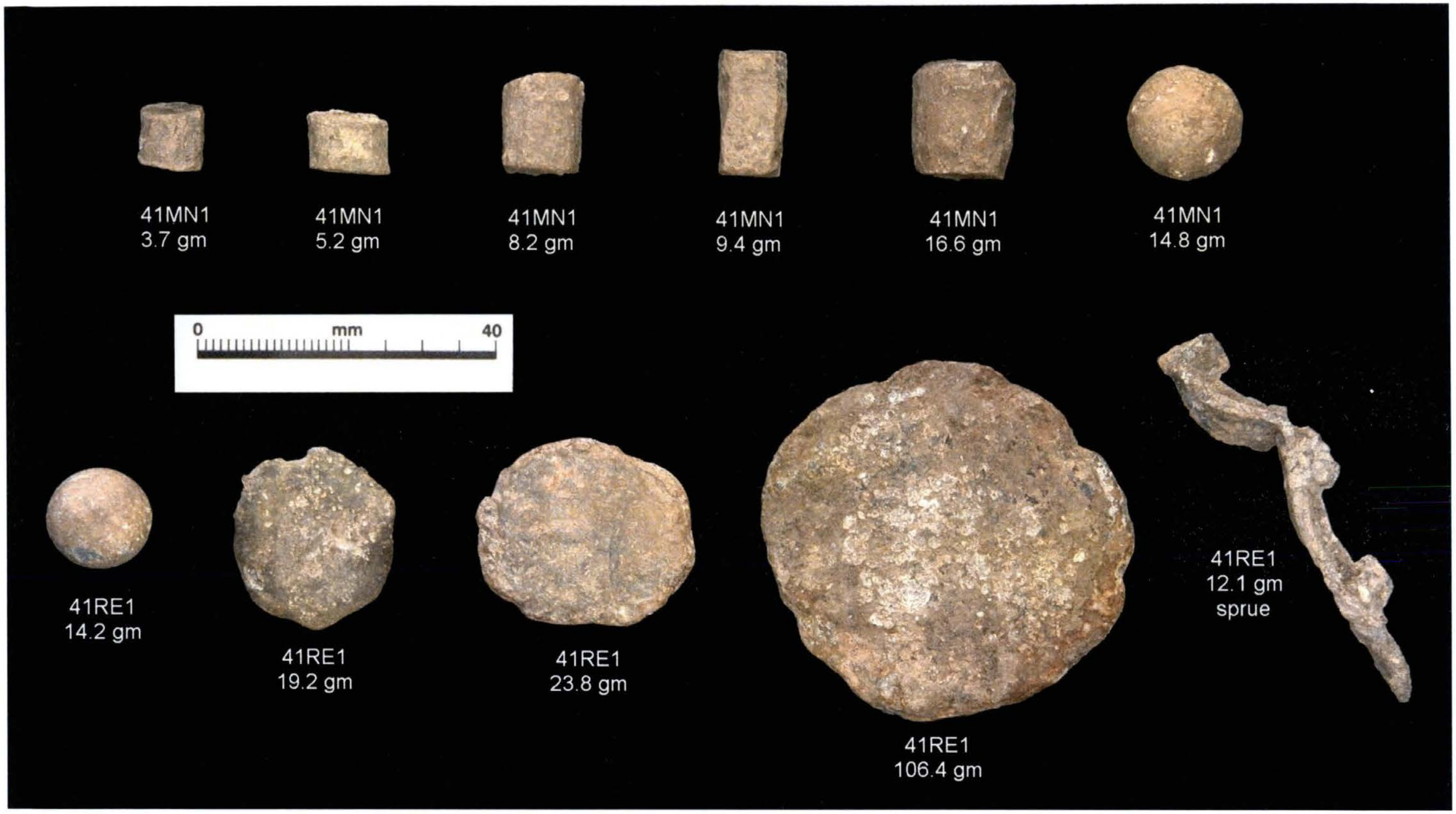


Photo 6: Artifacts from Presidio San Sabá (41MN1) and Mission San Lorenzo (41RE1)

From the collections of the Texas Archeological Research Laboratory and Texas Tech University. Photos by Monica Trejo.

Photo 7: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 1

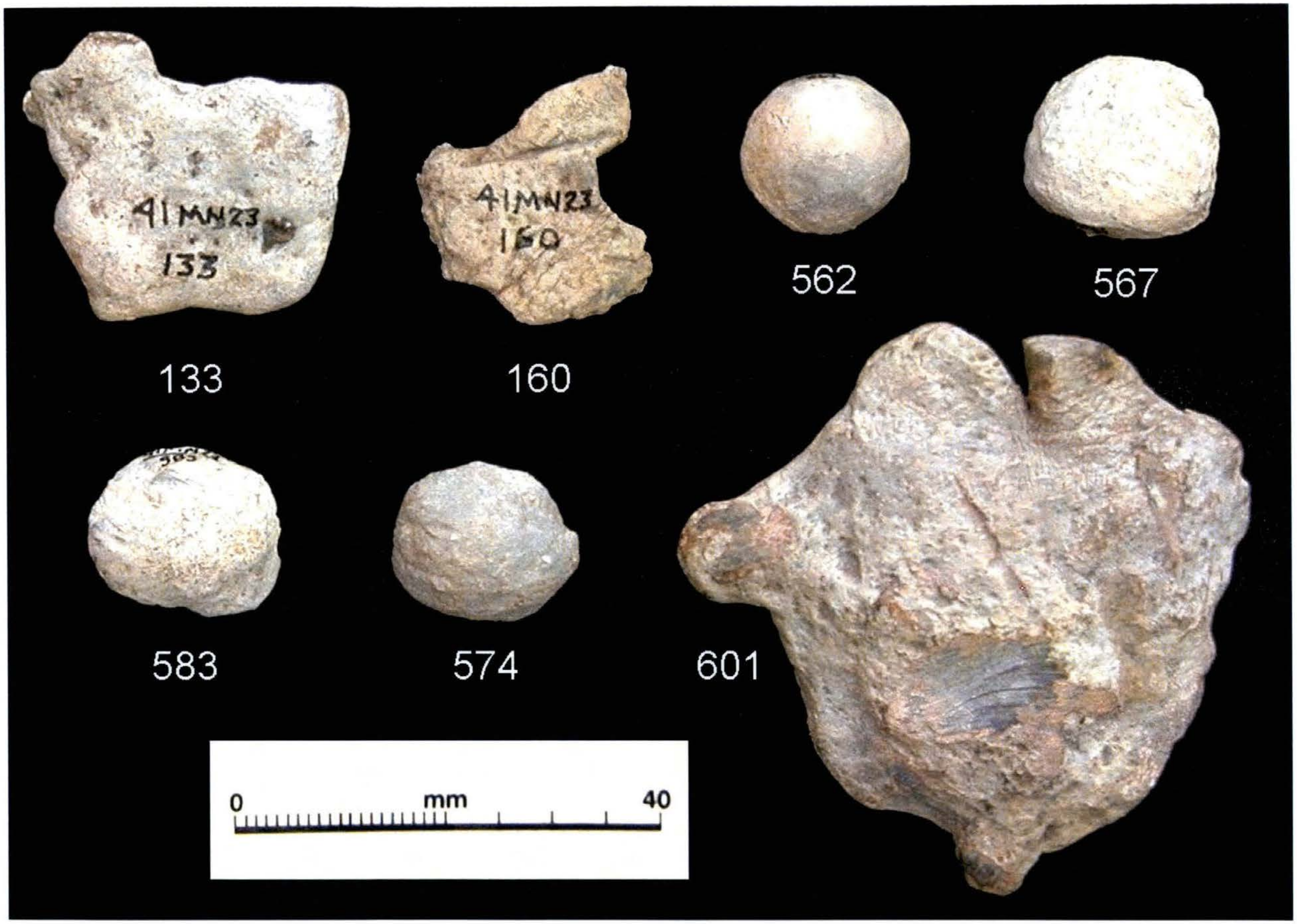


Photo 8: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 2

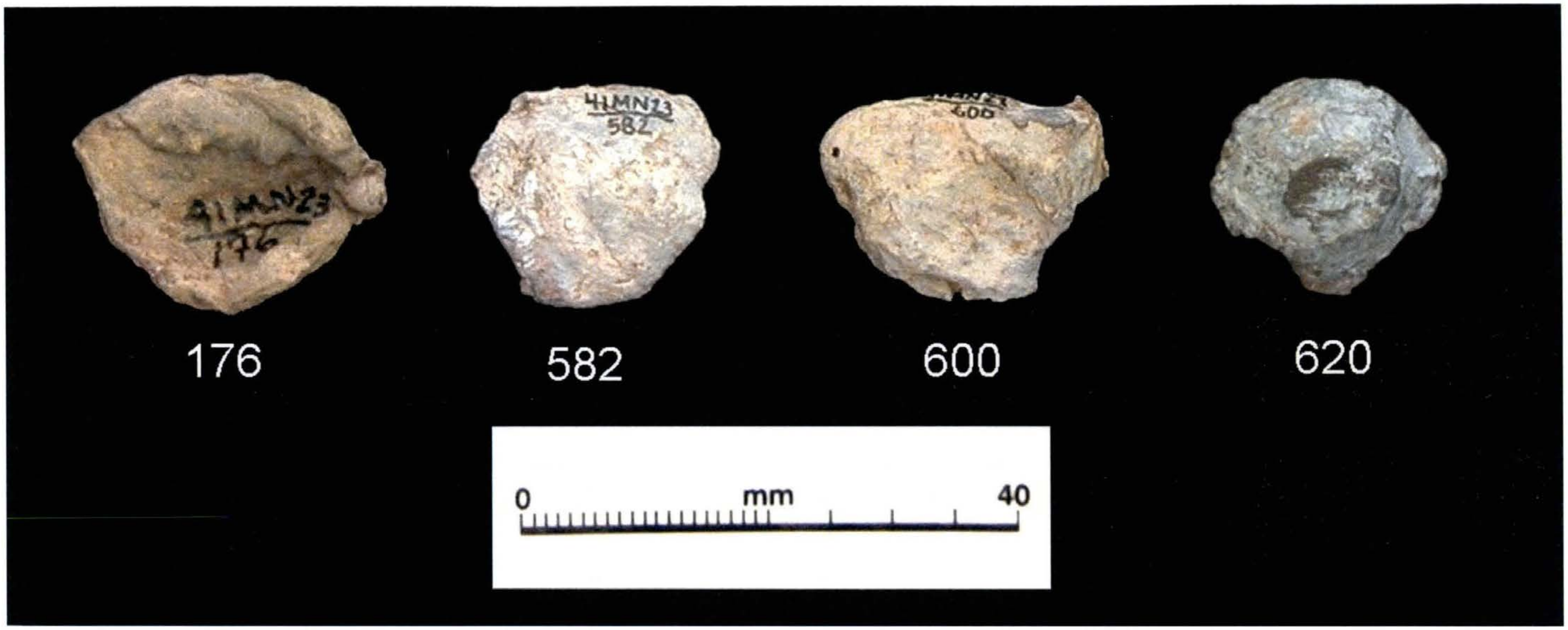


Photo 9: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 3

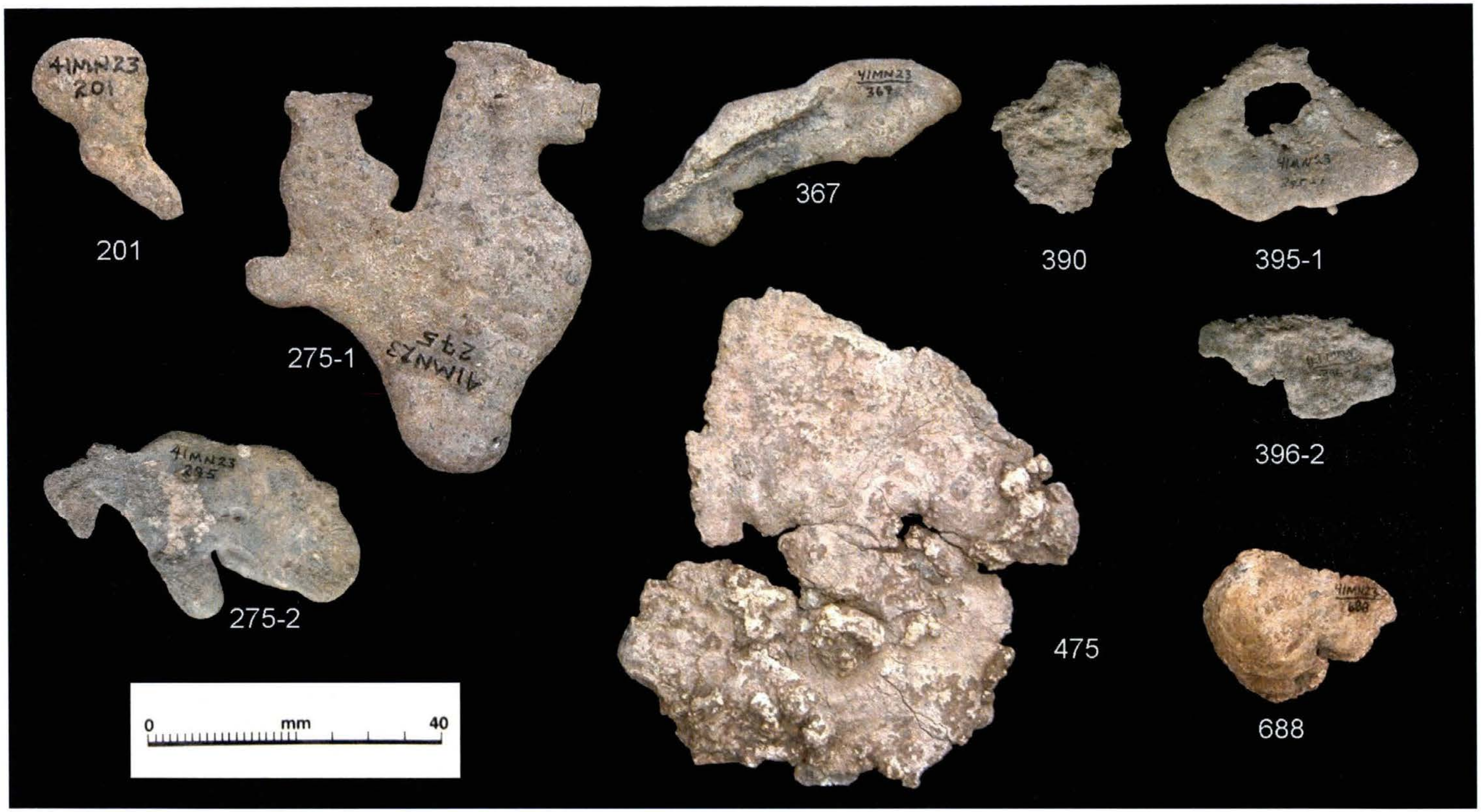


Photo 10: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 4

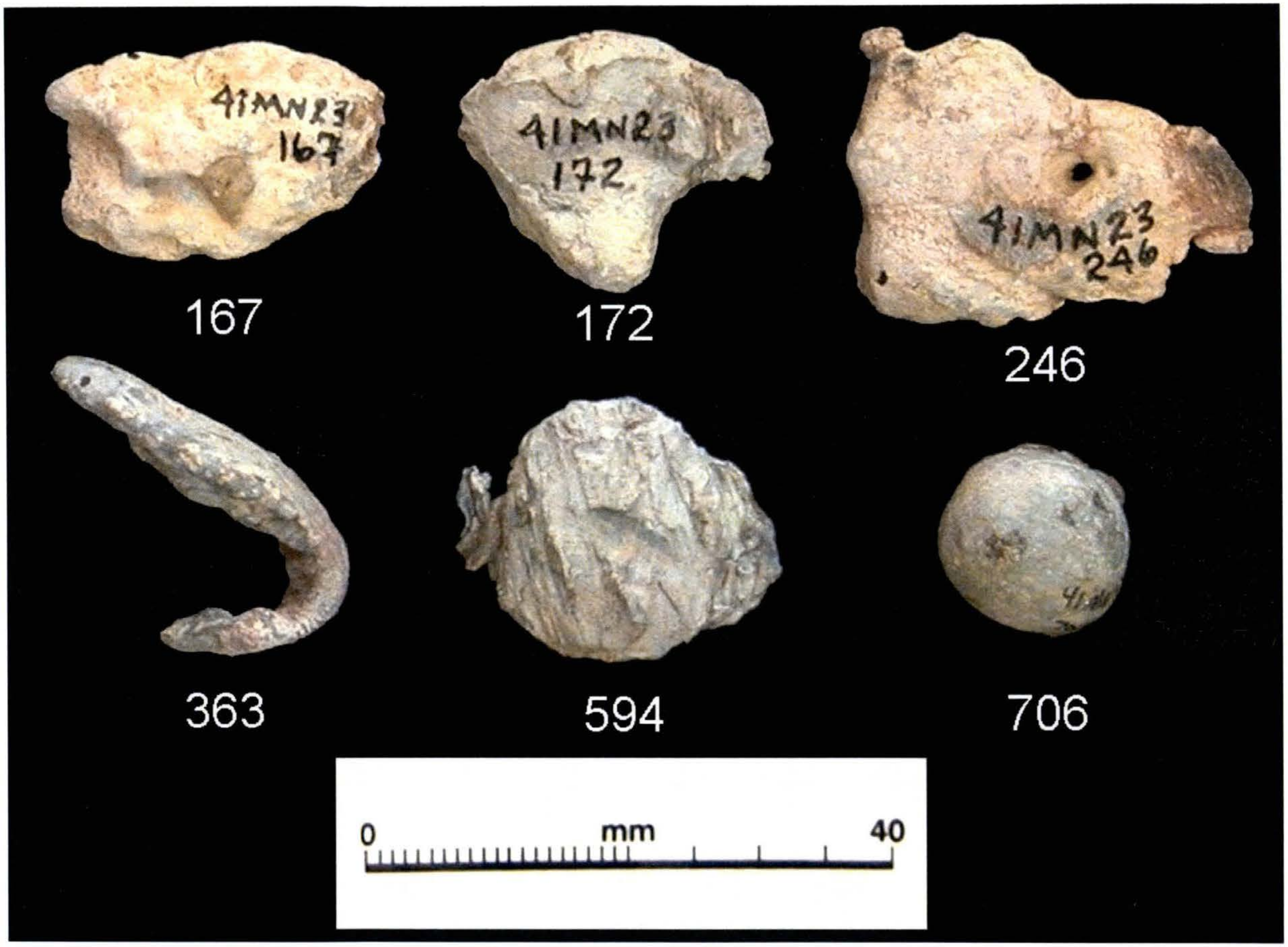


Photo 11: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 5

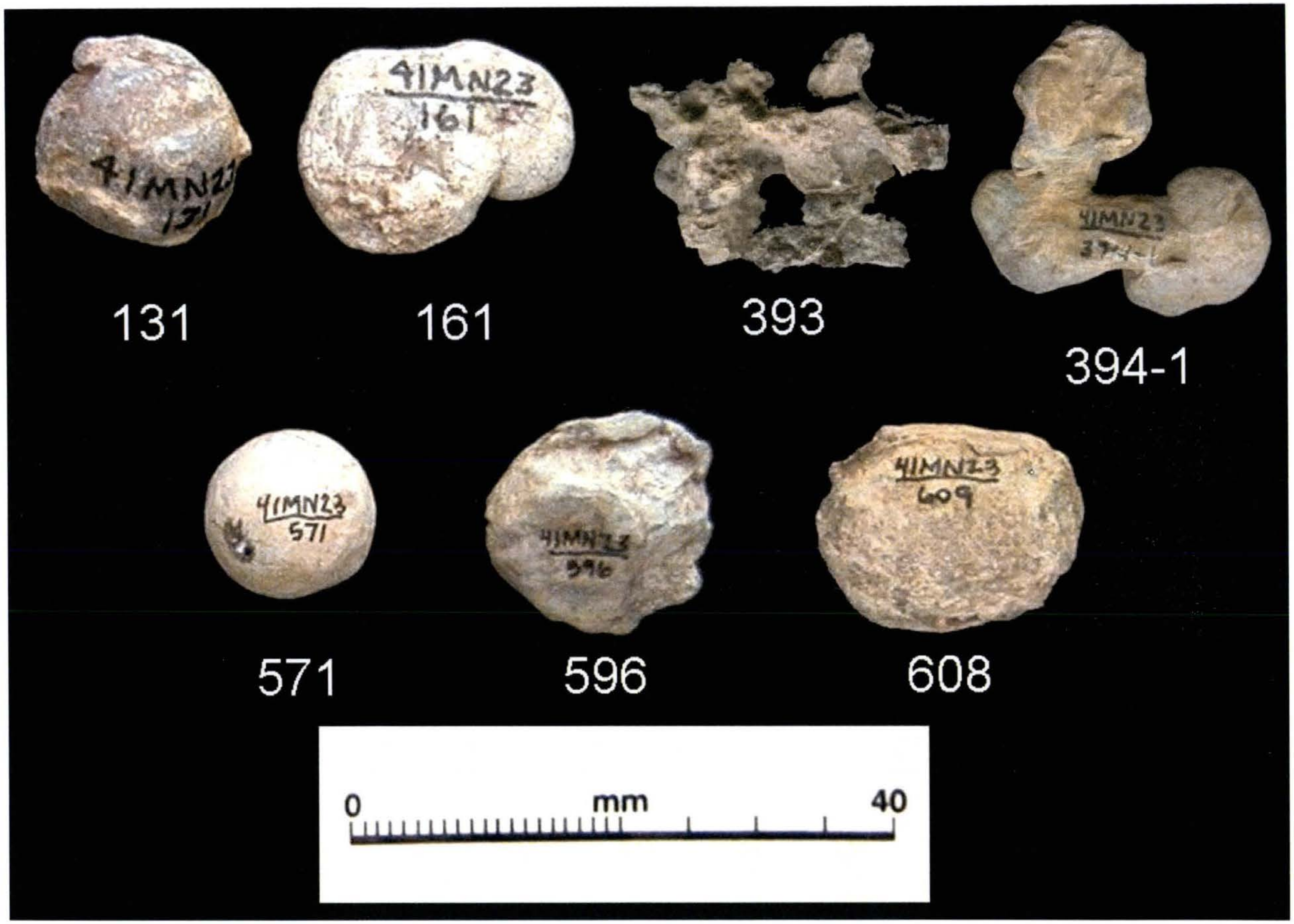


Photo 12: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 6

Photo 13: Artifacts from Mission Santa Cruz de San Sabá (41MN23) forming Isotope Group 7

APPENDIX D:

DATA ON LEAD PRODUCTION, IMPORTS, EXPORTS, TRADE, PRICES, AND EVENTS AMONG THE FRENCH, SPANISH, AND NATIVES FOR THE COLONIAL ERA, TO 1804

For weight measurements of lead, the French livre or English pound avoirdupois (lb. avdp.) appear to be the units of common use. The two are not equal. A French livre is equivalent to about 1.08 English pounds (Ekberg 1985:475). According to the weight systems likely in use at the time, an English pound avoirdupois is 453.6 grams, while a French livre is 489.41 grams (Ross 1983:25, 29, 59). French, English, and Spanish measurements also made use of a unit known as a quintal, or hundredweight (sometimes abbreviated as "cwt"). According to Ekberg (1985:475; 1998:235), a French quintal is equivalent to 108 English pounds. However, tables provided by Ross (1983:29, 59) indicate that there were two separate units for a hundredweight in the English avoirdupois system. 112 lbs. avdp. make up a quintal, or "long" avoirdupois hundredweight (equal to 50.8032 kilgorams), while 100 lbs. avdp. make up a cental, or "short" hundredweight (equivalent to 45.36 kilograms). A French quintal is equivalent to 48.941 kg. It would seem, then, that a French quintal is actually somewhere between a long and a short English hundredweight, with the long English hundredweight of 112 lbs. avdp. being about 3.8% heavier than a French quintal, and a short English hundredweight of 100 lbs. avdp. being about 7.3% lighter than a French quintal. In sum:

1 French livre	=	1.0789 lbs avdp.	=	489.41 gm
1 French quintal	=	100 French livres	=	48.941 kg
1 long English cwt (quintal)	=	112 lbs avdp.	=	50.8032 kg
1 short English cwt (cental)	=	100 lbs avdp.	=	45.36 kg

The above figures are of interest, as metrological units have often been transcribed or translated carelessly from original historical documents, with the unequal French livre and English pound frequently interchanged indiscriminately. Many of the figures provided in this chronology may therefore be corruptions or approximations of the actual figure, but remain reasonably accurate for comparative purposes. It can also be expected that many of the weights calculated during the colonial period were often approximations or general estimates with considerable errors. In some cases, such as that of annual yields, amounts may have been inflated to cast production figures in a more positive light (Ekberg 1985:156-157).

The primary unit of French colonial currency was the *livre tournois*, usually denoted just as *livre*, which is the same term used for a unit of weight. As a result, there is sometimes room for confusion as to whether the weight or the value of a certain quantity of a commodity is being expressed. Ekberg (1985:475) equates a French livre to one-fifth (0.20) of an American dollar, Spanish peso, or Spanish piastre. A French sol (or sou) is the twentieth part (0.05) of a livre, and hence equates to a hundredth (0.01) of a dollar, peso, or piastre. Prices expressed in sols and cents can be considered roughly interchangeable, then.

Other chronological listings exist of lead mining activities for the period under consideration. Abbot (1988:12-15) provides a useful chronology for the Upper Mississippi Valley lead mining region that continues to 1848. A copy could not be obtained prior to submission of this thesis of Millhouse's "Chronological History of Indian Lead Mining in the Upper Mississippi Valley from 1643 to 1840".

A Chronology of French, Spanish, and Native Colonial Lead Production and Transactions

1665 The Carnigan-Saliéres Regiment, sent from France to Canada to wage war on the Iroquois, was equipped with 6,000 bars and 4,000 slabs of lead, 6,415 pounds of lead balls and 2,000 pounds of shot. (Kent 2001:185)

1684 La Salle recommended that 7,000 pounds of lead balls and 3,000 pounds of lead (in bars?) be purchased in France for Fort Frontenac, where he held the trade concession. (Kent 2001:185)

1686 La Salle's ship *La Belle*, sunk in Matagorda Bay off the Texas gulf coast, carried approximately 5,000 pounds of lead, including almost 300,000 lead balls and shot. (Bruseth and Turner 2005:95; Maureen Brown, personal communication 2006)

1686 Anastasius Douay, of the La Salle expedition, commented that "The various accidents that befell us prevented our searching for the treasures of this country: we found lead quite pure and copper ready to work. The Indians told us that there were rivers where silver mines are found; others wished to conduct us to a country known to the Spaniards, abounding in gold and silver mines" (Cox 1905:265-266). This account comes from an extract of Douay's narrative prepared by Le Clercq.

1687 [Oct.] Joutel, returning overland to Canada from Fort St. Louis, notes in his account that "There is no Reason to question, but that there are in this Country, Mines of all Sorts of Metals, and of the richest, the Climate being the same as that of *New Mexico*. We saw several Spots, where it appeared there were Iron Mines, and found some Pieces of it on the Bank of the River, which Nature had cleansed. Travellers who have been at the upper Part of the *Missisipi*, affirm they have found Mines there, of very good Lead" (Joutel 1714 [1968]:172).

1688 A Montreal outfitter supplied three traders to the Illinois country with 71 livres of lead balls and 200 livres of lead, as well as eight muskets of two different qualities, 100 livres of gunpowder, eight gun pliers, a livre of gunworms, and 200 musket flints (Bauxar 1959:47; Quimby 1966:65; Walthall 1981:20; Kent 2001:185)

1689 A proposed invasion of New York was supplied from France with 4,000 pounds each of balls and lead (presumably in bar form). (Kent 2001:190)

1690s Cadillac in his memoirs notes that "There are several lead-mines in the Sioux country, which are very rich" (Quaife 1947:72). Likewise, Pierre Liette (a trader or army officer in the Mississippi Valley who apparently wrote his Memoir in 1702) notes "Some bits of red copper have been discovered in the vicinity of the river, but up to the present time no mine has been found. We have only found further down it several lead mines which are very rich. The French and the Indians make use of no others and they even carry on a trade in lead with the Indians who come to trade with them" (Quaife 1947:xviv-xxviii, 128).

1692 The officials of New France provided the Abenakis and Penobscots with a large number of guns, as well as 400 pounds of lead, 400 pounds of balls, and 700 pounds of duck shot. (Kent 2001:185)

1693 Gifts sent to New France for distribution to the Indians included 4,000 pounds of bullets and 700 pounds of *plomb à outarde* (sheet lead), as well as 2,526 pounds of gunpowder, 3,000 gunflints, 158 guns and sheaths, and 33 pistols. Some groups included in the distribution were the Hurons, Sauteux, Nipissing, Miamis, Illinois, and Puants. (Bouchard 1977:4).

1693 Shipments from New France to the Micmacs included 600 pounds of shot and 100 pounds of lead. Shipments to the Malecites included 500 pounds of shot and 100 pounds of lead. (Kent 2001:185)

1696 Shipments to the royal warehouses of Canada from the King's storehouse at Rochefort included 2,000 pounds of lead slabs, 1,000 pounds of lead bars, 4,000 pounds of bustard shot, 3,000 pounds of goose shot, and 2,000 pounds each of duck and beaver shot. Total: 14,000 pounds. (Kent 2001:185)

1701 Ammunition sent from France to the Biloxi fort on the Gulf Coast included 1,200 pounds of fowling shot and 200 pounds of plate lead (slabs) (all valued at 23.5 livres per quintal), and 1,000 pounds of goose shot as "presents to be made to the Indians of the said country [Mississippi]" (valued at 22.5 livres per quintal). (Brain 1979: 289-291; Kent 2001:185; Hamilton 1980:10 quotes these figures as being in *livres*.)

1701 Cadillac's inventory of materials sent from France for the founding of Detroit included 6,742 pounds of lead (at 31.5 livres per hundredweight), along with 86 bags for the lead. Additionally, 3,000 pounds of lead and balls (at 37.5 livres per hundredweight) were sent to Fort Frontenac for eventual transport to Detroit. Also, two canoe traders from Fort Roland and Bout de l'Isle were given charge of 300 pounds and 46 pounds of lead, respectively (each at 37.5 livres per hundredweight). Total: 10,088 pounds of lead to supply the founding of Detroit. 4,116 pounds of gunpowder are also listed in the inventory, as well as 25 pounds of lead scale weights at 4 sols 6 deniers per pound (equivalent to 22.5 livres per hundredweight). (Kent 2001:1011-1015)

1702-1713 Spain and France fought against England in the War of the Spanish Succession (also known as Queen Anne's War). This conflict kept France from tending diligently to the needs of the Louisiana colony, resulting in a dearth of trade goods (Brown 1992:26). As a result of the Treaty of Utrecht which ended this conflict, England received rights to the Spanish slaving contract (*asiento*) for a period of thirty years, which entitled it to not only supply the Spanish empire with slaves, but to also send annually to Mexico a vessel with 500 tons of duty-free merchandise (Bethell 1985:391, 410-413). Deagan (2007:101) states that two ships of 650 tons apiece were allowed. The French had actually held the *asiento* from 1640 to 1713, and the English would retain it until 1739 (Deagan 2007:101). See also entry for 1739, below.

1702 [Mar. 2] A letter to Father Jean de Lamberville, perhaps written by Father Gravier, requested things badly needed for the use of the Illinois missions, among them 50 livres of bullets and 50 livres of assorted large and small shot, as well as 150 livres of gunpowder and 500 gunflints (Good 1972:18-20).

1702 The Spanish governor at St. Augustine requested ammunition from Bienville (at the newly established fort at Mobile Bay) to assist him in his struggle against the English. Bienville provided 100 guns, 500 pounds of powder, and ammunition in response. (Surrey 1916:427)

1703 Ammunition sent from France to Mobile Bay included 3,000 pounds of lead balls, plus an additional 2,500 pounds of musket balls and 3,000 pounds of fowling shot "to arm on the premises Indian allies of France, and to give to persons dispatched to friendly nations" (all at 22 livres per cwt). (Brain 1979:294-295; Kent 2001:185; Hamilton 1980:10 quotes these figures as being in *livres*.)

1704 The French shipped to Mobile Bay as "presents for the savages" 500 trade guns, 5,000 livres of gunpowder, 6,000 gunflints, 2,500 livres of lead bullets, and 3,000 livres of small shot (Hamilton 1980:129). (It could be that these figures actually pertain only to 1703, owing to their similarity, and that Hamilton, citing a personal communication, gave the date 1704 in error.)

1708 The commissary general of Louisiana, Diron d'Artaguiette, sent some samples of lead and copper ore from the Illinois country to France (Alvord 1965:140).

1710 Antoine Denis Raudot, the co-Intendant of New France, wrote "There is near the Malameek a rich lead mine. Too imprudently, a few Frenchmen have taught these savages to melt lead and have even furnished them molds, with the result that we no longer sell it to them and they trade it with other nations" (Kinietz 1965:383-384). This passage appears to refer the Piankashaw, a sub-tribe of the Miami Indians of southern Wisconsin.

1711 An inventory of Cadillac's possessions at Detroit included 740 pounds of lead (bars?) and 200 pounds of "lead and gun balls together". Also, a brass or bronze gang mold weighing 14 pounds that could be used for casting 17 balls on one side and molded lead (presumably bars or strips) on the other, another small brass gang mold for casting nine balls that decrease in size, and one pair of poor-quality scissors for cutting sprue from cast balls. Also mentioned are a surgeon's chest with 11 lead boxes, a lead writing set weighing 2.25 pounds, and 33.5 pounds of "tin" (possibly pewter) in seven flat plates. (Kent 2001:1053-1055)

1711 An inventory of the possessions of Monsieur de Marigny at Detroit (undertaken at the same time as the inventory of Cadillac's possessions) included 241.5 pounds of lead in five bags and 164 pounds of gun balls in three bags. (Kent 2001:1057)

1713 In an attempt to prevent certain tribes from forming or maintaining alliances with the English, Bienville (Governor of Louisiana) "would stir up secretly some other powerful nations to which he would furnish powder, bullets and the greatest number of guns that he could to make war on the one that he saw was moved by the English…" (Brown 1992:27)

1713-14 A vessel from France arrived at Dauphin Island in 1713, with ammunition among its cargo. The cargo ship of 1714 and all its supplies were lost. (Surrey 1916:158)

1715 Duclos, *Ordannateur* (Intendant) of Crozat's monopoly of Louisiana, forwarded to the Navy Council of France a report (dated June 3, 1716) a proposed price schedule of commodities offered by the colonists to the Company (the list itself having been drawn up in June, 1715). This included lead in bars quoted at 10 sous a pound (and presumably extracted from Mine La Motte), but Crozat's directors refused to establish a set price on the basis of there being no market for lead. (Willms 1935:11-12)

1715-16 Lead supplied from Quebec is listed at 15 sols per livre (Thwaites 1902:401-405).

1715 [Sep. 10] The Montreal outfitter Monière supplied the Detroit trader Jean Bourgery with 61 pounds of lead balls in one bag (at 100 livres per hundredweight), as well as 41.5 pounds of gunpowder. (Kent 2001:1060)

1716 Philippe de Vaudreuil, Governor of Canada, wrote to the Duc d'Orleans, Regent of France, that it would be advisable that Canada be supplied annually with 40,000 pounds of powder and 60,000 pounds worth of lead *en saumon* (in pigs or bars), as well as "600 hunting guns from Tulle because… the Indians know them and do not want others" (Bouchard 1977:5; Kent 2001:185). (Note: Hamilton 1980:39 gives the date of this exchange as 1734, but Vaudreuil died in 1725. His son served as Governor of Louisiana from 1743-1853, and as Governor-General of Canada from 1755-1760.)

1718 The Intendant at Rochefort shipped 4,000 pounds worth of lead pigs and 2,000 pounds of powder, granted to the Iroquois nations by the Council. (Kent 2001:187)

1719-1721 The War of the Quadruple Alliance between Spain and France caused the temporary abandonment of Spanish missions among the Hasinai Caddo on the Angelina and Neches Rivers. As part of this, a small French garrison from Natchitoches occupied and took over the barely populated Mission San Miguel de Cuellar de los Adaes in an incident known as "The Chicken War" (Gregory et al. 2004:67).

1719 The Company of the West fixed the price of bullets at 8 sols per pound. (Surrey 1916:279). This is equivalent to 40 livres per hundredweight.

1719 Twenty miners bound for Illinois were temporarily redirected to a garrison at Dauphin Island in response to a perceived risk of Spanish attack (Briggs 1985:293).

1721 [Sep. 13-14] The Montreal outfitter Monière supplied an association of five *voyageur*-traders bound for Detroit with 100 pounds of balls, 50 pounds of shot (all at 60 livres per hundredweight), and 49 pounds of lead in one bag (at 75 livres per hundredweight) Also mentioned are 161.5 pounds of gunpowder. (Kent 2001:1063-1064)

1721 Presidio Los Adaes was founded. Initially all trade was officially banned, though by the early 1730s trade in foodstuffs was officially sanctioned owing to the difficulty of supplying such a distant outpost (Galán 2006:311). The Spanish traded Hasinai corn, hides, and horses in exchange for French goods. (Perttula 1992:207-208)

1723 Renaudiere estimated production capacity at Mine la Motte to be 10,000 pounds of lead per month with the aid of eight workmen (Rothensteiner 1926:208). Diron d'Artaguiette notes in his journal that Phillipe François Renaut had produced perhaps 6,000 pounds of lead at the Meramec mines in a time of about a month and a half (Rothensteiner 1926:210; Willms 1935:21).

1723 [July 1-5] The estate of Jacques Boudron, resident of Kaskaskia and captain of the town militia, is noted to have contained 40 pounds of lead balls, 1 bullet mold, 14 guns and one musket, a pair of pocket pistols, and 200 gunflints. Boudron was also active in the fur trade and his estate is cited as an example of the kind of property owned by the upper class in the Illinois country (Belting 1948:43-44; Emery 2004:30-31).

1724 [Sep.] The Montreal outfitter Moniére supplied the Detroit trader Jacques Campeau with 300 pounds of balls and 100 pounds shot (all at 70 livres per hundredweight), as well as 4 bags for the lead and 100 livres worth of gunpowder (probably equivalent to somewhere around 40-67 pounds of gunpowder at prevailing prices). (Kent 2001:1066)

1724 Philippe Renaut approached the Superior Council of Louisiana with a proposal to remit 20,000 pounds (or *poids*) of lead from his mines in the Illinois country for the use of the garrison at Fort des Chartres. The directors of the Company of the Indies established the price at 55 livres per quintal, which was applied directly to the reduction of Renaut's sizeable debt (Surrey 1916:303; Briggs 1985:293; Willms 1935:23). This equates to 11 sols per livre.

1725 Renaut's production from the Meramec Mines and Mine la Motte had increased to a reported 1,500 pounds per day. This figure may merely represent perceived potential rather than actual production, though, as Renaut lacked an adequate labor force. However, soon after this mining fell off sharply due to general Indian hostilities in the mining region associated with the Fox Wars, as well as a withdrawl of financial backing from the Company of the Indies (Alvord 1965:159; Willms 1935:24).

1729 The Fort Pontchartrain (Detroit) trader Antoine Cuillerier wrote to his wife in Montreal, urging that she visit and send supplemental trade goods including lead balls and large shot. (Kent 2001:1067).

1729 The French garrison at Fort Toulouse, also known as the Alabama Post, relied critically on lead balls and gunpowder, supplied from Mobile, as the primary items of exchange with the Creek Indians for such essentials as food. "Powder and balls, which are the currency of the post" served as the basic medium of exchange in addition to deer hides (Waselkov 1992:36).

1731 [Dec. 10] Etienne Périer, Governor of Louisiana, writes to Maurepas, Minister of the Marine, to explain the difficulty of involved in maintaining the French alliance of the Chocktaw against the Chickasaws, and makes clear the dire necessity of maintaining regular shipments of lead:

> "The Choctaws appear to be well united among themselves and are more attached to us, which comes from the need that they have of us for their munitions and weapons, but unfortunately we lack light trade guns of the sort the Company used to send. The quantity of powder and of lead both in bullets and in shot that is consumed in this province will appear surprising to you, my lord. We cannot do without it, both for making a living and for the safety of the country, and it is of the utmost importance that we should not be in want of it."

In the same letter, the Governor relates that a party of Natchez Indians had attacked the village of the Natchitoches, but that they were defeated by St. Denis and his garrison along with Attacapa and Caddo Indians. The governor laments that "I should have wished that the party that I sent had gone and driven them back into the lands of the Ouachitas, where they are without powder or arms…" (Rowland et al. 1984a:104-105). This passage seems to indicate that trade with the Wichitas for firearms and ammunition was still poorly developed at this date.

1732 [Mar. 9] Périer wrote to Salmon (commissary general of Louisiana) and Maurepas, providing estimates of the amount of powder and lead used annually in the colony: "In regard to the annual consumption, we cannot give it positively either for powder or for lead. That depends upon events, but without emergencies it may amount to 30,000 [pounds] of powder and to 60,000 [pounds] of lead, including that which is distributed in presents to the Indians and that which is sold to the inhabitants" (Rowland et al. 1984a:117).

1732 [June 9] The Montreal outfitter Moniére supplied the Detroit trader Antoine Cuillerier with 250 pounds of lead balls, 100 pounds of large shot, and 50 pounds of pigeion shot (all at 50 livres per hundredweight), as well as eight bags for the lead and 200 pounds of gunpowder. (Kent 2001:1070)

1733 [Jan.] Etienne Périer, Governor of French Louisiana, complained of the lack of lead in the entire province. Lead production during the entire French period was rather sporadic and unreliable. (Ekberg 1982:141)

1733 [June] Ammunition sent from France to the Louisiana colony consisted of 30,000 pounds of ball and shot, broken down thusly: 20,000 pounds of balls numbering 28 and 32 to the *livre*, and 10,000 pounds of fowling shot broken down into 2,500 pounds each of bustard shot, duck shot, wild pigeon or royal shot, and half-royal shot. The contracts for such awarded at 243 *livres*, 15 *sols* per thousand pounds, duty free (the equivalent of 24.375 *livres* per cwt), and 263 *livres*, 15 *sols* per thousand pounds, with duty imposed (the equivalent of 26.375 *livres* per cwt). Bids for this contract, duty free, began at 28 *livres* per cwt, with subsequent bids at 27.5, 27, 26, 25.5, and 24.375 *livres*. Bids for this contract, with duty imposed, began at 30 *livres* per cwt, with the subsequent winning bid at 26.375 *livres*. (Brain 1979:296; Hamilton 1980:129)

1733 The French rescued 120 Spanish sailors in August, 1732 who had been stranded by a storm in the Gulf region. They were taken to New Orleans and cared for before they could be returned to Veracruz. There, in recognition of their good treatment of the Spaniards, the French delegation entreated the viceroy of New Spain to not only repay the sum expended in their upkeep, but to loan them 50,000 *livres*, sell them 10,000 pounds of lead, and allow them to purchase a boat of about 70 tons. The viceroy allowed the purchase of the boat and provided them with 5,000 *livres* and 35 quintals of lead (approximately 3,920 pounds avoirdupois) "for Pensacola". The intent of this exchange was apparently for the French to use the lead in trade with the Spanish garrison at Pensacola. In this encounter, the French appealed to the Mexican viceroy to open up regular trade between Louisiana and Mexico, but little was accomplished in this regard (Surrey 1916:398-399). Briggs (1985:293), apparently citing the same manuscript source (series C13A of the *Inventaire des Archives Coloniales – Correspondance à l'arrivée en provenance de la Louisiane*), claims that lead was actually being exported from the Illinois country to Veracruz in 1733. This may be a mis-translation or other error.

1734 Ammunition sent from France to the Louisiana colony consisted of 78,000 pounds of ball and shot, broken down thusly: 30,000 pounds of balls numbering 28 and 32 to the pound (avoirdupois), 20,000 pounds of balls numbering 25 and 28 to the pound (avoirdupois), 10,000 pounds of bustard shot, 8,000 pounds of duck shot, and 10,000 pounds half-royal or wild pigeon shot. The contracts for such awarded at 280 *livres* per thousand pounds (the equiavlent of 28 *livres* per cwt). Bids for this contract began at 35 *livres* per cwt, with subsequent bids at 34, 33, 32.5, 30, 29, and 28 *livres*. (Brain 1979:296; Hamilton 1980:129)

1736 [May 30] The Montreal outfitter Pierre Guy supplied the Detroit *voyageur*-trader Jacque Pille with 50 pounds of ball and shot, as well as 29 pounds of gunpowder. (Kent 2001:1073)

1737 [Apr.] The Frenchman Legros (Juan Bautista el Gruesso) was taken prisoner by soldiers from Los Adaes for illegally introducing commerce into Spanish territory, despite having been issued a trading license by the Spanish Lieutenant General Ybiricu. Among the goods confiscated that he had brought to trade to the Cadodacho were 6 *arrobas* (150 pounds) of ammunition and 2.5 arrobas of gunpowder. (Galán 2006:272-273)

1737 [June] Ybiricu also confiscated materials which the French trader Delachaise had brought to trade directly with the Spanish at Los Adaes, including 25 pounds of ammunition (at two reales per pound) and 30 pounds of gunpowder (at 3 reales per pound). (Galán 2006:275)

1739-1748 The War of Jenkins' Ear broke Spain's obligation to England of allowing unfettered English merchandise to enter New Spain as part of the *asiento* slaving contract. The South Seas Company would formally renounce the *asiento* and the attendant privilege of an annual trade ship in 1750 (Bethell 1985:391, 410-412). See also entry for 1702-1713 above.

1740 Renaut surrendered the royal concession to his lead mines and returned to France shortly thereafter (Caldwell 1941:47). Other researchers have given the date of 1744 (Alvord 1965:209). The output of the mines at this time was estimated at 40,000 pounds annually, with enough produced to supply the western French posts as well as exporting some to Canada and New Orleans (Caldwell 1941:47).

1740 A campaign against the Chickasaw in 1740 called for "9,000 pounds of gun balls, 22 to the pound and 28 to 30 to the pound for the natives" (Kent 2001:191). This would indicate that the larger balls were intended for use in military guns (probably in the musket range) and the less massive balls for use in Indian trade guns.

1740-1751 Ledgers of the Huron mission trading store make references to the trade of ball and shot, heavy shot, dust shot, bulk lead, and a hunting bag with pounds of shot or balls. Entries indicate that lead was sometimes used almost as a currency for goods and services. (Kent 2001:187, 1084)

1740s According to expense bills of the French posts in the Illinois country, lead in this decade was priced rather consistently at about 20 sols per pound (Caldwell 1941:48).

1741 [Apr. 25] Jadart de Beauchamp, a military commander at Mobile, mentions in a report to Maurepas that five boats of voyageurs returning to Canada from the Illinois Country were attacked by either Chickasaws or Cherokees while ascending the Wasbash. This resulted in sixteen French being killed and others taken prisoner. "The boats were laden with peltries, tobacco, flour, a large amount of lead, and, as an additional misfortune, with twelve to fifteen hundred pounds of powder" (Rowland et al. 1984a:182-183).

1741 De Gruy notes that 2,300 pigs of lead were taken from Mine la Motte. (Ekberg 1982:148) This equates to approximately 138,000 to 184,000 pounds of lead based on pigs weighing 60 to 80 pounds each. Hanley (1942:201) uses an average of 70 pounds per pig to arrive at a figure of 161,000 pounds.

1741 The annual yield of the Meramec mines (where Renaut had been active) was estimated at 40,000 pounds of lead per year (Caldwell 1941:47).

1741 Texas Governor Orobio y Bazterra claimed to permit Los Adaes only the allowed trade in corn with the French, while attempting to prevent "the introduction of 'contraband' goods like gunpowder and ammunition." Further, Adaesaños were forbidden to trade with anyone from Natchitoches. (Galán 2006:254)

1742 De Gruy notes that 2,228 pigs of lead were taken from Mine la Motte. (Ekberg 1982:148) This equates to approximately 133,680 to 178,240 pounds of lead based on pigs weighing 60 to 80 pounds each. Hanley (1942:201) uses an average of 70 pounds per pig to arrive at a figure of 155,960 pounds.

1742-1743 Two existing records for Pierre Messager, a miner at the Meramec mines and also a merchant in lead, show his dealings in lead. One of these transactions is for 6,000 pounds (Briggs 1985:294).

1743 The only royal vessel to arrive in Louisiana this year left New Orleans with 30,000 pounds of lead from the Illinois country (Surrey 1916:200-201). It was allowed to be used as ballast on the king's ship by the minister Salmon, with permission granted to continue sending lead this way if there was room for it (Caldwell 1941:47; Hanley 1942:42) This amout would be equivalent to about 375 to 500 pigs of lead of 60 to 80 pounds each. Hoquart, the Intendant of New France, estimated total lead production of the Illinois country in this year to be 75,000 pounds (Caldwell 1941:47).

1743 De Gruy notes in his report of his expeditions that lead from Mine la Motte supplied not only the Illinois country, but also such Canadian posts as Ouiatenon, Missilimakinac, and Detroit. (Ekberg 1982:141)

1743 [July 21] Vaudreuil, Governor of Lousiana, wrote to Salmon and Maurepas regarding the stiff competition in trade posed by the English and their firearms of superior quality, but also noted the difficulty of the Indians in acquiring ammunition except from the French:

> "More than this their arms, such as pistols and guns, are much better and more adorned, and the traders give them credit very often and at a better price by more than half than our traders, since they sell for two skins that for which ours demand five for the reason that furs are dearer and more sought after in England than in France, a skin of a male deer being worth five livres in England, while it is worth only two here... It will be objected that it is surprising that these Indians do not restrict themselves to commerce with the English and that they do not abandon the French entirely. That would doubtless happen if the Indians were not obliged to resort to us for powder and lead, which they obtain with great difficulty from the English... the English cannot except with great difficulty and expense furnish them the powder and bullets that they never lack on our side." (Rowland et al. 1984a:208-209; Waselkov 1992:42)

1744 [Feb. 12] Vaudreuil writes to Maurepas to express the dire urgency of receiving additional trade goods to maintain peaceful relations with tribes friendly to the French. The colony was at this time "in total want of munitions of war and of food supplies" (Rowland et al. 1984a:243). He notes also his desire to expand and introduce trade among new tribes:

> "If I had had a greater abundance of trade goods here, I would have put several traders in certain Talapoosa villages... on that side the Indians see few of our trade goods and as what is sent there in the largest quantities is powder and bullets and guns that are usually rather poor – for a thousand that are sent to this colony, five hundred will always be damaged – that convinces them that the French are entirely poor and do not know how to make goods as the English do" (Rowland et al. 1984a:223).

1744-1748 The War of the Austrian Succession erupted, into which France entered as an ally of Spain against England. Shipping to the French colonies during this period was especially hazardous, with more than 300 French vessels captured by the English by the end of the first year of the war. (Surrey 1916:202; Wedel 1981:41)

1744 Fort de Cavagnial (known colloquially as *Fort des Canzés* or *los Canes*) was established as a formal French post on the Missouri River near a village of Kansa Indians, and was operated for apparently nearly 20 years. Annual convoys of supplies were sent to the post from the Illinois Country. (Wedel 1981:41)

1744 30,000 pounds of lead were sent to New Orleans from the Illinois country. (Surrey 1916:303; Willms 1935:29)

1744-1750 There was a general, substantial increase in the amount of guns and ammunition received at New Orleans from France. (Surrey 1916:202-203)

1745 Two ships of the French Crown, *L'Éléphant* and *Chameau*, both carried lead bars from New Orleans for the return voyage to France, but were captured by the English. The lead was to be carried free of charge as ship ballast, and the ships carried 303 and 219 *plaques* (bars) of lead, respectively (Surrey 1916:203-206; Caldwell 1941:48). These same ships also carried a much greater proportion of deer hide bundles (976 and 484 bundles, respectively) as opposed to bison hides (37 and 45 bundles) (Wedel 1981:42).

1746 De Bertet, Commander of the Illinois, received direct orders from the Minister of the Marine to focus energies on agriculture rather than mining: "Although the exploitation of the mines which are found in the Illinois region cannot fail to be of interest, there must not at present be any consideration of undertaking it. There is another object which deserves preference to all else; and this is the culture of the land." (Caldwell 1941:48). The colonists seem to have ignored this decree in large part (Hanley 1942:40-42).

1746 Father Velasco at Los Adaes reported that Texas Governor Garcia "bartered" gunpowder and ammunition in exchange for hides from the Indians, and recommended that these supplies be regulated by having them purchased from the government's monopoly store in Mexico City and shipped to Los Adaes. He even suggested that expenses could be reduced by purchasing powder and ammunition from the French in Louisiana. (Galán 2006:243-244).

1747 At the urging of a Pennsylvania trader, the English provided powder and lead valued at £30 to 40 (pounds sterling) to the tribes around Lake Erie, to curry their favor and prevent them from allying with the French. (Surrey 1916:328)

1747-1748 Lead is noted among the items being sent downriver from the Illinois country to New Orleans (Surrey 1916:203, 293)

1748-1751 Texas Governor Pedro del Barrio engaged in illicit trade with the French at Los Adaes. (Galán 2006:272)

1750 Following the conclusion of the War of Austrian Succession and the impairments to French shipping it had caused, supplies began to arrive at New Orelans much more regularly and in much greater quantities. Governor Vaudreuil wrote to the minister of France, exclaiming "There has come here since the peace such a large quantity of ships that the abundance is beyond all expression", yet he still expressed irritation that more goods suitable to the Indian trade were not being sent. (Wedel 1981:44)

1750 By this date, the English had over one million settlers in their New England colonies, while France had only about 60,000 settlers. (Galán 2006:249)

1750 [Nov. 17] Father Louis Vivier, a Jesuit Missionary, noted in a letter that many mineral deposits, and especially lead, went unworked due to lack of capital, but that enough was produced to supply the entire Illinois Country, the Indians on the Mississippi and Missouri Rivers, and several posts in Canada. (Willms 1935:31)

Post-1750 The lead mines of the Illinois country produced enough lead after 1750 "to supply both the French and Indians there, also to send annual shipments to the frontier posts of New France. The output was incapable of further expansion at this time, because there were in the colony no men with capital willing to invest in such an enterprise." (Surrey 1916:303)

1750-62 The only royal vessel to arrive in Louisiana in 1750 carried supplies of ammunition. Ammunition was also brought by each of the three royal ships arriving in 1751, and by each of the two royal ships that arrived in the years 1752, 1753, and 1754 (however, no guns arrived from France in 1751 [Wedel 1981:47]). No royal vessel arrived in 1755, apparently owing to the stresses attending the onset of of the Seven Years War, and the only merchant vessel arriving in 1755 sank at the mouth of the Mississippi, though its cargo was salvaged. Six vessels left France for New Orleans in 1756 with ammunition as part of their cargo. No vessels at all arrived in 1757. In 1758 two merchant vessels and two royal vessels arrived, but with a severely reduced load of goods from what had been intended. Four vessels left France for Louisiana in 1759, all carrying ammunition and recruits for the army, but one was seized by the English on the outward voyage. A number of ships were sent to both New Orleans and Quebec in 1760, but none appear to have reached their destinations. Meanwhile, an English man-of-war blockaded the entrance to the Mississippi River and cut off all communication with France, but this was removed in late 1760. In 1761 only a single merchant ship arrived. In 1762 a single merchant ship and five royal ships were sent from France. (Surrey 1916:211, 218-223)

1751-1759 The muleteer Juan Antonio Maldonado, who loaded mules for Governor Barrios y Jáuregui, testified that all during the governor's tenure and upon his behalf he had transported [buffalo] hides and furs many times to Natchitoches to sell to the French. He claimed that upon every return trip he had twelve mules loaded with goods, often including guns, ammunition, and gunpowder. He also testified that Barrios y Jáuregui had conducted trade with the Bidais, Tejas, Nabedache, Orcoquisa, Tonkawa, and Yojuanes Indians. Lieutenant Joseph Gonzales, who managed the governor's store at Los Adaes, testified that in one year the governor sold 9,900 buffalo hides to the French, transported to Natchitoches in nine trips. A group of various Caddo tribes, composed of representatives of the Nabidachos, Ais, Adaes, and Bidais, as well as the Orcoquisa, testified that "their sustenance derives from hunting upon which they eat and dress, and it was indispensable that they barter guns, gunpowder, and other necessaries". [Testimony made in 1761 for Governor Martos against the trade transgressions of his predecessor, Gov. Barrios y Jáuregui.] (Galán 2006:317-321)

1751 [Nov.] Governor Barrios y Jáuregui wrote to the viceroy of New Spain to inform of the extensive French trade with the all the Indians of Texas, including muskets and gunpowder. The Spanish were unable to compete with the French due to the expense of transporting trade goods to New Spain. (Galán 2006:276)

1751 or 1752 An undated government indent of items shipped to Illinois includes 6,000 *livres* of lead pellets and 10,000 *livres* of gunpowder sent "for the French in payment for jobs" (Briggs 1985:376). [Briggs has "lbs?" listed as the unit of measure on both items. Apparently the manuscript does not provide units, although livres was probably the understood and implied unit. Also note Briggs may have translated "balls" or "shot" as "pellets". See also entry for 1753 below.]

1752 The 1752 census of the Illinois country, the *Recencement General du Pays des Illinoise*, took stock of people, livestock, and supplies that could be requisitioned in the event of a military emergency. This document records the following amounts of lead and balls present at each settlement, in *livres* (additionally, the figures for gunpowder at each settlement are given in parentheses, and the number of guns in brackets): Kaskaskia, 1,771 (61) [155]; Fort de Chartres, 276 (97) [101]; St. Philippe, 159 (13) [27]; Port du Rocher, 30 (9) [37]; Cahokia, 68 (67) [29]; and St. Genevieve, 7 (3) [14] (Belting 1948:39; Briggs 1985:360-361). This amounts to a total of 2,311 *livres* of lead and balls, 250 *livres* of gunpowder, and 363 guns tallied in the Illinois country.

1752 [Jan. 15] Major Barthelmy Daniel Macarty, Commandant of the Illinois at Fort des Chartres, notes in a letter to Vaudreuil, then Governor of Louisiana (and later of Canada), that Louis Delisle (a trader of the Illinois country) would be allowed to take all the lead and tobacco he could carry to the Miami Post (Fort des Miamis) on the Wabash River. Another trader, Fonblanche, would provide similar supplies to the post at Detroit from provisions procured in Canada (Pease and Johnson 1940:465-466).

1752 [Mar. 27] In another letter from Macarty to Vaudreuil, he writes that de Gruy is expected to

> "transfer to the king's stores twenty thousand of lead, which makes almost the whole sum due. This Monsieur works at great expense, having no negroes, and white labor costing considerably here, which eats up the little profit he might make. Actually he has twenty-five men working at the mine, having undertaken to supply a hundred thousand to the posts of Canada; a very rich vein has been found, since in six weeks a white and a negro have cast it to the value of three thousand livres of silver" (Pease and Johnson 1940:563).

De Gruy owed some 6,000 livres to one of his creditors in New Orleans, Pierre-François Olivier de Vezin (Ekberg 1982:139). The matter of De Gruy's debt, dating back to 1747, received frequent mention in official letters of 1752 and 1753 (Pease and Johnson 1940:338, 464, 562, 601, 626, 773-776, 789). At a price of six sous per livre (see entry immediately below for December, 1752), 20,000 livres of lead (weight) amounts to exactly 6,000 livres in currency. This instance serves as an example of the manner in which lead served as a currency and bartering medium in the cash-strapped French colonies. The value of 3,000 livres of silver mentioned would indicate that 10,000 pounds of lead had been produced in the six week period discussed, again assuming the price of 6 sous per livre. Of De Gruy's apparent contract to supply Canada with 100,000 pounds of lead, Ekberg (1985:156) notes that this figure may have been artificially inflated by Macarty to place the region's economic potential in a favorable light. Such an amount would equate to approximately 1,250 to 1,667 pigs of lead of 60 to 80 pounds apiece, or an average of 1,500 bars.

1752 [Apr. 8] Vaudreuil describes the increasing problem of the English encroachment into French territory and their attempts to cause disorder and discontent among the tribes loyal to the French. He fears an insurrection and makes a plea to Rouille, Minister of the Marine, for shipments of lead from France:

> "...much in the way of munitions of war and arms are necessary as well as a larger quantity of trade goods to use as is customary in making the tribes act. Otherwise one cannot count on them, and accordingly I am persuaded, Monseigneur, that you will be good enough to provide for this by giving your orders in consequence at the port of Rochefort. There in last year's supply trade guns and bullets were forgotten, which are the most essential articles for presents to the Indians who have been supplied with bad arms which I have bought from the traders and with lead in grain and bulk from the king's storehouse which has been cast into the necessary bullets. The colony indeed is entirely stripped of these two articles to such a point that the enterprise which the Choctaw have considered undertaking against the Chickasaw this spring cannot possibly have all the success which I had reason to expect of it... I persuade myself that you will be good enough to pay attention to my remonstrances on this point as it is moreover of infinite consequence that the Illinois country should not be exposed to lack of munitions of war at a time so critical as that of the revolutions which are to be feared there. M. de Macarty... observes to me that all these revolutions will interrupt the manufacture of lead which was carried on yearly for the consumption

of this country and that he will have to get it from the lower colony, where we are in extreme want of it. I am persuaded, Monseigneur, that you will be good enough to supply this by giving your orders in consequence to the contractors at Rochefort, to send us the additional arms and other munitions of war that I have the honor to ask of you on this occasion by the first ships which leave France" (Pease and Johnson 1940:581-589; Hanley 1942:44 apparently mistakes the date and correspondents involved in this transaction, attributing the letter to Macarty rather than to Vaudreuil, and giving the date as February 1).

1752 [Sep.] Michel, commissary general at New Orleans, wrote that whereas a convoy of two boats had normally been sent annually to the Illinois Country, "now that they carry the goods of other posts along the route, there ascend today two convoys annually with four to five boats in each…" (Wedel 1981:45)

1752 [Oct.] Governor Barrios y Jáuregui again wrote to the viceroy of New Spain about the French trade with the Indians of Texas, and especially with the Hasinai Caddos. (Galán 2006:276)

1752 [Dec.] Macarty writes again to Vaudreuil,

"I have given you an account by M. de Reggio of the richness of Mine à la Motte, where I have been. If the country were peopled and the vein continues there is no doubt that its lead could be sold on the spot at three sous a pound. The greatest difficulty lies in transporting it by land as there are fourteen leagues up and down in the hills. The number of people and wagons necessary to bring it down to the city would double the price, but at six sous lead would not be dear… M. de Gruis has much lead at the mine to send. He hopes to get enough from it to satisfy M. Olivier this fall. He was even beginning to have it wagoned when the roads became impassable with snow and ice. I shall take care that he satisfies his undertaking to M. Olivier. He was on detachment some days after the said Lusignans [a "notoriously dangerous fugitive black slave" (Ekberg 1985:139)] appeared at the mine with some Indians" (Pease and Johnson 1940:773-776, 789).

1753 [Feb.] Don Manuel Antonio de Soto Bermúdez investigated the illicit French trade at Los Adaes and determined that guns and ammunition were in especially high demand among both Indians and Spaniards. (Galán 2006:277)

1753 [Apr.] Governor Barrios y Jáuregui requested permission to trade freely with the Indians such items as gunpowder and ammunition. He proceeded to conduct and monopolize illicit trade with the French and Indians throughout the 1750s, also smuggling goods from French Natchitoches for exchange with the Bidai and Orcoquiza Indians on the lower Trinity and Brazos Rivers. (Galán 2006:245-246)

1753 The French traders Jean Chapuis and Luis Foissy journeyed from the Illinois Country to Santa Fe, trading along the way with the Osages, Missouris, Kansas (among whose villages the French had had residents for eight years), and Pawnees, with whom the French are reported to have already been trading for ten years (John 1975:320-321).

1753 [May 20] Macarty, Commandant of the Illinois, wrote to Rouille (Minister of the Marine),

> "We always hope that Your Greatness will be pleased to send us families to increase the farming of this country as well as salt smugglers to work in the lead mines which are very abundant and supply a part of the posts of Canada and the tribes of that region as well as those here. If workmen were not so expensive, you could even supply this colony and carry on the trade with the Spaniards. The greatest difficulty is transporting it to the river, the mine being fourteen leagues off and those hilly, for there is no want of wood to construct boats to carry it down to New Orleans. Lead sells here at six sous a pound. If we had a caster of lead in grain, the king could dispense with sending it to this colony as none of it would be more expensive than in France if you wished to allow for the cost of the freight to carry it into these colonies and for its taking the room needed for other things. From the facility with which the posts on the river going down to New Orleans, and from New Orleans in the direction of Mobile could get it, it would save the king the transport of fifteen to twenty thousand pounds to be sent up here or into the posts. This expense would more than pay for a caster independently of the loss en route of lead in grain; and it would procure an article of commerce for the country. I hope, Monseigneur, that you will be good enough to give much attention to this point which is essential for this country" (Pease and Johnson 1940:818-819).

Hanley (1942:35) shows that Mine la Motte is the primary mine under consideration here. She also offers the suggestion that Macarty deliberately understated the value of lead at six sous a pound in order to make his proposition of sending skilled workmen and expanding the production of the mines more attractive (45-46). The "lead in grain" in this passage is interpreted by Briggs (1985:295) as a request for the establishment of a "lead pelleting plant" (i.e., the manufacture of lead balls and shot). According to Briggs, nothing ever came of this plan. [Briggs may have translated "balls" or "shot" as "pellets". See also entry for 1751 or 1752 above.]

1753 [Sep.] The French military commander Joseph Marin records that ten of his men had been sent "to the mine to make musket balls with the sixty Sakis [Sauks] working there" (Murphy 2000:23, 33). (This reference regards lead production in the Upper Mississippi Valley.)

1753-58 Fort Duquesne (modern Pittsburgh, Pennsylvania) was built on the upper Ohio River in 1753, in order to prevent a takeover of the Ohio Valley by the English. It began to be supplied in 1753 by the Illinois country with various staples, including ammunition. The Ohio convoys consisted of 15 to 16 boats that were sent annually from the Illinois country bearing all manner of goods in addition to ammunition. Supplies were also soon sent up the Wabash to the French troops in Canada. As the French and Indian War progressed, and owing to the movement of troops and munitions, these convoys began to be sent twice per year with double the number of boats, in addition to special convoys as needed. Also, after 1755 the frontier posts found it increasingly difficult to receive goods from New France (Quebec and Montreal), so the Illinois country had to provide for troops in these areas as well. (Surrey 1916:47-48, 297-298)

1754-1763 The French and Indian War pitted Britain against France in North America. The corresponding conflict on the European Continent, the Seven Years' War, lasted from 1756-1763.

1754 "New France suffered chronic trade deficits. Typical was the year 1754 when it exported only 1,719,683 livres worth of goods and received 5,202,461 livres worth of imports, for a deficit of 3,482,778 livres. All luxury goods, firearms, ammunition, gunpowder, and wine were imported." (Nester 2000:66)

1754 [ca. Jan] The Council of War and Estates in Mexico City complained that Governor Sandoval did nothing to prevent illicit French trade in Spanish Texas, allowing them to "enter into agreements with the Texas, Nacogdoches, Nazones, and Nadotes Indians" for goods including gunpowder and ammunition. The Spanish royal advisors noted that little could be done, though, considering the lack of Spanish forces and the many treaties that St. Denis held with such groups as the Natchitoches, Texas, and other Caddoan Indians. (Galán 2006:253-255)

1754 [June 23] Kerlérec (Governor of Louisiana) wrote to Rouille (the Minister of the Marine),

> "I am addressing to M. de Macnamara, lieutenant general and commandant at Rochefort, a little packet which I beg him to have forwarded to you by the first occasion which presents itself. You will find in it, Monseigneur, copper ore from the mine which the Sieur de Gruis has discovered in the Illinois and which he is exploiting; he could not do it more slowly than he does on account of the shortage of his labor which consists I believe of one negro. You will also find two samples of copper extracted and purified which seem to me to be good. That officer assures me that it assays 12 1/2 percent and M. de Macarty assures me of the same, the assays having been made in his presence. Father de Guyenne, the Jesuit, and the other missionaries, with the Sieurs de Neyon and Saucier were also present at the assay in question. The Sieur de Gruis is asking an exclusive privilege for the exploitation of this mine; but he hopes at the same time that the king will advance him some negroes for

which he will soon pay, putting himself in a situation to buy others..."
(Pease and Johnson 1940:860)

1754 [Sept. 17] Pierre René Harpain de la Gautrais, a captain of the Illinois country in partnership with de Gruy, wrote to Kerlérec (Governor of Louisiana) and d'Auberville (*ordonnateur*) pleading that a skilled workman or two knowledgable in lead smelting be sent from France along with all proper tools and materials. Especially requested were workmen capable of recognizing the minerals in the vicinity of the La Motte and Meramec mines, along with the other metals that often accompany lead. This was requested so that lead could be furnished to the posts of the Illinois and of Canada at less cost and effort than required in sending it from France. In forwarding his request to Machault (the newly installed Minister of the Marine), Kerlérec and d'Auberville commented that the lead workings yielded up to 60 or 70 percent metal though more was possible, and that "By means of these workmen we will no longer be under the necessity of drawing from France the lead in shot for the consumption of this colony which mounts annually to more than fifty thousand...". Furthermore, they expressed confidence in the ability of Gautrais and de Gruy to supply and distribute all the ammunition necessary for the French posts, and for this reason d'Auberville had entrusted them with the supplies (presumably of ammunition sent from France) for the posts of the upcountry for the following year. (Pease and Johnson 1940:894-900)

1754 [Sep.] Governor Barrios y Jáuregui sent Sergeant Domingo del Río and 25 soldiers from Los Adaes to the mouth of the Trinity River to verify if the French had initiated illegal trade with the Orcoquisas Indians. They reported that they found among the Orcoquisas 17 *fusiles* and 2,000 *piedras* ("rocks" or bullets) (Galán 2006:278-279). In the course of this expedition, the French trader Joseph Blancpain, owner of a trade goods store at Natchitoches, was arrested on October 10, along with his brother, another Frenchman, and "two black men". His trade goods were confiscated and routed by Jáuregui "through Presidio San Xavier de Gigedo... and distributed among the auxiliary troops as plunder." Blancpain was imprisoned for four months in Texas and then sent to prison in Mexico City. In February, 1755 he testified that he had been given permission for his trading expedition by Kerlérec, Governor of Louisiana. While he had given presents to Bidais and Orcoquisas chiefs (including five or six guns, some gunpowder and ammunition), he insisted that he had bartered only among the Atacapas (also living near the mouth of the Trinity River) with whom he had been trading, under license, for 25 years. Among his confiscated goods were 1,000 pounds of ammunition, another 200 pounds of "munitions", four and a half barrels of gunpowder (each weighing 100 pounds), as well as rifles, pistols, and gun parts. Blancpain died in prison in Mexico City in 1755. This event helped fuel the Spanish effort to establish missions and presidios at the mouth of the Trinity, not only to deter illicit French trade in this region, but to prevent Spanish smuggling among the Orcoquisas as well. (Galán 2006:278-287).

1756 [Dec. 12] Kerlérec, Governor of Louisiana, wrote to Machault, Minister of the Marine in Paris:

> "All my letters are filled with representations about the needs of this colony. They are today more pressing than ever. The King's warehouses are stripped of *limbourg* and other goods necessary for the presents and the trade with the Indians, and we do not find any at our merchants' any longer. This situation is the more critical, my lord, because according to the news that I receive from the Alabamas and from Mobile our Indians are complaining every day about our delay in furnishing them their ordinary needs... I must warn you that the longer we delay in making this nation a present, which it claims openly, and in supplying it abundantly with its needs... the more we must also fear some rebellion and treachery on its part. It is therefore very important that we receive as quickly as possible supplies of goods and powder for war, otherwise there is everything to fear for the colony" (Rowland et al. 1984b:179).

Already by this time, many of the goods received were diverted to the needs of the ongoing French and Indian War (Wedel 1981:48).

1756, 1760, and 1761 Records indicate that the French garrison at Fort Toulouse (also known as the Alabama Post) received gunpowder and lead balls from Mobile in every month of these years, for use in the Indian trade upon which the soldiers of the Post depended for their subsistence (Waselkov 1992:38). See also entry for 1729, above.

1757 The Castor Vein, or Beaver Mine, in the vicinity of Mine La Motte (between the St. Francis River and Castor Creek) was discovered and opened by two miners named Toupard and Tussain and by Nicholas Noël dit La Rose, using two slaves supplied by prominent miner François Vallé. According to the agreement, the use of the slaves entitled Vallé to half the proceeds of the mine over the next many years. (Hanley 1942:53-55; Willms 1935:31-32)

1757 [Jan. 28] Kerlérec wrote again to Machault:

> "I find myself more and more in the most critical position. We have no more merchandise for the trade with the Indians or for their presents. The nation of the Choctaws is openly grumbling. The Alabamas, who serve as a barrier between the British and us, and all the other different nations of this continent are not contented either... they must have something real if we wish to make them dissatisfied with the English...I have left for this colony only nine thousand [pounds] of powder. I have had the honor to explain to you all the other needs of the colony [including] cannons, gunners and soldiers..." (Rowland et al. 1984b:180; Thomson 1997:133)

1757 [Mar. 13] Kerlérec wrote again to Machault:
"All the King's warehouses are empty. This is the time to deliver the presents to the Choctaws, Alabamas, and other nations, as they all loudly announce... All the warehouses of private persons are also stripped of the things most necessary for the Indians and the needs of the settlers, and the latter do not know how to find a market for their produce. No boat has come to us from France for a long time... We have hardly any gunpowder left. That in brief is the state of the colony, which has everything to fear, especially on the part of the Indians, if we do not receive promptly goods for their presents and their needs" (Rowland et al. 1984b:182; Thomson 1997:133).

1757 [Aug. 28] Kerlérec wrote to Peirène de Moras, Minister of the Marine:
"I have... made known to you our needs, which are becoming more pressing from day to day. Up to the present I have held the Indians back by different pretexts, which are now as exhausted as the resources that we found in the warehouses of private persons. Gunpowder, which is an essential article for the red men, we totally lack, since we have only fifteen hundred pounds left, from which I have to reply to the requests of all the posts" (Rowland et al. 1984b:184).

1758 The Governor of Canada requested half a million lead balls from France, 250,000 apiece of balls sized at 20-22 to the pound (.61-.63 inches in diameter) and 250,000 sized at 28-30 to the pound (.55-.56 inches in diameter). In addition, 6,000 grenadier muskets and 8,000 Tulle hunting guns were requested, with 2,000 of the Tulle hunting guns, lacking bayonets, intended for arming the Indians (Kent 2001:191). Jay C. Blaine surmised that the smaller balls (.55-.56 inches) were intended for use with fowling pieces included in the same requisition. Allowing for a windage of 0.02 to 0.04 inches to allow for clearance of the patch-wrapped ball within the bore, this implies .58 inch (or about 14.7-14.8 mm) as a typical bore diameter for French trade guns of the period. He also surmised that the larger balls requested (.61-.63 inches, or 15.5-16.0 mm) would indicate use in a gun with a bore diameter of approximately .65 inches (or 16.5 mm), with such measurements beginning to approach the bore sizes of some eighteenth century military guns. (Miroir et al. 1973:155-158)

1758 [May] The Montreal outfitters Moniére and Brouillard supplied the Detroit trader Jean Chapron 16.5 pounds of lead, as well as 400 pounds of gunpowder in seven kegs, an additional 5 pounds of gunpowder, and 2 bags for the powder and lead. (Kent 2001:1079)
**note to above entry: note small amount of lead in this large invoice compared to quantity of gunpowder purchased – 16.5 vs. 400 pounds (7 kegs worth of gunpowder)

1758 [Dec. 12] Kerlérec, Governor of Louisiana, provides comments relating to both the shipment and scarcity of ammunition near the start of the Seven Years' War in a general accounting of the tribes about Fort de Chartres:

> "The course of the Ohio or Beautiful River has been well known from the post of the Illinois only since [the beginning of] this last war. It is from this post that all the food supplies have departed for Fort Duquesne and from which since [the beginning of] the war a convoy of fifteen or sixteen boats annually departs more or less loaded with flour, biscuits, corn, oil, tallow, bacon and tobacco, salt, and lead in [the form of] bullets, and other products necessary both for the French who are there and for the Indians who surround them" (Rowland et al. 1984b:208-209).

Writing on the difficulties encountered in presenting the Choctaws with their annual suite of presents, he noted: "We have seen ourselves for some time not provided with powder and bullets, which are the attractive items for the Indians, without taking into consideration the fact that they are the safety of the colony. This situation is unique and had never yet happened" (Rowland et al. 1984b:221).

1758-1760 While embroiled in the Seven Years' War, Louisiana apparently acquired some lead from the Spanish at Veracruz. "On August 28, 1758, it is stated that four months had elapsed since a boat had been sent to Vera Cruz for a supply of ammunition and that nothing as yet had been heard from it." The increasing economic turmoil made it difficult to engage in such transactions, though, as the Mexican merchants were reluctant of accepting French credit. (Surrey 1916:406)

1759 A manifest of supplies to be sent from France to Louisiana for the needs of the colony in 1759 includes many articles relating to firearms and ammunition. The request "to supply the warehouses for the various needs of the service" included 300 hundredweight of gunpowder, 20,000 gun flints, 200 quintals of duck shot, 10 quintals of goose shot, 120 quintals of dove shot, 100 quintals of snipe shot, and 60 quintals of smaller shot (making for a total request of 490 quintals of ammunition, or over 50,000 pounds). Additionally requested were 4 ball molds of 18 caliber, 6 molds of 28 caliber, 12 molds of 30 caliber, 12 molds of 32 caliber, 6 assorted lead molds for duck and snipes, and 24 sprue-cutters and shears. Also requested were 600 pounds of white lead and 50 pounds of red lead (for non-ammunition purposes). Very interestingly, the manifest also included a somewhat cryptic entry for "200 [?] of salt making 80,000 weighing 500 pounds of arsenic trisulfide for working lead". Among items listed to be given to the Indians generally as presents and for use in trade (with specific listings for the Choctaw, Cherokee, and the "Alabama, Attacapa, Kickapoo, Mascouten, and Shawnee" collectively) are included large quantities of 30-caliber trade guns, gunpowder, gun flints, and gun worms, although ammunition to be distributed to the Indians is conspicuously missing from the manifest (Rowland et al. 1984b:227-241).

1760 In an attempt to keep illicit trade channels open, Governor Kerlérec wrote to Governor Martos y Navarrete, noting that his predecessor, Barrios y Jáuregui, had "traded all kinds of goods during his governorship to the Tonkakwas, and other Savages, who would have become your enemies without this interesting business", and added that Martos knew the Missions of Ais, Nacogdoches, and Orcoquisas engaged daily in trade with Natchitoches, and that his people carried on commerce "publicly with the Hasinais, Nadacotes, and Nacogdoches." (Galán 2006:293-294)

1760 The French ship *Aurore* was one of six ships loaded in France with relief supplies bound for Montreal, intended for the retaking of Quebec (which had fallen to the British in September, 1759). None of the ordnance or ammunition reached its intended destination. The *Aurore* carried 76 kegs of balls with 200 pounds of balls to a keg, sized at 18 to 22 balls to the pound (Kent 2001:184, 191). The *Aurore* and another ship were captured by the British on the second day out from Bordeaux. The three remaining ships from the original French fleet of six never succeeding in delivering their cargos of munitions, but rather came under British attack and sank in Restigouche Bay of Nova Scotia. One of these, the *Machault*, was partially excavated from 1969-1972. While precise figures are not given, "thousands" of pieces of Rupert shot ranging from 2 to 5 mm were recovered, as well as lead balls of .69 calibre, and 14 larger cast lead balls for use either with swivel guns or as grape or canister shot (Zacharchuk and Waddell 1984:17-19; Bryce 1984:51-55).

1761 [June 8] Kerlérec wrote to Nicolas René Beryer, Minister of the Marine "[I have] almost no more soldiers, and they are naked and are dying of hunger; I have about nine thousand pounds of powder left, nearly six thousand of which are badly damaged and rejected; no more Indian merchandise and no hope at all of getting any…" (Rowland et al. 1984b:272.

1761 Testimony of the muleteer Juan Antonio Maldonado reveals that the Franciscan missionaries at Mission Nacogdoches were actively engaged in illicit trade and smuggling on the Texas-Louisiana border, exchanging hides for lard, gunpowder (4-6 pounds) and ammunition (8-12 pounds) to distribute among the Indians and their immediate missions". Lieutenant Joseph Gonzales also testified that the padres at Mission Nacogdoches and Mission Ais exchanged gunpowder and ammunition for bear grease. (Galán 2006:261-262, 320; John 1975:343)

1765-95 The value of lead at Ste. Genevieve ranged from about 5-15 sols per livre (Ekberg 1985:475).

1766 Daniel Bloüin, owner of Mine la Motte, sold the property to Jean Baptiste Datchurut. Involved in the transaction were 204 lead bars "of ordinary weight", two heaps of lead ore ready for smelting, and fifty bars of lead at the Saline Creek salt works which had been transported that far on the way to Ste. Genevieve (Hanley 1942:50-51).

1766 Philip Pittman, an English military engineer stationed in the Illinois Country following the conclusion of the Seven Years' War, commented on the abundant resources of Ste. Genevieve: "The situation of the village is very convenient... A lead mine, which supplies the whole country with shot, is about fifteen leagues distance." (Norris 1991:134-135)

1766 The viceroy's *fiscal* (state attorney), the Marqués de Aranda, instructed Governor Martos y Navarrette (at Los Adaes) to offer gifts of guns, gunpowder, and ammunition to Orcoquisa chiefs (the captains of the Orcoquisa nation), to win them over after unfounded rumors were spread that St. Denis the younger had urged the Orcoquisa to kill Spanish soldiers and settlers at Presidio San Agustín. (Galán 2006:292, 295-298)

1766 Ten Frenchmen were captured by soldiers from Los Adaes and imprisoned. Confiscated trade goods included six new guns and over 100 pounds of gunpowder. Five were released with the warning that continued trade would result in ten years imprisonment at the Presidio, while trafficking in guns and ammunition would result in torture and execution. (Galán 2006:300-301, 305)

1767 Texas Governor O'Conor (of Los Adaes) wrote to the Spanish viceroy that he felt Los Adaes to be a completely useless garrison that was probably doing more harm to Spanish interests than anything, considering the trade in contraband between the Adaesaños and the Caddo and French merchants, whereby goods ultimately entered the hands of the Norteños and Comanches who were commiting depredations against San Antonio de Béxar. (Galán 2006:304-306)

1768 The viceroy, Marqués de Croix, wrote to the Spanish Governor of Louisiana, Ulloa, that French smugglers were doing great harm by trading weapons and ammuntion to the Apache and Comanche in exchange for deer hides and lard. ["supplying guns and munitions of war to the Apache and Comanche Indians with which they commit many robberies and deaths in the province of Texas."] (Galán 2006:306) The viceroy also wrote to the Governor of Texas, O'Conor, that he had learned from the Governor of New Mexico that the Comanche Indians near that province were well supplied by the Jumano [Wichita] Indians with guns and ammunition. (Galán 2006:307)

1768 [July] A convoy of three bateaux returning to Ste. Genevieve from New Orleans, owned by merchants named Carpentier, Chamard, and Beaulieu, each carried back lead and shot (along with guns and gunpowder) as reflected in their bills of lading. This indicates that lead was still probably imported fairly routinely, with its origin likely in France or England, with much probably intended for the Indian trade. This also demonstrates the ongoing inability of the Mississippi Valley mines to fully satisfy the need for lead on the colonial frontier. (Ekberg 1985:169-172)

1770 According to the production records from several miners, Mine la Motte may have yielded about 78,000 pounds of lead (Hanley 1942:65, 84, 201).

1770 Ste. Genevieve merchant Daniel Fagot shipped four sheets of lead, along with other goods, to New Orleans (Ekberg 1998:228).

1770 After acquiring Louisiana from the French, the Spanish continued the French tradition of making annual presents to the Indians to maintain good relations. In 1770 the Spanish distributed approximately 360 pesos worth of free goods to four Caddoan groups at Natchitoches, including the Upper Kadohadacho ("Gran Cado"), Lower Kadohadacho ("Petit Cados"), Natchitoches, and Yatasi. Perttula (1992:210-211) believes the following figures were probably typical up through 1776. The distribution alloted to the Upper Kadohadacho accounted for 127 pesos of the 360 pesos in value distributed, and among the many goods given were two fusils, 20 pounds of powder, 40 pounds of lead balls, 48 gun worms, and 200 gunflints. The Lower Kadohadacho received half this amount of goods, with the exception of 20 gun worms. The Natchitoches received 8 pounds of lead balls and 4 of powder, while the Yatasi received 12 pounds of lead balls and 6 of powder. Both the Natchitoches and Yatasi received 50 gunflints and 12 worm screws. Similar distributions also took place in this year at Arkansas Post, New Orleans, and St. Louis. (Bolton 1914[1]:132-134; Perttula 1992:210-211; Lee 1998:148).

Twenty or thirty times the overall value of all the goods given as presents was needed annually to sustain the trade with the Kadohadacho for hides, horses, and bear oil. The trader Juan Piseros entered into a contract with Athanase de Mézières to provide the actual trade goods needed for the year. For the Upper Kadohadacho, the contract called for 900 pounds of lead balls (30-32 caliber, or likely, 30-32 to the pound), 400 pounds of French gunpowder, 40 staple fusils of good caliber, 1,000 gunflints, and 12 pounds of copper wire suitable for bracelets or worm screws. The contract amounts for the Lower Kadohadacho were half these amounts, with the exception of 30 staple fusils and four dozen actual worm screws specified. The contract amounts for the Yatasi are generally the same as for the Lower Kadohadocho: 450 pounds of lead balls, 200 pounds of French gunpowder, and 500 gunflints. The quantities that vary for the Yatasi are 15 staple fusils and either 1 or 12 dozen worm screws ("*1d.* of wormscrews"). Contract figures for the Natchitoches trade are not provided. (Bolton 1914[1]:144-145; Perttula 1992:210-211; Lee 1998:149).

1771 François Vallé, the captain of the militia in Ste. Genevieve who also had lead mining interests, had among his cargo of goods shipped to New Orleans 1,800 pounds of lead (Ekberg 1998:229).

1772 600.25 quintals of lead (64,839 pounds) were conveyed down the Mississippi from Ste. Genevieve (Santa Genoveva) to New Orleans (now Nueva Orleans) (Houck 1909[1]:55). A bill of lading shows that the Ste. Genevieve merchant Daniel Fagot shipped 50 sheets of lead, along with other goods, to New Orleans (Ekberg 1985:167; Ekberg 1998:230). Ekberg (1998:230) claims each of the 50 sheets of lead weighed 70 pounds, but the Spanish census for 1772 shows that Fagot's share of lead accounted for 11 of the 600.25 quintals shipped that year, or approximately 1,188 pounds. This would result in an average of about 24 pounds per sheet of lead – far less than the figure of 60-80 pounds typically quoted for lead bars.

1772 An account in dispute at Ste. Genevieve shows that 79 lead bars ranged in weight from 57 to 89 pounds, with most weighing 78 pounds (Hanley 1942:217).

1773-1775 Owing to Indian attacks at Mine La Motte, much lead ore which had already been extracted went unsmelted during this year, causing drops in production (Hanley 1942:70).

1773 Only 178 quintals of lead (19,227 pounds) were conveyed down the Mississippi from St. Genevieve to New Orleans (Houck 1909[1]:87). The drop is likely attributable to Osage and Chickasaw aggressions in the mining regions (Ekberg 1985:156). François Vallé (a prominent miner) was entitled to the value of 14,355.5 pounds of bar lead as his half-share of the Castor Vein's production in this year (Hanley 1942:75). This would imply that 28,711 pounds had been produced at this mine alone in 1773. Given the total export for the district given above, it is evident that a substantial amount of lead was either reserved for local consumption, sent elsewhere than New Orleans, or simply not shipped. Also, lead in this year was valued at a little more than 5 sous a pound (Ekberg 1985:151 footnote 45), though the price doubled between 1773 and 1774 due to Indian agressions (Hanley 1942:78).

1774 1,078 quintals of lead (116,445 pounds). were conveyed down the Mississippi from St. Genevieve to New Orleans (Houck 1909[1]:93). Joseph Vallé, son of François Vallé, was killed in an Indian raid on Mine La Motte this year (Hanley 1942:70).

1775 "Cheraquis" [perhaps actually Chickasaw] Indians forced the abandonment of Mine La Motte, and although some lead was produced from other mines, it wasn't sufficient to satisfy regional demands. As a consequence no lead was shipped to New

Orleans in 1775 (Houck 1909[1]:100, Ekberg 1985:156). 28,000 pounds of lead from the Castor Vein were sent to Ste. Genevieve this year, but it was probably urgently needed for local consumption after two poor years of mining and hence not sent downriver (Hanley 1942:85). In a Ste. Genevieve account from this year, 213 pigs of lead from the Castor Vein (the same just mentioned?) were valued at $588 (Espinosa 1938:294). Presuming lead pigs of 70 pounds apiece, this would be equivalent to about 4 cents a pound – a figure which does not seem to make sense in light of the fact that lead was so scarce.

1780s Data on lead production in the Mississippi Valley for this decade is entirely lacking, though production likely increased because of the discovery of Mine à Breton. (Ekberg 1985:157).

1783 In recommendations drawn up by the Spanish for the distribution of annual presents to the friendly tribes in the Province of Texas, guns, gunpowder, and lead balls are among the items to be given as presents. The quantities of lead balls (in pounds) stipulated for the various tribes are given as follows: Tawakoni (72), Taovayas (144), Tonkawa (72), Texas [or Tejas] (36), Bidai (36), Arkokisas/Cocos/Mayeyes (18), and Kichais (18). For each tribe, half the corresponding weight of gunpowder was recommended, and one gun for every 12 pounds of lead balls (except for the latter two tribes, for which 2 guns were recommended). Additionally, friendly chiefs, appointed as *capitánes* or *gobernadores* were to receive for themselves one gun, 4 pounds of powder, and 8 pounds of lead balls. (Perttula 1992:211-213).

1791 327,300 pounds of lead were sent from St. Genevieve to New Orleans. (Houck 1909[1]:327; Ekberg 1985:157 appears to be in error on the figure he states.)

1793 Pierre Dehault Delassus held a contract with the Spanish Intendency to supply the government with 30,000 pounds of lead balls and bars every year for five years. No action was taken, though, and the contract was passed over to his son, Jacques St. Vrain, in 1795. After twelve more years, still no action had been undertaken (Hanley 1942:137, 202-203).

1796 165,000 pounds of lead were sent from St. Genevieve, and 54,000 pounds from New Bourbon, for a total of 219,000 pounds. (Houck 1909[2]:143; Ekberg 1985:157 appears to be in error on the figure he states.)

Late 1790s to early 1800s The cost of transporting lead from Mine á Breton (near the Meramec mines) to Ste. Genevieve was about $7.00 per thousand pounds, and another $7.00 to transport it by boat from Ste. Genevive to New Orleans (Schroeder 2000:348, 352). This accounts for a total added shipping expense for the raw product of 1.4 cents per pound, at a time when lead was valued at only about 5-10 cents per pound (Hanley 1942:196).

1800 438,080 pounds of lead were sent from St. Genevieve to New Orleans. (Houck 1909[2]:414, Ekberg 1985:157) (This figure comes from a foldout chart in Houck with handwritten figures. The correct amount is either 238,080 or 438,080, depending on whether you interpret the first figure from the foldout chart as a 2 or 4.)

1804 216,000 pounds of lead were sent from St. Genevieve and its Districts to New Orleans. (Houck 1909[2]:365-368)

1804 Moses Austin placed the yield of the ten named mines of the southern Missouri lead belt at 596,000 pounds of lead, which along with Dubuque's maximum estimate of 30,000 pounds for the Upper Mississippi Valley makes a total of 626,000 pounds (Hanley 1942:201). Austin also estimated the annual potential of the the Ste. Genevieve lead mines at 730,000 pounds (Ekberg 1985:157).

REFERENCES CITED

Abbot, Larry R.
1988 Frontier Lead Mining in the Upper Mississippi Valley. *Journal of the Iowa Archeological Society* 35:1-15.

Alfonso, S., F. Grousset, L. Massé, and J.-P. Tastet
2001 A European Lead Isotope Signal Recorded from 6000 to 300 Years BP in Coastal Marshes (SW France). *Atmospheric Environment* 35:3595-3605.

Allen, Henry Easton
1939 The Parrilla Expedition to the Red River in 1759. *Southwestern Historical Quarterly* 43:53-71.

Alvarez, Salvador
1994 Agricultural Colonization and Mining Colonization: The Area of Chihuahua During the First Half of the Eighteenth Century. In *In Quest of Mineral Wealth: Aboriginal and Colonial Mining and Metallurgy in Spanish America*, edited by Alan K. Craig and Robert C. West, pp. 171-204. Geoscience and Man Vol. 33. Geoscience Publications, Department of Geography and Anthropology. Louisiana State University Press, Baton Rouge.

Alvord, Clarence Walworth
1965 *The Illinois Country 1673-1818*. Reprinted by Loyala University Press, Chicago, in The American West series, edited by John Francis Bannon. Originally published 1922, Illinois Centennial Publications Vol. 1, Illinois Centennial Commission. A. C. McClurg & Co., Chicago.

Anderson, Dean L.
1991 Variability in Trade at Eighteenth-Century French Outposts. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 218-236. University of Illinois Press, Urbana.

Arribas, Antonio, Jr. and Richard M. Tosdal
1994 Isotopic Composition of Pb in Ore Deposits of the Betic Cordillera, Spain: Origin and Relationship to Other European Deposits. *Economic Geology* 89:1074-1093.

Augustine, Luke Michael
2002 *Lead Isotope Ratios: The Key to Addressing Migration Patterns of European-Americans to Grafton, IL.* Ph.D. dissertation, Loyola University Chicago. University Microfilms, Ann Arbor.

Austin, Robert J., Ronald M. Farquhar, and Karen J. Walker
2000 Isotope Analysis of Galena from Prehistoric Archaeological Sites in South Florida. *Florida Scientist* 63:123-13.

Baker, J., S. Stos, and T. Waight
2006 Lead Isotope Analysis of Archaeological Metals by Multiple-Collector Inductively Couples Plasma Mass Spectrometry. *Archaeometry* 48:45-56.

Bakewell, Peter J.
1971 *Silver Mining and Society in Colonial Mexico, Zacatecas 1546-1700.* Cambridge Latin American Studies No. 15. Cambridge University Press, London.

Bakewell, Peter J.
1986 Mining in Colonial Spanish America. In *The Cambridge History of Latin America.* Volume 2: *Colonial Latin America*, edited by Leslie Bethell, pp. 105-151. Cambridge University Press.

Baron, Sandrine, Jean Carignan, Sarah Laurent, and Alain Ploquin
2006 Medieval Lead Making on Mont-Lozère Massif (Cévennes-France): Tracing Ore Sources Using Pb Isotopes. *Applied Geochemistry* 21:241-252.

Bauxar, J. Joe.
1959 The Historic Period. *Illinois Archaeology.* Illinois Archaeological Survey Bulletin No. 1, edited by Elaine A. Bluhm, pp. 4-58. Illinois Archaeological Survey, Carbondale.

Baxter, M. J.
1999 On the Multivariate Normality of Data Arising from Lead Isotope Fields. *Journal of Archaeological Science* 26:117-124.

Baxter, M. J. and C. C. Beardah
1997 Some Archaeological Applications of Kernel Density Estimates. *Journal of Archaeological Science* 24:347-354.

Baxter, M. J., C. C. Beardah, and S. Westwood
2000 Sample Size and Related Issues in the Analysis of Lead Isotope Data. *Journal of Archaeological Science* 27:973-980.

Bell, Robert E. (Don G. Wyckoff, Susan Vehik, and Michelle Barry, editors)
2004 *Ferdinandina. Biography of a French-Indian Trading Community on the Southern Plains.* R. E. Bell Monographs in Anthropology: No. 3. Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, Norman.

Bell, Robert E., Edward B. Jelks, and William W. Newcomb
1967 *A Pilot Study of Wichita Indian Archeology and Ethnohistory*. Final Report for Grant GS-964, National Science Foundation.

Bell, Robert E. and Tyler Bastian
1967 Preliminary Report Upon Excavations at the Longest Site, Oklahoma. In *A Pilot Study of Wichita Indian Archeology and Ethnohistory*, edited by Robert E. Bell, Edward B. Jelks, and William W. Newcomb, pp. 54-118. Final Report for Grant GS-964, National Science Foundation.

Belting, Natalia Maree
1948 *Kaskaskia Under the French Regime*. Illinois Studies in the Social Sciences, Vol. 29, No. 3. University of Illinois, Urbana.

Bethell, Leslie (editor)
1985 *The Cambridge History of Latin America*. Volume 2: *Colonial Latin America*. Cambridge University Press.

Birk, Douglas A.
1991 French Presence in Minnesota: The View from Site Mo20 near Little Falls. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 237-266. University of Illinois Press, Urbana.

Blaine, Jay C.
1992 A Summary and Discussion of Additional Findings at the Gilbert Site, an Eighteenth-Century Norteno Occupation in Rains County, Texas. *Bulletin of the Texas Archeological Society* 63:175-196.

Blaine, Jay C. and R. King Harris
1967 European Trade Goods: Guns. In *The Gilbert Site: A Norteño Focus Site in Northeastern Texas*, edited by Edward B. Jelks, pp. 33-86. *Bulletin of the Texas Archeological Society* Vol. 37 for 1966.

Bolton, Herbert Eugene
1914 *Athanase de Mézières and the Louisiana-Texas Frontier 1768-1780.* Two volumes. The Arthur H. Clark Company, Cleveland, Ohio.
1915 The Location of La Salle's Colony on the Gulf of Mexico. *Mississippi Valley Historical Review* 2:165-182.

Bonine, Mindy L., Christian T. Hartnett, and Abigail Peyton
2009 *Intensive Cultural Resource and Metal Detector Survey of Portions of the Proposed Farm-to-Market 511 Road Expansion Project, Brownsville, Cameron County, Texas.* SWCA Environmental Consultants, Austin, Texas.

Bouchard, Russel
1977 The Trade Gun in New France, 1690-1760. *The Canadian Journal of Arms Collecting* 15(1):3-12.

Boulle, Pierre H.
1974 Patterns of French Colonial Trade and the Seven Years' War. *Histoire Sociale – Social History* 7:48-86.

Brading, D. A.
1970 Mexican Silver Mining in the Eighteenth Century: The Revival of Zacatecas. *Hispanic American Historical Review* 50:665-681. Reprinted 1997 in *Mines of Silver and Gold in the Americas*, edited by Peter Bakewell, pp. 303-319. Variorum: Hampshire, Great Britain.

Brading, D. A. and Harry E. Cross
1972 Colonial Silver Mining: Mexico and Peru. *The Hispanic American Historical Review* 52:545-579.

Brady, Ellen Mayo
2000 Historical Accounts and Legends Associated with Los Almagres. In *Geology and Historical Mining, Llano Uplift Region, Central Texas*, edited by J. Richard Kyle, pp. 23-32. Austin Geological Society Guidebook 20, Austin, Texas.

Brain, Jeffrey P.
1979 *Tunica Treasure*. Papers of the Peabody Museum, Harvard University, vol. 71. Published jointly by the Peabody Museum, Harvard University, Cambridge, and the Peabody Museum of Salem, Salem, Massachusetts.

Brévart, O., B. Dupre and C. J. Allegre
1982 Metallogenic Provinces and the Remobilization Process Studied by Lead Isotopes; Lead-Zinc Ore Deposits from the Southern Massif Central, France. *Economic Geology* 77:564-575.

Briggs, Winstanley
1985 *The Forgotten Colony: Le Pays des Illinois*. Ph.D. dissertation, University of Chicago. University Microfilms, Ann Arbor.

Brill, Robert H. and J. M. Wampler
1967 Isotope Studies of Ancient Lead. *American Journal of Archaeology* 71:63-77.

Brown, Ian W.
1992 Certain Aspects of French-Indian Interaction in Lower Louisiana. In *Calumet & Fleur-De-Lys: Archaeology of Indian and French Contact in the Midcontinent*, edited by John A. Walthall and Thomas E. Emerson, pp. 17-33. Smithsonian Institution Press, Washington D. C.

Brown, Michael T. and Lori R. Wicker
2000 Discriminant Analysis. In *Handbook of Applied Multivariate Statistics and Mathematical Modeling*, edited by Howard E. A. Tinsley and Steven D. Brown, pp. 209-235. Academic Press, San Diego.

Brumwell, Stephen
2002 *Redcoats: The British Soldier and War in the Americas, 1755-1763*. Cambridge University Press, New York.

Bruseth, James E., Jeffrey J. Durst, Tiffany Osburn, Kathleen Gilmore, Kay Hindes, Nancy Reese, Barbara Meissner and Mike Davis
2004 A Clash of Two Cultures: Presidio La Bahía on the Texas Coast as a Deterrent to French Incursion. *Historical Archaeology* 38(3):78-93.

Bruseth, James E. and Toni S. Turner
2005 *From a Watery Grave: The Discovery and Excavation of La Salle's Shipwreck*, La Belle. Texas A&M University Press, College Station.

Bryce, Douglas
1984 *Weaponry from the* Machault, *an 18th-Century French Frigate*. Studies in Archaeology, Architecture and History, Parks Canada, Ottawa.

Burt, Roger
1969 Lead Production in England and Wales, 1700-1770. *The Economic History Review*, New Series 22:249-268.
1995 The Transformation of the Non-Ferrous Metals Industries in the Seventeenth and Eighteenth Centuries. *The Economic History Review*, New Series 48:23-45.

Caldwell, Norman Ward
1941 *The French in the Mississippi Valley 1740-1750*. Illinois Studies in the Social Sciences Vol. 26 No. 3. University of Illinois Press, Urbana.

Canals, A. and E. Cardellach
1997 Ore Lead and Sulphur Isotope Pattern from the Low-Temperature Veins of the Catalonian Coastal Ranges (NE Spain). *Mineralium Deposita* 32:243-249.

Caran, S. Christopher
2000 The Lost Spanish Silver Mines of Llano County, Texas. *Heritage: A Publication of the Texas Historical Foundation* 18(4):9-15, 35.

Caran, S. Christopher, Joe R. Wallace, and James Stotts
2000 Evidence of Spanish Colonial Mining at the James Stotts Ranch, Llano County, Texas. In *Geology and Historical Mining, Llano Uplift Region, Central Texas*, edited by J. Richard Kyle, pp. 65-74. Austin Geological Society Guidebook 20, Austin, Texas.

Carlson, Arne K.
1996 Lead Isotope Analysis of Human Bone for Addressing Cultural Affinıty: A Case Study from Rocky Mountain House, Alberta. *Journal of Archaeological Science* 23:557-567.

Carlson, Shawn Bonath
1991 *The Search for San Sabá: An Apache Mıssıon on the San Saba River, Menard Couny, Texas*. Archeological Surveys Report No. 9. Archeological Research Laboratory, Texas A&M University, College Station.

Coatsworth, John H.
1986 The Mexican Mining Industry in the Eighteenth Century. In *The Economies of Mexico and Peru During the Late Colonial Period, 1760-1810*, edited by Nils Jacobsen and Hans-Jürgen Puhle, pp. 26-45. Colloquium Verlag, Berlin. Reprinted 1997 in *Mines of Silver and Gold ın the Americas*, edited by Peter Bakewell, pp. 263-282. Variorum: Hampshire, Great Britain.

Couturier, Edith Boorstein
2003 *The Silver King: The Remarkable Lıfe of the Count of Regla in Colonial Mexico*. University of New Mexico Press, Albuquerque.

Cox, Issac Joslin
1905 *The Journeys of Réné Robert Cavilier Sieur de La Salle*. A. S. Barnes & Company, New York.

Cumming, George L., Stephen E. Kesler, and D. Krstıc
1979 Isotopic Composition of Lead in Mexican Mineral Deposits. *Economic Geology* 74:1395-1407.

Curths, Karen
1981 The Routes of French and Spanish Penetration into Oklahoma. *Red River Valley Hıstorical Review* 6:18-30.

Deagan, Kathleen
2007 Elicitıng Contraband through Archaeology: Illicit Trade ın Eighteenth-Century St. Augustine. *Historical Archaeology* 41:98-116.

Doe, Bruce R. and Randall Rohrbaugh
1977 *Lead Isotope Data Bank: 3,458 Samples and Analyses Cited.* United States Department of the Interior Geological Survey, Open-File Report 79-661.

Doe, Bruce R. and Maryse H. Delevaux
1972 Source of Lead in Southeast Missouri Galena Ores. *Economic Geology* 67:409-425.

Drass, Richard R., Stephen M. Perkins, and Susan C. Vehik
2004 Radiocarbon Dates for the Bryson-Paddock Site, 34KA5. *Oklahoma Archeology: Journal of the Oklahoma Anthropological Society* 52(4):26-28.

Dunn, William Edward
1914 The Apache Mission on the San Sabá River: Its Founding and Failure. *Southwestern Historical Quarterly* 17:379-414.
1917 *Spanish and French Rivalry in the Gulf Region of the United States, 1678-1702: The Beginnings of Texas and Pensacola.* University of Texas Bulletin No. 1705, and Studies in History No. 1, Austin.

Ekberg, Carl J.
1982 Antoine Valentin de Gruy: Early Missouri Explorer. *Missouri Historical Review* 76:137-150.
1985 *Colonial Ste. Genevieve.* Patrice Press, Gerald, Missouri.
1998 *French Roots in the Illinois Country: The Mississippi Frontier in Colonial Times.* University of Illinois Press, Chicago.

Ekberg, Carl J., Charles R. Smith, William D. Walters, Jr. and Frederick W. Lange
1981 *A Cultural, Geographical, and Historical Study of the Pine Ford Lake Project Area: Washington, Jefferson, Franklin, and St. Francis Counties, Missouri.* Illinois State University Press, Normal.

Emery, Jason A.
2004 *What Do Tin-Enameled Ceramics Tell Us? Explorations of Socio-Economic Status Through the Archaeological Record in Eighteenth-Century Louisiana: 1700-1790.* Master's thesis, Louisiana State University, Baton Rouge. University Microfilms, Ann Arbor.

Espinosa, J. Manuel
1938 Spanish Louisiana and the West: The Economic Significance of the Ste. Genevieve District. *Missouri Historical Review* 32:287-297.

Farquhar, R. M. and I. R. Fletcher
1980 Lead Isotope Identification of Sources of Galena from Some Prehistoric Indian Sites in Ontario, Canada. *Science*, New Series, Vol. 207, No. 4431:640-643.
1984 The Provenience of Galena from Archaic/Woodland Sites in Northeastern North America: Lead Isotope Evidence. *American Antiquity* 49:774-785.

Farquhar, R. M., J. A. Walthall, and R. G. V. Hancock
1995 18th Century Lead Smelting in Central North America: Evidence from Lead Isotope and INAA Measurements. *Journal of Archaeological Science* 22:639-648.

Flores, Ramón Sánchez
1994 Technology of Mining in Colonial Mexico: Installations, Tools, Artifacts and Machines Used in the Patio Process, Sixteenth to Eighteenth Centuries. In *In Quest of Mineral Wealth: Aboriginal and Colonial Mining and Metallurgy in Spanish America*, edited by Alan K. Craig and Robert C. West, pp. 137-153. Geoscience and Man Vol. 33. Geoscience Publications, Department of Geography and Anthropology. Louisiana State University Press, Baton Rouge.

Forrestal, Peter P.
1935 *Peña's Diary of the Aguayo Expedition*. Preliminary Studies of the Texas Catholic Historical Society, Volume II No. 7. Austin, Texas.

Foster, William C.
1995 *Spanish Expeditions Into Texas, 1689-1768*. University of Texas Press, Austin.

Foster, William C. (editor) and Johanna S. Warren (translator)
1998 *The La Salle Expedition to Texas: The Journal of Henri Joutel, 1684-1687*. Texas State Historical Association, Austin.

Galán, Francis X.
2006 *Last Soldiers, First Pioneers: The Los Adaes Border Community on the Louisiana-Texas Frontier, 1721-1779*. Unpublished Ph.D. dissertation, Southern Methodist University, Dallas, Texas.

Gale, Noel H. and Zofia Stos-Gale
2000 Lead Isotope Analyses Applied to Provenance Studies. In *Modern Analytical Methods in Art and Archaeology*, edited by Enrico Ciliberto and Giuseppe Spoto, pp. 503-584. Chemical Analysis Series, Vol. 155. John Wiley & Sons, New York.

Garner, Richard L.
1988 Long-Term Silver Mining Trends in Spanish America: A Comparative Analysis of Peru and Mexico. *The American Historical Review* 93:898-935.

Garrison, George P.
1900 "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. *The American Historical Review* 5:518-542.

Gibson, Arrell Morgan
1981 Waterways of Oklahoma. *Red River Valley Historical Review* 6:6-17.

Gilmore, Kathleen
1967 *A Documentary and Archeological Investigation of Presidio San Luis de las Amarillas and Mission Santa Cruz de San Sabá, Menard County, Texas: A Preliminary Report.* Report No. 9, Texas State Building Commission, Archeological Program, Austin.
1973 *The Keeran Site: The Probable Site of La Salle's Fort St. Louis in Texas*. Office of the State Archaeologist Reports No. 24, Texas Historical Commission, Austin.
1986 *French-Indian Interaction at an 18th Century Frontier Post: The Roseborough Lake Site, Bowie County, Texas*. Contributions in Archaeology No. 3, Institute of Applied Sciences, North Texas State University, Denton.
1992 French, Spanish, and Indian Interaction in Colonial Texas. *Bulletin of the Texas Archeological Society* 63:123-133.

Gold, Gerald L.
1993 Lead Mining and the Survival and Demise of French in Rural Missouri. In *French America: Mobility, Identity, and Minority Experience Across the Continent*, edited by Dean R. Louder and Eric Waddell, translated by Franklin Philip, pp. 143-155. Louisiana State University Press, Baton Rouge.

Goldhaber, Martin B., Stanley E. Church, Bruce R. Doe, John N. Aleinikoff, Joyce C. Brannon, Frank A. Podosek, Elwin L. Mosier, Cliff D. Taylor, and Carol A. Gent
1995 Lead and Sulphur Isotope Investigation of Paleozoic Sedimentary Rocks from the Southern Midcontinent of the United States: Implications for Paleohydrology and Ore Genesis of the Southeast Missouri Lead Belts. *Economic Geology* 90:1875-1910.

Good, Mary Elizabeth
1972 *Guebert Site: An 18th Century, Historic Kaskaskia Indian Village in Randolph County, Illinois*. Central States Archaeological Societies, Memoir No. 2.

Gregory, Hiram Ford
1973 *Eighteenth Century Caddoan Archaeology: A Study in Models and Interpretation*. Unpublished Ph.D. dissertation, Southern Methodist University, Dallas, Texas.

Gregory, Hiram Ford, George Avery, Aubra L. Lee, and Jay C. Blaine
2004 Presidio Los Adaes: Spanish, French, and Caddoan Interaction on the Northern Frontier. *Historical Archaeology* 38(3):65-77.

Griffith, William Joyce
1954 *The Hasinai Indians of East Texas as Seen by Europeans, 1687-1772*. Middle American Research Institute, Philological and Documentary Studies Vol.2 No. 3. Preprinted from Publication No. 12, pp. 41-168. Tulane University, New Orleans.

Habicht-Mauche, Judith A., Stephen T. Glenn and A. Russell Flegal
2000 Isotopic Tracing of Prehistoric Rio Grande Glaze-Paint Production and Trade. *Journal of Archaeological* Science 27:709-713.

Habicht-Mauche, Judith A., Stephen T. Glenn, Mike P. Schmidt, Rob Franks, Homer Milford and A. Russell Flegal
2002 Stable Lead Isotope Analysis of Rio Grande Glaze Paints and Ores Using ICP-MS: A Comparison of Acid Dissolution and Laser Ablation Techniques. *Journal of Archaeological Science* 29:1043-1053.

Hadley, Diana, Thomas H. Naylor, and Mardith K. Schuetz-Miller (editors)
1997 *The Presidio and Militia on the Northern Frontier of New Spain: A Documentary History. Volume Two, Part Two: The Central Corridor and the Texas Corridor, 1700-1765*. University of Arizona Press, Tucson.

Hadley, Phillip Lance
1975 *Mining and Society in the Santa Eulalia Mining Complex, Chihuahua, Mexico: 1709-1750*. Unpublished Ph.D. dissertation, University of Texas, Austin.

Hagni, Richard D.
1995 The Southeast Missouri Lead District. In *Carbonate-hosted Lead-zinc-fluorite-barite Deposits of North America*, pp. 44-78. Society of Economic Geology, Littleton, Colorado.

Hall, Robert L.
1991 The Archaeology of La Salle's Fort St. Louis on Starved Rock and the Problem of the Newell Fort. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 14-28. University of Illinois Press, Chicago.

Hamilton, T. M.
1960 Some Gun Parts from 18th Century Osage Sites. In *Indian Trade Guns*, edited by T. M. Hamilton. *The Missouri Archaeologist*, 22:120-149.
1980 *Colonial Frontier Guns*. The Fur Press, Chadron, Nebraska.

Hanley, Lucy Elizabeth
1942 *Lead Mining in the Mississippi Valley During the Colonial Period.* Unpublished Master's thesis, Saint Louis University, St. Louis.

Harper, Elizabeth Ann
1953 The Taovayas Indians in Frontier Trade and Diplomacy, 1719 – 1768. *Chronicles of Oklahoma* 31:268-289.

Harris, R. K., Inus Marie Harris, Jay C. Blaine, and Jerrylee Blaine
1965 A Preliminary Archeological and Documentary Study of the Womack Site, Lamar County, Texas. *Bulletin of the Texas Archeological Society* 36:287-363.

Hartley, John D.
1975 *Kaw Reservoir – The Northern Section. Report of Phase IV Research of the General Plan for Investigation of the Archaeological Resources of Kaw Reservoir, North-Central Oklahoma.* Archaeological Site Report No. 30, Oklahoma River Basin Survey. University of Oklahoma Office of Research Administration, Norman, Oklahoma.

Hartley, John D. and A. F. Miller
1977 *Archaeological Investigations at the Bryson-Paddock Site: An Early Contact Period Site on the Southern Plains*. Archaeological Site Report No. 32, Oklahoma River Basin Survey. University of Oklahoma Office of Research Administration, Norman, Oklahoma.

Helper, Mark A.
2000 Geology of the Eastern Llano Uplift. In *Geology and Historical Mining, Llano Uplift Region, Central Texas*, edited by J. Richard Kyle, pp. 33-48. Austin Geological Society Guidebook 20, Austin, Texas.

Heyl, Allen V.
1983 Geologic Characteristics of Three Major Mississippi Valley Districts. In *International Conference on Mississippi Valley Type Lead-Zinc Deposits, Proceedings Volume*, edited by Geza Kisvarsanyi, Sheldon K. Grant, Walden P. Pratt, and John Koenig, pp. 27-60. University of Missouri-Rolla, Rolla.

Heyl, Allen V., M. H. Delevaux, R. E. Zartman, and M. R. Brock.
1966 Isotopic Study of Galenas from the Upper Mississippi Valley, the Illinois-Kentucky, and Some Appalachian Valley Mineral Districts. *Economic Geology* 61:933-961.

Heyl, Allen V., G. P. Landis, and R. E. Zartman
1974 Isotopic Evidence for the Origin of Mississippi Valley-Type Mineral Deposits: A Review. *Economic Geology* 69:992-1006.

Hindes, V. Kay, Mark R. Wolf, Grant D. Hall, Kathleen Gilmore, and Philip A. Dennis
1995 *The Rediscovery of Santa Cruz de San Sabá, A Mission for the Apache in Texas*. San Saba Regional Survey Report No. 1, Archaeology Laboratory, Texas Tech University. Published jointly by the Texas Historical Foundation and Texas Tech University, Lubbock.

Hoffman, M. M.
1930 *Antique Dubuque: 1673-1833*. Dubuque Telegraph-Herald Press, Dubuque, Iowa.

Höhndorf, A. and H. Dill
1986 Lead Isotope Studies of Strata-bound, Vein-type, and Unconformity-related Pb, Sb, and Bi Ore Mineralizations from the Western Edge of the Bohemian Massif (F. R. Germany). *Mineralium Deposita* 21:329-336.

Houck, Louis
1909 *The Spanish Regime in Missouri.* 2 vols. R R. Donnelley & Sons Co., Chicago.

Housh, Todd B. and Fred W. McDowell
2005 Isotope Provinces in Laramide and Mid-Tertiary Igneous Rocks of Northwestern Mexico (Chihuahua and Sonora) and Their Relation to Basement Configuration. In *The Mojave-Sonora Megashear Hypothesis. Development, Assessment, and Alternatives*, edited by T. H. Anderson, J. A. Nourse, J. W. McKee, and M. B. Steiner, pp. 671-692. Geological Society of America Special Paper 393. Geological Society of America, Boulder, Colorado.

Hunter, John Warren
1935 [1905] *Rise and Fall of the Mission San Saba.* Reprinted by J. Marvin Hunter, 1935. Frontier Times, Bandera, Texas.

James, Eric William and Christopher D. Henry
1993a Pb Isotopes of Ore Deposits in Trans-Pecos Texas and Northeastern Chihuahua, Mexico: Basement, Igneous, and Sedimentary Sources of Metals. *Economic Geology* 88:934-947.
1993b Southeastern Extent of the North American Craton in Texas and Northern Chihuahua as Revealed by Pb Isotopes. *Geological Society of America Bulletin* 105:116-126.

James, Eugene LeRoy
1957 *The History of Lead Mining in Southeastern Missouri.* Unpublished Master's thesis, Northeast Missouri State Teachers College, Kirksville, Missouri.

Joel, E. C., J. S. Olin, and M. J. Blackman
1988 Lead Isotope Studies of Spanish, Spanish-Colonial and Mexican Majolica. In *Proceedings of the 26th International Archaeometry Symposium*, edited by R. M. Farquhar, R. G. V. Hancock, and L. A. Pavlish, pp. 188-195. Archaeometry Laboratory, Department of Physics, University of Toronto, Canada.

John, Elizabeth A. H.
1975 *Storms Brewed in Other Men's Worlds: The Confrontation of Indians, Spanish, and French in the Southwest, 1540-1795.* Texas A&M University Press, College Station.
1992 A Case Study in the Interdependence of Archeology and History: The Spanish Fort Sites on the Red River. *Bulletin of the Texas Archeological Society* 63:197-209.

Johnson, Leroy Jr. and Edwad B. Jelks
1958 The Tawakoni-Yscani Village, 1760: A Study in Archeological Site Identification. *The Texas Journal of Science* 10:405-422.

Joutel, Henri
1714 [1968] *A Journal of the Last Voyage Perform'd by Monsr. de la Sale, To The Gulph of Mexico, To find out the Mouth of the Mississippi River [The Last Voyage Perform'd by de la Sale]*. March of America Facsimile Series Number 31. University Microfilms, Inc., Ann Arbor.

Keene, David
1991 Fort de Chartres: Archaeology in the Illinois Country. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 29-41. University of Illinois Press, Urbana.

Kent, Timothy J.
2001 *Ft. Pontchartrain at Detroit: A Guide to the Daily Lives of Fur Trade and Military Personnel, Settlers, and Missionaries at French Posts*. 2 Vols. Silver Fox Enterprises, Ossineke, Michigan.

Kinietz, W. Vernon
1965 *The Indians of the Western Great Lakes, 1615-1760*. University of Michigan Press, Ann Arbor.

Kisvarsanyi, Geza, Sheldon K. Grant, Walden P. Pratt, and John Koenig (editors)
1983 *International Conference on Mississippi Valley Type Lead-Zinc Deposits, Proceedings Volume*. University of Missouri-Rolla, Rolla.

Krahn, L. and A. Baumann
1996 Lead Isotope Systematics of Epigenetic Lead-Zinc Mineralization in the Western Part of the Rheinisches Schiefergebirge, Germany. *Mineralium Deposita* 31:225.237.

Kyle, J. Richard
2000 Metallic Mineral Deposits and Historical Mining in the Llano Region. In *Geology and Historical Mining, Llano Uplift Region, Central Texas*, edited by J. Richard Kyle, pp. 49-64. Austin Geological Society Guidebook 20, Austin, Texas.

Large, D., R. Schaeffer, and A. Höhndorf
1983 Lead Isotope Data from Selected Galena Occurrences in the North Eifel and North Sauerland, Germany. *Mineralium Deposita* 18:235-243.

Lee, Dana Bowker
1998 *A Social History of Caddoan Peoples: Cultural Adaptation and Persistence in a Native American Community*. Unpublished Ph.D. dissertation, University of Oklahoma, Norman.

Leith, Elizabeth A.
2008 European Trade Goods on the Southern Plains: The Bryson-Paddock (34KA5) and Deer Creek (34KA3) Sites. *Plains Anthropologist* 53:551-564.

Lévêque, J. and U. Haack
1993 Pb isotopes of Hydrothermal Ores in the Harz. *Monograph Series on Mineral Deposits* 30:197–210. Society for Geology Applied to Mineral Deposits, Gebrüder Borntraeger, Berlin-Stuttgart.

Lippolt, Hans Joachim, Ulrike Schorn and Robert T. Pidgeon
1983 Genetic Implications of New Lead Isotope Measurements on Schwarzwald Vein and Upper Triassic Sediment Galenas. *Geologische Rundschau* 72:77-104.

Luhr, James F., Christopher D. Henry, Todd B. Housh, J. Jorge Aranda-Gómez and William C. McIntosh
2001 Early Extension and Associated Mafic Alkaic Volcanism from the Southern Basin and Range Province: Geology and Petrology of the Rodeo and Nazas Fields, Durango, Mexico. *Geological Society of America Bulletin* 113:760-773.

McDowell, Fred W., Todd B. Housh, and David A. Wark
1999 Nature of the Crust Beneath West-Central Chihuahua, Mexico, Based Upon Sr, Nd, and Pb Isotopic Compositions at the Tomóchic Volcanic Center. *Geological Society of America Bulletin* 111:823-830.

McMillan, Nancy J., Alan P. Dickin and David Haag
2000 Evolution of Magma Source Regions in the Rio Grande Rift, Southern New Mexico. *Geological Society of America Bulletin* 112:1582-1593.

McWilliams, Jennifer K.
2001 *Material Culture and Mission Inventories. A Comparison of Archaeological and Archival Data from the Mission Santa Cruz de San Sabá, Menard County, Texas.* Unpublished Master's thesis, Texas Tech University, Lubbock.

McWilliams, Jennifer K. and Douglas K. Boyd
2007 *Interim Report on Archeological Data Recovery of the Southern Portion of Mission Santa Cruz de San Sabá (41MN23) in the FM 2092 Right of Way, Menard County, Texas*. Prewitt and Associates, Inc., Austin, Texas.
2008 *Historical Assessment and Archeological Survey of 4.9 Miles of FM 2092 from Menard to Fivemile Crossing, Menard County, Texas*. Texas Department of Transportation Environmental Affairs Division, Archeological Studies Program, Report No. 103. Reports of Investigations No. 155, Prewitt and Associates, Inc., Austin, Texas.

Mango, Helen, Half Zantop, and Naomi Oreskes
1991 A Fluid Inclusion and Isotope Study of the Rayas Ag-Au-Cu-Pb-Zn Mine, Guanajuato, Mexico. *Economic Geology* 86:1554-1561.

Marcoux, Eric
1998 Lead Isotope Systematics of the Giant Massive Sulphide Deposits in the Iberian Pyrite Belt. *Mineralium Deposita* 33:45-58.

Marcoux, Eric and Hubert Bril
1986 Héritage et Sources des Métaux d'Après la Géochimie Isotopique du Plomb. *Mineralium Deposita* 21:35-43.

Martin, Terrance J.
2004 Subsistence Under Siege: Animal Remains from 11ML6, the Suspected Site of the 1730 Mesquakie Fort. In *An Upper Great Lakes Archaeological Odyssey: Essays in Honor of Charles E. Cleland*, edited by William A. Lovis and Charles E. Cleland, pp. 183-198. Wayne State University Press, Detroit.

Megaw, Peter Kenneth McNeill
1990 *Geology and Geochemistry of the Santa Eulalia Mining District, Chihuahua, Mexico*. Ph.D. dissertation, Department of Geosciences, University of Arizona, Tucson. University Microfilms, Ann Arbor.

Millen, Timothy M., Robert E. Zartman, and Allen V. Heyl
1995 *Lead Isotopes from the Upper Mississippi Valley District – A Regional Perspective*. U.S. Geological Survey Bulletin 2094-B. United States Government Printing Office, Washington D. C.

Millhouse, Phillip
n.d. *A Chronological History of Indian Lead Mining in the Upper Mississippi Valley from 1643 to 1840*. Manuscript on file, Galena Public Library, Galena, Iowa.

Miranda-Gasca, Miguel Ángel, Joaquín Ruiz, Spencer R. Titley, and P. J. Conley
1993 Tectonic Evolution of the Guerrero Terrane, Mexico from Pb-Isotope Data and Base Metal Composition of Ore Deposits. In *Proceedings of the First Circum-Pacific and Circum-Atlantic Terrane Conference*, edited by F. Ortega-Gutierrez, pp. 86-97.

Miroir, M. P., R. King Harris, Jay C. Blaine, and Janson McVay
1973 Bénard de la Harpe and the Nassonite Post. *Bulletin of the Texas Archeological Society* 44:113-167.

Monna, F., K. Hamer, J. Lévêque, and M. Sauer
2000 Pb Isotopes as a Reliable Marker of Early Mining and Smelting in the Northern Harz Province (Lower Saxony, Germany). *Journal of Geochemical Exploration* 68:201-210.

Murphy, Lucy Eldersveld
2000 *A Gathering of Rivers: Indians, Métis, and Mining in the Western Great Lakes, 1737-1832*. University of Nebraska Press, Lincoln.

Nathan, Paul D. (translator) and Lesley Byrd Simpson (editor).
1959 *The San Sabá Papers: A Documentary Account of the Founding and Destruction of San Sabá Mission*. John Howell Books, San Francisco, California.

National Institute of Standards and Technology
1991 Certificate of Analysis, Standard Reference Material 981. Electronic document, https://www-s.nist.gov/srmors/certificates/view_cert2pdf.cfm?certificate=981, accessed September 23, 2009.
2004 Certificate of Analysis, Standard Reference Material 982. Electronic document, https://www-s.nist.gov/srmors/certificates/view_cert2pdf.cfm?certificate=982, accessed September 23, 2009.

Nef, John U.
1941a Industrial Europe at the Time of the Reformation (ca. 1515 – ca. 1540). *The Journal of Political Economy* 49:1-40.
1941b Silver Production in Central Europe, 1450-1618. *The Journal of Political Economy* 49:575-591.

Nester, William R.
2000 *The Great Frontier War: Britain, France, and the Imperial Struggle for North America, 1607-1755*. Praeger Publishers, Westport, Connecticut.

Newcomb, William W., Jr.
1993 Historic Indians of Central Texas. *Bulletin of the Texas Archeological Society* 64:1-63.

Newcomb, William W. and W. T. Field
1967 An Ethnohistoric Investigation of the Wichita Indians in the Southern Plains. In *A Pilot Study of Wichita Indian Archeology and Ethnohistory*, edited by Robert E. Bell, Edward B. Jelks, and William W. Newcomb, pp. 240-395. Final Report for Grant GS-964, National Science Foundation.

Niederschlag, E., E. Pernicka, Th. Seifert, and M. Bartelheim
2003 The Determination of Lead Isotope Ratios by Multiple Collector ICP-MS: A Case Study of Early Bronze Age Artefatcs and Their Possible Relation with Ore Deposits of the Erzgebirge. *Archaeometry* 45:61-100.

Norment, Aaron R.
2007 *An Examination and Analysis of the Metal Artifacts from Presidio San Sabá (41MN1), Menard County, Texas*. Unpublished Master's thesis, Texas Tech University, Lubbock.

Norris, F. Terry
1991 Ste. Genevieve, a French Colonial Village in the Illinois Valley. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 133-148. University of Illinois Press, Urbana.

Nriagu, Jerome O.
1998 Tales Told in Lead. *Science*, New Series, 281:1622-1623.

Odell, George H.
2002 *La Harpe's Post: A Tale of French-Wichita Contact on the Eastern Plains*. The Alabama University Press, Tuscaloosa.
2008 Interpreting Wichita Lifeways at the Cusp of Contact. *Plains Anthropologist* 53:471-486.

Parkerson, Codman
1974 *A Brief History of Bullet Moulds*. Pioneer Press Publishing Company, Nashville, Tennessee.

Pease, Theodore Calvin and Ernestine Johnson
1940 *Illinois on the Eve of the Seven Years' War, 1747-1755*. Collections of the Illinois State Historical Library Volume 29, French Series Volume 3. Illinois State Historical Library, Springfield.

Perkins, Stephen M. and Timothy G. Baugh
2008 Protohistory and the Wichita. *Plains Anthropologist* 53:381-394.

Perkins, Stephen M., Susan C. Vehik, and Richard R. Drass
2008 The Hide Trade and Wichita Social Organization: An Assessment of Ethnological Hypotheses Concerning Polygyny. *Plains Anthropologist* 53:431-444.

Perttula, Timothy K.
1992 *The Caddo Nation: Archaeological and Ethnohistoric Perspectives*. University of Texas Press, Austin.

Pomiès, C., A. Cocherie, C. Guerrot, E. Marcoux, and J. Lancelot
1998 Assessment of the Precision and Accuracy of Lead-Isotope Ratios Measured by TIMS for Geochemical Applications: Example of Massive Sulphide Deposits (Rio Tinto, Spain). *Chemical Geology* 144:137-149.

Prieto, Carlos
1973 *Mining in the New World.* McGraw-Hill Book Company, New York.

Probert, Alan.
1969 Bartolomé de Medina: the Patio Process and the Sixteenth Century Silver Crisis. *Journal of the West* 8:90-124. Manhattan, Kansas.

Quaife, Milo Milton
1947 *The Western Country in the 17th Century: The Memoirs of Lamothe Cadillac and Pierre Liette.* The Lakeside Press, R. R. Donnelley & Sons Co., Chicago.

Quimby, George Irving
1966 *Indian Culture and European Trade Goods: The Archaeology of the Historic Period in the Western Great Lakes Region.* University of Wisconsin Press, Madison.

Rabinowitz, Michael B.
2005 Lead Isotopes in Soils Near Five Historic American Lead Smelters and Refineries. *Science of the Total Environment* 346:138-148.

Reinhard, Karl J. and Mohamad Ghazi
1992 Evaluation of Lead Concentrations in 18th-Century Omaha Indian Skeletons Using ICP-MS. *American Journal of Physical Anthropology* 89:183-195.

Ringrose, David R.
1970 Carting in the Hispanic World: An Example of Divergent Development. *The Hispanic American Historical Review* 50:30-51.

Rodríguez-Alegría, Enrique
2002 Indígena Ware: Spain to Valley of Mexico. In *Geochemical Evidence for Long-distance Exchange*, edited by Michael D. Glascock, pp. 13-31. Bergin and Garvey, Westport Connecticut.

Rohl, B. M.
1996 Lead Isotope Data from the Isotrace Laboratory, Oxford: *Archaeometry* Data Base 2, Galena from Britain and Ireland. *Archaeometry* 38:165-180.

Rohrbaugh, C. L.
1982 A Hypothesis for the Origins of the Kichai. In *Pathways to Plains Prehistory: Anthropological Perspectives of Plains Natives and Their Pasts. Papers in Honor of Robert E. Bell*, edited by Don G. Wyckoff and Jack L. Hofman, pp. 51-61. Oklahoma Anthropological Society Memoir No. 3 and The Cross Timbers Heritage Association Contributions No. 1. Oklahoma City.

Ross, Lester A.
1983 *Archaeological Metrology. English, French, American and Canadian Systems of Weights and Measures for North American Historical Archaeology*. History and Archaeology No. 68. National Historic Parks and Sites Branch, Parks Canada and Environment Canada, Ottawa.

Rothensteiner, John E.
1926 Earliest History of Mine La Motte. *Missouri Historical Review* 20(2):199-213.

Rowland, Dunbar, Albert G. Sanders, and Patricia Kay Galloway
1984a *Mississippi Provincial Archives: French Dominion, 1729-1748*. Vol. 4. Louisiana State University Press, Baton Rouge.
1984b *Mississippi Provincial Archives: French Dominion, 1749-1763*. Vol. 5. Louisiana State University Press, Baton Rouge.

Russell, R. D. and Ronald M. Farquhar
1960 *Lead Isotopes in Geology*. Interscience Publishers, New York.

Sánchez-Crispin, Alvaro
1994 The Territorial Organization of Metallic Mining in New Spain. In *In Quest of Mineral Wealth: Aboriginal and Colonial Mining and Metallurgy in Spanish America*, edited by Alan K. Craig and Robert C. West, pp. 155-170. Geoscience and Man Vol. 33. Geoscience Publications, Department of Geography and Anthropology. Louisiana State University Press, Baton Rouge.

Sangster, D. F., P. M. Outridge, and W. J. Davis
2000 Stable Lead Isotope Characteristics of Lead Ore Deposits of Environmental Significance. *Environmental Review* 8:115-147.

Savary des Brûlons, Jacques
1751-55 *The Universal Dictionary of Trade and Commerce*, translated from the French of... Monsieur Savary... with large additions and improvements,... by Malachy Postlethwayt, Esq. Vol. 1. London. Based on information from English Short Title Catalogue. Eighteenth Century Collections Online. Gale Group.

Sayre, E. V., K. A. Yener, and E. C. Joel
1992 Statistical Evaluation of the Presently Accumulated Lead Isotope Data from Anatolia and Surrounding Regions. *Archaeometry* 34:73-105.

Schroeder, Walter A.
2000 *Opening the Ozarks. Historical Geography of the Ste Genevieve District (Missouri), 1760-1830.* Ph.D. dissertation, University of Missouri, Columbia. University Microfilms, Ann Arbor.
2003 The Enduring French Creole Community of Old Mines, Missouri. *Historical Geography* 31:43-54.

Silvy, Antoine
1980 *Letters from North America.* Translated by Ivy Alice Dickson. Mika Publishing Company, Belleville, Ontario.

Sinclair, A. J., J. C. Mocquar, and H. Rouvier
1993 Re-evaluation of Lead Isotopic Data, Southern Massif Central, France. *Mineralium Deposita 28*:122-128.

Smith, Todd F.
2000 *The Wichita Indians: Traders of Texas and the Southern Plains, 1540-1845.* Texas A&M University Press, College Station.
2008 Wichita Locations and Population, 1719-1901. *Plains Anthropologist* 53:407-414.

Stacy, Carl C., Henry M. Miller, and Richard C. Froede
1990 Surface Analysis of a Musket Shot Dated Between 1644 and 1655 Found in Historic St. Mary's City, Maryland. *Journal of Forensic Sciences* 35:753-761.

Steen, Charlie R.
1953 Two Early Historic Sites on the Southern Plains. *Bulletin of the Texas Archeological Society* 24:177-188.

Stos-Gale, Zofia., Noel. H. Gale, J. Houghton, and R. Speakman
1995 Lead Isotope Data from the Isotrace Laboratory, Oxford: *Archaeometry* Data Base 1, Ores from the Western Mediterranean. *Archaeometry* 37:407-415.

Stubbs, Donna L.
2004 Prehistoric Lead Mining in the Dubuque Area. *Journal of the Iowa Archeological Society* 51:9-16.

Sudbury, Byron
1976 Ka-3, The Deer Creek Site: An Eighteenth Century French Contact Site in Kay County, Oklahoma. *Bulletin of the Oklahoma Anthropological Society* 24:1-135.

Surrey, Nancy M. Miller
1916 *The Commerce of Louisiana During the French Regime, 1699-1763*. Studies in History, Economics and Public Law, Vol. 71, No. 1. Columbia University, New York.

Swartzlow, Ruby Johnson
1933 *The Early History of Lead Mining in Missouri*. Unpublished Master's thesis, University of Missouri, Columbia.
1934a The Early History of Lead Mining in Missouri: First Article, Early Development in the Eighteenth Century. *Missouri Historical Review* 28(3):184-194.
1934b The Early History of Lead Mining in Missouri: Second Article, The French Period (1700-1770). *Missouri Historical Review* 28(4):287-295.
1934c The Early History of Lead Mining in Missouri: Third Article, The Spanish Period (1770-1800). *Missouri Historical Review* 29(1):27-34.
1935a The Early History of Lead Mining in Missouri: Fourth Article, The Austin Period (1800-1820). *Missouri Historical Review* 29(2):109-114.
1935b The Early History of Lead Mining in Missouri: Fifth Article, The Austin Period (1800-1820). *Missouri Historical Review* 29(3):195-205.

Tabachnick, Barbara G. and Linda S. Fidell
1996 *Using Multivariate Statistics*. Third edition. Harper Collins College Publishers, New York.

Thibodeau, Allyson M., David J. Killick, J. Ruiz, J. T. Chesley, K. Deagan, J. M. Cruxent, and W. Lyman
2007 The Strange Case of the Earliest Silver Extraction by European Colonists in the New World. *Proceedings of the National Academy of Sciences of the United States of America* 104:3663-3666.

Thompson, Henry C.
1955 *Our Lead Belt Heritage: A Series of Articles*. News-Sun, Flat River, Missouri.

Thomson, Laquita
1997 A Cartographic Adventure: William Bonar in the Creek Nation During the Seven Years' War. In *Proceedings of the 21st Annual Meeting of the French Colonial Historical Society, 1997*, edited by A. J. B. Johnson, pp. 120-140. Michigan State University Press, East Lansing.

Thwaites, Rueben G.
1895 Notes on Early Lead Mining in the Fever River Region. In *Collections of the State Historical Society of Wisconsin*. Vol. 13. State Historical Society of Wisconsin, Madison.
1900 *The Jesuit Reltions and Allied Documents: Travels and Explorations of the Jesuit Missionaries in New France, 1610 – 1791.* Vol. 65. Lower Canada, Mississippi Valley 1696 – 1702. The Burrows Company, Cleveland.
1902 *The French Regime in Wisconsin, 1634-1760.* State Historical Society of Wisconsin, Madison.

Torres-Alvarado, Ignacio S., Surendra P. Verma, and Gerardo Carrasco-Núñez
2000 Compilation of Radiogenic Isotope Data in Mexico and Their Petrogenetic Implications. *Proceedings of the Indian Academy of Sciences (Earth and Planetary Sciences)* 109:67-78.

Trimble, Michael K., Teresita Majewski, Michael J. O'Brien, and Anna L. Price
1991 Frontier Colonization of the Saline Creek Valley. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 165-188. University of Illinois Press, Urbana.

Trincherini, P. R., P. Barbero, P. Quarati, C. Domergue, and L. Long
2001 Where Do the Lead Ingots of the Saintes-Maries-de-la-Mer Wreck Come From? Archaeology Compared with Physics. *Archaeometry* 43:393-406.

Tunnell, Curtis D. and W. W. Newcomb, Jr.
1969 *A Lipan Apache Mission: San Lorenzo de la Santa Cruz, 1762-1771*. Bulletin 14 of the Texas Memorial Museum, Austin.

University of Texas Department of Geological Sciences
2009 Isotope Geochemistry Facilities. Electronic document, http://www.geo.utexas.edu/isochem/default.htm, accessed September 23, 2009.

Urbanus, Jason
2008 Harvard Reconnects with Its Native American Past. *Archaeology Magazine* March/April 2008:33-35.

Usner, Daniel H., Jr.
1985 The Deerskin Trade in French Louisiana. In *Proceedings of the Tenth Meeting of the French Colonial Historical Society, 1984*, edited by Philip P. Boucher, pp. 75-93. University Press of America, Lanham, Maryland.
1987 The Frontier Exchange Economy of the Lower Mississippi Valley in the Eighteenth Century. *The William and Mary Quarterly* 44:166-192.

Velasco F., A. Pesquera, and J. M. Herrero
1996 Lead Isotope Study of Zn-Pb Ore Deposits Associated with the Basque-Cantabrian Basin and Paleozoic Basement, Northern Spain. *Mineralium Deposita* 31:84-92.

Verma, Surendra P., Ignacio S. Torres-Alvarado, Muharrem Satir, and Patrick F. Dobson
2005 Hydrothermal Alteration Effects in Geochemistry and Sr, Nd, Pb, and O Isotopes of Magmas from the Los Azufres Geothermal Field (Mexico): A Statistical Approach. *Geochemical Journal* 39:141-163.

Wade, Mariah F.
2003 *The Native Americans of the Texas Edwards Plateau, 1582-1799*. University of Texas Press, Austin.
2007 *Spanish Colonial Documents Pertaining to Mission Santa Cruz de San Sabá (41MN23), Menard County Texas*. Texas Department of Transportation Environmental Affairs Division, Archeological Studies Program, Report No. 102. Reports of Investigations No. 154, Prewitt and Associates, Inc., Austin, Texas.

Walter, Tamra
2004 The Archaeology of Presidio San Sabá: A Preliminary Report. *Historical Archaeology* 38(3):94-105.

Walter, Tamra L., Elizabeth A. Cooper, Nancy Zayatz and Grant D. Hall
2003 *The Ruin of Ruins: Archaeological Excavations at Presidio San Sabá, 41MN1, Menard County, Texas, 2000-2002 Field Seasons*. San Saba Regional Survey Report 2, Texas Tech University Archaeology Laboratory, Lubbock.

Walthall, John A.
1981 *Galena and Aboriginal Trade in Eastern North America*. Scientific Papers, Vol. XVII, Illinois State Museum, Springfield.

Walthall, John A. and Thomas E. Emerson
1991 French Colonial Archaeology. In *French Colonial Archaeology: The Illinois Country and the Western Great Lakes*, edited by John A. Walthall, pp. 1-13. University of Illinois Press, Urbana.
1992 Indians and French in the Midcontinent. In *Calumet & Fleur-De-Lys: Archaeology of Indian and French Contact in the Midcontinent*, edited by John A. Walthall and Thomas E. Emerson, pp. 1-13. Smithsonian Institution Press, Washington D. C.

Walthall, John A., Stephen H. Stow and Marvin J. Karson
1979 Ohio Hopewell Trade: Galena Procurement and Exchange. In *Hopewell Archaeology*, edited by David S. Brose and N. M. B. Greber, pp. 247-250. Kent State University Press, Kent, Ohio.
1980 Copena Galena: Source Identification and Analysis. *American Antiquity* 45:21-42.

Waselkov, Gregory A.
1992 French Colonial Trade in the Upper Creek Country. In *Calumet & Fleur-De-Lys: Archaeology of Indian and French Contact in the Midcontinent*, edited by John A. Walthall and Thomas E. Emerson, pp. 35-53. Smithsonian Institution Press, Washington D. C.

Weddle, Robert S.
1964 *The San Sabá Mission: Spanish Pivot in Texas*. University of Texas Press, Austin.
1968 *San Juan Bautista: Gateway to Spanish Texas*. University of Texas Press, Austin.
1973 *Wilderness Manhunt: The Spanish Search for La Salle*. University of Texas Press, Austin.
1987 *La Salle, the Mississippi, and the Gulf: Three Primary Documents*. Texas A&M University Press, College Station.
1991 *The French Thorn: Rival Explorers in the Spanish Sea, 1682-1762*. Texas A&M University Press, College Station.
2000 Foreword. In *The San Sabá Papers: A Documentary Account of the Founding and Destruction of San Sabá Mission*, edited by Lesley Byrd Simpson, pp. vii-xi. New edition, Southern Methodist University Press, Dallas, Texas.
2001 *The Wreck of the* Belle, *the Ruin of La Salle*. Texas A&M University Press, College Station.
2007 *After the Massacre: The Violent Legacy of the San Sabá Mission*. Texas Tech University Press, Lubbock.

Wedel, Mildred Mott
1971 J.-B. Bénard, Sieur de La Harpe: Visitor to the Wichitas in 1719. *Great Plains Journal* 10:37-70.
1972 Claude-Charles Dutisné: A Review of His 1719 Journeys. *Great Plains Journal* 12:4-25; 146-173.
1978 *La Harpe's 1719 Post on Red River and Nearby Caddo Settlements*. Texas Memorial Museum Bulletin 30, The University of Texas at Austin.
1981 *The Deer Creek Site, Oklahoma: A Wichita Village Sometimes Called Ferdinandina, an Ethnohistorian's View*. Oklahoma Historical Society Series in Anthropology No. 5, Oklahoma City.
1982 The Wichita Indians in the Arkansas Basin. In *Plains Indian Studies: A Collection of Essays in Honor of John C. Ewers and Waldo R. Wedel*, edited by Doug Ubelaker and H. Viola, pp. 118-134. Smithsonian Contributions to Anthropology No. 30. Smithsonian Institution Press, Washington, D.C.

Wedepohl, K. H. and A. Baumann
1997 Isotope Composition of Medieval Lead Glasses Reflecting Early Silver Production in Central Europe. *Mineralium Deposita* 32:292-295.

West, Robert C.
1994 Early Silver Mining in New Spain, 1531-1555. In *In Quest of Mineral Wealth: Aboriginal and Colonial Mining and Metallurgy in Spanish America*, edited by Alan K. Craig and Robert C. West, pp. 119-135. Geoscience and Man Vol. 33. Geoscience Publications, Department of Geography and Anthropology. Louisiana State University Press, Baton Rouge.

Western Historical Company
1880 *The History of Sauk County, Wisconsin*. Western Historical Company, Chicago.

Whitney, Josiah Dwight
1970 [1854] *The Metallic Wealth of the United States Described and Compared with That of Other Countries*. Lippincott, Grambo & Co., Philadelphia. 1970 reprint. ARNO and the New York Times, New York.

Wiegers, Robert Paul
1985 *Osage Culture Change Inferred from Contact and Trade with the Caddo and the Pawnee*. Ph.D. dissertation, University of Missouri-Columbia. University Microfilms, Ann Arbor.

Willms, Welton Lyle
1935 *Lead Mining in Missouri 1700-1811*. Unpublished Master's thesis, Washington University, St. Louis.

Works, Martha A.
1992 Creating Trading Places on the New Mexican Frontier. *Geographical Review* 82:268-281.

Young, Otis E.
1970 *Western Mining: An Informal Account of Precious-Metals Prospecting, Placering, Lode Mining, and Milling on the American Frontier from Spanish Times to 1893*. University of Oklahoma Press, Norman.
1994 Black Legends and Silver Mountains: Spanish Mining in Colonial Spanish America Reconsidered. In *In Quest of Mineral Wealth: Aboriginal and Colonial Mining and Metallurgy in Spanish America*, edited by Alan K. Craig and Robert C. West, pp. 109-118. Geoscience and Man Vol. 33. Geoscience Publications, Department of Geography and Anthropology. Louisiana State University Press, Baton Rouge.

Young, Suzanne M. M. and A. Mark Pollard
2000 Atomic Spectroscopy and Spectrometry. In *Modern Analytical Methods in Art and Archaeology*, edited by Enrico Ciliberto and Giuseppe Spoto, pp. 503-584. Chemical Analysis Series, Vol. 155. John Wiley & Sons, New York.

Zacharchuk, Walter and Peter J. A. Waddell
1984 *The Excavation of the* Machault, *an 18th-Century French Frigate*. Studies in Archaeology Architecture and History, Parks Canada, Ottawa.

Zalduegui, J. F. Santos, S. García de Madinabeitia, and J. I. Gil Ibarguchi
2004 A Lead Isotope Database: The Los Pedroches – Alcudia Area (Spain); Implications for Archaeometallurgical Connections Across Southwestern and Southeastern Iberia. *Archaeometry* 46:625-634.

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